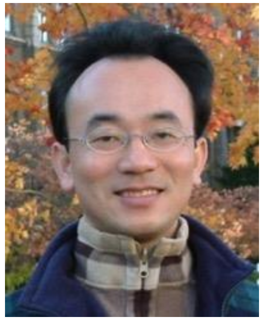
Introduction to Artificial Intelligence in Finance and Quantitative Analysis

1132AIFQA01
MBA, IM, NTPU (M5147) (Spring 2025)
Tue 5, 6, 7 (13:10-16:00) (B3F17)

https://meet.google.com/miy-fbif-max



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Institute of Information Management, National Taipei University

https://web.ntpu.edu.tw/~myday

Min-Yuh Day, Ph.D.

Professor, Information Management, NTPU

Visiting Scholar, IIS, Academia Sinica

Ph.D., Information Management, NTU

Director, Intelligent Financial Innovation Technology, IFIT Lab, IM, NTPU

Director, Fintech and Green Finance Research Center, NTPU

Division Director, Sustainable Development, Sustainability Office, NTPU

Artificial Intelligence, Generative AI, ESG and Green Financial Technology, Big Data Analytics, Electronic Commerce, Biomedical Informatics

Course Syllabus
National Taipei University
Academic Year 113, 2nd Semester (Spring 2025)

- Course Title: **Artificial Intelligence in Finance and Quantitative Analysis**
- Instructor: Min-Yuh Day
- Course Class: MBA, IM, NTPU (3 Credits, Elective)
- Details
  - EMI Course
    (3 Credits, Elective, One Semester) (M5147)
- Time & Place: Tue, 5, 6, 7, (13:10-16:00) (B3F17)
- Google Meet: https://meet.google.com/miy-fbif-max

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Course Objectives

1. Understand the fundamental concepts and research issues of Artificial Intelligence in Finance and Quantitative Analysis.
2. Equip with Hands-on practices of Artificial Intelligence in Finance and Quantitative Analysis.
3. Conduct information systems research in the context of Artificial Intelligence in Finance and Quantitative Analysis.

Course Outline

- This course introduces the **fundamental concepts, research issues, and hands-on practices** of **AI in Finance and Quantitative Analysis**.
- Topics include:
  1. Introduction to Artificial Intelligence in Finance and Quantitative Analysis
  2. AI in FinTech: Metaverse, Web3, DeFi, NFT, Generative AI for Financial Innovation Applications
  3. Investing Psychology and Behavioral Finance
  4. Event Studies in Finance
  5. Finance Theory and Data-Driven Finance
  6. Financial Econometrics
  7. AI-First Finance
  8. Deep Learning in Finance; Reinforcement Learning in Finance; Generative AI in Finance
  9. Algorithmic Trading; Risk Management; Trading Bot and Event-Based Backtesting
  10. Industry Practices of AI in Finance and Quantitative Analysis
  11. Case Study on AI in Finance and Quantitative Analysis

Core Competence

- Exploring new knowledge in information technology, system development and application 80 %
- Internet marketing planning ability 10 %
- Thesis writing and independent research skills 10 %

Four Fundamental Qualities

- Professionalism
  - Creative thinking and Problem-solving 40 %
  - Comprehensive Integration 40 %
- Interpersonal Relationship
  - Communication and Coordination 10 %
  - Teamwork 5 %
- Ethics
  - Honesty and Integrity 0 %
  - Self-Esteem and Self-reflection 0 %
- International Vision
  - Caring for Diversity 0 %
  - Interdisciplinary Vision 5 %

College Learning Goals

- Ethics/Corporate Social Responsibility
- Global Knowledge/Awareness
- Communication
- Analytical and Critical Thinking

Department Learning Goals

- Information Technologies and System Development Capabilities
- Internet Marketing Management Capabilities
- Research capabilities

