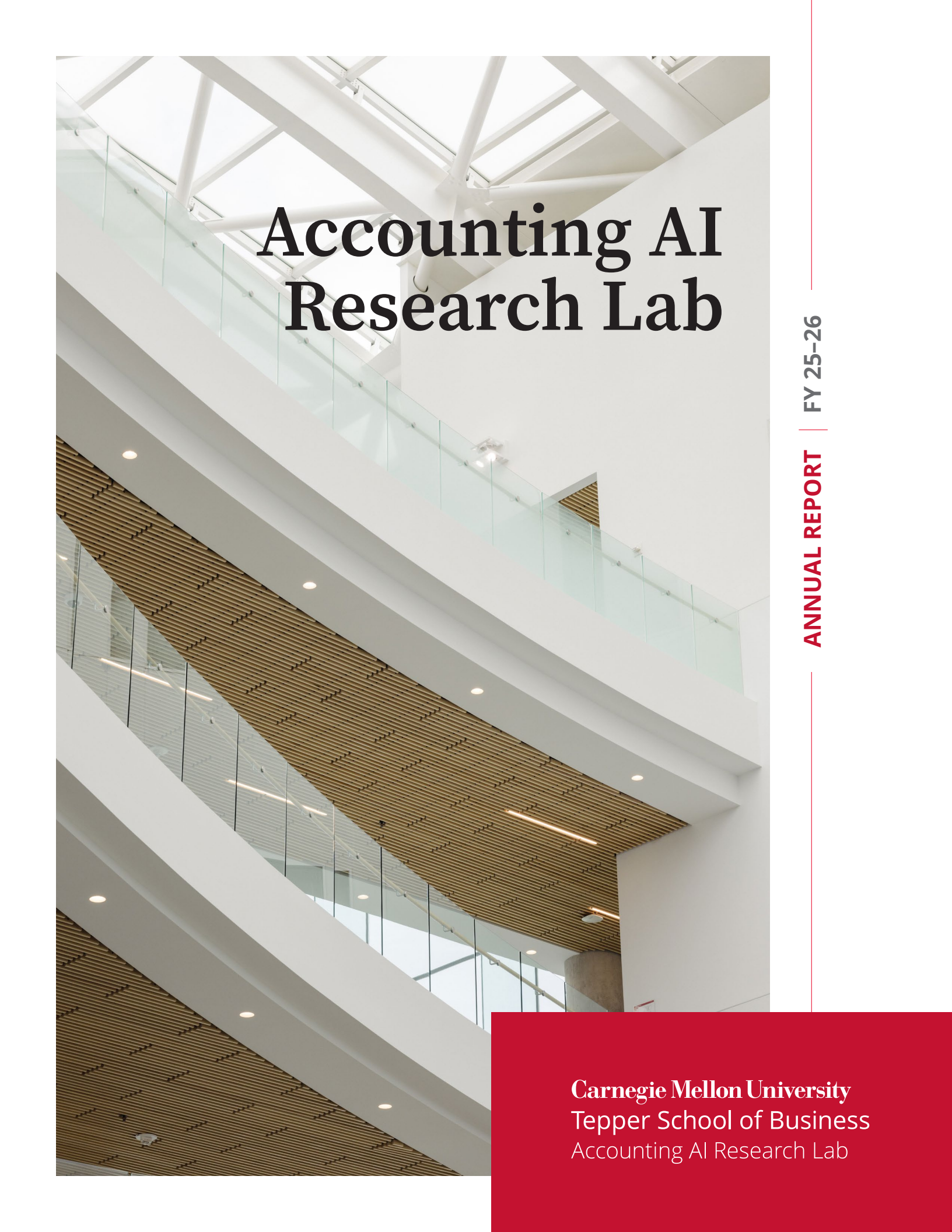




Accounting AI Research Lab

ANNUAL REPORT | FY 25-26

Carnegie Mellon University
Tepper School of Business
Accounting AI Research Lab

A LETTER FROM THE DIRECTOR

The Accounting AI Research Lab completed its first year under its new name in 2025–2026, but the work it represents has been building for much longer.

