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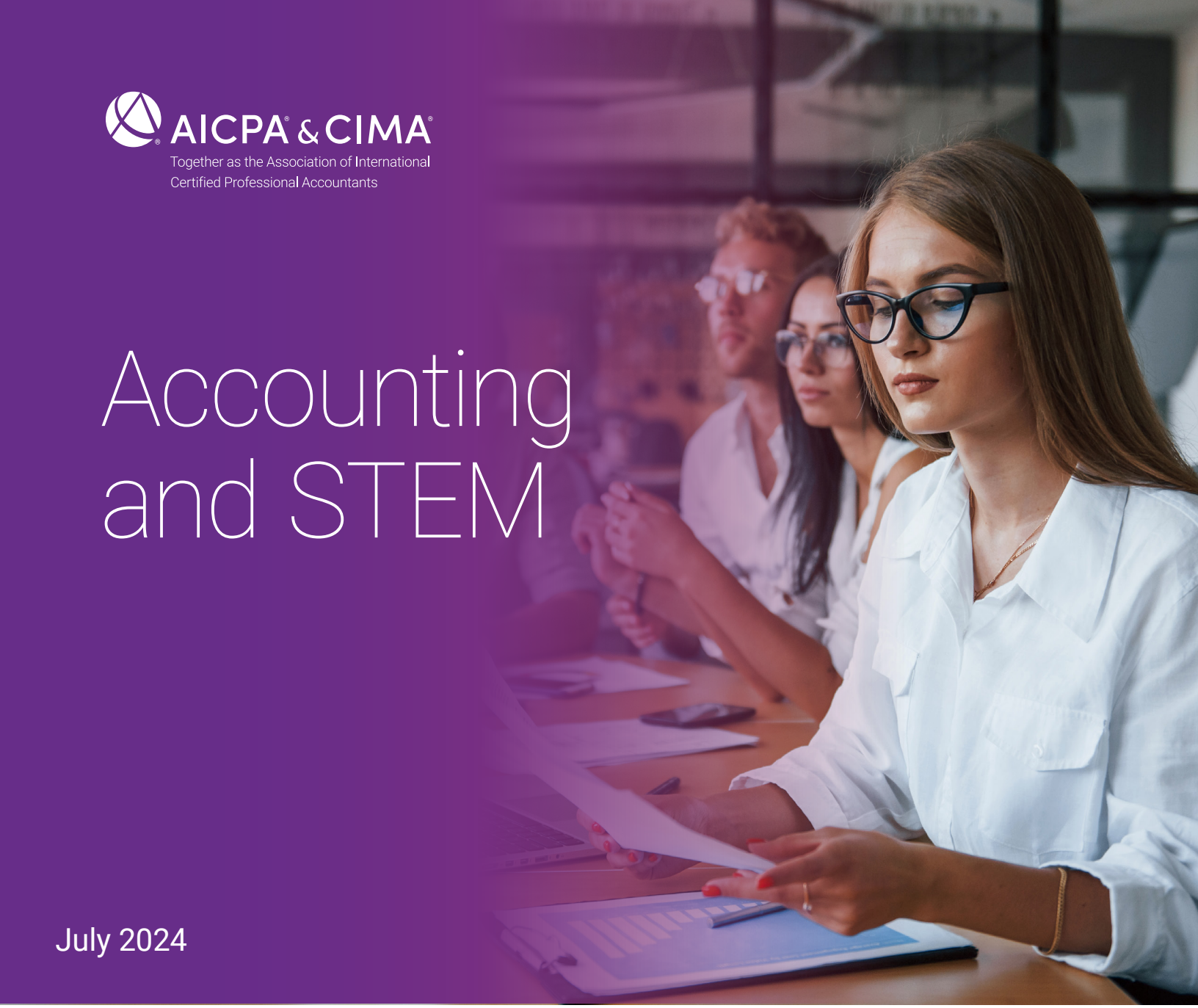
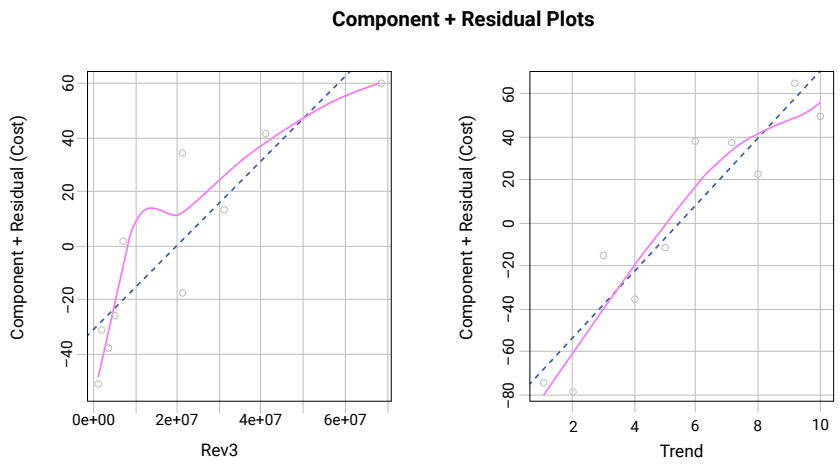
Together as the Association of International Certified Professional Accountants

Accounting and STEM



July 2024



Residual plots produced in R Studio, car package, for teaching linear regression residual analysis in modeling airline operating costs.

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I. Executive Summary

Accounting, at its core, is an information technology for financial performance measurement, reporting, and optimization, paired with risk assessment and management.

Accounting has always incorporated STEM skills into its practice. However, over the past decade, as technology and data have transformed the financial system, it has demanded a significant shift in what skills and knowledge professional accountants use to best serve their clients. Beyond traditional accounting skills in database management, statistics, mathematics, and risk assessment, today's accountants must also be proficient with new and emerging technologies like artificial intelligence (AI), machine learning, data analytics, crypto assets, and blockchain. With such added knowledge, accountants are well-equipped to enhance their capacity to protect the interests of their clients and the capital markets as a whole.

In short, accounting is increasingly and inexorably rooted in the STEM ecosystem. By virtue of their education, licensure and practice, accountants are members of the STEM community.

Accounting Education and STEM

As the financial ecosystem has become deeply integrated with technological advances, accounting schools have responded by updating the competencies and skills accounting students learn.

STEM instruction is not optional but necessary for degree-granting accounting programs to maintain their accreditation. Although U.S. degree-granting accounting programs vary in their precise curricula, a 2024 survey of U.S. accounting schools conducted by AICPA suggests that:

- U.S. accounting programs require at least one course in at least 12 topics widely considered to be STEM.
- The vast majority of accounting programs require coursework in STEM topics.
- The majority of required courses at most accounting programs contain STEM content.

The AICPA study also found that the STEM content of accounting academic programs equals or exceeds that of some programs classified under Classification of Instructions Program (CIP) codes defined as STEM by the Department of Homeland Security (DHS).

Accounting Professional Licensure Requirements and STEM

Accounting graduates who sit for the Uniform CPA Examination must demonstrate facility with multiple STEM disciplines to earn their licenses in every state and territory. Data and technology concepts are woven throughout all sections of the CPA Exam, which covers aspects of IT infrastructure, from platforms and services, to security, confidentiality, and privacy, as well as the foundational skills needed to build and develop technology.

In response to the changes to the CPA Exam, AICPA and the National Association of State Boards of Accountancy (NASBA) have developed the CPA Evolution Model Curriculum, "to assist faculty who want to prepare their students for the CPA profession." The curriculum includes multiple modules and topics that cover STEM content, including financial data analytics and information technology.

Accounting Profession's Use of STEM-Related Research, Innovation, and Technology

As the financial system has embraced new technologies, the accounting profession has taken steps to ensure its practitioners are well-positioned to handle and analyze data in more sophisticated ways. Many public accounting firms have developed patented technologies, including software apps or other analytical tools that allow accountants to better and more quickly perform risk assessments.

Accounting professionals develop software that facilitates financial analytics, financial data processing, knowledge management, data visualization, effective decision communication, statistical inference, and dynamic modeling of financial data.

At the university level, degree-granting accounting programs prioritize original research and innovation initiatives that engage students in solving real-world problems, which provides tangible, ongoing benefits to the U.S. and global financial systems. Faculty and students have published research on blockchain, audit efficacy, and data security. In many degree-granting programs, students use analytical tools such as regression analysis, data analysis techniques, visualization tools, and new technologies to solve case problems. Further, accounting school graduates have gone on to develop apps to improve audit efficiency.

The accounting profession's connection to the development of new technologies is further reflected in the field's deep engagement in the patent system. The Cooperative Patent Classification (CPC) system recognizes the extent to which accounting is driven by innovation and new technologies by including a full section on patent classifications for accounting, as well as other related topics. In addition, a review of patents issued under this subsection reveals numerous patents issued in the last 20 years to accounting firms for their development of new technologies to assist in accounting.

Conclusion

In recent years, the accounting profession has significantly increased its involvement in the development of technology and statistical tools providing better insights into financial performance, optimization, and risk management, leading to increased reliability and trust in the nation's financial system. These shifts underscore the extent to which accounting is a STEM profession that harnesses science, statistics, and technology to maintain the country's competitive edge.

II. Introduction: Accounting and STEM

Accounting and STEM have a long history together. Since the early 1960s, the accounting profession has been deeply involved in the development of information technology and statistical tools — including Bayesian methods — for financial reporting and auditing.[1] Over the last decade or two, the profession has significantly ramped up its development of technological innovation to help businesses manage risk and compete in an expanding, increasingly complex, and data-rich global economy.

As Lawrence A. Gordon, Ph.D., the EY Alumni Professor of Managerial Accounting and Information Assurance at University of Maryland, has noted, "technology is changing the way capital markets operate, the infrastructure underlying capital markets, and how participants in the capital markets interact with each other. Technology is also beginning to change the currency used in capital markets (i.e., recent developments with crypto assets). In essence, technology is changing the very nature of what we call capital markets."[2]

An example of how technology is changing the financial system is the role of data analytics:

> Data analytics is transforming the way contemporary accounting is analyzing, interpreting and reporting information. In fact, the technology associated with data analytics is shifting the focus of contemporary accounting from performing functions like gathering and summarizing data to that of analyzing and interpreting large data sets. In managerial accounting, for example, it is possible to create real-time analyses, interpretations and visualizations of budgets and forecast variances. It is also possible to use a variety of data available on the internet (e.g., macroeconomic forecasts of Gross Domestic Product, Investments, etc.) to enhance forecasting and profit planning models. In addition, it is now possible to audit an entire population, rather than a sample, while at the same time producing a comprehensive visualization of the audit's findings. Reporting of company financial reports are also being drastically changed by the field of data analytics. In fact, one can easily imagine the day when publicly traded corporations will provide a link to the company's financial information on a real-time basis, supported by tables, reports, figures and graphs in the same way stock market information is currently available.[3]

1 *See, e.g.,* Richard Michael Cyert, *Statistical sampling for accounting information* (Prentice-Hall quantitative methods series) 1962; William H. Kraft, Jr., "Statistical Sample for Auditors: A New Look," J. Accountancy, Aug. 1968, pp. 49–56 (proposing a Bayesian approach to dollar-unit-sampling (DUS)); John H. McCray, "A Quasi-Bayesian Audit Risk Model for Dollar Unit Sampling," *The Accounting Review,* Jan. 1984, pp. 35–51 (citing audit firm Haskins and Sells' use of (DUS) by 1970, and "quasi-Bayesian" DUS by 1979).

2 Lawrence A. Gordon, "The Impact of Technology on Contemporary Accounting: An ABCD Perspective," accessed on March 12, 2024, https://networth.rhsmith.umd.edu/sites/default/files/_docs/The%20Impact%20of%20Technology%20on%20Contemporary%20Accounting.pdf.

3 *Ibid.*

Figure 1 is a representation of how a linear regression influence plot was developed to teach accounting students how to identify anomalies in the audit of a company's financial statements.

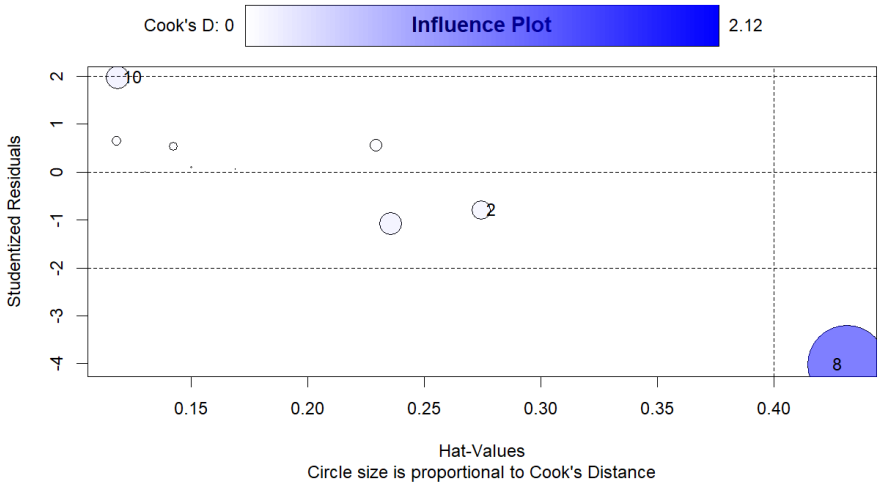


Figure 1 — Linear regression influence plot used to teach anomaly identification in auditing. Produced in R Studio using the car package influencePlot function. Fox J, Weisberg S (2019). An R Companion to Applied Regression, Third edition. Sage, Thousand Oaks CA. https://socialsciences.mcmaster.ca/jfox/Books/Companion/.

Just as technological advances have spurred profound transformations in the financial system, they have driven a rebalancing of the knowledge and skills that professional accountants must deploy on the job. The role of accountants is to provide clients and the general public with accurate, unbiased information that enables market players to make informed economic decisions. This evolving role requires proficiency in technologies that are reshaping the financial system, including AI, machine learning, deep learning, crypto assets and blockchain, and natural language processing.

Recognizing the significant shift in the technology of financial markets, the STEM-related education and training of accountants has adapted. The STEM content incorporated into university accounting programs' curricula embraces an expanding role in research, innovation, and the development of new technologies, including data analytics, machine learning, AI, natural language processing, and statistical modeling. This is true across the range of accounting subdisciplines, from auditing and financial reporting to taxation, accounting information systems, cybersecurity, management accounting, and forensic accounting.

Accredited U.S. accounting education programs are required to deliver significant STEM content, including:

- Information Technology
- Mathematics
- Statistics
- Algebra
- Business Analytics
- Business Statistics
- Computer and Information Systems and Systems Security
- Data Analytics
- Data Modeling and Database Administration
- Data Processing Technology
- Data Visualization

Furthermore, accounting graduates who sit for the Uniform CPA Examination must demonstrate facility with multiple STEM topics to earn their licenses in every state. The accounting profession also has embraced its obligations to advance innovation through the development of new, patentable technologies and cutting-edge research that enables accountants to ensure the fiduciary health of their clients in an increasingly complex financial system.

Together, these generational shifts demonstrate that the accounting profession is a key component of the nation's efforts to build and maintain a STEM-educated workforce.

III. Federal STEM Definitions and Accounting

There currently does not exist a single, uniform definition of "STEM discipline." As the Congressional Research Service notes, "The lack of a common definition for STEM has contributed to confusion, and even contradictory findings, in federal agency, academic, and nonprofit research on the condition of the U.S. STEM workforce and labor supply."[4]

As a result, federal agencies have taken vastly different approaches to defining the scope of STEM education.

Statutory Definitions of STEM Offer Wide Leeway to Agencies in How They Define STEM Subjects.

Congress has written a number of definitions of STEM into U.S. law. The one most cited by other statutes is codified at 42 U.S. Code (USC) Section 18901(27) as "science, technology, engineering, and mathematics, including computer science." 33 USC Section 893a, applicable to National Oceanic and Atmospheric Administration programs mostly agrees, though excluding computer science.

For some National Science Foundation programs, 42 USC 1862i(j)(8) includes cybersecurity. In all cases, it appears that Congress has provided wide discretion to federal agencies in applying statutory definitions of STEM to specific educational fields.

STEM Job Classification by the Federal Government

The Department of Labor maintains the Standard Occupational Classification (SOC), a "federal statistical standard used by federal agencies to classify workers into occupational categories for the purpose of collecting, calculating, or disseminating data." The SOC classifies all workers into one of 867 detailed occupations according to their occupational definition.

In 2018, the Occupational Employment and Wage Statistics (OEWS) program in the Bureau of Labor Statistics (BLS) identified SOC occupations it considers to be STEM fields.[5]

Although OEWS does not currently include accounting (SOC code 13-2011) in its STEM framework, the SOC definition of accounting, which has not been updated since at least 2000, fails to reflect the evolving skillsets and knowledge requirements that accountants currently possess.

4 "Science, Technology, Engineering, and Mathematics (STEM) Education: An Overview," Congressional Research Service, Updated June 12, 2018, https://files.eric.ed.gov/fulltext/ED593605.pdf.

5 "List of occupations used in OES STEM," Bureau of Labor Statistics, Accessed March 12, 2024, https://www.bls.gov/oes/stem_list.xlsx.

In fact, accounting today incorporates multiple aspects of occupations that BLS defines as STEM, including the following SOC codes:

Table 1: SOC Codes Defined as STEM Similar to Accounting	
15-2051 Data Scientists	Develop and implement a set of techniques or analytics applications to transform raw data into meaningful information using data-oriented programming languages and visualization software. Apply data mining, data modeling, natural language processing, and machine learning to extract and analyze information from large structured and unstructured datasets. Visualize, interpret, and report data findings. May create dynamic data reports.
15-2041 Statisticians	Develop or apply mathematical or statistical theory and methods to collect, organize, interpret, and summarize numerical data to provide usable information. May specialize in fields such as biostatistics, agricultural statistics, business statistics, or economic statistics. Includes mathematical and survey statisticians.
15-2031 Operations Research Analysts	Formulate and apply mathematical modeling and other optimizing methods to develop and interpret information that assists management with decision-making, policy formulation, or other managerial functions. May collect and analyze data and develop decision support software, services, or products. May develop and supply optimal time, cost, or logistics networks for program evaluation, review, or implementation.
15-1252 Software Developers	Research, design, and develop computer and network software or specialized utility programs. Analyze user needs and develop software solutions, applying principles and techniques of computer science, engineering, and mathematical analysis. Update software or enhance existing software capabilities. May work with computer hardware engineers to integrate hardware and software systems and develop specifications and performance requirements. May maintain databases within an application area, working individually or coordinating database development as part of a team.
11-3021 Computer and Information Systems Managers	Plan, direct, or coordinate activities in such fields as electronic data processing, information systems, systems analysis, and computer programming.

It would be logically consistent to treat accounting as STEM, given that accounting practitioners routinely engage in the very same tasks and possess the same knowledge base as the occupations listed above.

STEM Educational Classification by the Federal Government

The primary federal government vehicle for categorizing educational fields of study is the Department of Education's Classification of Instructional Programs (CIP) coding system, which "provides a taxonomic scheme that supports the accurate tracking and reporting of fields of study and program completions activity."[6]

The Department of Education does not identify which CIP codes qualify as STEM topics. However, the U.S. DHS establishes and maintains a list of CIP codes on its Designated Degree program for the optional practical training extension for F-1 students with STEM degrees.[7]

As further sections of this white paper show, degree-granting programs that are designated under the CIP code for accounting (52.0301) have as much, if not more, STEM-related content than similar degree-granting programs that are designated under CIP codes that DHS defines as STEM. (See Section IV.)

6 "The Classification of Instructional Programs," National Center for Education Statistics, accessed June 9, 2024, https://nces.ed.gov/ipeds/cipcode/Default.aspx?y=56.

7 "DHS STEM Designated Degree Program List," U.S. Immigrations and Customs Enforcement, July 12, 2023, https://www.ice.gov/doclib/sevis/pdf/stemList2023.pdf.

IV. Accounting Education and STEM

As the financial ecosystem has become deeply integrated with technological advances, accounting programs have responded by updating the competencies and skills needed by accounting students to succeed. Instruction in such new technological concepts is not optional, but necessary for degree-granting accounting programs to maintain their accreditation. Accreditation for U.S. degree-granting accounting programs is overseen primarily by AACSB International (AACSB), a nonprofit association of business schools, accounting programs, corporations, and other organizations devoted to the promotion and improvement of higher education in business and accounting.

Accounting programs can obtain supplemental accreditation by demonstrating compliance with AACSB's accounting accreditation standards (AACSB Standards) through a process of self-evaluation and peer review, followed by periodic peer reviews of its strategic improvement to continue accreditation.[8] The accreditation standards and processes are updated annually by the Accounting Accreditation Policy Committee and the AACSB Board of Directors.

The AACSB Standards require that accounting programs include significant STEM education in their curricula — and that such programs apply STEM knowledge toward solving real-world challenges.

In particular, Standard A5 of the AACSB Standards states, "Consistent with mission, expected outcomes, and supporting strategies, accounting degree programs include learning experiences that develop skills and knowledge related to the integration of information technology in accounting and business. This includes the ability of both faculty and students to adapt to emerging technologies as well as the mastery of current technology."[9]

To demonstrate compliance with Standard A5, accounting programs must integrate, "current and emerging accounting and business practices in three primary components within the curricula":

- Information systems and business processes including data creation, manipulation/management, security, and storage.
- Data analytics includes, for example, statistical techniques, clustering, data management, modeling, analysis, text analysis, predictive analytics, learning systems, or visualization.
- Technology agility among learners and faculty should be developed, recognizing the need for continual learning of new skills needed by accounting professionals.