Syllabus

Week	Date	Subject/Topics
1	2025/02/18	Introduction to Artificial Intelligence in Finance and Quantitative Analysis
2	2025/02/25	AI in FinTech: Metaverse, Web3, DeFi, NFT, Generative AI for Financial Innovation Applications
3	2025/03/04	Investing Psychology and Behavioral Finance
4	2025/03/11	Event Studies in Finance
5	2025/03/18	Case Study on AI in Finance and Quantitative Analysis I
6	2025/03/25	Finance Theory and Data-Driven Finance

Syllabus

Week Date Subject/Topics

7 2025/04/01 Self-Study

8 2025/04/08 Midterm Project Report

9 2025/04/15 Financial Econometrics

10 2025/04/22 AI-First Finance

11 2025/04/29 Industry Practices of AI in Finance and Quantitative Analysis

12 2025/05/06 Case Study on AI in Finance and Quantitative Analysis II

Syllabus

Week	Date	Subject/Topics
13	2025/05/13	Deep Learning in Finance; Reinforcement Learning in Finance; Generative AI in Finance
14	2025/05/20	Algorithmic Trading; Risk Management; Trading Bot and Event-Based Backtesting
15	2025/05/27	Final Project Report I
16	2025/06/03	Final Project Report II

Teaching Methods and Activities

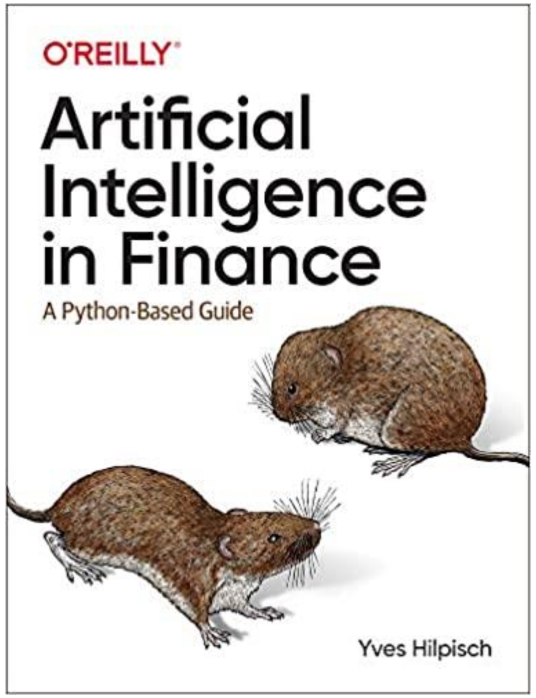
- Lecture
- Discussion
- Practicum

Evaluation Methods

- Individual Presentation 60 %
- Group Presentation 10 %
- Case Report 10 %
- Class Participation 10 %
- Assignment 10 %

Required Texts

- **Yves Hilpisch (2020),**
  Artificial Intelligence in Finance: A Python-Based Guide,
  O'Reilly Media.



Source: https://www.amazon.com/Artificial-Intelligence-Finance-Python-Based-Guide/dp/1492055433