Our research sits at the intersection of three communities: practitioners confronting real-world problems, accounting scholars with foundational bookkeeping theoretical insights, and computer scientists developing modern computational methods. This annual report documents what that convergence produced in year one: new research on the structure of accounting information, new computational tools for grounded textual extraction, and a growing community of faculty and students working across disciplinary boundaries. We are a small lab with an ambitious vision: to create the foundational knowledge and computational tools that define Computational Accounting Science. This report is our first account of that effort. We are grateful to our sponsors, our collaborators inside and outside of Carnegie Mellon, and the Tepper School for making it possible.



Pierre Jinghong Liang
Lab Founder and Director
Professor of Accounting



YEAR IN NUMBERS

FUNDING

5

SUPPORTERS

\$250K+

NEW FUNDING
RAISED THIS YEAR

5

NEW WORKING
PAPERS

4

COURSE
INNOVATIONS

6

LAB PhD
STUDENTS

7

COLLABORATORS
AND VISITORS

12

RESEARCH
PRESENTATIONS

PEOPLE

FACULTY

Pierre Jinghong Liang, Founder and Director, Tepper School of Business

Gaoqing Zhang, Co-director, Tepper School of Business

RESEARCH ASSISTANTS

Ashman Mehra, RA, School of Computer Science (SCS), CMU

Anjana Ramachandran, RA, Carnegie Institute of Technology (CIT), CMU

Zeyang Zhang, RA, Language Technologies Institute (LTI), CMU

Michael Zheng, RA, Machine Learning and Statistics, CMU

PhD STUDENTS

Jane Jae Yeon Pyo, PhD, and lab COO, Tepper School of Business

Orhun Gün, PhD, and lab CTO, Tepper School of Business

Yubin Kim, PhD, Tepper School of Business

Yihan Song, PhD, Tepper School of Business

Ziyi Yang, PhD, Tepper School of Business

Heyang Zhang, Tepper School of Business

AFFILIATED FACULTY AND LAB VISITORS

Nan Li, University of Minnesota

Bo Sun, University of Virginia

Bryan Routledge, Tepper School of Business, CMU

Leman Akoglu, CMU Heinz College of Information Systems and Public Policy and SCS

Xiao-Jun Zhang, UC Berkeley

Jungho Choi, Stanford University

Hoon Kim, Quantinno Capital Management LP



RESEARCH

ACCOUNTING CLASSIFICATION ENTROPY ↗

Article

Could the structural layout of a balance sheet matter more than its raw numbers? Accounting Classification Entropy (ACE) and Accounting Classification Entropy-Relative (ACER) apply information theory to corporate finance using Shannon and Kullback-Leibler entropy principles to quantify hidden data in financial report structures. By moving beyond one-dimensional metrics like earnings-per-share, this framework measures the true information embedded within a company's entire financial architecture.

Li, Nan and Liang, Pierre Jinghong and Pyo, Jae Yeon (Jane) and Zhang, Gaoqing, Accounting Classification Entropy (October 10, 2025). Available at SSRN: <https://ssrn.com/abstract=5588192> or <http://dx.doi.org/10.2139/ssrn.5588192>

THREE ENTROPY MEASURES OF DOUBLE-ENTRY BOOKKEEPING GRAPH CLASSIFICATION STRUCTURE ↗

Working Paper

Double-entry bookkeeping has been essentially unchanged for more than five hundred years, but what are its underlying rules, stated with mathematical precision? This foundational position paper proposes that three simple laws govern the entire system: a balance law, a conservation law, and a linearity law. These laws reveal that any set of bookkeeping records can be expressed, without loss, as a mathematical network: accounts become nodes and transactions become the connections between them. On that network, the paper builds three new yardsticks, inspired by Claude Shannon's information theory, that measure how much information is carried by the structure of the books themselves. It is the theoretical cornerstone beneath much of the lab's other work: it establishes that the centuries-old architecture of accounting is a rigorous object of study, and that modern computational tools can read signals from it that conventional analysis cannot.