8 AACSB accreditation processes are ISO 9001:2015 certified globally and support and uphold the Code of Good Practice for Accrediting Bodies of the Association of Specialized and Professional Accreditors (ASPA)1. Additionally, AACSB is committed to upholding the guidelines of the European Union's General Data Protection Regulation (GDPR). See "AACSB Accounting Accreditation Standards," AACSB, July 1, 2022, https://www.aacsb.edu/educators/accreditation/accounting-accreditation/aacsb-accounting-accreditation-standards.

9 https://www.aacsb.edu/-/media/documents/accreditation/_2020-aacsb-business-accreditation-standards-_final--july-1-2024.pdf?rev=e40931bf2adc4e37a3074c0e88453e5c&hash=D6C8A21B021E62F9E088471EDFE3539D

To ensure that programs are in compliance with Standard A5, accounting faculty are integrating technology throughout their curriculum, including developing apps for and with their students. See Figure 2 for an example of how students create visual representations using an app developed by the faculty.

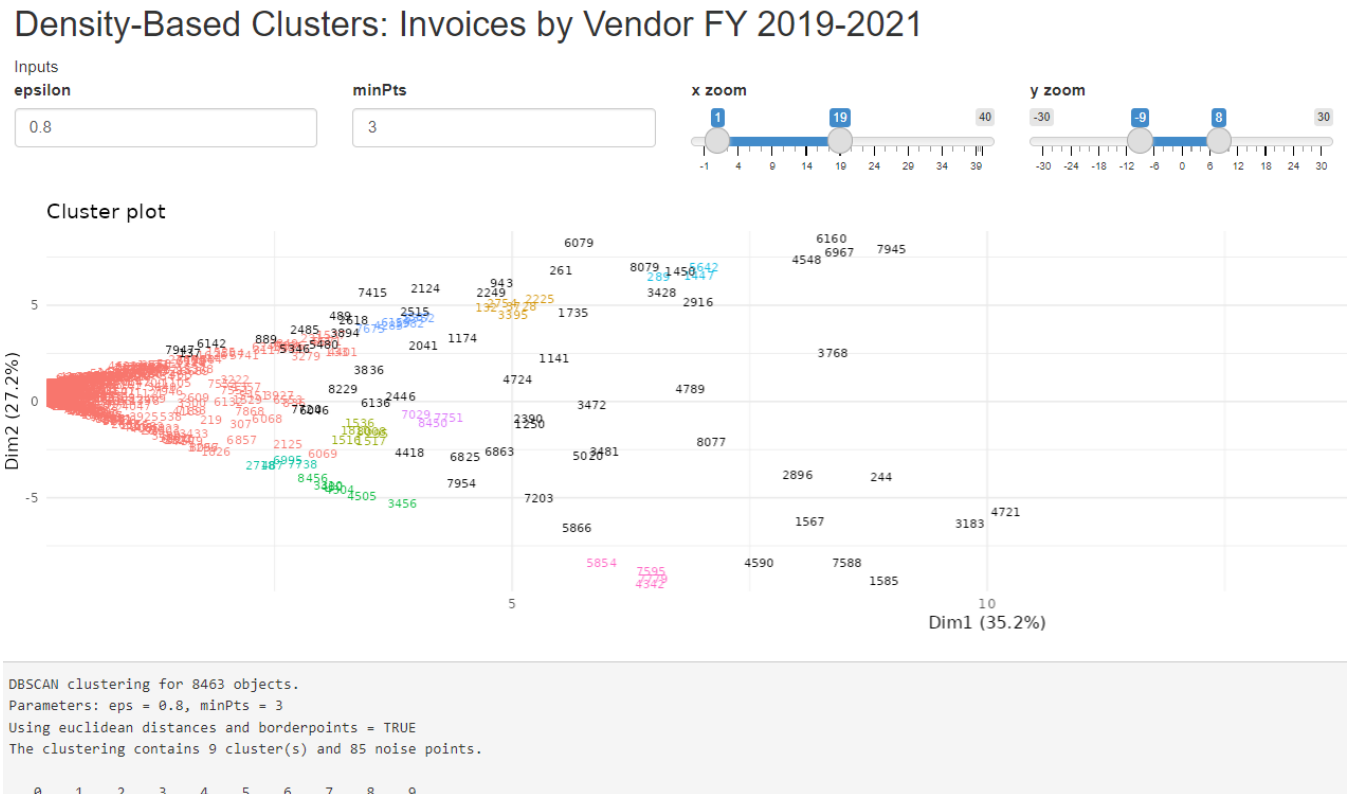


Figure 2 — R Shiny app developed by accounting faculty in the R dbscan and shiny packages to teach anomaly detection in auditing. Accessible at https://hotviz.shinyapps.io/APClusters/. *Hahsler M, Piekenbrock M (2023). dbscan: Density-Based Spatial Clustering of Applications with Noise and Related Algorithms. R package version 1.1-12,* https://CRAN.R-project.org/package=dbscan.

Furthermore, the AACSB Standards require not only STEM curriculum, but also "high-quality intellectual contributions that are consistent with its mission, expected outcomes, and strategies and that impact the theory, practice, and teaching of accounting, business, and management." See Appendix B for examples. The standards define intellectual contributions as both basic and discovery scholarship that, "increas[es] the knowledge base and the development of theory;" and applied or integrative/application scholarship that "draws from basic research and uses accumulated theories, knowledge, methods, and techniques to solve real-world problems and/or issues associated with practice."

Two other accreditors of business schools and accounting programs are the Accreditation Council for Business Schools and Programs and the International Accreditation Council for Business Education. Both of these accrediting agencies have requirements that faculty continue to maintain knowledge and skills needed by the professions their students aspire to and that the content of the courses must also maintain this high standard.

In other words, accounting students are required not simply to learn how to understand new technologies but also to work to develop real-world applications of technology for the benefit of broader economic and financial systems.

Typical Accounting Curricula

Although each U.S. degree-granting accounting program varies in their precise curricula, every AACSB-accredited program must meet the requirements described above.

As such, accounting students are required to take courses in numerous STEM disciplines. A 2024 survey of U.S. accounting schools conducted by AICPA asked U.S. accounting programs to report on the number of courses they require that include content in topics widely considered STEM, including subjects on DHS's Designated Degree Program List.

The survey found that every school that responded to the survey requires STEM content in their courses in at least 12 topic areas defined as STEM by DHS on its Designated Degree Program List.

The survey showed, among other findings, that:

- **U.S. Accounting Programs Require At Least One Course in At Least 12 Topics Defined by DHS as STEM**

  According to the AICPA survey, on average accounting programs require students to take at least one course that covers each of at least 12 topics widely defined as STEM, as well as offering additional courses as electives that cover STEM content. In many cases, schools reported that they had more than one required course that covered STEM topics.

Table 2: Average Number of Courses with STEM Content

STEM TOPIC	Average Number of Required Courses	Average Number of Elective Courses
Information Technology	2.2	1.4
Mathematics	2.2	1.0
Computer and Information Systems Security/Auditing/Information Assurance	1.8	1.0
Data Analytics	1.7	1.1
Data Processing and Data Processing Technology	1.5	0.8
Business Analytics	1.4	1.2
Algebra	1.4	0.8
Data Visualization	1.4	0.8
Business Statistics	1.2	0.2
Statistics	1.2	0.4
Financial Analytics	1.1	0.6
Data Modeling/Warehousing and Database Administration	1.0	0.7

- **The Vast Majority of Accounting Programs Require Coursework in STEM Topics**

  The AICPA survey found that a predominance of U.S. accounting programs require coursework in several topics widely considered to be STEM. For example, more than eight out of 10 responding programs require students to take courses in Information Technology, and nearly equivalent numbers of schools require instruction in Computer/Information Systems and Business Statistics.

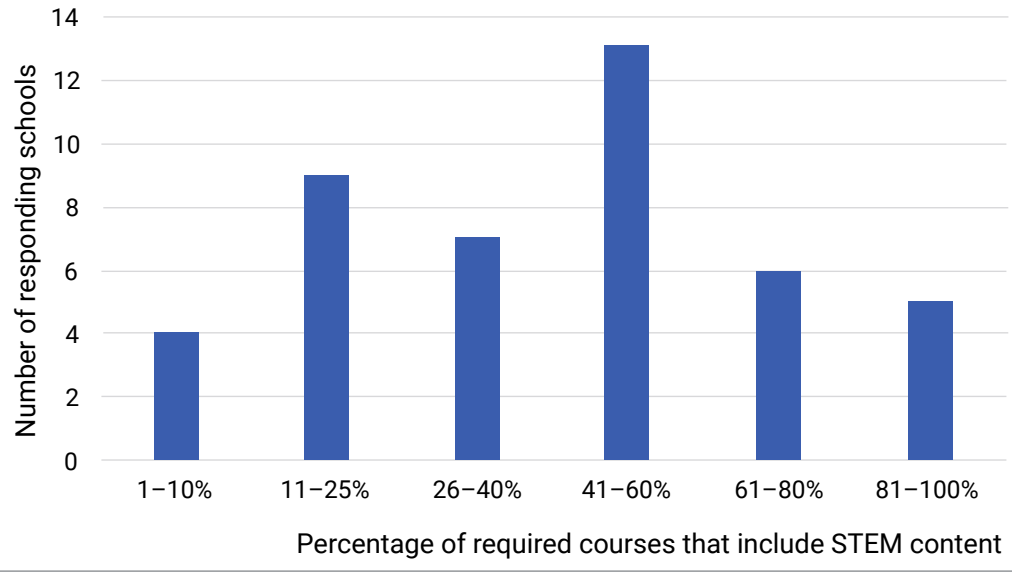
Table 3: Percentage Of Schools That Require Content in STEM Topics

STEM TOPIC	Percentage of Schools
Information Technology	83.3%
Computer/Info Systems Security/Auditing	77.1%
Business Statistics	77.1%
Statistics	75.0%
Data Analytics	70.8%
Data Processing and Data Processing Technology	68.8%
Data Visualization	64.6%
Algebra	64.6%
Business Analytics	62.5%
Mathematics	60.4%
Data Modeling/Warehousing and Database Administration	58.3%

- **The Majority of Required Courses at Most Accounting Programs Contain STEM Content**

  The prevalence of STEM content in accounting programs is further demonstrated by the fact that, at more than half of U.S. schools, at least 40% of required courses in their degree-granting accounting programs include STEM content.

Table 4: Percentage Of Schools That Require Content in STEM Topics



- **Accounting Programs Contain Significant Content in STEM Subjects**

  When taken as a whole, the data shows that required STEM content, based on CIP codes defined by DHS as STEM, is a prevalent requirement in the vast majority of accounting education programs in the United States.

Table 5: Prevalence of STEM Content Across U.S. Accounting Programs

CIP Code	CIP Title	Average Number of Required Courses Per School That Cover Topic	Percentage of Schools That Require Courses Covering Topic
11.0103	Information Technology	2.2	83.3%
11.0301	Data Processing and Data Processing Technology	1.5	68.8%
11.0802	Data Modeling/Warehousing and Database Administration	1.0	58.3%
11.1003	Computer and Information Systems Security/Auditing/ Information Assurance	1.8	77.1%
27.0101	Mathematics	2.2	60.4%
27.0102	Algebra	1.4	64.6%
27.0501	Statistics	1.2	75.0%
30.7101	Data Analytics	1.7	70.8%
30.7102	Business Analytics	1.4	62.5%
30.7103	Data Visualization	1.4	64.6%
30.7104	Financial Analytics	1.1	52.1%
52.1302	Business Statistics	1.2	77.1%
AVERAGE		**1.5**	**67.9%**

- **Accounting Programs Have STEM Content at Least Equivalent to Programs Currently Defined as STEM**

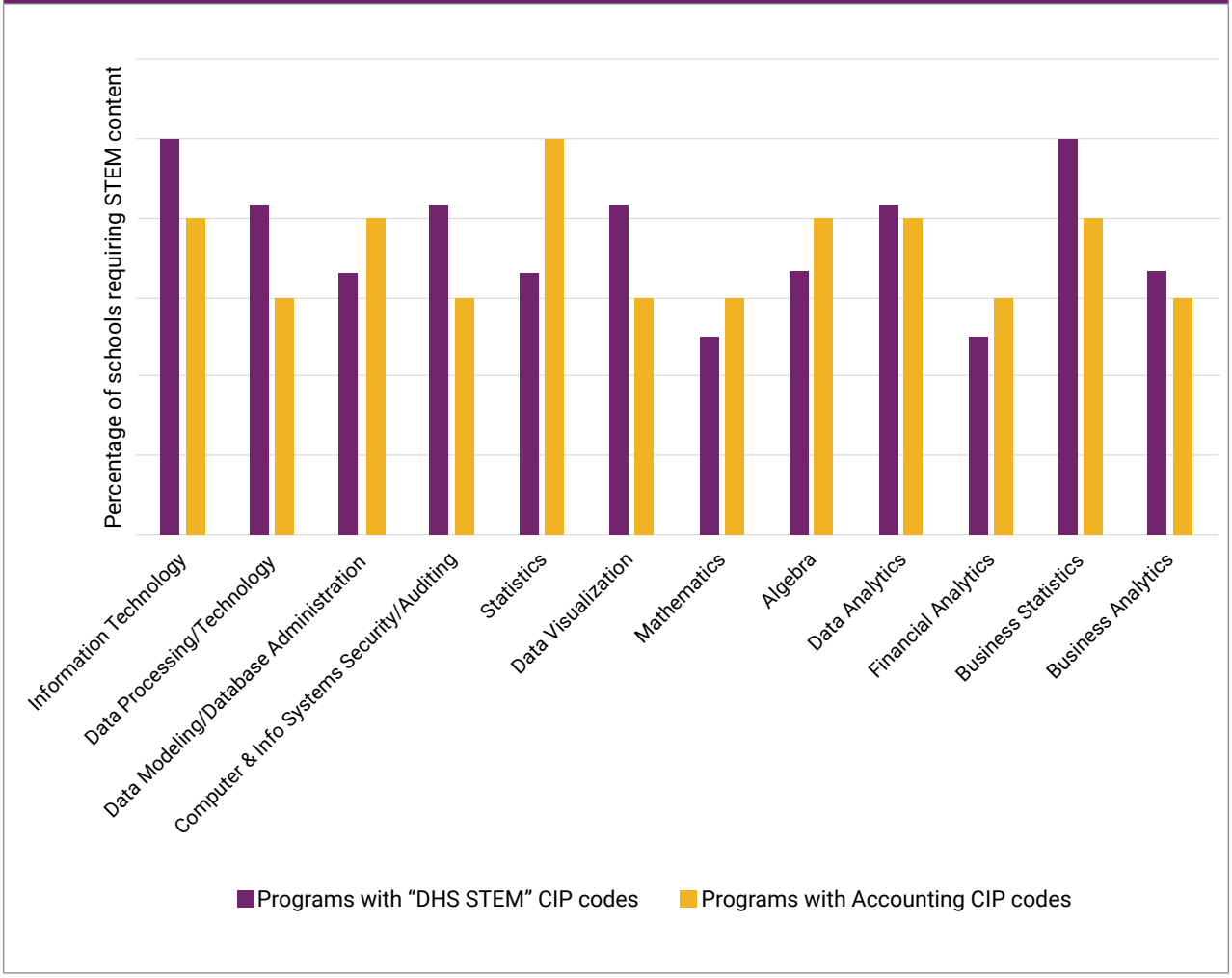
  The AICPA study also looked at the amount of STEM content in accounting programs that are classified under the accounting CIP code (52.0301) as compared to programs listed under CIP codes defined as STEM by DHS.

  The study looked at curricula for programs classified under these CIP codes, all of which are included on DHS's Designated Degree Program List:

  - 11.1003 (Computer and Information Systems Security/Auditing/Information Assurance)
  - 30.7102 (Business Analytics)
  - 52.1399 (Management Sciences and Quantitative Methods, Other)

  As the chart below shows, the study found that accounting programs classified under 52.0301 as accounting have equivalent STEM content as those classified under STEM-defined CIP codes — and in some cases, have even more STEM content than programs classified under STEM-defined CIP codes.

Table 6: Comparison of Accounting CIP Programs and Programs Defined as STEM by DHS



V. Accounting Professional Licensure Requirements and STEM

The importance of STEM knowledge to accounting is further reflected in the Uniform CPA Examination (Exam), passage of which is required to become a licensed Certified Public Accountant (CPA) in every state and territory in the country.

Licensure candidates are required to pass three core exam sections covering Auditing and Attestation (AUD); Financial Accounting and Reporting; and Taxation and Regulation (REG). Each candidate also is required to choose one discipline (Business Analysis and Reporting, Information Systems and Controls (ISC), or Tax Compliance and Planning) to demonstrate knowledge and skills in that discipline.

Recognizing the increasing importance of STEM knowledge in the accounting profession — based on an extensive practice analysis conducted by AICPA — the AICPA and the National Association of State Boards of Accountancy (NASBA) began an exhaustive review of the content of the CPA Exam. As a result, AICPA updated the CPA Exam at the start of 2024 to ensure content has a pervasive focus on data and technology throughout all sections. These updates are intended to assess a candidate's ability to understand how data is structured, how information flows through IT systems and business processes, and how statistical analysis can assist in assessing risk and responding to it. In addition, the CPA Exam covers aspects of IT infrastructure, from platforms and services, to cybersecurity, confidentiality, and privacy, as well as the foundational skills needed to build and develop technology.[10]

Table 7: Data, Technology, and Statistics Concepts in the CPA Exam	
Exam Section	Data, Technology, and Statistics Concepts
Auditing and Attestation	Focus on understanding how data is structured and flows through underlying systems, verifying the completeness and accuracy of source data, and applying data analytics and statistical techniques to assist in risk assessment.
Financial Accounting and Reporting	The verification of the completeness and accuracy of source data used in the preparation of financial statements and the use of various sources of data and information to prepare supporting schedules for account balances.
Taxation and Regulation	The verification of the completeness and accuracy of source data used to prepare returns and supporting schedules and the consideration of the outputs of automated validation checks and diagnostic tools that highlight potential errors or anomalies.
Business Analysis and Reporting	• Verification of the completeness and accuracy of source data used in comparing historical results to budgets and forecasts and deriving the impact of transactions and events (actual and proposed). • Determination of methods to transform data to make it useful for decision-making. • Determination of attribute structures, formats, and sources of data needed to prepare financial statement analysis. • Use of outputs from data analytic techniques to explain an entity's results or to identify and detect discrepancies.
Tax Compliance and Planning	The verification of the completeness and accuracy of source data used to prepare returns and supporting schedules.

10 "Everything you need to know about the CPA Exam," AICPA, Accessed on May 1, 2024, https://www.aicpa-cima.com/resources/toolkit/cpa-exam.

In addition, one CPA Exam Discipline section, ISC, tests the knowledge and skills with respect to information systems, including processing integrity, availability, security, confidentiality and privacy. These competencies are based on widely recognized standards, including by the National Institute of Standards and Technology and the Cybersecurity and Infrastructure Security Agency.[11]

Of particular note is Area I of the ISC section, which is focused on information systems and data management. The area includes the following competency areas:

- IT architecture components and the use of cloud-based models for IT infrastructure, platforms, and services
- Enterprise and accounting information systems, the business processes they enable and controls over processing integrity
- System availability and IT change management
- Data collection, storage, structured query language (SQL) queries, and integration of data from different data sources
- Business process models

CPA Evolution Model Curriculum

In response to the then-proposed changes to the CPA Exam, AICPA and NASBA developed the CPA Evolution Model Curriculum in 2021, "to assist faculty who want to prepare their students for the CPA profession."[12] As the model curriculum points out, "The role of today's CPA has evolved. Newly licensed CPAs need deeper skill sets, more competencies and greater knowledge of emerging technologies. That's why the CPA licensure model is changing. The CPA Evolution initiative, a joint project between the AICPA and NASBA, aims to transform the CPA licensure model to recognize the rapidly changing skills and competencies the practice of accounting requires today and will require in the future."

The model curriculum aligns with the CPA Exam and is divided into six sections (three core and three discipline/elective). Each section is further broken down into modules that include topics whose learning objectives are designed to ensure students obtain the necessary knowledge and skills to both successfully pass the CPA Exam and serve their clients as CPAs.

11 "Uniform CPA Examination® Blueprints," AICPA, December 1, 2022, Accessible at https://www.aicpa-cima.com/resources/article/learn-what-is-tested-on-the-cpa-exam.

12 "CPA Evolution Model Curriculum," AICPA and NASBA, Accessed on June 9, 2024, https://nasba.org/wp-content/uploads/2021/06/Model-curriculum_web_6.11.21.pdf.

Woven throughout the curriculum are modules and topics that cover STEM topics, including financial data analytics and information technology. (See Table 8.)