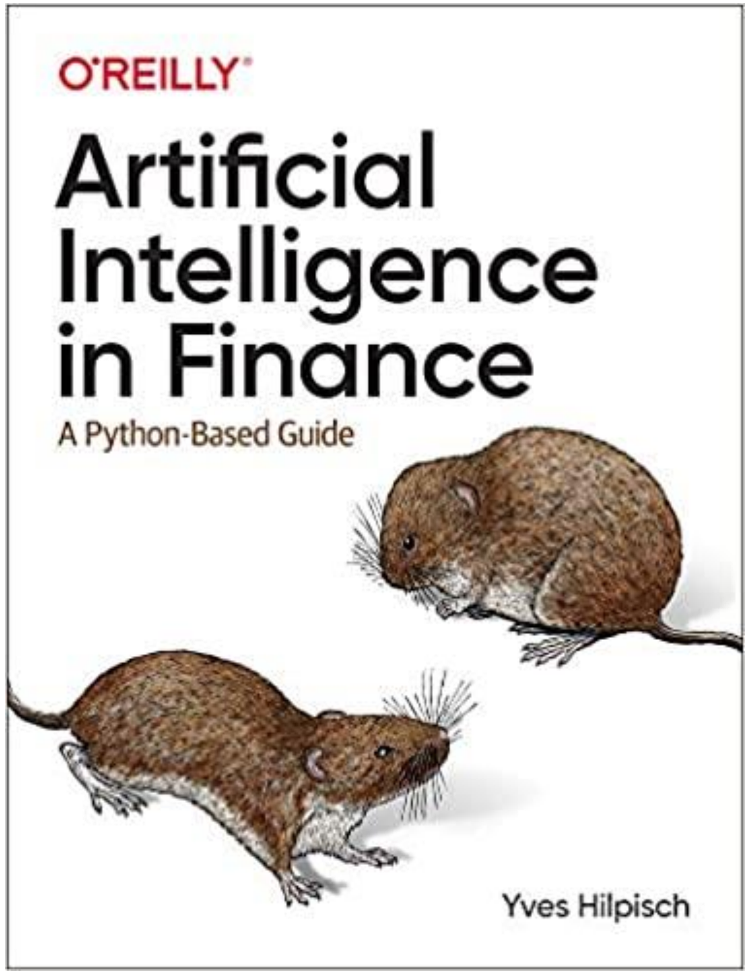
Reference Books

- Stefan Jansen (2020), Machine Learning for Algorithmic Trading: Predictive models to extract signals from market and alternative data for systematic trading strategies with Python, 2nd Edition, Packt Publishing.
- Aurélien Géron (2022), Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 3rd Edition, O’Reilly Media.
- Hariom Tatsat, Sahil Puri, Brad Lookabaugh (2020), Machine Learning and Data Science Blueprints for Finance: From Building Trading Strategies to Robo-Advisors Using Python, O'Reilly Media
- Chris Kelliher (2022), Quantitative Finance With Python: A Practical Guide to Investment Management, Trading, and Financial Engineering, Chapman and Hall/CRC.
- Simon Thompson (2023), Green and Sustainable Finance: Principles and Practice in Banking, Investment and Insurance, 2nd Edition, Kogan Page.
- Cino Robin Castelli, Cyril Shmatov (2022), Quantitative Methods for ESG Finance, Wiley
- Abdullah Karasan (2021), Machine Learning for Financial Risk Management with Python: Algorithms for Modeling Risk, O’Reilly Media.
- Yves Hilpisch (2018), Python for Finance: Mastering Data-Driven Finance, 2nd Edition, O'Reilly Media.

Other References

- Paolo Sironi (2016), FinTech Innovation: From Robo-Advisors to Goal Based Investing and Gamification, Wiley.
- Yves Hilpisch (2020), Financial Theory with Python: A Gentle Introduction, O’Reilly Media.
- Yves Hilpisch (2020), Python for Algorithmic Trading: From Idea to Cloud Deployment, O’Reilly Media.
- Yuxing Yan (2017), Python for Finance: Apply powerful finance models and quantitative analysis with Python, Second Edition, Packt Publishing.

Yves Hilpisch (2020),
Artificial Intelligence in Finance: A Python-Based Guide,
O'Reilly



Source: https://www.amazon.com/Artificial-Intelligence-Finance-Python-Based-Guide/dp/1492055433