Liang, Pierre Jinghong. 2026. "Three Entropy Measures of Double-Entry Bookkeeping Graph Classification Structure." Working Paper wp-2025-01, *Accounting AI Research Lab Working Paper Series*, Tepper School of Business at Carnegie Mellon University, Pittsburgh, PA. This version April 2026 (first version 2025-Mar). First presentation at Columbia University 2026 March.



ACCOUNTING GRAPH ENTROPY (AGE): MEASURING INFORMATION OF FINANCIAL STATEMENT GRAPH STRUCTURE ↗

Working Paper

How do you tell from the financial statements alone whether a company has quietly reinvented itself over the past year? Accounting graph entropy (AGE) turns a firm's balance sheet, income statement, and cash flow statement into a single connected network, then measures how much the network's shape shifts from one year to the next, producing one interpretable number for the degree of structural change. Because the measure is built from the full articulation of the statements, it can still be separated to show if the change came from a firm's operations, financing, or earnings. Applied at scale to decades of public-company data, the measure spikes during major economic disruptions and cleanly traces the wholesale reinvention of the financial-services industry in the early 2000s. It also carries real predictive power: firms with larger structural change show less persistent earnings, and the measure helps explain their subsequent stock returns.

Liang, Pierre Jinghong, Jane Jae Yeon Pyo, Gaoqing Zhang, and Xiao-Jun Zhang. 2026. "Accounting Graph Entropy (AGE): Measuring Information of Financial Statement Graph Structure." Working Paper wp-2025-02, *Accounting AI Research Lab Working Paper Series, Tepper School of Business at Carnegie Mellon University*, Pittsburgh, PA. This version June 17, 2026 (first version 2025-Jul, first presented at the CMU Accounting Mini-Conference in August 2025).

ENTROPIC UNCERTAINTY: MEASURING FIRM AND AGGREGATE UNCERTAINTY FROM THE GRAPH STRUCTURE OF FINANCIAL STATEMENTS ↗

Working Paper

Most gauges of economic uncertainty are built from the stock market, surveys, or the tone of news coverage, all of which can be swayed by sentiment, mood, or spin. This project builds an uncertainty measure from a very different and harder-to-manipulate source: the structure of companies' audited quarterly and annual filings. By converting each firm's financial statements into a network and tracking how unpredictably that structure moves over time, the work produces a firm-by-firm measure of genuine economic uncertainty grounded entirely in mandatory disclosures. That firm-level signal adds real forecasting power for future investment, hiring, and earnings surprises beyond existing measures. Aggregated across the economy, it yields an uncertainty index whose spikes line up with meaningful declines in real economic activity, establishing the architecture of financial statements as a new, internally grounded window into economic uncertainty.

Liang, Pierre Jinghong, Bo Sun, and Ziyi Yang. 2026. "Entropic Uncertainty: Measuring Firm and Aggregate Uncertainty from the Graph Structure of Financial Statements." Working Paper wp-2026-02, *Accounting AI Research Lab Working Paper Series, Tepper School of Business at Carnegie Mellon University*, Pittsburgh, PA. First version 2026-Jun (prepared for SITE 2026-Sep)



PHOENIX PEERS: USING DOUBLE-ENTRY BOOKKEEPING GRAPHS FOR COMPARABLE FIRM IDENTIFICATION ↗

Working Paper

“Phoenix Peers” is a peer selection methodology grounded in the topological structure of double-entry bookkeeping. Unlike traditional approaches that rely on categorical industry codes or observable outcomes, we measure firm similarity using the Jensen-Shannon distance between directed graphs representing the flow of economic value through financial statements. Using Compustat data from 1987–2024, we document that structural accounting similarity captures a dimension of operational comparability that is largely orthogonal to industry and size groupings, exhibiting less than 1% overlap with traditional benchmarks. Empirically, Phoenix Peers triple the explanatory power of comparable-firm valuation regressions, increasing the adjusted R² for enterprise-value-to-sales ratios from 13% to 39%. These findings demonstrate that the mathematical laws governing accounting systems encode fundamental information about business models that is invisible to standard classification schemes.