Table 8: CPA Evolution Model Curriculum Modules with STEM Content	
Part I: CPA Evolution Core	
Section 1: Accounting and Data Analytics Core	
Module 8: Financial Data Analytics	Topic 1: Logical thinking Topic 2: Financial data Topic 3: Data mining of structured financial data Topic 4: Analysis of financial data Topic 5: Visualization
Section 2: Audit and Accounting Information Systems Core	
Module 4: Information Technology	Topic 1: Understanding of information technology (IT) Topic 2: Understanding an entity's IT environment Topic 3: Control Environment, IT general controls and entity-level controls
Part II: CPA Evolution Discipline	
Section 1: Business Analysis and Reporting Discipline	
Module 10: Advanced Data Analytics	Topic 1: Advanced critical thinking Topic 2: Advanced logical thinking Topic 3: Advanced data concepts Topic 4: Advanced data mining Topic 5: Advanced data analysis Topic 6: Advanced data visualization Topic 7: Communicating results on advanced data analytics Topic 8: Advanced data ethics Topic 9: Advanced data management and relationships
Section 2: ISC Discipline	
Module 1: IT Governance and Risk Assessment	Topic 1: IT governance, strategy, and standards Topic 2: Assurance-related research Topic 3: Business processes and the design of IT internal controls Topic 4: IT risk identification and assessment Topic 5: IT control frameworks Topic 6: IT general controls (ITGC) Topic 7: Application controls Topic 8: IT change management Topic 9: Cybersecurity risk management Topic 10: System interfaces/flow of data

Table 8: CPA Evolution Model Curriculum Modules with STEM Content (cont.)	
Module 2: Performing Procedures, Tests of Internal Controls	Topic 1: Logical access controls Topic 2: IT change management Topic 3: Tests of internal controls related to business processes Topic 4: Sufficient appropriate evidence: Specific matters that require special consideration
Module 4: Use and Management of Data 4: Use and Management of Data	Topic 1: Data governance Topic 2: Data preparation/manipulation

VI. Accounting Education's Use of STEM-Related Research, Innovation, and Technology

As the financial system has embraced new technologies, the accounting profession has taken steps to ensure that its practitioners are well positioned to handle and analyze data in more sophisticated ways. Many public accounting firms have developed proprietary and patented technologies and software, including programs that allow accountants to better and more quickly perform risk assessments (including with AI technology).

Accounting professionals also work to create programs that allow for financial analytics, financial data processing, knowledge management, data visualization, effective decision communication, machine learning for finance, statistical inference, and dynamic modeling on financial data. Accounting professionals often use technology skills that are integral to the audit function and other areas of American business, including IT auditing (which demands a high level of technological knowledge and skills to evaluate the IT infrastructure), AI, blockchain, data analytics, and forensic and predictive accounting and cybersecurity, among others.

The accounting profession continues to further this knowledge through its development of cutting-edge tools like the Dynamic Audit Solution (DAS). DAS is an end-to-end, fully integrated, data-driven audit solution that puts the power of data analytics, AI, and machine learning in the hands of auditors, allowing them to digitally transform their audit practice and services to clients. The DAS solution integrates data science, accounting and auditing by leveraging a data-driven audit. It helps expand the much-needed and valued skills around data science of an auditor by incorporating the use of data analytics and data visualization through features and functionality that enhance the quality of the audit and the value of insights delivered to clients.

Accounting firms' proprietary digital technologies equip audit professionals to be proficient in data science, integration, and analytics. These audit professionals must become experts in the data which they spend time analyzing. They must further be able to identify and analyze new risks and anomalies, as well as help businesses reengineer systems so that they are able to speak to one another.

One example is accounting firms' use of blockchain implementations, applications, and assurance services. This allows users to access ledgers in real time, as well as create smart contracts and record transactions. Blockchain technology is growing in use by global corporations (such as Walmart, Amazon, Anheuser-Busch, and McDonald's) and is changing the way transactions are processed and how they are accounted for. As such, accountants are now performing increasingly complex analyses of financial results.

Another example is accounting firms' use of robotic process automation, software technology that enables users to build, deploy, and manage software robots that emulate human actions interacting with digital systems and software. Accountants are writing scripts and developing bots to improve the operations and financial management of organizations.

Research and Technology Innovation at Accounting Schools

At the university level, degree-granting accounting programs prioritize original research and innovation initiatives that not only enable students to engage in real-world research and innovation but provide tangible benefits to the U.S. and global financial systems. These include:

- At the University of North Georgia, students use R (an open source programming language and a software environment for statistical computing and graphics) and SQL (a programming language for storing and processing information in a relational database) to perform audit, tax, and forensic accounting tasks involving data transformation, visualization, and statistical techniques (e.g., density-based cluster analysis, linear regression). Students also use Bayesian networks — a compact, flexible and interpretable probabilistic graphical model of variables and their conditional dependencies — to practice audit risk assessment and business valuation under conditions of uncertainty. One faculty member's related research is published in a series of articles on using linear regression and Bayesian networks in estimating business value and economic damages.[13] [See Figure 3.]

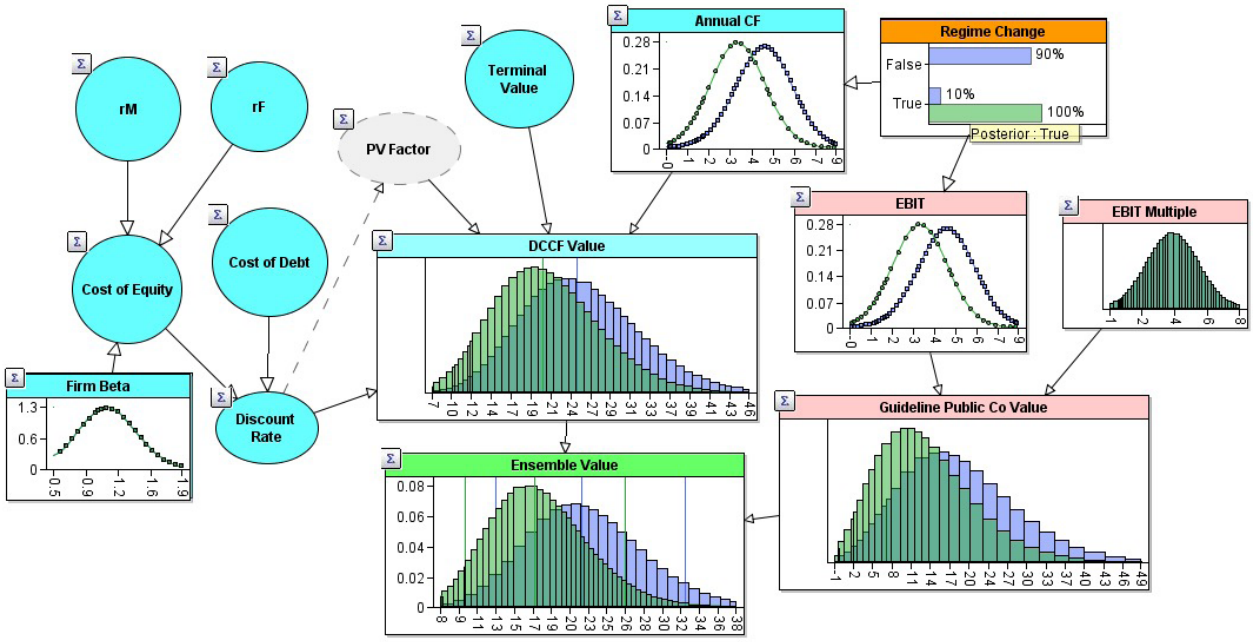


Figure 3 — Bayesian network model used in teaching business valuation to forensic accounting students.

- At the University of North Dakota, incorporating information systems into the accounting program has led to extensive collaboration in research and publications in accounting information systems and outlets such as IEEE Access. Published research has included topics ranging from blockchain[14] and audit efficacy[15] to data security.[16] One faculty member's work was cited by the SEC's 2023 final standard on, "Cybersecurity Risk Management, Strategy, Governance and Incident Disclosure."[17]

13 See, e.g., Schulzke, K.(July 2021). "Estimating Business Value with Bayesian Networks," The Value Examiner, 6–18. Available at https://thevalueexaminer.com/2021/21-JA/#page=6.

14 Zuo, Y. (2022). "Tokenizing Renewable Energy Certificates (RECs) — a Blockchain Approach for REC Issuance and Trading." IEEE Access, 10, 134477–134490. Available at https://ieeexplore.ieee.org/document/9994695.

15 Guo, X., Zuo, Y. "When auditing meets Blockchain: A study on improving audit efficiency using Blockchain smart contracts." In late round review at International Journal of Accounting Information Systems.

16 Zuo, Y. (2023). "Big Data and Big Risk — A Four-factor Framework for Big Data Security and Privacy." International Journal of Business Information Systems, 42(2), 224–242.

17 SEC final rule "Cybersecurity Risk Management, Strategy, Governance, and Incident Disclosure" (RIN 3235-AM89) (https://www.sec.gov/files/rules/final/2023/33-11216.pdf) cites Katherine Campbell, et al., "The Economic Cost of Publicly Announced Information Security Breaches: Empirical Evidence From the Stock Market," 11 (3)
J. OF COMPUT . SEC . 432, 431-448 (2003), DOI: 10.3233/JCS-2003-11308, available at https://www.researchgate.net/publication/220065342_The_

- Two Babson College faculty members are members of the American Accounting Association's Strategic and Emerging Technologies section. Their research is in this area, including studies on the impact of AI on accounting[18] and Best Practices of Integrating Sustainability into Business and Accounting.[19]
- The Brad D. Smith Schools of Business/Lewis College of Business in Marshall University's DBA, Accounting Concentration, is heavily focused on quantitative research methods and analysis.
- The University of Northern Iowa has embedded quantitative analysis and data analytics in its accounting curricula, noting that, "It is impossible to separate accounting and business analytics and quantitative analysis."
- At Utah State University, accounting students use analytical tools to solve case problems, including regression analysis, data analysis techniques, visualization tools, and new technologies.
- At New Jersey City University, accounting students are required to research emerging technology issues in Accounting such as data analytics, AI, cybersecurity, and blockchain.
- The University of Alabama at Birmingham's accounting faculty published an accounting information systems textbook with two alumni as co-authors on the project.[20]
- Faculty at University of North Georgia use Benford's "My Law," which is used as one tool among many in screening for financial statement manipulation, in teaching about crypto assets. [See Figure 4.]

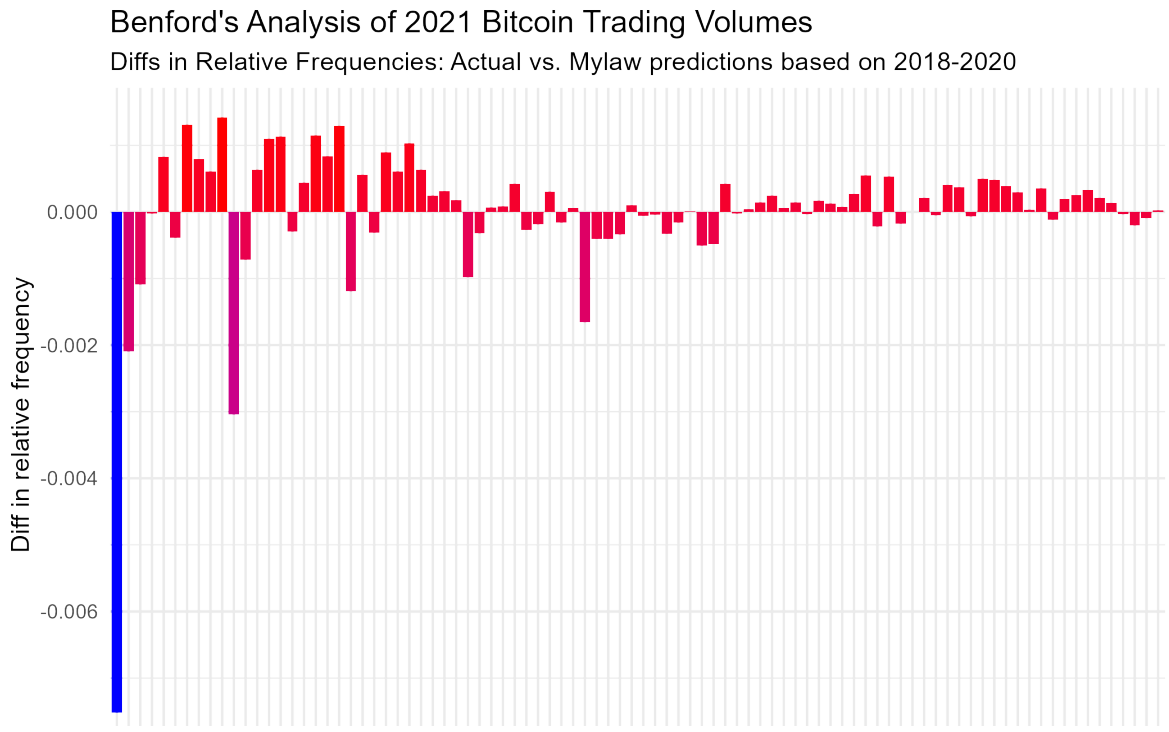


Figure 4 — An example of Benford's "My Law" plot coded by an accounting faculty member for teaching the use of Mark Nigrini's "My Law" for validation of Bitcoin trading volumes. Coded in R using benford.analysis and tidyverse packages.

Economic_Cost_of_Publicly_Announced_Information_Security_Breaches_Empirical_Evidence_from_the_Stock_Market.

18 David A Wood, et al, "The ChatGPT Artificial Intelligence Chatbot: How Well Does It Answer Accounting Assessment Questions?" Issues in Accounting Education (2023) 38 (4): 81–108., Nov. 1, 2023, https://publications.aaahq.org/iae/article-abstract/38/4/81/10903/The-ChatGPT-Artificial-Intelligence-Chatbot-How?redirectedFrom=fulltext.

19 Rezaee, Zabihollah, et al, "Best Practices of Integrating Business Sustainability and ESG Sustainability into Business and Accounting Curricula," The AAA Conference: Sustainability, ESG, and Accounting: Implications for the Academy and the Profession: One Year Later, Washington, DC, February 2024, https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1849273&dswid=-2418.

20 Foksinska, Alicja, Brannock, Danielle, & Savage, Arline A., "Accounting Information Systems: Connecting Careers, Systems, and Analytics, 1st Edition," Wiley, 2022.

Accounting and Patents

The accounting profession's connection to the development of new technologies is further reflected in the field's deep engagement in the patent system, including through successful applications for numerous patents to accounting firms.

The Cooperative Patent Classification (CPC) is a joint partnership between the U.S. Patent and Trademark Office (USPTO) and the European Patent Office, under which the two agencies have agreed to harmonize their existing classification systems and migrate toward a common classification scheme.[21] In 2013, the USPTO moved from using the United States Patent Classification system to the CPC system. CPC has since been adopted by many countries throughout the world.[22]

The CPC includes nine classifications of patentable technologies, each with corresponding subsections. Underscoring the extent to which accounting is driven by innovation and new technologies, the CPC includes a full section on patent classifications for accounting, as well as other related topics.[23]

Section G06 *(Computing; Calculating or Counting)*, and Subsection G06Q *(Information and Communication Technology [ICT] Specially Adapted for Administrative, Commercial, Financial, Managerial or Supervisory Purposes; Systems or Methods Specially Adapted for Administrative, Commercial, Financial, Managerial or Supervisory Purposes, Not Otherwise Provided For)* includes G06Q 40/00, Finance; Insurance; Tax strategies; Processing of corporate or income taxes.

Of special note is G06Q 40/12, Accounting, which the CPC defines as "ICT specially adapted for recording, analyzing, verifying or reporting of funds or other quantitatively innumerable factors used in a business."

Table 9: Cooperative Patent Classifications for Finance		
G06Q 40/00		**Finance; Insurance; Tax strategies; Processing of corporate or income taxes**
	G06Q 40/02	Banking (e.g., interest calculation or account maintenance (credit or loans G06Q 40/03))
	G06Q 40/03	Credit; Loans; Processing thereof
	G06Q 40/04	Trading; Exchange (e.g., stocks, commodities, derivatives, or currency exchange)
	G06Q 40/06	Asset management; Financial planning or analysis
	G06Q 40/08	Insurance
	G06Q 40/10	Tax strategies
	G06Q 40/12	Accounting
	G06Q 40/123	{Tax preparation or submission}
	G06Q 40/125	{Finance or payroll}
	G06Q 40/128	{Check-book balancing, updating or printing arrangements}

21 "About CPC," Cooperative Patent Classification, European Patent Office & U.S. Patent and Trademark Office, accessed June 8, 2024, https://www.cooperativepatentclassification.org/about.

22 "Patent Classification," U.S. Patent and Trademark Office, accessed June 8, 2024, https://www.uspto.gov/patents/search/classification-standards-and-development#:~:text=On%20January%201%2C%202013%2C%20the,many%20countries%20throughout%20the%20world.

23 "Scheme G," Cooperative Patent Classification, European Patent Office & U.S. Patent and Trademark Office, accessed June 8, 2024, https://www.cooperativepatentclassification.org/sites/default/files/cpc/scheme/G/scheme-G06Q.pdf.

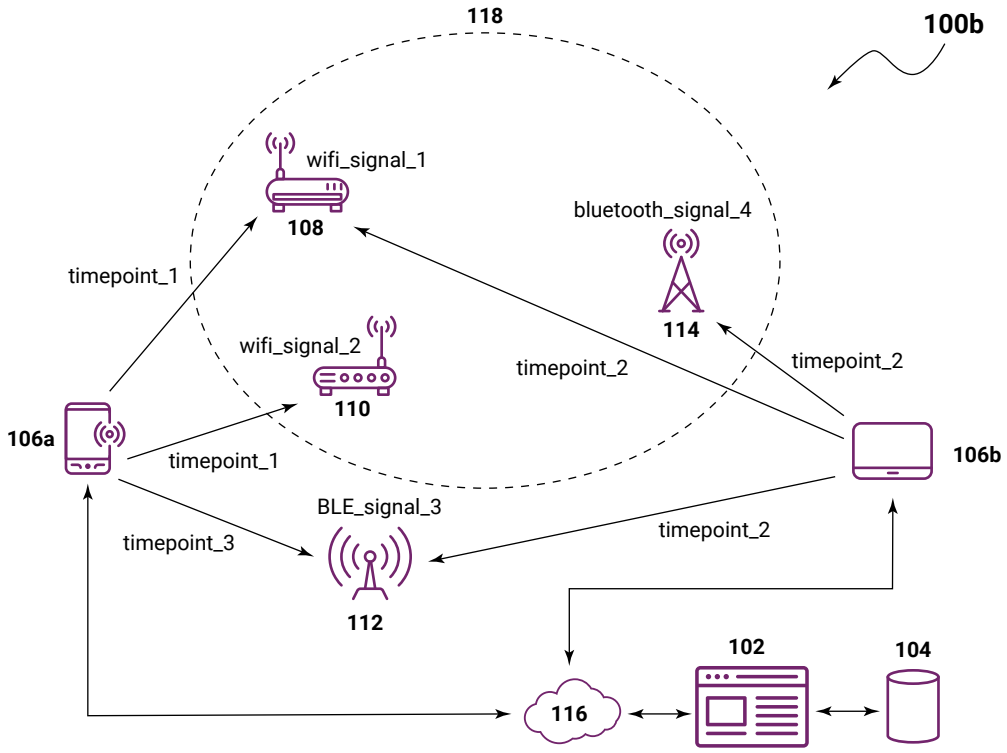


Figure 5 — Example of a patent developed by Big Four accounting firm PWC to measure project team performance.

In fact, a review of patents issued under this subsection reveals numerous patents that have been issued in the last 20 years to accounting professionals for their development of new technologies to assist in accounting. See an example graphic in Figure 5 and an extensive listing of patents filed by CPAs, accounting firms, and accounting academics in Appendix C.

VII. Conclusion

For more than 50 years, the accounting profession has been an active, contributing member of the STEM community. Recently, it has expanded its efforts in the creation of technological and statistical tools and innovation that provide better insights into financial performance and increase reliability and trust in the nation's financial system. These shifts underscore the extent to which accounting is a STEM profession that harnesses science and technology to maintain the country's competitive edge.

In response to this new landscape, the accounting education system has incorporated additional STEM material into its curricula, demanding that accounting students master the technological, scientific, and mathematical knowledge necessary to serve their clients and the general public. The prominence of STEM content on the CPA Exam highlights the reality that accounting is a STEM profession where knowledge of technology and mathematical concepts is not a luxury but a prerequisite.

The accounting profession embraces its responsibility by leading the development of technology, in the form of patent, copyright, and trade secret properties, that advance the interests of the financial sector and the consumers, businesses and governments they protect. As the financial sector continues to be transformed by new technologies that just a few decades ago were the realm of science fiction, the essential role that accountancy and accounting education play in the formation of a STEM-literate workforce will continue to grow.