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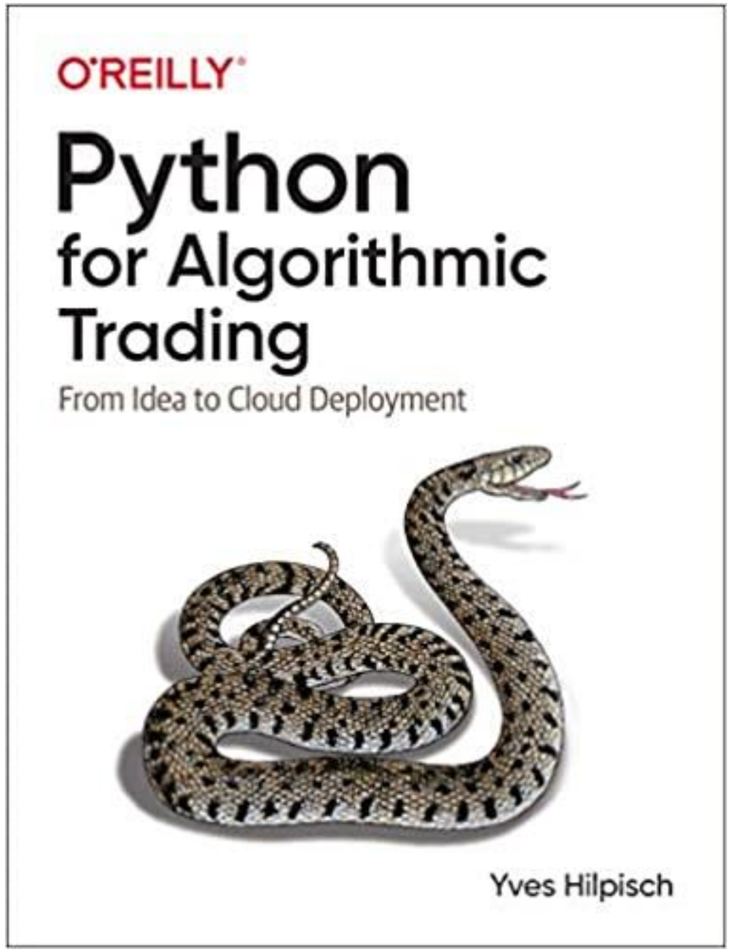
Python for Algorithmic Trading:

From Idea to Cloud Deployment,

O’Reilly

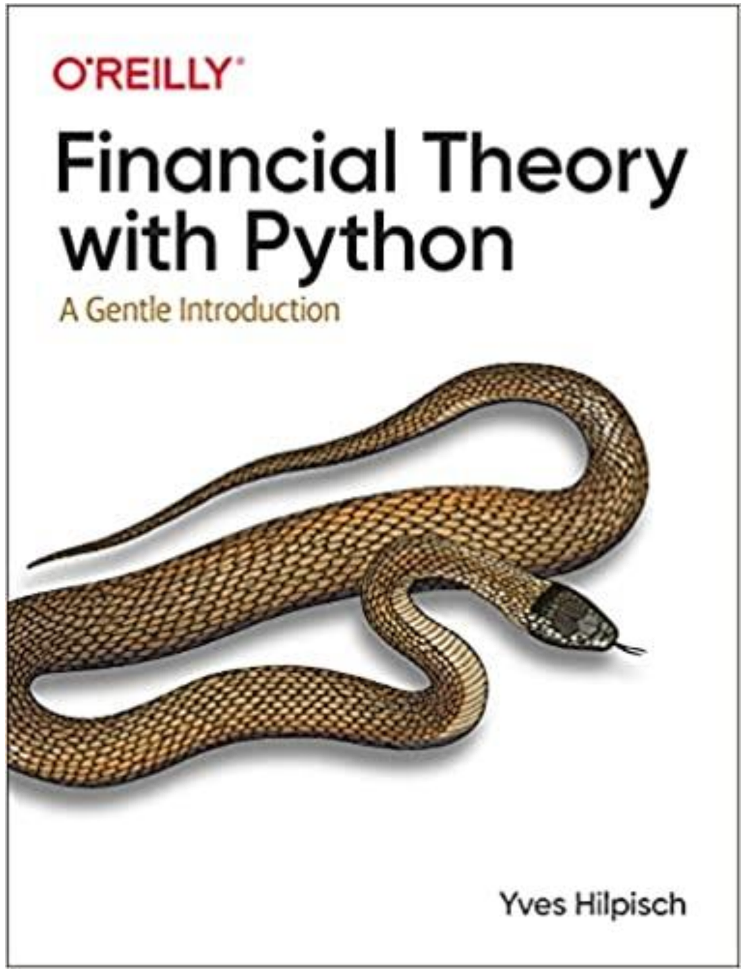


Source: https://www.amazon.com/Python-Algorithmic-Trading-Cloud-Deployment/dp/149205335X