Gün, Eyup O., Liang, Pierre Jinghong and Hollifield, Burton. 2025. “Phoenix Peers: Using Double-Entry Bookkeeping Graphs for Comparable Firm Identification.” Working Paper wp-2025-03, *Accounting AI Research Lab Working Paper Series*, Tepper School of Business at Carnegie Mellon University, Pittsburgh, PA. First version 2025-Dec.

YUJI IJIRI (1935–2017): MEASUREMENT, ACCOUNTABILITY, AND ACCOUNTING AS A SOCIAL INSTITUTION ↗

Article (in progress)

Commissioned by Accounting Horizons, a flagship journal of the American Accounting Association, this memorial article by Professor Pierre Liang, with Martin E. Persson (University of Illinois Urbana-Champaign) and Shyam Sunder (Yale University), revisits the five-decade scholarly program of Yuji Ijiri (1935–2017). The article reads his work through two questions he considered unresolved: how accounting sustains fair relationships among those who report, receive, and mediate financial information, and what makes the 500-year-old and largely unchanged artifact, double-entry bookkeeping, so enduring. Drawing on newly examined material from the Carnegie Mellon University Archives, the memorial also documents Ijiri’s stewardship of GSIA, of doctoral education, and of the American Accounting Association’s scholarly commons. His view that the “double” in double-entry reflects causation, not classification, directly informs the lab’s research on the mathematical structure of accounting records.

Liang, Pierre Jinghong, Martin E. Persson, and Shyam Sunder. 2026. “Yuji Ijiri (1935–2017): Measurement, Accountability, and Accounting as a Social Institution.” Working Paper wp-2026-01, *Accounting AI Research Lab Working Paper Series*, Tepper School of Business at Carnegie Mellon

CONFERENCES AND PRESENTATIONS

Pierre Jinghong Liang

- Accounting Mini-Conference, Tepper School of Business/CMU
- Quantinno Capital Management LP Lecture series
- Stanford Institute for Theoretical Economics Conference on Macro Uncertainty and Volatility (Sep 2026)
- Taiwan Accounting Association Annual Conference Keynote
- UC-Berkeley (Haas Business School)

Gaoqing Zhang

- National University of Singapore
- Singapore Management University
- Tsinghua University

Orhun Gün (PhD)

- 6th Greater China Area Finance Conference (Jun 2026)

Jane Jae Yeon Pyo (PhD)

- American Accounting Association Financial Accounting Reporting Section (AAA-FARS)
- Future Alpha 2026

Nan Li (affiliated faculty)

- UC San Diego
- Pennsylvania State University



OUTREACH IN EDUCATION

- **“AI-assisted Accounting Introduction Pedagogy Design”:** Lab Director Pierre Liang served as the subject matter expert (SME) in this Capstone Project at the Master of Educational Technology and Applied Learning Science (METALS) program at the Human-Computer Interaction Institute (HCII), School of Computer Science at Carnegie Mellon University, sponsored by Yale University on behalf of Yale School of Management, Spring-Summer 2026.



The capstone team partnered with Yale SOM to solve two related problems: How should introductory accounting be taught for learners with varying levels of prior knowledge? How can a custom AI tutor support that learning in a way that is aligned with the course and strengthens students' reasoning?