VIII. Appendix A: CPA Evolution Model Curriculum/Modules with STEM Content

Part I: CPA Evolution Core
Section 1: Accounting and Data Analytics Core
Module 8: Financial Data Analytics
Topic 1: Logical thinking
Summary: Define main logical thinking concepts related to financial data analytics.
Learning objective(s):
1. Define conditional thinking in financial data analytics.
2. Identify appropriate conditional logic statements in financial analysis.
3. Identify what conditions are met in a conditional statement related to financial analysis.
4. Explain relational concepts (e.g., normalization, integrity, cell referencing) in financial data.
5. Explain the different types of codes (e.g., relational, functional, object-oriented) related to financial data.
6. Identify universal code concepts (e.g., loop) in financial data.
Topic 2: Financial data
Summary: Explain main components of financial data and extract-transform-load (ETL) processes.
Learning objective(s):
1. Identify basic concepts of financial data analytics.
2. Explain the dimensions or characteristics of financial data.
3. Define the ETL process and principles of ETL as related to financial data.
4. Define the goals of the ETL process related to financial data.
5. Identify methods to cleanse, prepare, and transform structured financial raw data
Topic 3: Data mining of structured financial data
Summary: Explain main concepts of data mining related to financial data.
Learning objective(s)
1. Define data mining of structured financial data.
2. Describe correlations, patterns, and anomalies in structured financial data.
Topic 4: Analysis of financial data
Summary: Describe data analysis concepts and models.
Learning objective(s):
1. Describe the analytical maturity model (descriptive, diagnostic, predictive, and prescriptive).
2. Determine and interpret appropriate descriptive analysis, mins, max, means, median, standard deviation, and distribution shapes.
3. Determine and interpret appropriate diagnostic data analysis, correlations, patterns, and anomalies.

Part I: CPA Evolution Core
Section 1: Accounting and Data Analytics Core
Module 8: Financial Data Analytics
Topic 5: Visualization
Summary: Describe data visualization techniques.
Learning Objective(s)
1. Describe the various types of data relationships.
2. Describe the data visualization techniques used to identify patterns, trends, and correlations.
3. Match the appropriate data visualization method to specific data sets and circumstances.

Section 2: Audit and Accounting Information Systems Core
Module 4: Information Technology
Topic 1: Understanding of IT
Summary: Explain the role of IT within the organization.
Learning objective(s):
1. Explain the role that IT personnel, processes, and strategies play in IT governance and in supporting an entity's overall vision, strategy, and business objectives.
2. Identify hardware, software, databases, networks, mobile technology, etc. used by an entity.
3. Describe the advantages, disadvantages, risks, and other considerations associated with cloud computing and IT outsourcing arrangements, including the use of System and Organization Controls for service organizations reports from third parties.
4. Identify the role and benefits of information systems (e.g., enterprise resource planning, e-commerce, and supply chain management systems).
Topic 2: Understanding an entity's IT environment
Summary: Describe an entity's IT environment and its impact on the financial reporting.
Learning objective(s):
1. Describe an entity's IT environment (application systems and IT infrastructure database, operating system, network).
2. Identify implications to risk of outsourced IT environment components.
3. Identify the IT-related significant business processes and data flows that directly or indirectly affect an entity's financial statements.
Topic 3: Control Environment, IT general controls, and entity-level controls
Summary: Identify and document significant components of entity-level controls, including IT.
Learning objective(s):
1. Identify and document the significant components of an entity's control environment (entity-level), including its IT general controls and application controls.
2. Identify the categories of IT general controls and pervasive impact on financial reporting.
3. Identify the types of IT application controls and impact on financial reporting.
4. Describe the testing strategies used in selecting, developing, and implementing new information systems.
5. Recognize effective IT control activities, including manual, IT dependent, and automated controls, as well as preventive, detective, and corrective controls.

Part II: CPA Evolution Discipline
Section 1: Business Analysis and Reporting Discipline
Module 10: Advanced Data Analytics
Topic 1: Advanced critical thinking
Summary: Evaluate stakeholders' interests and recommend a course of action by developing relevant questions, examining bias, calculating probabilities and weightings, and comparing and engaging alternative and iterative analyses.
Learning objective(s):
1. Evaluate various stakeholders' interests.
2. Recommend a course of action, given a situation.
3. Develop relevant questions.
4. Apply relevant knowledge to question generation.
5. Examine the specific type of bias (i.e., confirmation bias, anchoring).
6. Calculate and analyze outcome probabilities and weightings.
7. Compare alternative analyses.
8. Engage in iterative analyses.
9. Contrast signal and noise.
Topic 2: Advanced logical thinking
Summary: Demonstrate ability to apply logical thinking to interpret and create conditional statements and apply relational concepts.
Learning objective(s):
1. Apply relational logic concepts to answer questions.
2. Interpret conditional logic statements.
3. Create a condition statement.
4. Understand alternative accounting information system models, such as the resources, events, and agents (REA) model, and create the appropriate model.
5. Apply relational concepts.
6. Create program code using proper syntax.
Topic 3: Advanced data concepts
Summary: Demonstrate ability to extract, transform, and load data.
Learning objective(s):
1. Apply appropriate joins to analyze data.
2. Explain and apply principles of extract, transform, and load.
3. Design and implement controls used to ensure completeness, accuracy, and validity of data.
4. Extract data from a raw data file.
5. Construct a data set.
6. Apply data cleaning techniques.
7. Apply data transformation techniques.
8. Describe and evaluate relational, dimensional, and big data models.
9. Explain and implement data loading processes.
10. Identify the capabilities needed in tools that support data modeling and analysis.
Topic 4: Advanced data mining
Summary: Apply data mining techniques.
Learning objective(s):
1. Apply data mining techniques to a data set.

Part II: CPA Evolution Discipline
Section 1: Business Analysis and Reporting (BAR) Discipline
Module 10: Advanced Data Analytics
Topic 5: Advanced data analysis
Summary: Determine and interpret appropriate predictive and prescriptive analysis.
Learning objective(s):
1. Determine/interpret appropriate predictive analysis, (e.g., regression, time series, forecasting).
2. Determine/interpret appropriate prescriptive, (e.g., optimization modeling, Monte Carlo simulation).
Topic 6: Advanced data visualization
Summary: Explain and apply data visualization methods.
Learning Objective(s)
1. Compare and contrast data visualization methods.
2. Apply data visualization methods to specific data sets and circumstances.
3. Create appropriate dashboards and scorecards.
Topic 7: Communicating results on advanced data analytics
Summary: Design and interpret the results of a key performance indicators dashboard; apply what-if analysis to assumptions.
Learning objective(s)
1. Design a KPI dashboard based on business user roles.
2. Interpret the results of a KPI and provide recommended response.
3. Apply what-if analysis to assumptions.
4. Design analytic with built in controls for completeness, accuracy, and validity.
Topic 8: Advanced data ethics
Summary: Identify misleading visuals and evaluate data models for appropriate checks and balances.
Learning objective(s):
1. Identify and critique a misleading visual.
2. Identify common design principles to avoid misleading visuals.
3. Evaluate data models for appropriate checks and balances.
4. Evaluate the impact of AI on data analysis and processing.
Topic 9: Advanced data management and relationships
Summary: Identify considerations associated with loading data into a final target database; define attributes of a data repository; and determine methods to transform raw data.
Learning objective(s):
1. Describe considerations associated with loading data into the final target database (e.g., operational data store, data warehouse or data lake) including the constraints that apply (e.g., uniqueness, referential integrity, mandatory fields), the types of loading (initial, incremental, full refresh), and load verification.
2. Define the attributes of a data repository such as its relevance, elements to be included or excluded, relationships between those elements and characteristics used to determine its validity, completeness, and accuracy.
3. Determine methods to transform raw data (structured and unstructured) to make it useful for decision-making by correcting or removing data in the data set that is incorrect, inaccurate, incomplete, improperly formatted or duplicated and to convert, aggregate, merge, replace, validate, format, and split data.
4. Describe considerations associated with loading data into the final target database (e.g., operational data store, data warehouse or data lake) including the constraints that apply (e.g., uniqueness, referential integrity, mandatory fields), the types of loading (initial, incremental, full refresh), and load verification.
5. Define the attributes of a data repository such as its relevance, elements to be included or excluded, relationships between those elements and characteristics used to determine its validity, completeness, and accuracy.
6. Determine methods to transform raw data (structured and unstructured) to make it useful for decision-making by correcting or removing data in the data set that is incorrect, inaccurate, incomplete, improperly formatted or duplicated and to convert, aggregate, merge, replace, validate, format, and split data.

Part II: CPA Evolution Discipline
Section 2: Information Systems and Controls (ISC) Discipline
Module 1: IT Governance and Risk Assessment
Topic 1: IT governance, strategy and standards
Summary: Explain IT governance and strategy, and awareness of IT standards
Learning objective(s):
1. Summarize relevant IT standards.
2. Define the basics of hardware, software, databases, networks, mobile technology, etc. used by an entity internally, externally, and through outsourcing arrangements (e.g., application service providers and cloud computing).
Topic 2: Assurance-related research
Summary: Explain basics of assurance-related research and techniques.
Learning objective(s):
1. Explain the importance of assurance-related research and appropriate techniques for conducting it.
2. Apply research techniques to resolve basic to intermediate assurance-related issues.
Topic 3: Business processes and the design of IT internal controls
Summary: Explain IT systems, controls, and resources; identify risks to information systems and the organizational risk appetite.
Learning objective(s):
1. Identify IT systems that are, directly or indirectly, the source of financial and operational transactions or the data used for the processes/systems in scope of the engagement (e.g., how the entity uses IT systems to capture, store, and process information).
2. Identify and document an entity's relevant IT automated and manual internal controls for applications and data, within the flow of an entity's transactions for a significant business process and consider the effect of these controls on the completeness, accuracy, and reliability of an entity's data.
3. Evaluate whether relevant internal controls (automated and manual for applications and data) are effectively designed and placed in operation.
4. Identify the controls associated with availability.
5. Explain the role and appropriate usage of various IT resources: applications, data, infrastructure, and people.
6. Recall risks inherent to information systems and the organizational risk appetite.
Topic 4: IT risk identification and assessment
Summary: Demonstrate awareness of IT risks and their related business impact.
Learning objective(s):
1. Identify IT-related risks at the entity, application and IT general control level and related business impact on the layers of security (data/database, application, server/operating system, network/infrastructure).
Topic 5: IT control frameworks
Summary: Identify IT control frameworks.
Learning objective(s):
1. Identify major IT control frameworks (e.g., Control Objectives for Information and Related Technology (COBIT), ISO/IEC 17799: Code of Practice for Information Security Management, and Information Technology Infrastructure Library (ITIL)).
Topic 6: IT general controls (ITGC)
Summary: Identify IT control activities.
Learning objective(s):
1. Identify effective IT control activities, including manual, IT dependent, and automated controls, as well as preventive, detective, and corrective controls.

Part II: CPA Evolution Discipline
Section 2: Information Systems and Controls (ISC) Discipline
Module 1: IT Governance and Risk Assessment
Topic 7: Application controls
Summary: Identify and evaluate appropriate application controls.
Learning objective(s):
1. Choose appropriate, identify, and make use of specific application controls (e.g., authorization, access, separation of duties) for a given set of circumstances.
2. Evaluate the results of the appropriate tests of application controls (manual, automated, IT dependent) related to business processes.
3. Apply special consideration when controls have design or operating effectiveness deficiencies or exceptions.
Topic 8: IT change management
Summary: Explain IT change management risks and processes.
Learning objective(s):
1. Explain the risks associated with an inadequate change control and change management process for an entity's information systems and processes, including acquisition, integration, and outsourcing.
2. Identify the design of the appropriate tests of change management controls.
Topic 9: Cybersecurity risk management
Summary: Recognize the basics of cybersecurity and risk management.
Learning objective(s):
1. Recognize key cybersecurity concepts and terms.
2. Recognize common cybersecurity frameworks and standards (e.g., NIST, AICPA Trust Services Criteria).
3. Recall types of tests of cybersecurity testing approaches.
4. Identify threats and risks related to information confidentiality and privacy.
Topic 10: System interfaces/flow of data
Summary: Analyze and evaluate the flow of transactions in a system interface diagram to identify risks.
Learning objective(s):
1. Analyze and evaluate the flow of transactions represented in a narrative, flowchart, data diagram, and system interface diagram to identify the risks in key business processes related to the completeness, accuracy, and continued processing integrity in input, storage, processing, and output processes.

Module 2: Performing Procedures, Tests of Internal Controls
Topic 1: Logical access controls
Summary: Determine logical access controls and prepare results of appropriate tests of security.
Learning objective(s):
1. Identify logical and physical access and segregation of duties risks.
2. Explain the design of the appropriate test to evaluate security, logical, and physical access in support of data, application, operating system, network, and infrastructure.
3. Prepare results of the appropriate tests of security, logical, and physical access in support of data, application, operating system, network, and infrastructure.
Topic 2: IT change management
Summary: Perform tests and report on the results of change management controls.
Learning objective(s):
1. Perform tests of the design and operating effectiveness of relevant internal controls (automated and manual for applications and data).
2. Prepare the results of the appropriate tests of change management controls.

Part II: CPA Evolution Discipline
Section 2: Information Systems and Controls (ISC) Discipline
Module 2: Performing Procedures, Tests of Internal Controls
Topic 1: Logical access controls
Summary: Determine logical access controls and prepare results of appropriate tests of security.
Learning objective(s):
1. Identify logical and physical access and segregation of duties risks.
2. Explain the design of the appropriate test to evaluate security, logical, and physical access in support of data, application, operating system, network, and infrastructure.
3. Prepare results of the appropriate tests of security, logical, and physical access in support of data, application, operating system, network, and infrastructure.
Topic 2: IT change management
Summary: Perform tests and report on the results of change management controls.
Learning objective(s):
1. Perform tests of the design and operating effectiveness of relevant internal controls (automated and manual for applications and data).
2. Prepare the results of the appropriate tests of change management controls.
Topic 3: Tests of internal controls related to business processes
Summary: Design appropriate tests of the application controls related to business processes.
Learning objective(s):
1. Design of the appropriate tests of the application controls (manual, automated, IT dependent) related to business processes.
Topic 4: Sufficient appropriate evidence: Specific matters that require special consideration
Summary: Identify additional procedures needed to obtain sufficient appropriate evidence due to data analytic procedures.
Learning objective(s):
1. Interpret results and determine additional procedures to be performed as a result of data analytic procedures using outputs (e.g., reports and visualizations) from audit data analytic techniques to determine relationships among variables.

Part II: CPA Evolution Discipline
Section 2: Information Systems and Controls (ISC) Discipline
Module 4: Use and Management of Data
Topic 1: Data governance
Summary: Recognize the basics of a data governance program.
Learning objective(s):
1. Recognize the legal, ethical, business intellectual property and customer sensitivity considerations that should be included in a data governance program that covers what data is needed, the necessary practices throughout the data life cycle, and assignment of responsibility for the governance program.
Topic 2: Data preparation/manipulation
Summary: Identify basics of data extraction, preparation, and manipulation.
Learning objective(s):
1. Recall the capabilities needed in data extraction tools and the important considerations in making a data extraction request such as the data source, format, and integrity of the data.
2. Describe key characteristics of a relational database (e.g., data dictionary, data types, tables, records, fields, relationships, keys, views, queries, and reports).
3. Explain considerations associated with loading data into the final target database (e.g., operational data store, data warehouse or data lake) including the constraints that apply (e.g., uniqueness, referential integrity, mandatory fields), the types of loading (initial, incremental, full refresh), and load verification.
4. Define the attributes of a data repository such as its relevance, elements to be included or excluded, relationships between those elements, and characteristics used to determine its validity, completeness, and accuracy.
5. Determine methods to transform raw data (structured and unstructured) to make it useful for decision-making by correcting or removing data in the data set that is incorrect, inaccurate, incomplete, improperly formatted, or duplicated and to convert, aggregate, merge, replace, validate, format, and split data.

IX. Appendix B: Academic Accounting STEM-Relevant Research

Year	Title	Outlet	STEM	Platform/s	Abstract/Description
2016	Moderating "Cry Wolf" Events with Excess MAD in Benford's Law Research & Practice	JFAR	M	R, SAS	False positives or "Type I errors," wherein test results indicate fraud where none actually exists, have been described as a costly "cry wolf problem" in auditing practice. Benford's Law (which is used as one tool among many in screening for financial statement manipulation) is especially prone to false positives when applied to small and moderately sized datasets. Relying in part on Monte Carlo simulations, we describe with greater precision than extant literature the mathematical correlation between N and Mean Absolute Deviation (MAD), a statistic increasingly used for assessing deviation from Benford's Law. We recommend replacing MAD with an alternative, Excess MAD, which explicitly adjusts for N in estimating deviation from Benford's Law. Applying nonparametric, generalized additive modeling to public company financial statement numbers, we demonstrate the differing outcomes expected from Excess MAD and MAD and produce evidence suggesting that, despite Sarbanes-Oxley and Dodd-Frank legislation, Benford's Law conformity of public company financial statement numbers remained relatively stable across four decades beginning in 1970.
2020	Mathematical Formulation of the Effectiveness of "Separation of Duties" as a Preventive Control Activity	JFAR	M	n/a	We contribute to the literature by examining, for the first time, degrees of separation of duties and ask whether SOD is an effective preventive control. We develop a mathematical model of the theoretical number of organizational fraud incidents, with and without SOD. We find that SOD results in the same or increased possibilities of fraud, relative to a lack of SOD, and that SOD needs to prevent 99% of frauds to always be an effective preventive control. Moreover, SOD's effectiveness is impaired by collusion. We suspect, however, that while acknowledging this impairment most people disregard or assign a low probability to collusion. We find that even when we assign low probabilities, the sheer number of possible collusive engagements weakens SOD as an effective preventive control. We illustrate our results with evidence provided by the Association for Certified Fraud Examiners (ACFE).
2023	Fraud Detection Using Python & Fraudit	AAA IDA 2023	T, M	Python, Fraudit	Uses MC simulation and neural nets to detect fraud in banking data.

Year	Title	Outlet	STEM	Platform/s	Abstract/Description
2023	Monte Carlo Valuation and Forecasting Simulations with Excel, R, Python	AAA IDA 2023	T, M	R, Python	Monte Carlo Valuation and Forecasting Simulations with Excel, R, Python. Includes MC simulation scripts for R and Python.
2021	Digital Assets Case	EY ARC	T	EY Helix	EY Helix (proprietary software) is used by EY's Assurance practice to leverage new analytics techniques and technologies to enhance quality and drive efficiency in the audit. EY Helix is a proprietary tool and it is not available for the classroom. However, the EYARC has developed EY Helix Blockchain Analyzer for Public Networks for Students, a simplified tool based on elements of the EY Blockchain Analyzer within the EY Helix platform designed specifically for the classroom using TIBCO Spotfire® via the cloud (no software is required for use). The tool helps students simulate real-world audit analytics procedures by using similar data, analyses and tools used by professional auditors. In this case, students will learn basics about blockchain and digital assets; accounting for cryptocurrencies; auditor's responsibilities and audit risk assessment regarding cryptocurrency transactions; use of public blockchain data; and how to use their audit tool, the EY Helix Blockchain Analyzer for Public Networks for Students, to audit the company's cryptocurrency portfolio.
2020	Timp Health Case - Linear regression	EY ARC, ACCT 7530	T, M	R	Adaptation and extension of an EY ARC case focused on using linear regression to forecast drug costs. This case asks students to assume the role of a cost analyst within Timp Health, a company that specializes in pharmacy benefit management. The task is to analyze drivers of gross drug costs and, ultimately, to develop, test, deploy, and interpret a regression model that best predicts future gross drug costs. The real-world data for this case includes gross drug costs, along with other data fields, at both member and record detail levels. Requires students to "ETL" the data, code, train, and select linear regression models using appropriate model selection routines, interpret linear regression output, including model diagnostics like influence plots.

Year	Title	Outlet	STEM	Platform/s	Abstract/Description
2023	Constituent Input on Regulatory Initiatives: A Machine-Learning Approach to Efficiently and Effectively Analyze Unstructured Data	JIS	T, M	Python	Determining whether constituent opinion agrees or disagrees with proposed regulation is crucial to improving our understanding of standard-setting practices. However, the constituent feedback mechanisms provided by regulators to constituents results in large-scale unstructured datasets (thus establishing an obstacle in examining differences of opinion between parties). Utilizing publicly available documents of FASB, this study trains machine-learning models to efficiently and effectively categorize the level of agreement and disagreement on proposed regulation between the regulator and its constituent base. We employ three different approaches — a lexicon-based approach using the dictionary method and two participant-based approaches leveraging human raters (AMT and AS). We find that the machine-learning models demonstrate more accuracy in correctly classifying observations as compared to human raters. Further, the analysis indicates that the machine-learning models using the participant-based approach and the lexicon-based approach achieve similar accuracy in predicting constituent agreement and disagreement with proposed regulation.
2023	Climate Change Risk Disclosures and Audit Fees: A Text Analytics Assessment	JETA	T	Pyth	In this paper, we first conduct a longitudinal study of public companies' climate change risk disclosures from 2005 to 2019. Results indicate that although the number of firms disclosing climate change risks increased over time, disclosure length and disclosure clarity did not improve consistently during the study period. It seems that firms temporarily adjusted their disclosure behaviors around 2010 to satisfy the SEC's 2010 guidance regarding climate change disclosures. From that point forward, however, companies' disclosure length and clarity declined. Climate change and disclosures in a client's environment can elevate both inherent risk and audit risk. Accordingly, the second part of the study empirically examines whether climate change risk disclosures are embedded into the auditors' risk model and associated audit prices. Results suggest that audit fees are significantly associated with climate change risk disclosure length and clarity, and lower climate change risk disclosure clarity is associated with higher audit fees.
2023	Teaching Data Analytics with Python (and R)	AAA IDA 2023	T	R, Python	Identifies CPA Evolution learning objectives that can be achieved with Python & R.
2023	Hands-on SQL practice	AAA IDA 2023	T	SQL	Uses SQL Lite in DB Browswer to teach SQL. Students will learn about transaction processing systems by constructing and querying a simple one (ties back to documentation covered in the revenue transaction cycle). Students will practice problem-solving while working with new technology. Students will gain experience querying a database using SQL (including joining tables, grouping, and filtering).