Yves Hilpisch (2021),

Financial Theory with Python: A Gentle Introduction,

O'Reilly

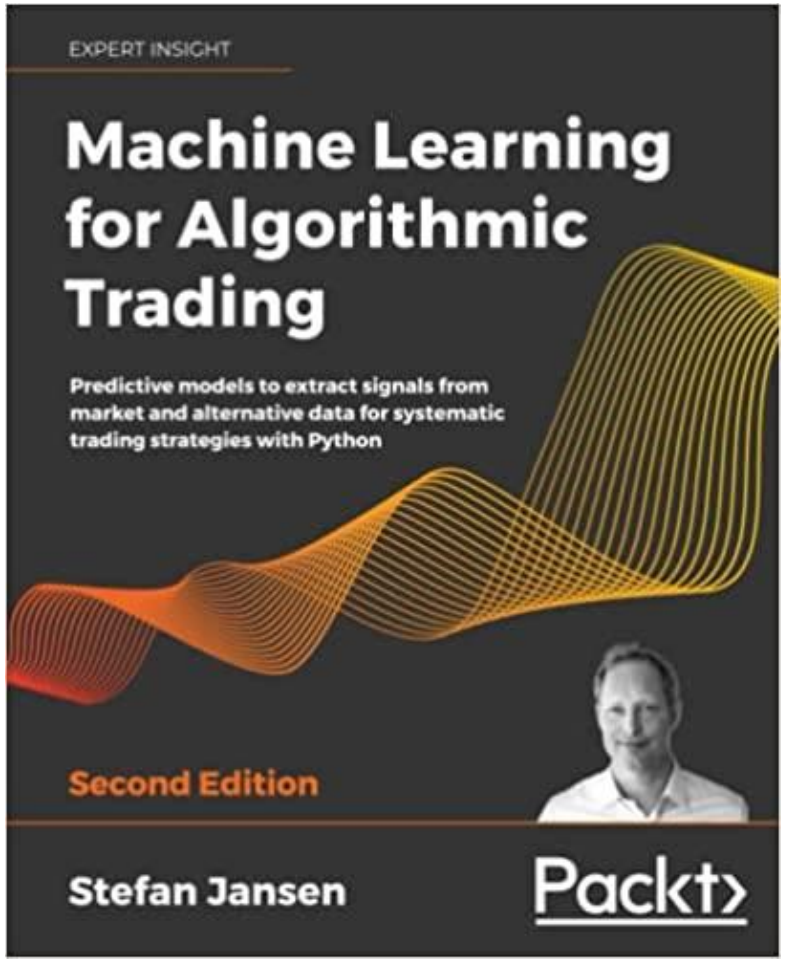


Source: https://www.amazon.com/Financial-Theory-Python-Gentle-Introduction/dp/1098104358

Stefan Jansen (2020),

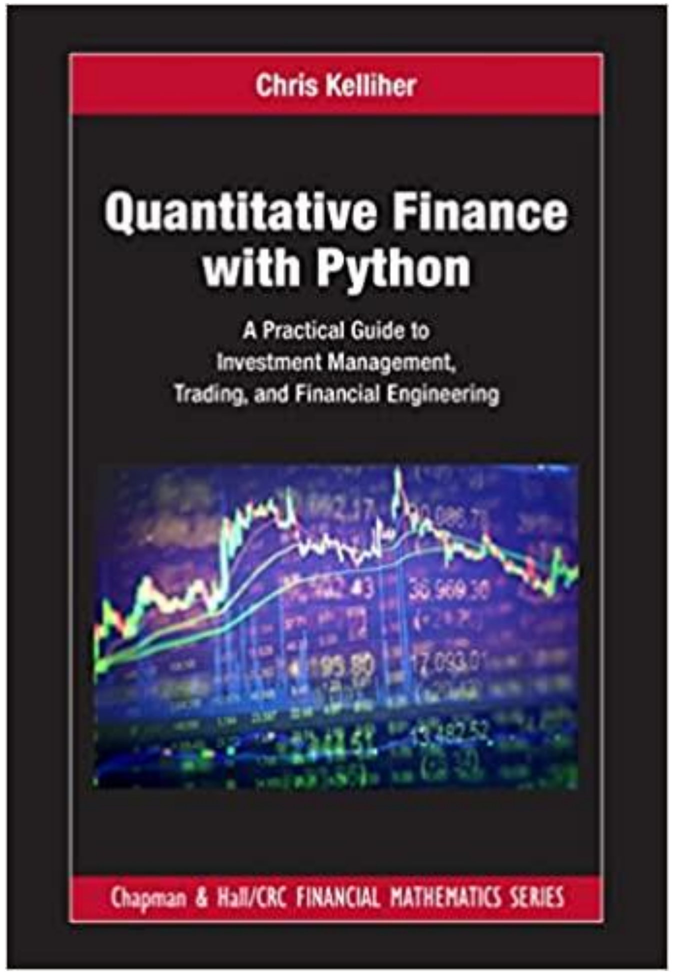
Machine Learning for Algorithmic Trading:

Predictive models to extract signals from market and alternative data for systematic trading strategies with Python, 2nd Edition,
Packt Publishing.



Source: https://www.amazon.com/Machine-Learning-Algorithmic-Trading-alternative/dp/1839217715/

Chris Kelliher (2022),
Quantitative Finance With Python:
A Practical Guide to Investment Management, Trading, and Financial Engineering,
Chapman and Hall/CRC.

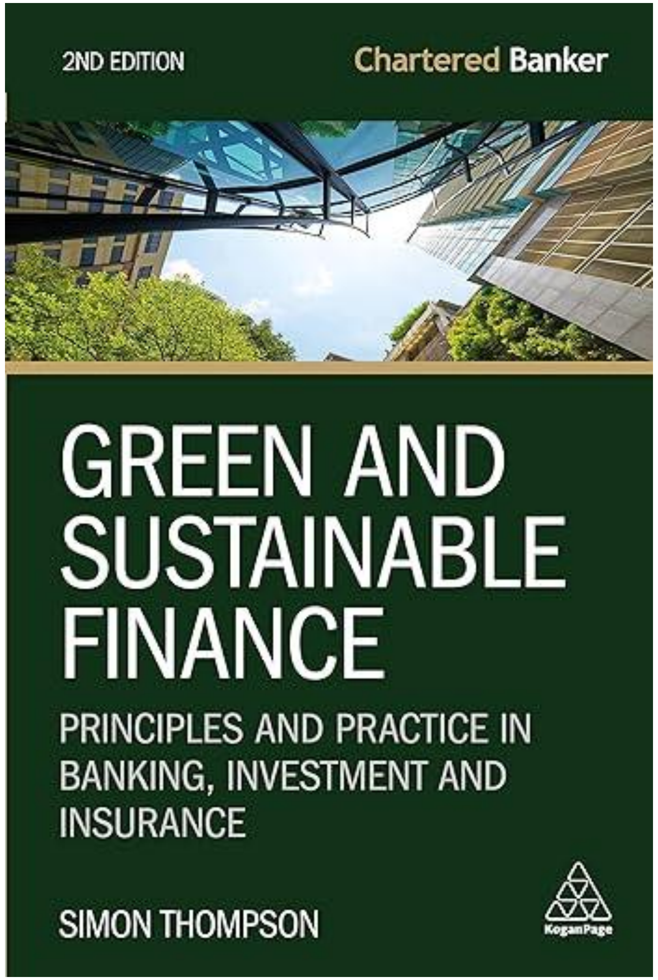


Source: https://www.amazon.com/Quantitative-Finance-Python-Engineering-Mathematics/dp/1032014431/

Simon Thompson (2023),

Green and Sustainable Finance:

Principles and Practice in Banking, Investment and Insurance, 2nd Edition, Kogan Page