The redesigned accounting pre-work, a preparatory course for MBA and EMBA students, features a newly created integrated learning (web) platform where students experience practical problems, discover accounting ideas from the experience, and formalize them into accounting terminologies, all with a custom AI tutor to support the course experience. The delivered product is a coherent, supportive, and accessible accounting pre-work experience for students

- **Tepper Undergraduate (UG) and MBA courses: Business Language Analytics (70-498 and 45-900):** with the help of the lab's research output, these courses help equip students with a mastery of financial language structure at a level such that students would feel comfortable facing any analytical tasks in their future careers. Leveraging the lab's research into graph theory and large language models, this course provides students with accounting concepts and tools to create structures in financial data, and hands-on experience in applying economic, statistical, and data-mining tools to analyze corporate business language.

OUTREACH IN RESEARCH

- **Entropy Project Overview** presented at Tepper's 75th Anniversary Academic Symposium (by Prof. Zhang in March 2025)
- **Keynote speech** at Workshops in Accounting Research at the University of Zurich (by Prof. Liang in June 2025)
- **Keynote speech** at Taiwan Accounting Association Annual Conference (by Prof. Liang in November 2025)
- **BBA-presentation** on "The AARL: Transforming Accounting for the AI Age", a research highlight presentation to Tepper Business Board of Advisors (by Prof. Liang in April 2026)
- **Keynote lecture** at Quantinno Capital Management LP inaugural lecture series (by Prof. Liang in June 2026)



FUNDING AND INFRASTRUCTURE

CURRENT FUNDING:

PwC Sponsored Research (\$147,000) work completed in 2025

NEW FUNDING: (TOTALING \$250K+)

- Quantinno Capital Management LP (Private Donor Gift)
- Marsha and Marvin Goodfriend (Private Donor Gift)
- Tepper School Dean's Office (Restricted Seed Funding)
- PNC Center for Innovation in Financial Services (Gift)
- PNC Center for Innovation in Financial Services (PhD funding)
- Center for Intelligent Business (CIB) (Research Project Funding)

COMPUTE:

to accommodate the increasing need for compute, the lab has been actively utilizing the local computing resources, including the Pittsburgh Supercomputing Center and Orchard clusters

LAB SERVER:

the first fully dedicated lab server has been purchased, featuring two Nvidia Blackwell GPUs, to be deployed in Fall 2026

DATASETS:

AGE/AGER Panel (Shannon entropy and KL divergence measures derived from GAAP bookkeeping graphs) has been completed, and with limited release (to current lab research collaborators under Distribution-ready with controlled data-sharing framework AARL-DUA-1.0)

LOOKING AHEAD

The lab's second year will focus on deepening the research threads established in year one while expanding the lab's collaborative network and infrastructure.

A main priority is work directly tied to industry in the form of industry partner-sponsored collaborations. Other priorities include continued development of the bookkeeping graphs and accounting entropy research programs, growth of the business language analytics pipeline, and investment in compute infrastructure to support larger-scale experiments. The lab will also continue to build its educational offerings and its community of interdisciplinary collaborators across CMU and beyond.

PROFILE: YUJI IJIRI



Yuji Ijiri (1935–2017): GSIA PhD 1963 under William W. Cooper; Tepper School of Business faculty from the late 1960s until his 2011 retirement. Ijiri's work spanned the foundations of accounting measurement, the axiomatic structure of bookkeeping, and the theory of stewardship. He is best known for proposing triple-entry bookkeeping: an extension of the double-entry system designed to capture not only the state of an enterprise but the forces driving its change. He is the only four-time recipient of the American Accounting Association's Notable Contributions to the Accounting Literature Award and an Accounting Hall of Fame inductee. The lab's bookkeeping graphs project, which models transactions as graph structures and applies graph neural networks to detect anomalies, builds on a conviction Ijiri expressed throughout his career: that accounting's representational structure is a central object of theoretical inquiry, not a fixed technical convention.

cmu.edu/tepper/accounting-lab

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github.com/cmu-bla