Year	Title	Outlet	STEM	Platform/s	Abstract/Description
2023	Introducing Machine Learning in Auditing Courses	JETA	T	IBM SPSS	The advances in machine learning have gained close attention from audit practitioners and standard setters. However, fewer than half of accounting programs teach predictive analysis, including machine learning. To develop students' knowledge and skills of machine learning in auditing applications, this study introduces machine learning to the accounting curriculum and presents a novel hands-on approach for teaching machine learning in auditing courses. The objective is to provide students who have no statistics background and programming skills with the basic knowledge of machine learning and hands-on exercises for predicting auditing tasks. In addition to instruction manuals, this study demonstrates an implementation of machine learning exercises in a graduate-level auditing course.
2023	Accounting Data Analytics in R: A Case Study Using Tidyverse	JETA	T	R	Data analytics (DA) has gained widespread attention in accounting and auditing recently. Despite the significant potential presented by DA programming languages such as R and Python, their application remains limited. This study presents the tidyverse approach of R for DA in the field of accounting. This approach can greatly benefit undergraduate or graduate accounting students without any coding knowledge. In addition, a teaching case suitable for auditing, accounting information systems, or accounting/auditing analytics classes is presented for instructors to adopt in their courses. Evidence from classrooms suggests that this approach is effective in teaching R for DA and in introducing advanced DA tools for the next generation of accountants.
2022	A Second Look at a Mathematical Formulation of the Effectiveness of "Separation of Duties" as a Preventive Control Activity	JFAR	M	n/a	Barra, Savage, and Im (2020) provide a mathematical model showing SOD increases fraud, contradicting widespread and long-held beliefs. This paper argues that Barra et al.'s (2020) controversial conclusion relies on unrealistic assumptions. In particular, we object to the assumption that any randomly formed collusion group of the right size can commit fraud. Instead, we argue that a group can only commit fraud if it controls the duties of authorization, recordkeeping, and custody of assets. In addition, we argue that assigning equal probabilities to outcomes assumes away the very feature of SOD that decreases fraud risk; namely, SOD adds a point of failure by requiring the fraudster to recruit other employees. We nevertheless show that SOD can increase fraud risk when its implementation requires hiring many new employees. However, other controls can be combined synergistically with SOD to restore its fraud-decreasing ability.

Year	Title	Outlet	STEM	Platform/s	Abstract/Description
2023	Machine Learning Activity-Based Costing: Can Activity-Based Costing's First-Stage Allocation Be Replaced with a Neural Network?	JETA	T, M	Python	Using a design science approach, I test whether machine learning can replace the first-stage allocation of activity-based costing (ABC). I call this combination machine learning activity-based costing (MLABC). I conduct three numerical experiments using simulated datasets and find evidence that MLABC can produce relatively accurate overhead allocations like ABC if (1) the data include longitudinal correlations between cost drivers and cost resources, (2) correlations between cost drivers and cost resources include interactions, and (3) avoiding ABC's cost study does not leave the firm ignorant of a cost driver that accounts for a substantial amount of variance between cost drivers and cost resources. I find limited evidence that MLABC can facilitate active experimentation with the firm's cost function to learn more about it. I also conduct two supplemental mini-cases with data from practice. These mini-cases help test assumptions from my numerical experiments.
2023	Designing a Classifying System for Nonprofit Organizations Using Textual Contents from the Mission Statement	JETA	T, M	Python	Comparing an entity's financial indicators with those of similar organizations can provide a better understanding of its operational and financial health. This study describes the design and implementation of a prototype multilabel classification method to categorize nonprofit organizations (NPOs) using the textual content of their mission statements to enable beneficial comparisons. Positive unlabeled learning was used to improve the classification performance of partially labeled data. Naive Bayes, Gradient Boosting, Random Forest, and Support Vector Machine (SVM) algorithms were applied to determine the most effective method for classifying NPOs. The SVM model performed best in identifying "Housing and Shelter" organizations. The SVM classifier identified organizations that were not previously classified as "Housing and Shelter" but provided housing and shelter services as a part of their programs and activities. The new classification method can help donors, grant providers, and researchers to identify similar nonprofit organizations at the operational level.
2023	Python Stock Analysis Package	AAA IDA 2023	T	Python	This Python package is a financial statement analysis tool that uses Alpha Vantage and Streamlit to fetch and display financial data for a given stock ticker. It defines several functions that fetch and standardize financial data for a given ticker, as well as functions that display the data in a tabular format. https://github.com/hamid-vakilzadeh/Stock-Analysis

Year	Title	Outlet	STEM	Platform/s	Abstract/Description
2017	Toward a Unified Theory of Materiality in Securities Law	Columbia J. Transnational Law	M	Agena AI	Regulatory efforts in the United States and European Union have recently refocused on materiality, an essential but elusive securities law concept. The renewed focus is due in part to increasing globalization of capital markets, data, and information channels that has highlighted inconsistencies in theory and application. In the United States, the Supreme Court has loosely defined materiality through a line of cases beginning with TSC Industries v. Northway and Basic, Inc. v. Levinson, whose reasonable investor rubric is frequently disregarded by lower courts, prosecutors, and the SEC. Meanwhile, in the E.U., courts have only lightly addressed materiality. Scholars in law and behavioral economics have criticized the TSC-Basic rubric for its ambiguity, unpredictability, and disconnection from market psychology. Recognizing these criticisms, this article conducts an international comparative investigation of materiality in the legislation, regulation, and case law of the United States and European Union, revealing a shared, probabilistic Bayesian infrastructure. The article then proposes a flexible Bayesian framework that harmonizes the substantive evaluation of materiality under existing U.S. and E.U. law. Finally, it models application of the framework using Bayesian network analysis in the context of a hypothetical stock transaction.
2023	Modeling Cybersecurity Risk with Bayesian Networks	AAA IDA 2023	T, M	Agena AI	Demonstrates the use of Bayesian networks to perform quantitative, probabilistic assessment of cybersecurity risk, using the 2021 Colonial Pipeline Ransomware hack as the focal case study. Includes sensitivity analysis and creation of hybrid influence diagrams and cost-benefit-optimized decision trees. Relies on information entropy.
2022-23	Postgre SQL RDBMS project	ACCT 4330	T	SQL	Requires undergrad AIS students to build a PostgreSQL server, create a relational database and use it to perform data prep, wrangling, transformation, multiple joins (including subqueries), and table creation using PostgreSQL. Uses synthetic corporate data generated by HUB of Analytics Education, https://www.hubae.org/datvironment/batoys/.
2022-23	Bayesian network risk assessment of CECL estimate under SAS 143	ACCT 7520	T, M	Agena AI	Requires MAcc students to use Bayesian networks to model and probabilistically quantify (probabilities and odds) the risk of material misstatement of a Current Expected Credit Losses (CECL) estimate, following SAS 143 & 145, and AU-C 240. Includes multiple scenario analysis and sensitivity analysis. Adapts Barone et al. (2022), A Critical Analysis of Calculations of CECL at Dynamic Corporation, Issues in Acctg. Education (53-66). Relies on information entropy.

Year	Title	Outlet	STEM	Platform/s	Abstract/Description
2020	EY BioPhirma P-Card Case - R adaptation	ACCT 7530	T	R	Requires MAcc students to use R (instead of Alteryx) to complete selected tasks in the EY ARC BioPhirma data analytics case. Involves coding in R to perform "ETL" (data prep, wrangling, transformation) plus anomaly detection and natural language processing using TF-IDF in R.
2021-23	Detection of Anomalies using Density-Based Cluster Analysis in R - Real Data	ACCT 7530	T, M	R	Requires MAcc students to wrangle, prep, and detect anomalies in real A/P data using density-based cluster analysis to identify vendors and employees who may merit further audit attention. Data provided by Rushton CPAs and the City of Gainesville, Georgia. Uses the dbscan package in R. See https://rdrr.io/cran/dbscan/ and https://www.youtube.com/watch?v=RDZUdRSDOok. Related exam questions are based on the technical article, https://rdrr.io/cran/dbscan/f/inst/doc/dbscan.pdf. Visualization of the clustering can be observed in the Shiny app at https://hotviz.shinyapps.io/APClusters/.
2021	Estimating Business Value with Bayesian Networks	The Value Examiner	T, M	Agena AI	Given the wide plausible ranges for business value, the greatest value that a business valuation expert offers a client may be the ability to persuade others (e.g., judges) to locate their preponderance of probabilities (evidence) across the client's interval within the plausible range. Accomplishing this feat is a function of technical valuation expertise, as well as communication tools and techniques. This article explores Bayesian networks as a platform for facilitating probabilistic analysis, negotiation, and communication of business value. Relies on information entropy.
2019	Estimating Economic Damages with Linear Regression and Bayesian Networks Part II	The Value Examiner	T, M	Agena AI	In 2010, Robert M. Lloyd wrote, "In an ideal world, a court would be able to hear the evidence, estimate the plaintiff's damages, and quantify its own confidence that the estimate was accurate." This article argues that Bayesian networks can move the legal world very close to Lloyd's ideal. Part I addressed linear regression principles, flaws, and pitfalls in the context of an actual case. Part II defines Bayesian networks, illustrates how Bayesian networks could have been used advantageously in the actual case, and posits that Bayesian networks are a highly effective tool for triers of fact to evaluate the fact and amount of damages with "reasonable certainty." Along the way, Part II challenges the popular mythology that point estimates offer higher certainty than value ranges.

Year	Title	Outlet	STEM	Platform/s	Abstract/Description
2019	Estimating Economic Damages with Linear Regression and Bayesian Networks Part I	The Value Examiner	T, M	R, Agena AI	Expert witnesses often use linear regression in dispute resolution settings. Part I of this two-part article illuminates linear regression principles and pitfalls in the context of an actual case and offers related practice pointers. Part II demonstrates the use of Bayesian networks for a more transparent and user-friendly estimation of damages and firm value. While Bayesian networks have so far seen scant action in court, their user-friendliness and technical and aesthetic superiority point to their usefulness as evidence in dispute resolution.
2021	Building reactive Shiny web apps	ACCT 7530	T, M	R, Shiny	Requires MAcc students to use R (multiple packages including shiny and dbscan) to program and deploy on the internet a "reactive" web app that allows non-programmers to identify anomalous vendor accounts and employees in a real A/P database by manipulating cluster analysis parameters and other inputs. See working example at https://hotviz.shinyapps.io/APClusters/.
2023	Teaching Predictive Audit Data Analytic Techniques — Time Series Forecasting with Transactional and Exogenous Data	JETA	T, M	Python	Audit data analytics is gaining increasing attention from both audit researchers and practitioners. To provide accounting students with firsthand experience utilizing data analytics, this teaching case showcases the implementation of data analytic techniques to transactional-level data from real-world business practice. Specifically, this case demonstrates the application of seasonal autoregressive integrated moving average models, utilizing exogenous weather data, to predict daily sales amounts of a wholesale club retailer. The learning objective is to demonstrate this process and teach students to apply predictive data analytics through Python programming and incorporate and use exogenous data in sales prediction.

X. Appendix C: Extensive Listing of Patents filed by CPAs, Accounting Firms, and Accounting Academics

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11564636B1	System and method for physiological health simulation	Systems and methods for health and body simulations to predict numerous physiological parameters in a subject or a population of subjects based on the input of limited physiological data.	A61B 5/7275 - Determining trends in physiological measurement data	2023	PRICEWATERHOUSE COOPERS LLP
US11510168B2	Systems and methods for generating and updating proximal groupings of electronic devices	Embodiments described herein generate proximal groupings of wireless signals based upon the temporal persistence and spatial proximity of the wireless signals as observed by a plurality of observer devices. For example, a first observer device may observe a first set of wireless signals at a first timepoint and a second observer device may observe a second set of wireless signals at a second timepoint. The first observer device may again observe a third set of wireless signals at a third timepoint. Based upon these observations, a server may generate a proximal grouping a wireless signals containing a subset of the first, second, third of wireless signals based upon temporal persistence and spatial proximity. Temporal persistence may be based upon the repeated observations of the subset of wireless signals across different timepoints and the spatial proximity may be based upon the proximity of locations of the observer devices.	G01S 5/0289 - Relative positioning of multiple transceivers	2022	PRICEWATERHOUSE COOPERS LLP
US019596B2	System and method for enriching and normalizing data	An integrated platform system that employs a series of machine learning techniques and prediction and detection units that can process input data and extract and generate meaningful insights and predictions therefrom. The system integrates together multiple different data storage types and applications that generates data of different types, and an associated processing system for processing the different data types, store the data in a common data model to normalize the data, determine the data lineage of the data, and then process the data using different types of techniques. The data can also be processed by a prediction unit for generating meaningful insights and predictions or by an anomaly detection unit for detecting one or more anomalies in the data.	G06F 16/215 - Improving data quality; Data cleansing, e.g. de-duplication, removing invalid entries or correcting typographical errors	2024	KPMG LLP

*Patents may have additional CPC classifications in addition to those shown in the table

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US12038907B1	Apparatus and methods for maintaining data integrity for database management	In an embodiment, metadata representing a plurality of objects included in a database is received. A first set of objects from the plurality of objects that are compliant with a predetermined set of rules are identified using the metadata and not using the plurality of objects. A second set of objects from the plurality of objects that are not compliant with the predetermined set of rules are identified using the metadata and not using the plurality of objects. A risk associated with each object from the second set of objects is determined. Based on at least one risk associated with at least one object from the second set of objects, at least one recommendation to modify the at least one object to reduce non-compliance of the database is provided.	G06F 16/2365 - Ensuring data consistency and integrity	2024	EYGS LLP (Ernst & Young)
US11977565B2	Automated data set enrichment, analysis, and visualization	Systems, methods, and graphical user interfaces (GUIs) for ingesting and enriching data regarding a plurality of entities are provided. A first data set comprising company data and a second data set comprising customer data are ingested. The first data set is processed to generate a processed data set. The first data set may be processed by applying an entity matching technique, wherein one or more data elements are generated based on whether an entity of the first data set and an entity of the second data set are commonly associated. The first data set may additionally or alternatively be processed by applying a statistical matching technique, wherein one or more predicted data elements are generated based on similarity between an entity of the first data set and one or more entities of the second data set.	G06F 16/287 - Relational database visualization	2024	PWC PRODUCT SALES LLC
US12021991B2	Methods and systems for implementing zero-knowledge proofs in transferring partitioned tokens on distributed ledger-based networks	One or more embodiments described herein disclose methods and systems that are directed at providing enhanced privacy, efficiency, convenience and security to distributed ledger-based networks (DLNs) via the implementation of zero-knowledge proofs (ZKPs) in the DLNs. ZKPs allow participants of DLNs to make statements on the DLNs about some private information and to prove the truth of the information without having to necessarily reveal the private information publicly. As such, the disclosed methods and systems directed at the ZKP-enabled DLNs provide privacy, ease and efficiency to participants of the DLNs while still allowing the DLNs to remain as consensus-based networks.	G06F 21/74 - Protecting computer components operating in dual or compartmented mode	2024	EYGS LLP (Ernst & Young)

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US12032726B1	Method to obfuscate keyboard keys against interception	Systems and methods for obfuscating keyboard keys against interception are provided. In an example, a protected application is dynamically virtualized in user space, wherein the virtualization comprises an isolated keyboard path. Keystrokes are injected to the isolated keyboard path, wherein the injected keystrokes are associated with a respective timestamp, and user input keystrokes are obfuscated with the injected keystrokes and the obfuscated keystrokes are passed to a low level hook. The obfuscated keystrokes passed to the low level hook are separated according to tags associated with the obfuscated keystrokes to obtain the user input keystrokes. The user input keystrokes are transmitted to a target window of the protected application.	G06F 21/83 - input devices, e.g. keyboards, mice or controllers thereof	2024	DELOITTE DEV LLC
US12020004B1	Systems and methods to generate human-readable instruction code based on a declarative specification	A method according to an embodiment includes receiving, via a processor, (1) first data representing one or more coding requirements defined by a user, (2) an indication of one or more target computer programming languages, and (3) a first machine-readable code. The method also includes modifying the first machine-readable code to generate a second machine-readable code based, at least in part, on the first data. The method also includes generating target machine-readable code based, at least in part, on the one or more target computer programming languages and the second machine-readable code.	G06F 8/35 - Creation or generation of model driven source driven	2024	EYGS LLP (Ernst & Young)
US10956786B2	Machine learning based extraction of partition objects from electronic documents	An object-extraction method includes generating multiple partition objects based on an electronic document and receiving a first user selection of a data element via a user interface of a compute device. In response to the first user selection, and using a machine learning model, a first subset of partition objects from the multiple partition objects is detected and displayed via the user interface. A user interaction, via the user interface, with one of the partition objects is detected, and in response, a weight of the machine learning model is modified, to produce a modified machine learning model. A second user selection of the data element is received via the user interface, and in response and using the modified machine learning model, a second subset of partition objects from the multiple partition objects is detected and displayed via the user interface, the second subset different from the first subset.	G06F 3/0482 - Interaction techniques with lists of selectable items based on graphical user interfaces based on graphical user interfaces	2021	ERNST & YOUNG U S LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11822773B2	Systems and methods for generating and utilizing an interactive causal loop diagram using a causal loop designer	Systems and methods for generating and utilizing an interactive causal loop diagram using a causal loop designer are provided. In one or more examples, a computer-implemented method for creating a causal loop diagram comprising visually emphasized elements can comprise displaying a first element and a second element, wherein the first element and the second element comprise visually emphasizable elements. In response to receiving a user command to connect the first element to the second element, the method can comprise displaying a connection between the first element and the second element, wherein the connection comprises a visually emphasizable element. In one or more examples, the method comprises displaying a causal loop diagram comprising the first element, the second element, and the connection. In response to a user activating a visual emphasis tool, the method can comprise visually emphasizing one or more of the visually emphasizable elements.	G06F 3/0484 - nteraction techniques based on graphical user interfaces nteraction techniques based on graphical user interfaces	2023	PWC PRODUCT SALES LLC
US11526261B1	System and method for aggregating and enriching data	An intelligent forecasting system that includes sources of financial and non-financial input data and a user interface generator for generating user interfaces having window elements that display the input data. The window element includes a persistent navigation pane element having vertically stacked actuatable navigation soft buttons for accessing one or more portions of an intelligent forecasting. The navigation soft buttons include, among other buttons, an Outlier Treatment soft button for processing the input data by applying thereto a statistical processing model to detect outliers in the input data, a Model Selection soft button for selecting a statistical forecasting model to apply to the input data, a Signal Explorer soft button for selecting a signal transformation method for transforming the input data, a Model Prediction soft button for selecting one of the statistical forecasting models to apply to the input data, and a Simple Prediction soft button for automatically generating forecasts.	G06F 3/0484 - nteraction techniques based on graphical user interfaces nteraction techniques based on graphical user interfaces	2022	KPMG LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11726792B1	Methods and apparatus for automatically transforming software process recordings into dynamic automation scripts	An apparatus includes a processor and a memory storing instructions to cause the processor to receive files including a table database and sequence record data. The processor is further caused to generate a script by mapping each screen feature from a set of screen features extracted from the sequence record data to a table from the table database. The processor is further caused to generate a screen schema based on the script, by attempting to correlate addresses associated with the sequence record data to the screen features, to generate the screen schema including a table of dynamic. The processor is further caused to automatically generate a generic automation script based on the sequence record data and the screen schema to be consumed by a software bot to execute user actions in the sequence record data in an automated fashion.	G06F 9/3879 - Arrangements for executing machine instructions for non-native instruction execution	2023	EYGS LLP (Ernst & Young)
US11216531B2	Enterprise software adoption platform systems and methods	This invention relates to software adoption platform systems and methods. An exemplary computer-implemented method comprises at an electronic device with a display, displaying a window associated with a software system; displaying, within the window, a user interface corresponding to a software adoption platform, wherein the user interface corresponding to the software adoption platform comprises: a user-specific score associated with the software system, and a plurality of user affordances corresponding to a plurality of actions within the software system; upon selection of a user affordance of the plurality of user affordances, automatically displaying a page of the software system in the window based on the selected user affordance, and automatically displaying one or more messages overlaid over the page of the software system, wherein the one or more messages are generated by the software adoption platform.	G06F 9/453 - Arrangements for executing specific help system programs	2022	PRICEWATERHOUSE COOPERS LLP
US11924352B2	Systems, apparatus and methods for local state storage of distributed ledger data without cloning	Distributed ledger-based networks (DLNs) employ self-executing codes, also known as smart contracts, to manage interactions occurring on the networks, which may result in the generation of a massive amount of DLN state data representing the interactions and participants thereof. The instant disclosure discloses systems, apparatus and methods that allow interactions to occur on the DLNs without modification to stored data, thereby improving the storage capabilities of the networks.	G06F 11/3495 - Recording or statistical evaluation of computer activity for systems	2024	EYGS LLP (Ernst & Young)