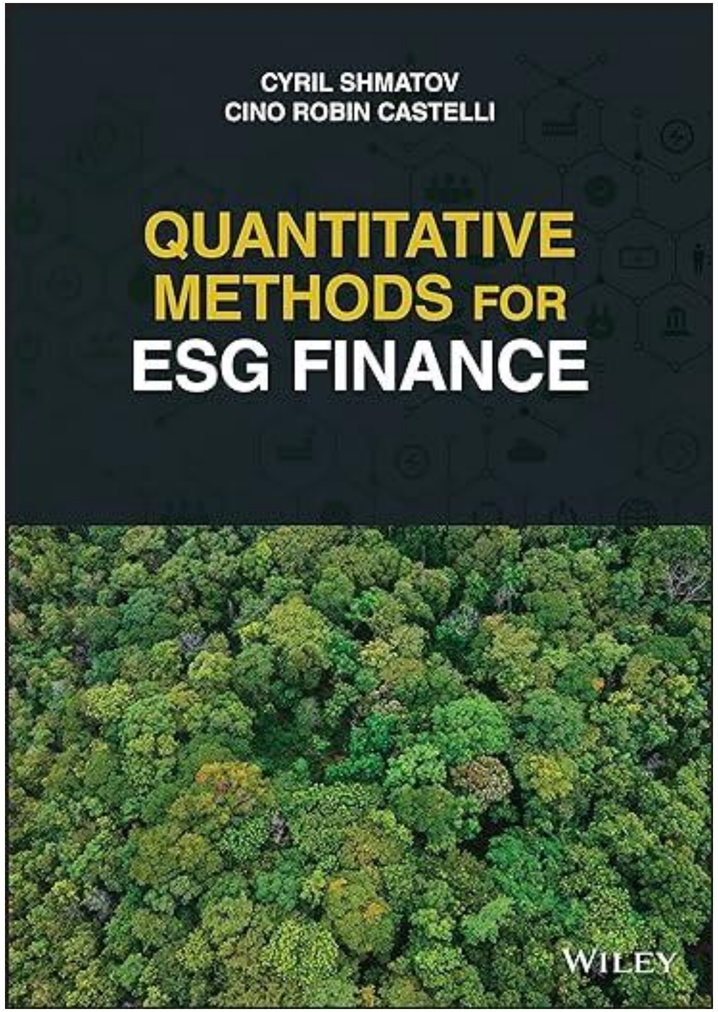


Source: https://www.amazon.com/Green-Sustainable-Finance-Principles-Investment/dp/1398609242/