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US10871977B2	Automated software script remediation methods and systems	A method for real-time remediation of a software script includes, during execution of the script, attempting to identify a first user interface (UI) object. In response to failing to identify the first UI object, similarity scores are calculated based on the data of the plurality of UI objects and historical data associated with the first UI object. A second UI object is identified, from the plurality of UI objects, based on the calculated similarity scores. The script and/or an object repository referenced by the script are then automatically modified so that subsequent execution of the script includes attempting to identify the second UI object instead of the first UI object.	G06F 11/368 - Preventing errors by testing or debugging software for test version control	2020	ERNST & YOUNG LLP
US11681688B2	Immutable and decentralized storage of computer models	The present disclosure relates generally to storing computer models, and more specifically to a platform for achieving replicability of a computer model (e.g., a trained machine-learning algorithm) by storing and providing access to data associated with the computer model using an immutable and decentralized ledger system (e.g., a blockchain ledger) and a distributed database. An exemplary computer-enabled method for storing a computer model, the method comprises: receiving data associated with the computer model; generating one or more asset files based on the data associated with the computer model; generating one or more hash values corresponding to the one or more asset files; generating one or more of location trackers corresponding to the one or more asset files; generating a ledger entry comprising the one or more hash values and the one or more location trackers; and adding the ledger entry to a blockchain ledger.	G06F 16/1837 - Distributed file systems, management specially adapted to peer-to-peer storage networks	2023	PRICEWATERHOUSE COOPERS LLP
US11921705B2	Information storage and retrieval using an off-chain isomorphic database and a distributed ledger	A processor-implemented method for the ownership transfer and tracking of tangible assets using a blockchain is described. In an embodiment, the method includes generating a root node associated with a tangible asset via a processor. The root node has a first hash value that represents a storage location of the root node, data associated with a tangible asset, and a second hash value that represents a storage location of the subsidiary node. The method also includes storing a hierarchical hash-linked tree structure in a non-transitory, processor-readable memory. The hierarchical hash-linked tree structure can include multiple nodes. The multiple nodes include the root node and the subsidiary node. The subsidiary node has the second hash value, and data associated with a tangible sub-asset of the tangible asset.	G06F 16/2379 - File system structures for updates performed during online database operations	2024	ERNST & YOUNG U S LLP & EYGS LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11726988B2	Scalable and advanced analytics computing platform for distributed ledger data and custody solutions	Systems and methods disclosed herein are directed to a scalable and advanced analytics computing platform for distributed ledger data for integrating an entity's legacy systems, distributed ledger systems, and crypto-asset transactions, as well as related metadata. The systems and methods further relate to a custody adapter implementation that enables interactions across multiple custody technology providers, sub-custody providers, and internal custody solutions.	G06F 16/2379 - File system structures for updates performed during online database operations	2023	KPMG LLP
US11580112B2	Systems and methods for automatically determining utterances, entities, and intents based on natural language inputs	Systems and methods for processing natural language inputs to determine user intents using an insights repository are provided. An insights repository system is configured to build an insights repository as a data structure representing a plurality of entities and relationships among those various entities. The insights repository system may receive information from various sources via an event stream, and may process the information using event rules. Based on the application of the event rules, the system may configure an insights repository data structure representing various entities, relationships between various entities, and the strengths of relationships between various entities. After the insights repository is created, consumers may execute queries against the insights repository. Furthermore, the insights repository system may automatically query the insights repository to generate insight information to be published to an insight feed to which consumer systems may subscribe to receive automatic updates.	G06F 16/24564 - Recursive query execution	2023	PRICEWATERHOUSE COOPERS LLP
US11416510B2	Systems and methods for applying lifecycle processes to digital data objects utilizing distributed ledger technology and artificial intelligence	Systems and methods disclosed herein provide for applying lifecycle processes to digital data objects utilizing blockchain and artificial intelligence. Embodiments of the systems and methods provide for interacting with a digital data object from a variety of different source systems as well as dynamically modifying particular attributes associated with the digital data objects based on real-time information and/or user-specified requirements.	G06F 16/254 - Extract, transform and load [ETL] procedures	2022	KPMG LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US9875290B2	Method, system and computer program product for using an intermediation function	The present disclosure relates to methods and systems for generating an intermediation function and performing the intermediation function. The first method selects at least one command among a plurality of pre-defined commands stored at a configuration server, configures parameters of the at least one command, processes the at least one command to generate the intermediation function, transmits the intermediation function and the parameters to an intermediation platform, and stores the intermediation function and the parameters at the intermediation platform. The second method receives the intermediation function and parameters from the configuration server, stores the received intermediation function and the parameters at the intermediation platform, receives data from a user based on the parameters, processes the user data with the intermediation function based on the parameters, and transmits information generated by the processing of the user data to a database server.	G06F 16/258 - Data format conversion from or to a database	2018	DELOITTE IT INC
US7590658B2	System, software and method for examining a database in a forensic accounting environment	A system, software and method which enable the forensic examination of a database, particularly, a financial database such as a general ledger. The system, software and method leverage "n-" or multi-dimensional data interrogation analytics, particularly, online analytical processing ("OLAP"), to enable real-time data analysis of various dimensions of multi-dimensional data in the database and identification of records that are unusual and/or significant including from patterns or relationships among the data.	G06F 16/283 - Multi-dimensional databases or data warehouses	2009	DELOITTE DEV LLC
US8819021B1	Efficient and phased method of processing large collections of electronic data known as "best match first"™ for electronic discovery and other related applications	A method of more efficient, phased, iterative processing of very large collections of electronic data for the purposes of electronic discovery and related applications is disclosed. The processing minimally includes: text extraction, and the creation of a keyword search index, but may include many additional stages of processing as well. The method further includes: definition of an initial set of characteristics that correspond to "interesting" data, followed by the iterative completion of processing of this data based on a combination of user feedback on the overall relevance of the documents being processed and the system's assessment of whether or not the data it has recently selected to promote in the processing completion queue has the desired quality and quantity of relevant data. The process continues until all identified data has either been fully processed, or discarded at some intermediate stage of processing as being likely irrelevant. This has the result of effectively finishing the processing much earlier, as the later documents in the processing queue will be increasingly irrelevant.	G06F 16/3331 - Query processing	2014	ERNST & YOUNG U S LLP & inventors

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11188585B2	Systems and methods for aligning data tables to domain ontologies	Systems and methods disclosed herein provide for semantically aligning data tables, controlled domain vocabularies, and domain ontologies. The systems and methods provide for aligning the data tables, controlled domain vocabularies, and domain ontologies based on a proxy table ontology representing a physical syntactical structure of the data table.	G06F 16/367 - Creation of an ontology	2021	KPMG LLP
US11907299B2	System and method for implementing a securities analyzer	The invention relates to computer-implemented systems and methods for analyzing and standardizing various types of input data such as structured data, semi-structured data, unstructured data, and images and voice. Embodiments of the systems and the methods further provide for generating responses to specific questions relating to certain rates and terms, such as LIBOR, as well as complex legal constructs, such as interest rate fallback waterfalls, for risk assessment and mitigation. The present invention performs environmental, social, governance analytics on asset-backed securities including commercial mortgage-backed securities.	G06F 16/90332 - Natural language query formulation or dialogue systems	2024	KPMG LLP
US11216659B2	Converting table data into component parts	A system and method of processing source data that includes table data by converting the table data into machine encoded text data having associated therewith text coordinate data having a Y-axis component and an X-axis component, and then generating from the machine encoded text data a plurality of pixels along the Y-axis component and the X-axis component. The system then performs a clustering technique on the plurality of pixels to generate a plurality of clusters of pixels based on similar attributes, and classifying each of the plurality of clusters of pixels as a selected row of the table and as a selected column of the table, thus making available the information encoded in the table for subsequent processing.	G06F 16/906 - Details of database clustering and classification functions independent of the retrieved data types	2022	KPMG LLP
US11281901B2	Document extraction system and method	A system for giving meaning to data in a non-standardized digital document. In some embodiments, the system includes a web portal, a recognition server and an extraction system. The web portal is accessible via a network for receiving a non-standardized digital source document. The recognition server is configured to perform optical character recognition analysis on the non-standardized digital source document and generates document recognition data including positional locations of a plurality of characters in the non-standardized digital source document. The extraction system is configured to identify labels and corresponding values represented in the non-standardized digital source document and automatically maps the labels to a plurality of predetermined variables in an external software system to which the values from the non-standardized digital source document are to be imported.	G06F 16/93 - Details of document management database functions independent of the retrieved data types	2022	CROWE LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US10915641B2	Implementation of continuous real-time validation of distributed data storage systems	Provided herein is a system and method for implementing a real-time and continuous validation tool for a distributed ledger-based computing system (i.e., blockchain). In one or more examples a real-time validation tool and system can continuously monitor a blockchain computing system for activities that indicate abnormal or risky behavior, and can generate a report to a user that details those events. The real-time validation tool can be implemented as a node in a blockchain computing system and can use information gleaned from blockchain activity occurring in real-time as well as external data gathered from various sources to determine if one or more events has occurred that is indicative of abnormal or risky activity occurring within the blockchain computing system. The validation tool can be used to improve and secure an existing blockchain computing system against cyber intrusions and various integrity issues.	G06F 21/577 - Assessing computer platform vulnerabilities and evaluating computer system security	2021	PRICEWATERHOUSE COOPERS LLP
US8813228B2	Collective threat intelligence gathering system	Threat intelligence is collected from a variety of different sources. The threat intelligence information is aggregated, normalized, filtered and scored to identify threats to an information network. Threats are categorized by type, maliciousness and confidence level. Threats are reported to network administrators in a plurality of threat feeds, including for example malicious domains, malicious IP addresses, malicious e-mail addresses, malicious URLs and malicious software files.	G06F 21/577 - Assessing computer platform vulnerabilities and evaluating computer system security	2014	DELOITTE DEV LLC & inventors
US11722324B2	Secure and accountable execution of robotic process automation	Systems and methods for secure and accountable execution of computer scripts are disclosed. A system for validating an execution of a set of computer instructions may be configured to receive a first cryptographic hash, the first cryptographic hash corresponding to the set of computer instructions, to receive a second cryptographic hash, the second cryptographic hash corresponding to a runtime utility, wherein the runtime utility is configured to execute the set of computer instructions, to generate a ledger entry comprising the first cryptographic hash, the second cryptographic hash, and an indicator of success, and to add the ledger entry to a blockchain ledger, wherein the blockchain ledger is configured to receive the ledger entry from an authenticated node.	G06F 21/64 - Protecting data integrity	2023	PRICEWATERHOUSE COOPERS LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US9098730B2	System and method for preserving electronically stored information	A system and method for collection of electronically stored information (ESI) from Windows based desktops and laptops is disclosed that are under the control of remote custodians. The system and method include an external persistent memory storage device and a software application tool that is loaded onto the persistent memory storage device. The external persistent memory storage device is connected to the computer system hosting the persistent memory storage device to be examined, for example, by way of a USB or Ethernet port. Once connected to the computer system hosting the persistent memory storage device to be examined, a Quick Start program, which, when opened, allows the required processing to be methodically performed. Documentation is provided for completing information regarding the chain of custody of the external persistent memory storage device. The documentation may be imprinted on a security receptacle for receiving the external persistent memory storage device. The security receptacle is configured to protect the persistent memory storage device from electrostatic discharge and to indicate if the bag or container was tampered with after it was sealed.	G06F 21/87 - Security arrangements for protecting computers by means of encapsulation	2015	BDO USA LLP & SHIRK ERIC
US11520957B2	Creating digital twins at scale	Described are methods and systems for calibrating simulation models to generate digital twins for physical entities. In some embodiments, a method includes receiving a plurality of datasets for a plurality of corresponding physical entities. A calibration request is enqueued to a calibration requests queue for each received dataset and includes information indicating a dataset and a corresponding physical entity. A plurality of calibration engines and a plurality of corresponding simulation clusters for generating a plurality of calibration results for a plurality of calibration requests dequeued from the calibration requests queue can be deployed. Each calibration result is enqueued to a calibration results queue as the plurality of calibration engines generates the calibration result and a plurality of calibration results dequeued from the calibration results queue in association with the plurality of corresponding physical entities can be stored as information used to generate a plurality of corresponding digital twins.	G06F 30/15 - Computer-aided vehicle, aircraft or watercraft design	2022	PRICEWATERHOUSE COOPERS LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US10534846B1	Page stream segmentation	Described are system, method, and computer-program product embodiments for performing language-agnostic page stream segmentation. In some embodiments, a method includes receiving a multi-page file associated with a plurality of documents. A plurality of characters present on each page of the set of consecutive pages, including a first page and a second page, of the multi-page file can be detected. A plurality of structural data for each page can be computed based on a position and a font format for one or more of the detected characters. The plurality of structural data between the first page and the second page can be compared to determine whether the second page corresponds to a boundary between two documents of the plurality of documents. The multi-page file can be segmented at the second page in response to determining that the second page corresponds to the boundary.	G06F 40/114 - Handling natural language pagination data	2020	PRICEWATERHOUSE COOPERS LLP
US11907650B2	Methods and systems for artificial intelligence-assisted document annotation	Methods and systems for artificial intelligence (AI)-assisted document annotation and training of machine learning-based models for document data extraction are described. The methods and systems described herein take advantage of a continuous machine learning approach to create document processing pipelines that provide accurate and efficient data extraction from documents that include structured text, semi-structured text, unstructured text, or any combination thereof.	G06F 40/169 - Handling natural language annotation data	2024	PWC PRODUCT SALES LLC
US11763072B2	System and method for implementing a document quality analysis and review tool	The invention relates to computer-implemented systems and methods for assessing the quality of a document or a technical memorandum written with a loosely defined template, stereotype and/or outline of key sections or headers. An embodiment of the present invention leverages Natural Language Processing (NLP) and Machine Learning (ML) techniques to identify key sections in a document using NLP text patterns and further establish, using ML, how closely a given section matches similar sections in other documents that are considered by human Subject Matter Experts (SMEs) to be "well-written" for the intended purpose of the overall document. An embodiment of the present invention further ascertains whether the overall flow of the document follows a general outline in terms of the order of sections.	G06F 40/169 - Handling natural language annotation data	2023	KPMG LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11929066B2	Intent-based conversational knowledge graph for spoken language understanding system	Described are systems, methods, apparatuses, and computer program product embodiments for automatically processing intent-based spoken language for SLU. The disclosed solution uses a scale-free network structured conversational knowledge graph that stores nodes representative of actions, objects, and intent names and edges representative of relationships between the nodes. For all phrases (including a sentence) from the same intent, the system calculates a mean feature vector using a Universal Sentence Embedding (USE) model as a feature element. The system also employs a multi-step intent detection strategy. A graph query technique may be used to match all potential intent nodes from the trained knowledge graph. The system may compute a covariance matrix between the feature element of an input phrase and feature elements of all potential intents. The major component of the covariance matrix along with the maximum covariance may be used to determine the final intent.	G06F 40/30 - Handling natural language data, semantic analysis	2024	PWC PRODUCT SALES LLC
US11681878B2	Methods and apparatus for creating domain-specific intended-meaning natural language processing pipelines	A method includes receiving a dataset that includes a plurality of input texts. Each input text from the plurality of texts is associated with a content category from a plurality of content categories based on a comparison between that input text and an intended meaning that is common for each comparison. For each model in a plurality of models, and for each content category from the plurality of content categories, that model is executed on each input text from the plurality of input texts to generate an average similarity/dissimilarity score for that content category. At least one model from the plurality of models is selected, based on the average similarity score for each content category from the plurality of content categories for each model in the plurality of models, to determine whether an input text is similar/dissimilar to the intended meaning.	G06F 40/30 - Handling natural language data, semantic analysis	2023	ERNST & YOUNG U S LLP
US6202933B1	Transaction card and methods and apparatus therefor	A transaction card carrying encrypted information for verifying that the card has not been forged comprises a card stock, a magnetic stripe storing account information, a printed or embossed account number and a barcode. It is possible, using conventional point-of-sale terminal equipment and magnetic stripe reading and barcode scanning hardware, to determine whether the account information on the transaction card has been forged. This is done by extracting the account number from the magnetic stripe using a magnetic stripe reader or by entering it manually, decrypting the information stored on the barcode and comparing the decrypted information to a representation of the account number information.	G06K 19/14 - Record carriers for use with machines and with at least a part designed to carry digital markings sensed by radiation	2001	ERNST & YOUNG U S LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11972345B2	Machine learning based file ranking methods and systems	A multi-label ranking method includes receiving, at a processor and from a first set of artificial neural networks (ANNs), multiple signals representing a first set of ANN output pairs for a first label. A signal representing a second set of ANN output pairs for a second label different from the first label is received at the processor from a second set of ANNs different from the first set of ANNs, substantially concurrently with the first set of ANN output pairs. A first activation function is solved based on the first set of ANN output pairs, and a second activation function is solved based on the second set of ANN output pairs. Loss values are calculated based on the solved activations, and a mask is generated based on at least one ground truth label. A signal, including a representation of the mask, is sent from the processor to each of the sets of ANNs.	G06N 3/08 - Neural networks, learning methods	2024	ERNST & YOUNG U S LLP
US11710039B2	Systems and methods for training image detection systems for augmented and mixed reality applications	Described are system, method, and computer-program product embodiments for developing an object detection model. The object detection model may detect a physical object in an image of a real world environment. A system can automatically generate a plurality of synthetic images. The synthetic images can be generated by randomly selecting parameters of the environmental features, camera intrinsics, and a target object. The system may automatically annotate the synthetic images to identify the target object. In some embodiments, the annotations can include information about the target object determined at the time the synthetic images are generated. The object detection model can be trained to detect the physical object using the annotated synthetic images. The trained object detection model can be validated and tested using at least one image of a real world environment. The image(s) of the real world environment may or may not include the physical object.	G06N 3/08 - Neural networks, learning methods	2023	PRICEWATERHOUSE COOPERS LLP
US11615325B2	Case-based reasoning systems and methods	Systems and methods disclosed herein provide for a case-based reasoning using universal ontologies. Embodiments of the systems and methods provide for comparing current and past cases based on the universal ontologies and sorting the past cases based on the comparison, wherein the universal ontology integrates authority information associated with the current and past cases.	G06N 5/025 - Knowledge representation, extracting rules from data	2023	KPMG LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11640554B2	Blockchain-based training data management system and method for trusted model improvements	Systems and methods disclosed herein are directed to blockchain-based training data management systems and methods for trusted improvements of models. Embodiments provide for the generation of metadata and smart contracts associated with certain data, using a blockchain to store the generated metadata and smart contracts, and curating training data for the improvement of the models utilizing the generated metadata and smart contract stored in the blockchain.	G06N 20/00 - Machine learning	2023	KPMG LLP
US12014291B2	System and method for processing distorted or inaccurate input data obtained from an environment	A regression planning and evaluation system that, when operated, obtains audit evidence, for example from manufacturing facility. The system comprises a server arrangement configured to (a) obtain input data, input data comprising data values of variables for multiple samples; (b) validate input data; (c) provide user with user interface to input audit parameters, audit parameters comprising at least one of: assurance level, tolerable error, statistical sampling technique; (d) generate regression plot and identify upper and lower acceptance bounds indicated with respect to regression line, regression plot represents variation of target variable with explanatory variable for samples and (e) identify key items to be tested, key items being samples falling outside the aforesaid acceptance bounds. Audit evidence, for example, can initiate further input data collection, further testing and so forth for reducing errors or distortions present in input data that was earlier acquired for analysis by system.	G06Q 10/0637 - Strategic management or analysis	2024	ERNST & YOUNG GMBH
US12014349B2	Transmitting and receiving embedded digital tokens within a blockchain environment	A system, method, apparatus, and computer program product for interactively broadcasting value via a sound, a Wi-Fi, a Bluetooth, an email, a messaging, an RFID, or an NFC to incentivize direct consumer engagement. The system produces verifiable data on customer preferences, habits, and purchasing while using secure digital cryptographic technology to convey an item of value. The system is configured to transact a digital token normally carried on a blockchain leger in an off-ledger condition. The digital token is embedded with a media content. A mobile computing device having a representation of a digital wallet is configured to detect the digital token, decode the digital token and transfer the digital token back to the blockchain ledger. When validated by the blockchain ledger, the digital token is transacted to a digital wallet on the blockchain ledger.	G06Q 20/326 - Payment applications installed on the mobile devices	2024	WEB3 IP HOLDINGS LLC, co-inventor: John Masotti, CPA, Managing Partner of Masotti & Masotti LLC

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11922374B2	Systems and methods for communication systems analytics	Embodiments of this disclosure relate to systems and methods for determining a set of one or more identified characteristics correlated with high performing projects. Methods include receiving communication data from a plurality of servers, the communication data associated with a plurality of conversations involving one or more users. The communication data is converted into a common format and used to generate a graph, the graph based upon characteristics identified in the communication data and users involved with the plurality of conversations. The communication data can be clustered according to the characteristics and the users, thereby generating one or more clusters around at least one of a characteristic and a user. User data and project data can be generated based on the one or more clusters and be used to determine the set of one or more identified characteristics correlated with high performing projects.	G06Q 10/06 - Resources, workflows, human or project management; Enterprise or organisation planning; Enterprise or organisation modelling	2024	PWC PRODUCT SALES LLC
US11372931B2	Method and system for collecting, visualising and analysing risk data	A method, comprising: displaying, on a user device, graphical objects representing risks; receiving, from the user device, gesture inputs via the graphical objects to collect risk data for the risks; providing a graphical risk model representing the risks and the collected risk data for display on the user device.	G06Q 10/06 - Resources, workflows, human or project management; Enterprise or organisation planning; Enterprise or organisation modelling	2022	KPMG AUSTRALIA IP HOLDINGS PTY LTD
US8788452B2	Computer assisted benchmarking system and method using induction based artificial intelligence	A system and method are provided for the collection of business performance data and the identification of patterns or rules from such data that are key predictors of future business performance. The performance data are preferably collected using one or several questionnaires containing a plurality of questions that probe into specific performance areas of companies. The questionnaires are used to collect responses applicable to a plurality of companies and the responses applicable to each company are stored in a database as separate company profiles to define the knowledge-base from which a rule induction engine may identify the key discriminators of business performance.	G06Q 10/06 - Resources, workflows, human or project management; Enterprise or organisation planning; Enterprise or organisation modelling	2014	DELOITTE DEV LLC & inventors

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US8239233B1	Work flow systems and processes for outsourced financial services	A status and workflow management system is provided, including a tax return preparation intake mechanism and computer systems for use by responsible persons responsible for respective parts of processing of a given individual tax return preparation project. A computer screen providing mechanism generates for each responsible person a work flow and status screen, so that a given responsible person is provided a work flow and status screen comprising information pertaining to the given responsible person and according to the given responsible person's personnel type. A task display generator displays to the given responsible person on his or her screen tasks to which he or she has been assigned. A task update mechanism updates tasks on the screen of the given responsible person in accordance with a sequence of workflow steps, to indicate when a given task is satisfied and to update tasks on the screen of a next assigned responsible person in the work flow to indicate a new unsatisfied task in accordance with a next workflow step.	G06Q 10/06 - Resources, workflows, human or project management; Enterprise or organisation planning; Enterprise or organisation modelling	2012	ALBRECHT MARK, CPA & XCM DEV LLC
US11720842B2	System and method for identifying comparables	The invention relates to a computer implemented system and method for identification of comparables. The method may comprise: receiving input data from a plurality of data sources for a comparable, generating labeled training data for a function classifier by labeling historical search results for comparables, generating probabilistic training data for the primary product and service classifiers, training the primary product and service classifiers using the labeled training data and the probabilistic training data, determining the functions, products, services, and risks of the comparable using the corresponding classifiers, receiving attributes of a tested party, applying a scoring algorithm to calculate a similarity score for the comparable, generating a recommendation to accept the comparable, reject the comparable, or give additional scrutiny to determine acceptability, and automatically providing a written justification for the decision to accept or to reject the comparable.	G06Q 10/0635 - Risk analysis of enterprise or organisation activities	2023	KPMG LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US10592838B2	Risk simulation and assessment tool	A risk simulation and assessment tool may enable a user to select scenarios and risk factors associated with a selected scenario. The risk factors may be defined by risk factor characteristics along with links that define connectivity or interconnectedness to other risk factors. The risk factor characteristics may also include impact, velocity, and likelihood. The tool may provide for a simplified way to create a computerized network map that includes the nodes of risk factors associated with each of the scenarios. The computerized network map may be displayed and dynamic adjustment may be available to the user. A simulation using the computerized network map may also be executed as defined by the risk factor characteristics, thereby enabling a user to determine how operations of an organization may be impacted by changing events that may occur in regions in which physical operations of an organization of the user exist.	G06Q 10/0635 - Risk analysis of enterprise or organisation activities	2020	KPMG LLP
US11294558B2	Interactive user interface for regression systems that process distorted or erroneous data obtained from an environment	Disclosed is an interactive user interface of a regression planning and evaluation system, wherein regression planning and evaluation system is employed to obtain audit evidence. The audit evidence is obtained based on input data pertaining to given use case. The interactive user interface comprises: (i) an input interface element that enables user to input audit parameters; and (ii) an output interface element that enables the regression planning and evaluation system to present to user: (a) a regression plot representing a variation of target variable with respect to an explanatory variable, wherein the regression plot indicates an upper and a lower acceptance bounds with respect to regression line, and wherein the regression plot is generated for a plurality of samples based upon input data and audit parameters; and (b) key items, wherein key items are identified as samples that fall outside the upper acceptance bound and the lower acceptance bound in regression plot.	G06Q 10/0637 - Strategic management or analysis	2022	ERNST & YOUNG GMBH
US11475389B1	System and method for audit report generation from structured data	A method and system for generating an audit report is described. Structured data that represents a prior performance of a business process is received at a processor from a staging database configured to receive raw data from a plurality of distinct data sources. Test control functions are selected by the processor from a plurality of predetermined test control functions. The plurality of predetermined test control functions are configured to read structured data from the staging database and to process the structured data to determine whether business processes have been properly performed. The selected one or more test control functions are executed by the processor to determine whether the business process has been properly performed using the received structured data. The audit report is generated by the processor to include the determination by the selected one or more test control functions of whether the business process has been properly performed.	G06Q 10/06395 - Quality analysis or management	2022	GRANT THORNTON LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11783333B2	Intelligent assertion tokens for authenticating and controlling network communications using a distributed ledger	A method includes generating, via a processor, a bill of materials (BOM) representation associated with a BOM indicating at least one good and including a representation of a plurality of dependencies to qualify the at least one good for at least one of a regulatory claim, a duty benefit claim or an admissibility claim. A smart contract code for a compliance declaration smart contrast that references the BOM representation is transmitted via the processor and to a distributed ledger. A representation of the plurality of assertion token is received, via the processor, from a plurality of remote compute devices, and in response to deploying the compliance declaration smart contract. A compliance declaration token is minted, via the processor, in response to receiving the representation of a plurality of assertion tokens and based on the compliance declaration smart contract.	G06Q 10/0833 - Logistics, tracking	2023	EYGS LLP (Ernst & Young)
US8335700B2	Licensed professional scoring system and method	A quantitative system and method that utilizes data sources external to a company, and when available, traditional data sources, e.g., internal company information, to (i) provide for matching criteria such as, for example, demographic needs, to a database that can provide a number of potential recruits or customers and that can also be used to screen both current and prospective company employees matching the criteria, and (ii) generate a statistical model that can be used to predict future profitability and productivity of licensed professionals.	G06Q 10/10 - Office automation, time management	2012	DELOITTE DEV LLC & inventors
US6754874B1	Computer-aided system and method for evaluating employees	A computer-aided method of evaluating personnel performance. The method includes the steps of making available to a user an electronic evaluation form, inputting a first set of data into the electronic form corresponding to the user, submitting the form including the first set of data for review to a second user and inputting a second set of data into the electronic form corresponding to the second user. The method is implemented with a user friendly and easily navigable computer system that includes a display device for presenting the electronic forms for personnel evaluation and includes a tool for customizing the electronic forms. In a preferred embodiment, the system presents users with electronic forms and controls access to and editing of the electronic forms based on the user's role (e.g., Feedback Receiver, Feedback Provider, Second Level Reviewer, Career Counselor). All evaluation data is stored in at least one database for future access and report generation.	G06Q 10/10 - Office automation, time management	2004	DELOITTE DEV LLC

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US8311866B1	System and method for customizing career paths	A computer-implemented system and method for customizing a worker's career development within an organization is provided. Information concerning the worker is obtained by either or both soliciting input directly from the worker and retrieving the information from one or more databases containing such information. The information is applied to a set of stored rules for defining available options along predefined career dimensions reflective of career-life fit. Based on application of the information to the set of stored rules, a profile is automatically created. If the profile accurately reflects the career-life fit goals of the worker, it is used as the operative profile for the worker until it is appropriate or necessary to change it. If the worker desires to change his/her profile at any time, with the assistance and approval power of a counselor and/or other representative(s) of the organization, the profile is adjusted to reflect the career-life fit goals of the worker within programmed and other parameters that are acceptable to the organization.	G06Q 10/105 - Human resources administration, management	2012	DELOITTE DEV LLC & inventors
US6199052B1	Secure electronic transactions using a trusted intermediary with archive and verification request services	Secure electronic transactions using a trusted intermediary with non-repudiation of receipt and contents of message. A system of, and method for, securely transmitting a package from a sender to a recipient, via an intermediary, are described, as is a novel data arrangement, stored in a computer-readable medium. A sender encrypts the message to form an encrypted inner envelope. A waybill is formed that among other things identifies the recipient as the destination and includes information indicating various levels of services desired, e.g., electronic notarization. The waybill and inner envelope are used to form an encrypted outer envelope that is addressed to a trusted intermediary. The intermediary receives the package and decrypts the outer envelope. It is unable to decrypt the inner envelope, due to the keys employed during encryption. The service information is processed, and the package is used to form a second package addressed to the recipient. The recipient decrypts the package and confirms receipt thereof, using a digest of the message. In this way, receipt and opening of the message cannot be properly repudiated by the recipient. An extra level of encryption to form an outer envelope from the intermediary to the recipient may be included, and the various envelopes and confirmation digests may be signed so that the contents and identities may be authenticated.	G06Q 20/02 - Payment architectures, schemes or protocols involving a neutral party	2001	DELOITTE & TOUCHE USA LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11010729B2	Cryptoconomy solution for administration and governance in a distributed system	A computer-implemented process, system, and computer readable medium are provided for administration and governance of fiat and cryptocurrency funds in a distributed computer system. In one example, a process includes, at an electronic device with one or more processors and memory, accessing a list of a plurality of participant nodes, which may include a fund administrator receiving a list of participants or nodes. The method further includes transferring crypto-currency (e.g., that is pegged to U.S. dollars, local currency, or the like) to one or more of the participant nodes. Each of the participant nodes may include an interface portal (e.g., a web-portal) for viewing transferred crypto-currency and for transacting (e.g., bidding, soliciting, etc.) with other participant nodes of the list of participant nodes with the crypto-currency.	G06Q 20/0655 - Private payment circuits, e-cash managed centrally	2021	PRICEWATERHOUSE COOPERS LLP
US11798114B2	Apparatus and method for locating a mobile asset	A node is provided for implementing an asset sharing scheme in which the asset is mobile. The node being is to determine a location of the mobile asset in dependence on data, relating to the mobile asset, that is recorded in a data corpus authenticated by a distributed authentication protocol. The node may be configured to interact with other nodes to implement the distributed authentication protocol.	G06Q 20/0658 - Private payment circuits, e-cash managed locally	2023	EYGS LLP (Ernst & Young)
US11580520B2	System, method, and apparatus to interactively broadcast value	A system, method, apparatus, and computer program product for interactively broadcasting value via a sound, a Wi-Fi, a Bluetooth, an email, a messaging, an RFID, or an NFC to incentivize direct consumer engagement. The system produces verifiable data on customer preferences, habits, and purchasing while using secure digital cryptographic technology to convey an item of value. The system is configured to transact a digital token normally carried on a blockchain leger in an off-ledger condition. The digital token is embedded with a media content. A mobile computing device having a representation of a digital wallet is configured to detect the digital token, decode the digital token and is transfer the digital token back to the blockchain ledger. When validated by the blockchain ledger, the digital token is transacted to a digital wallet on the blockchain ledger.	G06Q 20/326 - Payment applications installed on the mobile devices	2023	TING TECH LLC, co-inventor: John Masotti, CPA, Managing Partner of Masotti & Masotti LLC

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US6145079A	Secure electronic transactions using a trusted intermediary to perform electronic services	Secure electronic transactions using a trusted intermediary with non-repudiation of receipt and contents of message. A system of, and method for, securely transmitting a package from a sender to a recipient, via an intermediary, are described, as is a novel data arrangement, stored in a computer-readable medium. A sender encrypts the message to form an encrypted inner envelope. A waybill is formed that among other things identifies the recipient as the destination and includes information indicating various levels of services desired, e.g., electronic notarization. The waybill and inner envelope are used to form an encrypted outer envelope that is addressed to a trusted intermediary. The intermediary receives the package and decrypts the outer envelope. It is unable to decrypt the inner envelope, due to the keys employed during encryption. The service information is processed, and the package is used to form a second package addressed to the recipient. The recipient decrypts the package and confirms receipt thereof, using a digest of the message. In this way, receipt and opening of the message cannot be properly repudiated by the recipient. An extra level of encryption to form an outer envelope from the intermediary to the recipient may be included, and the various envelopes and confirmation digests may be signed so that the contents and identities may be authenticated.	G06Q 20/3827 - Details of payment protocols, use of message hashing	2000	DELOITTE & TOUCHE USA LLP
US11972420B2	Methods and systems for preventing transaction tracing on distributed ledger-based networks	Some embodiments disclose the use of zero-knowledge proofs (ZKPs) to prevent or at least mitigate privacy compromises that can occur to transactions conducted on distributed ledger-based networks (DLNs). In particular, some embodiments disclose methods and systems where ZKPs can be used to keep confidential or at least mitigate public revelation of private transaction data due to the analyses of the transaction fee or gas paid to facilitate the transaction on the DLN.	G06Q 20/383 - Details of payment protocols, anonymous user system	2024	EYGS LLP (Ernst & Young)
US11748752B2	Modular, configurable smart contracts for blockchain transaction processing validations	The invention relates to systems and methods for providing modular and configurable smart contracts for blockchain applications. The smart contracts may be utilized to retain all transaction attribute values in a world state database of the blockchain-implemented ledger. The systems and methods can further provide for dynamically configurable validation metadata and validation rules for transaction attributes recorded on a blockchain transaction log. The validation metadata and validation rules corresponding to the transaction attributes can be dynamically updated and applied to the transaction attributes to validate or invalidate a transaction.	G06Q 20/401 - Details of payment protocols, transaction verification	2023	KPMG LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US10872340B2	Fraud compliance device for card reading apparatus	An apparatus for monitoring compliance in fraud-prevention associated with a card reader device has a body to be selectively coupled to the card reader device at a coupling region of the card reader device. The body substantially mimics and at least partially overlays the coupling region of the card reader device when coupled to the coupling region. The card reader device has an opening for accepting a card containing electronic data. The body has a card-accepting region associated with the opening that is configured to substantially surround a periphery of the opening when the body is coupled to the card reader device. The card-accepting region permits the card to be at least partially inserted into the opening for reading of the electronic data by the card reader device when the body is coupled to the card reader device. The body further has no capacity to read the electronic data encoded in the machine-readable medium.	G06Q 20/4016 - Details of payment protocols, transaction verification, involving fraud or risk level assessment in transaction processing	2020	RSM US LLP & SECURESTATE LLC
US9031877B1	Credit card fraud prevention system and method	A mobile computing device is adapted to transmit to a scoring server URLs of websites browsed using the device. The scoring server can compare these URLs against a merchant URL obtained within a preselected time period from transaction data resulting from a transaction involving a payment product of the device user. A score can be calculated based on the similarity between each URL obtained from the device and the URL from the transaction data. The score represents the likelihood that a website browsed using the device and, as a result, the transaction, is fraudulent. The browsed URLs can also be scored against a database of known fraudulent websites. A notification concerning the legitimacy of the transaction based on the score can be generated and sent to the mobile device in real-time. On receiving the notification, the device can be used to either accept or decline the transaction in real-time.	G06Q 20/4016 - Details of payment protocols, transaction verification, involving fraud or risk level assessment in transaction processing	2015	DELOITTE DEV LLC
US11935073B1	System and methods for general ledger flagging	A method for flagging journal entries within a general ledger is described. A plurality of assessment routines are executed on transaction lines of the journal entries within the general ledger, each assessment routine of the plurality of assessment routines i) being configured to generate a base score for each transaction line, and ii) associated with a corresponding flagging threshold. A composite score is generated for each transaction line using the base scores generated by the plurality of assessment routines. For each journal entry within the general ledger: the journal entry is flagged when one or more base scores for the journal entry exceed the corresponding flagging thresholds of the assessment routines, or when none of the base scores for the journal entry exceed the corresponding flagging thresholds and the composite score exceeds a composite threshold. A report of flagged journal entries is generated.	G06Q 30/0185 - Product, service or business identity fraud	2024	GRANT THORNTON LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US10360607B2	Presence and proximity driven filtering of applications and media content	Access to certain application programs and/or media content items at or from an online storefront are granted or denied for a requesting computing device based on whether a subject computing device is present at or within a threshold proximity to a reference computing device or a reference location. The requesting computing device may include the reference computing device or another computing device.	G06Q 30/0607 - Electronic shopping, regulated	2019	ERNST & YOUNG LLP
US11941705B2	System and method for embedding a data analytics system in a third party native environment	A data processing and analytics system for processing financial related data includes a financial data processing unit that is secured by a security layer. The financial data processing unit and the security layer are embedded in a company native environment. The company has a plurality of data sources for providing raw financial data that is filtered by the security layer prior to transfer to the financial data processing unit. The financial data processing unit includes a raw data storage unit for storing the raw financial data, and a data processing unit for processing the raw financial data via one or more preloaded audit applications. The processed financial data is then employed to generate one or more financial reports that are then transferred to the financial expert externally of the company.	G06Q 40/00 - Finance; Insurance; Tax strategies; Processing of corporate or income taxes	2024	KPMG LLP
US7940899B2	Fraud detection, risk analysis and compliance assessment	Techniques using data matching and clustering algorithms are disclosed to aid investigators in detecting potentially fraudulent activity, performing risk analysis or assessing compliance with applicable regulations.	G06Q 40/00 - Finance; Insurance; Tax strategies; Processing of corporate or income taxes	2011	PRICEWATERHOUSE COOPERS LLP
US7756761B1	Tax return outsourcing and systems for protecting data	A financial services outsourcing method or system facilitates a direct service provider's ability to outsource financial services to numerous ultimate clients. The financial services are outsourced to an outsourcing group abroad. Ultimate client specific financial files and corresponding reference materials are loaded onto a remotely accessible part of a host server located in the United States. The host server provides access to a remote client computer of information concerning the ultimate client specific financial files and corresponding reference materials. The access may be limited to limited screen shot access. Outsourced personnel are retained to perform financial service projects (e.g., prepare individual tax returns) for ultimate clients of direct financial services firms. The outsourced personnel perform the financial service projects while located outside the United States. The status of the financial service project is monitored and reported.	G06Q 40/02 - Banking, e.g. interest calculation or account maintenance	2010	XCM DEV LLC, inventor: Mark Albrecht, CPA

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US7908196B2	System, method and financial product for providing retirement income protection	A system and method and a financial income protection product are provided for enabling individuals who are approaching or are in retirement to ensure future sources of income with a reduced initial monetary outlay than conventional income protection products such as, for example, annuities. Income benefits are provided to the individuals only when they need it, i.e., either when market returns have not kept pace with expectations and/or when the individuals have lived beyond the point in time at which their expected wealth expires.	G06Q 40/06 - Asset management; Financial planning or analysis	2011	DELOITTE DEV LLC
US7856388B1	Financial reporting and auditing agent with net knowledge for extensible business reporting language	A system and method utilizes intelligent agents for searching, analyzing, and reporting business, financial, or non-financial information available through communication networks, particularly the Internet, regardless of inconsistencies in formats and granularity of that information. This information may then be used by users for financial and non-financial information for business decisions, developing risk profiles and credit worthiness. The intelligent agent may search Internet resources for business information of companies upon a user's request. The intelligent agent parses the retrieved information consisted with series of texts and identifies tables containing various financial statements. Each extracted table may be parsed into line items and every line item may be identified by matching to the appropriate XBRL taxonomy. Finally, the intelligent agent tags the information using XBRL taxonomy and generates financial statements in XBRL. The intelligent agent may be utilized to search through the internet for financial and non-financial information for business decisions, developing risk profiles and credit worthiness.	G06Q 40/06 - Asset management; Financial planning or analysis	2010	UNIV KANSAS, co-inventors: Raj Srivastava, Miklos Vasarhelyi and Alex Kogan, all accounting professors
US8655687B2	Commercial insurance scoring system and method	A quantitative system and method that employs data sources external to an insurance company to generate a statistical model that may be used to predict commercial insurance profitability. The system and method are able to predict individual commercial insurance policyholder profitability on a prospective basis regardless of the internal data and business practices of a particular insurance company.	G06Q 40/08 - Insurance	2014	DELOITTE DEV LLC & inventors

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US8200511B2	Method and system for determining the importance of individual variables in a statistical model	A method and system for determining the importance of each of the variables that contribute to the overall score of a model for predicting the profitability of an insurance policy. For each variable in the model, an importance is calculated based on the calculated slope and deviance of the predictive variable. Since the score is developed using complex mathematical calculations combining large numbers of parameters with predictive variables, it is often difficult to interpret from the mathematical formula for example, why some policyholders receive low scores while other receive high scores. Such clear communication and interpretation of insurance profitability scores is critical if they are used by the various interested insurance parties including policyholders, agents, underwriters, and regulators.	G06Q 40/08 - Insurance	2012	DELOITTE DEV LLC,US & inventors
US9230284B2	Centrally managed and accessed system and method for performing data processing on multiple independent servers and datasets	A method of data processing between a hub computer and a plurality of spoke computers is disclosed. The hub computer is arranged to communicate with each of the spoke computers. Furthermore, each spoke computer is remote from the hub computer and remote from each other. The method comprises: (a) receiving at the hub computer from a user a request for the spoke computer to run a data processing operation on accounting data of an organization hosting the spoke computer, the accounting data locally accessible by the spoke computer; (b) the hub computer communicating the request to the spoke computer; (c) in response to receiving the request, the spoke computer running the data processing operation on the accounting data; and (d) the spoke computer returning results of the data processing operation to the hub computer.	G06Q 40/12 - Accounting	2016	DELOITTE LLP
US11983780B2	System and method of determining tax liability of entity	Disclosed is system that determines tax liability of entity. The system comprises server arrangement and database arrangement coupled in communication with server arrangement. The server arrangement is configured to: (a) obtain information pertaining to entity; (b) perform natural language processing on the information to generate conceptual representation; (c) determine at least two tax jurisdictions towards which entity has tax liability; (d) access, from database arrangement, knowledge-based information and/or regulation-based information pertaining to tax for at least two tax jurisdictions and analyse the knowledge-based information and/or the regulation-based information to generate conceptual representation of knowledge-based and/or regulation-based information for at least two tax jurisdictions; and (e) analyse conceptual representation of the information, based upon conceptual representation of knowledge-based and/or regulation-based information, to determine tax liability of entity towards at least two tax jurisdictions, wherein server arrangement, by analysing conceptual representation of the	G06Q 40/123 - Tax preparation or submission	2024	ERNST & YOUNG GMBH

		information, reduces errors or inaccuracies present in the information.			
Publication Number	**Name**	**Abstract**	**CPC – Current Primary***	**Year**	**Assignee - Standardized**
US12002134B2	Automated flow chart generation and visualization system	A system for generating digital flowcharts is provided. The system receives sketch image data comprising a plurality of shapes and text, and processes the sketch image data to generate flowchart data by applying a first model configured to generate shape data, applying a second model configured to generate text data, and generating linking data that associates shape data and text data. The system may generate and display a visualization of the flowchart data. The system may map the flowchart data to a region of a presentation slide and display a visualization of the flowchart data on the presentation slide.	G06T 11/203 - Drawing of straight lines or curves from basic elements for two-dimensional image generation	2024	PWC PRODUCT SALES LLC
US11915465B2	Apparatus and methods for converting lineless tables into lined tables using generative adversarial networks	A method for converting a lineless table into a lined table includes associating a first set of tables with a second set of tables to form a set of multiple table pairs that includes tables with lines and tables without lines. A conditional generative adversarial network (cGAN) is trained, using the table pairs, to produce a trained cGAN. Using the trained cGAN, lines are identified for overlaying onto a lineless table. The lines are overlaid onto the lineless table to produce a lined table.	G06V 10/454 - Local feature extraction by analysis of parts of the pattern by matching or filtering, integrating the filters into a hierarchical structure	2024	EYGS LLP (Ernst & Young)
US11727685B2	System and method for generation of process graphs from multi-media narratives	A system for characterizing content relating to a desired outcome is disclosed. The disclosed system can be configured to identify context included in content collected from various content sources, map the identified context into graph nodes and graph edges connecting the graph nodes, identify one or more features of the identified context and adjust at least one of: a graph node and a graph edge based on the identified one or more features, identify a graph incorporating the graph nodes, the graph edges, and at least one of an adjusted graph node and an adjusted graph edge, and provide a recommendation for at least one action for achieving the desired outcome based on the identified graph.	G06V 20/41 - Higher-level, semantic clustering, classification or understanding of video scenes	2023	KPMG LLP
US11763581B1	Methods and apparatus for end-to-end document image quality assessment using machine learning without having ground truth for characters	Methods and apparatus for end-to-end document image quality assessment without having ground truth for characters. An image quality assessment device integrates end-to-end machine learning without using ground truth to automatically predict an overall quality scores for images of documents. The image quality assessment device augments the size of individual image patches extracted from the images based on the contents and size of the images to maintain sufficient size of training data without compromising the reliability of the predicted scores for the images.	G06V 30/133 - Character recognition, detection or correction of errors, evaluation of quality of the acquired characters	2023	EYGS LLP (Ernst & Young)

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11941902B2	System and method for asset serialization through image detection and recognition of unconventional identifiers	An embodiment of the present invention is directed to a combination of two deep-learning computer vision models—customized with post-processing—wrapped in a mobile application that is backed by an Application Programming Interface (API) supporting concurrent mobile users to accomplish asset serialization tasks in a warehouse or other storage environment.	G06V 30/1456 - Image acquisition baseed on user interactions	2024	KPMG LLP
US5841895A	Method for learning local syntactic relationships for use in example-based information-extraction-pattern learning	A method is provided for learning local syntactic relationships for use in an example-based information-extraction-pattern learning element of an automated information extraction system. The example-based learning element learns information extraction patterns from user-provided examples of texts paired with events the texts contain; these patterns can then be used by the information extraction system to recognize similar events in subsequent texts. The learning element learns patterns by analyzing each example text/event pair to determine paths of local syntactic relationships between constituents in the text that indicate the event. The learning element employs an incomplete dictionary of local syntactic relationships for this analysis. The present invention learns new local syntactic relationships for text/event pairs that cannot be analyzed using the learning element's initial, incomplete dictionary of relationships. These new relationships are added to the dictionary, and allow the learning element to learn patterns from example text/event pairs that cannot be analyzed using only the initial dictionary.	G06V 30/246 - Character recognition using linguistic properties	1998	PRICEWATERHOUSE COOPERS LLP
US8587613B2	System and method for comparing and reviewing documents	A document processing system for accurately and efficiently analyzing documents and methods for making and using same. Each incoming document includes at least one section of textual content and is provided in an electronic form or as a paper-based document that is converted into an electronic form. Since many categories of documents, such as legal and accounting documents, often include one or more common text sections with similar textual content, the document processing system compares the documents to identify and classify the common text sections. The document comparison can be further enhanced by dividing the document into document segments and comparing the document segments; whereas, the conversion of paper-based documents likewise can be improved by comparing the resultant electronic document with a library of standard phrases, sentences, and paragraphs. The document processing system thereby enables an image of the document to be manipulated, as desired, to facilitate its review.	G06V 30/40 - Document-oriented image-based pattern recognition	2013	PRICEWATERHOUSE COOPERS LLP,US & inventors

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11715313B2	Apparatus and methods for extracting data from lineless table using delaunay triangulation and excess edge removal	A method for extracting data from lineless tables includes storing an image including a table in a memory. A processor operably coupled to the memory identifies a plurality of text-based characters in the image, and defines multiple bounding boxes based on the characters. Each of the bounding boxes is uniquely associated with at least one of the text-based characters. A graph including multiple nodes and multiple edges is generated based on the bounding boxes, using a graph construction algorithm. At least one of the edges is identified for removal from the graph, and removed from the graph to produce a reduced graph. The reduced graph can be sent to a neural network to predict row labels and column labels for the table.	G06V 30/412 - Layout analysis of documents structured with printed lines or input boxes	2023	EYGS LLP (Ernst & Young)
US11468237B2	Audit investigation tool	The invention relates to a computer-implemented system and method for providing an Audit Document Investigation Tool that augments the audit process at various investigation stages. As a critical component of audit technology initiatives, the Audit Document Investigation Tool provides a consistent, efficient workflow to ingest, automatically prioritize and investigate documents, leverageable by any procedure workflow and linkable to platforms for full audit trail and subsequent review.	G06V 30/412 - Layout analysis of documents structured with printed lines or input boxes	2022	KPMG LLP
US11837005B2	Machine learning based end-to-end extraction of tables from electronic documents	In some embodiments, a method includes identifying a set of word bounding boxes in a first electronic document, and identifying locations of horizontal white space between two adjacent rows from a set of rows in a table. The method includes determining, using a Natural Language Processing algorithm, an entity name from a set of entity names for each table cell from a set of table cells in the table. The method includes determining, using a machine learning algorithm a class from a set of classes for each row from the set of rows. The method includes extracting a set of table cell values associated with the set of table cells, and generating a second electronic document including the set of table cell values arranged in the set of rows and the set of columns such that the set of words in the table are computer-readable in the second electronic document.	G06V 30/414 - Analysis of document contents, extracting the geometrical structure	2023	EYGS LLP (Ernst & Young)

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11014535B2	Shared vehicle security	A vehicle comprising: a locking mechanism for securing the vehicle; a user input device exposed to the exterior of the vehicle; a transceiver for communicating with a network external to the vehicle; and a processor configured for implementing a public/private key security algorithm and coupled to the transceiver for sending and receiving data by means of the transceiver, and coupled to the locking mechanism for disengaging the locking mechanism to permit access to the vehicle; the processor being configured to: receive from the transceiver a data block including a first token, the first token representing a public key of a user; receive from the user input device a second token; compare the first and second tokens to determine whether the second token is consistent with having been derived from a private key that forms a key pair with the public key; and if that determination is positive, cause the locking mechanism to be disengaged.	G07B 15/02 - Arrangements or apparatus for collecting fares, tolls or entrance fees, taking into account a variable factor such as distance or time	2021	EYGS LLP (Ernst & Young)
US11206138B2	Biosignature-based tokenization of assets in a blockchain	An apparatus includes a tester to detect a biological signature of a biological sample, a processor, and a memory operably coupled to the processor. The memory stores instructions to cause the processor to receive an indication of the biological signature from the tester, and to generate, using a smart contract and through communication with a distributed ledger, a cryptographic token including a digital identifier based on the biological signature. The cryptographic token is transmitted to a remote processor for verification of the biological sample, in response to receiving the cryptographic token. The tester can detect the biological signature within a predetermined test duration that is less than a DNA sequencing duration associated with the biological sample, and the biological signature has a data precision sufficient to uniquely identify the biological sample from a plurality of biological samples.	G16H 10/60 - ICT specially adapted for the handling or processing of patient-related medical or healthcare data for patient-specific data	2021	ERNST & YOUNG U S LLP,US & ERNST & YOUNG SERVICES UK LTD & EYGS LLP
US11943358B2	Methods and systems for identifying anonymized participants of distributed ledger-based networks using zero-knowledge proofs	One or more embodiments described herein disclose methods and systems that are directed at providing enhanced privacy and security to distributed ledger-based networks (DLNs) via the implementation of zero-knowledge proofs (ZKPs) in the DLNs. ZKPs allow participants of DLNs to prove ownership of accounts on the DLNs without having to necessarily reveal private information such as the private key of the account publicly. As such, the disclosed methods and systems directed at the ZKP-enabled DLNs provide privacy to participants of the DLNs while still allowing the DLNs to remain as consensus-based networks.	H04L 93/239 - Cryptographic mechanisms or cryptographic arrangements for secret or secure communications, involving non-keyed hash functions	2024	EYGS LLP (Ernst & Young)

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11777734B2	Methods and systems for tracking and recovering assets stolen on distributed ledger-based networks	The instant disclosure illustrates how the privacy and security of activities occurring on distributed ledger-based networks (DLNs) can be enhanced with the use of zero-knowledge proofs (ZKPs) that can be used to verify the validity of at least some aspects of the activities without private information related to the activities necessarily being revealed publicly. Methods and systems that are directed at facilitating the tracking and recovery of assets stolen on ZKP-enabled DLNs while preserving the confidentiality of the tokens are presented herein.	H04L 93/239 - Cryptographic mechanisms or cryptographic arrangements for secret or secure communications, involving non-keyed hash functions	2023	EYGS LLP (Ernst & Young)
US11595211B2	Apparatus and methods for intelligent token-based authentication within a distributed database using hierarchical data files	Methods of using intelligent, blockchain-compatible asset tokens for non-fungible assets are described. The intelligent asset tokens can be customized to include a three-layer hierarchical identifier representing a hierarchy of asset data. The three-layer hierarchical identifier can include a reference layer representing the non-fungible asset type, a product layer representing the specific asset unit, and a rights and/or obligations layer representing rights and/or obligations associated with the specific asset unit of the product layer. Transactions of the non-fungible assets can be authenticated using the intelligent asset tokens, and can be performed using a smart contract at each layer of the hierarchy. A reference token can also be generated, specifying an address of a smart contract associated with an owner of a non-fungible asset. The smart contract can be used to enforce rules for the use of the intelligent asset tokens on the blockchain.	H04L 93/239 - Cryptographic mechanisms or cryptographic arrangements for secret or secure communications, involving non-keyed hash functions	2023	EYGS LLP (Ernst & Young)
US11481841B2	Systems, apparatus and methods for identifying distinguishing characteristics of fungible assets using zero-knowledge proof on a distributed ledger-based network	In some embodiments, a method includes storing data associated with fungible assets in a distributed ledger database. The method includes dividing fungible tokens into a first set of groups of fungible tokens based on the data and sending, via the distributed ledger-based network and based on an asymmetric cryptography key pair, each group of fungible tokens from the first set of groups of fungible tokens to a communication device from the first set of communication devices to cause the second plurality of communication devices to send, to a designated recipient communication device, non-fungible tokens for each group of fungible tokens from the second set of groups of fungible tokens. The first set of groups of fungible tokens is divided into a second set of groups of fungible tokens and received at a second set of communication devices.	H04L 93/239 - Cryptographic mechanisms or cryptographic arrangements for secret or secure communications, involving non-keyed hash functions	2022	EYGS LLP (Ernst & Young)

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US10848388B1	Distributed computing framework	A system comprises a seed node, one or more compute servers and a controller server. The seed node generates initial conditions for a computational process representing an environment having one or more layers with agents. Each compute server executes tasks to generate a portion of the environment. The controller server receives initial conditions of the environment from the seed node; determines a distribution of tasks for the computational process among the compute servers; and sends instructions to each compute server for execution of tasks determined for the respective compute server. The controller server measures an execution time period for the computational process in units of discrete time frames, and sends an update or synchronization instructions, or both, to one or more compute servers in each time frame.	H04L 41/145 - Network analysis or design, involving simulating, designing, planning or modelling of a network	2020	DELOITTE DEV LLC
US7448079B2	Method and apparatus for providing computer services	An apparatus and method are disclosed for providing one or more computer services to a plurality of customers (A,B,C). At least one virtual machine (VS) is set up on a real computer (30) for each of the customers (A,B,C) at the request of each of the customers (A,B,C). The or each virtual machine (VS) for each of the customers (A,B,C) has a specification specified by the respective customer (A,B,C).	H04L 63/0209 - Network architectures or network communication protocols for network security, architectural arrangements	2008	ERNST & YOUNG LLP
US6161181A	Secure electronic transactions using a trusted intermediary	Secure electronic transactions using a Trusted Intermediary. A system for, and method of, securely transmitting a package from a sender to a recipient, via an intermediary, are described, along with a novel data arrangement, stored in a computer-readable medium. A sender encrypts the message to form an encrypted inner envelope. A waybill is formed that among other things identifies the recipient as the destination and includes information indicating various levels of services desired, e.g., electronic notarization. The waybill and inner envelope are used to form an encrypted outer envelope that is addressed to a trusted intermediary. The intermediary receives the package and decrypts the outer envelope. It is unable to decrypt the inner envelope, due to the keys employed during encryption. The service information is processed, and the package is used to form a second package addressed to the recipient. The recipient decrypts the package and confirms receipt thereof, using a digest of the message. In this way, receipt of the message cannot be properly repudiated by the recipient. An extra level of encryption to form an outer envelope from the intermediary to the recipient may be included, and the various envelopes and confirmation digests may be signed so that the contents and identities may be authenticated.	H04L 63/045 - Network architectures or network communication protocols for network security, wherein the sending and receiving network entities apply hybrid encryption	2000	DELOITTE & TOUCHE USA LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11470068B2	System and methods for securely storing data for efficient access by cloud-based computing instances	Systems and methods for securely storing data for efficient access by cloud-based computing instances is provided. In one or more examples, a computing hub can receive one or more access requests to data stored within a persistent data storage computing resources that in connected to the computing hub. The computing hub can be configured to determine if the access request is from an authorized computing resource, and can then generate one or more tokens that provide access to the computing resource. The one or more tokens can include information regarding the IP address of the requesting cloud-based computing resource, and each time that the cloud-based computing resource uses the token to request access to the stored data, the computing hub can check the IP address of the computing resource against the IP address indicated on the token to decide whether or not to grant access to the data.	H04L 63/102 - Network architectures or network communication protocols for network security, entity profiles	2022	PRICEWATERHOUSE COOPERS LLP
US11316691B2	Methods and systems for enhancing network privacy of multiple party documents on distributed ledger-based networks	Embodiments of the instant disclosure include methods and systems directed at providing enhanced security and privacy to multiple party communications that occur on zero knowledge proof (ZKP)-enabled distributed ledger-based networks (DLNs). In particular, the methods and systems include subject matter related to the deployment, and approval, of a multi-party document or instrument for consideration and approval by multiple participants of the DLN.	H04L 63/123 - Network architectures or network communication protocols for network security, received data contents	2022	EYGS LLP (Ernst & Young)
US11381592B2	System and method for identifying cybersecurity threats	The invention relates to a computer-implemented system and method for automatic collection, analysis and reporting of data relating to a cybersecurity threat. The method may comprise the steps of: presenting an interface through which an executable can be configured and automatically generated; transmitting the executable to a client to enable the client to execute the executable on client systems to automatically collect forensic data; receiving from the client an encrypted data package that includes the forensic data; using a forensic toolset to automatically analyze the forensic data; presenting an option to select one or more of at least two types of output reports designed for different types of readers; inputting the analysis files into an automatic report generator to automatically generate the types of output reports selected by the client; and sending the output reports selected by the client to the client.	H04L 63/1433Network architectures or network communication protocols for network security, vulnerability analysis	2022	KPMG LLP

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11553036B2	System and method for cloud security monitoring	The invention relates to a computer-implemented system for security monitoring of Member accounts in a cloud environment. The Member accounts are provided as instances of cloud services in one or more monitored clouds by one or more cloud service providers. The system is programmed to automatically deploy software agents to the Member accounts. The software agents are configured to monitor activities in the Member accounts and to push security and operations data to a SIEM platform. The security and operations data may comprise alerts and activity logs for the Member accounts, public internet protocol (IP) addresses used by the Member accounts, and identifying information for individuals and information technology (IT) assets associated with the Member accounts. The system includes a user interface to define customized alerts based on the security and operations data, and the system generates and sends the customized alerts to a system administrator or security analyst.	H04L 67/34 - Network arrangements or protocols for supporting network services or applications, involving the movement of software or configuration parameters	2023	KPMG LLP
US8644473B1	Method and system for providing telephony services	A method is provided for directing calls placed to a telephone number associated with a user according to a reservation identifying the user, a workspace, and a start time. The method includes acts of receiving a first message from a telephone device located at the workspace in response to a first input at the telephone device on or after the start time, retrieving the reservation from a reservation database in response to receiving the first message, sending a second message to the telephone device based at least in part on a portion of the reservation identifying the user, receiving a third message sent in response to a second input at the telephone device, the third message including an identifier of the telephone device, retrieving the telephone number associated with the user from a user database, and directing calls placed to the telephone number associated with the user to the telephone device.	H04M 3/42263 - Systems providing special services or facilities to subscribers, Systems providing special services or facilities to subscribers	2014	ERNST & YOUNG U S LLP & inventors
US10810709B1	Systems and methods for improving the quality of text documents using artificial intelligence	In some embodiments, an apparatus includes a memory and a processor operatively coupled to the memory. The processor is configured to receive an electronic document having a set of pages, and partition a page from the set of pages of the electronic document into a set of portions. The processor is configured to convert each portion of the set of portions into a negative image of a set of negative images. The processor is configured to produce, based on an artificial intelligence algorithm, a de-noised negative image of each negative image and convert each de-noised negative image of a set of de-noised negative images into a positive image of a set of positive images, and combine each positive image of the set of positive images to produce a de-noised page. The de-noised page has artifacts less than artifacts of the page of the electronic document.	H04N 10/0331 - Scanning, transmission or reproduction of documents or the like, with an apparatus performing optical character recognition	2020	EYGS LLP (Ernst & Young)

Publication Number	Name	Abstract	CPC – Current Primary*	Year	Assignee - Standardized
US11843994B2	Asset tracking system using signal profiles	Provided are asset tracking systems for determining a location of an asset, comprising a mobile device comprising one or more detection antennas and a transmitter, and a device associated with an asset and emitting Bluetooth low energy signals, wherein the system is configured to: detect a plurality of electromagnetic signals of the environment and one or more Bluetooth low energy signals from the one or more Bluetooth low energy devices; generate a signal profile based on the plurality of electromagnetic signals; determine, based on a comparison of the signal profile to data of signal profiles at a plurality of locations in the environment, a mobile-device location in the environment; and determine, based on the mobile-device location and based on the one or more Bluetooth low energy signals, one or more asset locations in the environment.	H04W 4/029 - Services specially adapted for wireless communication networks, location-based management or tracking services	2023	PWC PRODUCT SALES LLC
US11632659B2	Method and system for determining location	An indoor geolocation system for determining a location in three-dimensional space includes a plurality of base stations and a mobile device movable about an indoor environment in three dimensions. The mobile device detects electromagnetic signals in the indoor environment emitted by devices other than the base stations, and generates a signal profile based on the signals. The mobile device transmits the signal profile to one or more of the base stations, which forward the signal profile to a remote server. The system determines a location of the in three-dimensional space of the mobile device by comparing the signal profile to data regarding signal profiles at a plurality of locations in the indoor environment. The data regarding signal profiles in the indoor environment may have been captured by a detection device other than the mobile device at a time prior to the detection of the electromagnetic signals by the mobile device.	H04W 4/33 - Services specially adapted for wireless communication networks, for indoor environments	2023	PRICEWATERHOUSE COOPERS LLP

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