Cino Robin Castelli, Cyril Shmatov (2022),

Quantitative Methods for ESG Finance,

Wiley

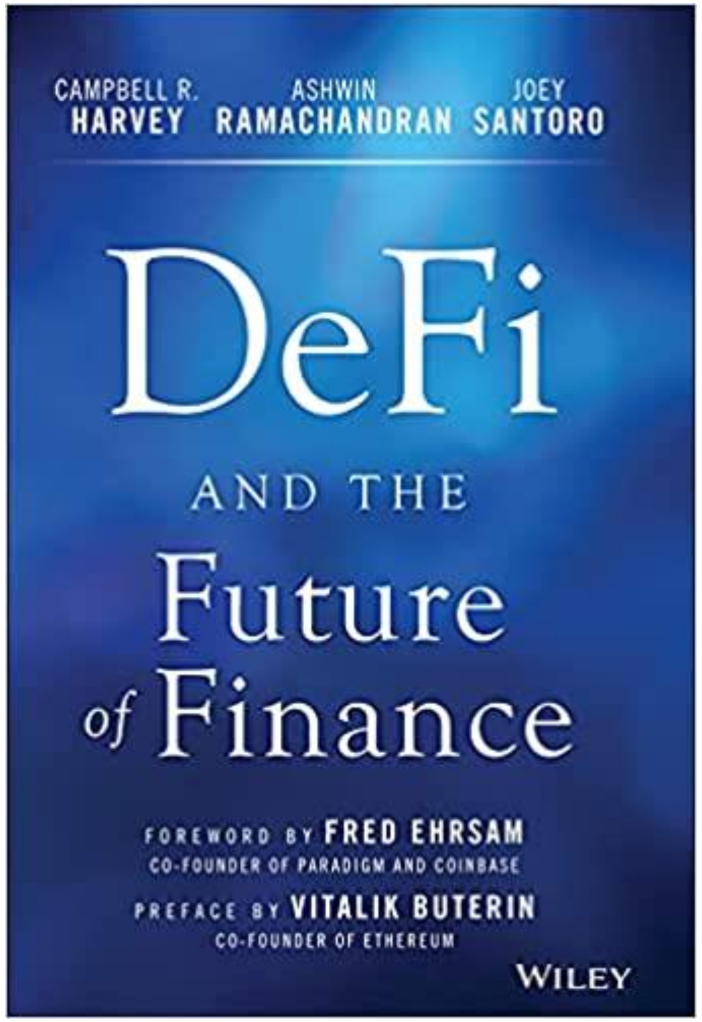


Source: https://www.amazon.com/Quantitative-Methods-Finance-Robin-Castelli/dp/1119903807/

Campbell R. Harvey, Ashwin Ramachandran, Joey Santoro, Fred Ehrsam (2021),

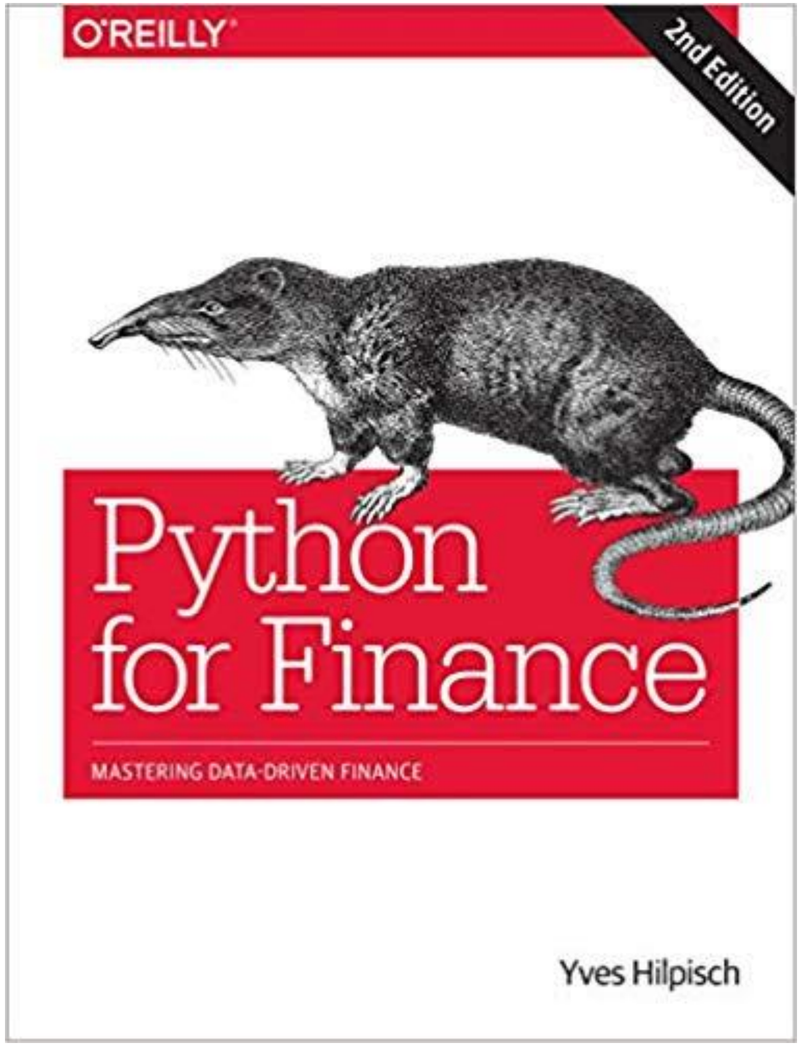
DeFi and the Future of Finance,

Wiley



Source: https://www.amazon.com/DeFi-Future-Finance-Campbell-Harvey-ebook/dp/B09DJV2QLC

Yves Hilpisch (2018),
Python for Finance: Mastering Data-Driven Finance,
O'Reilly



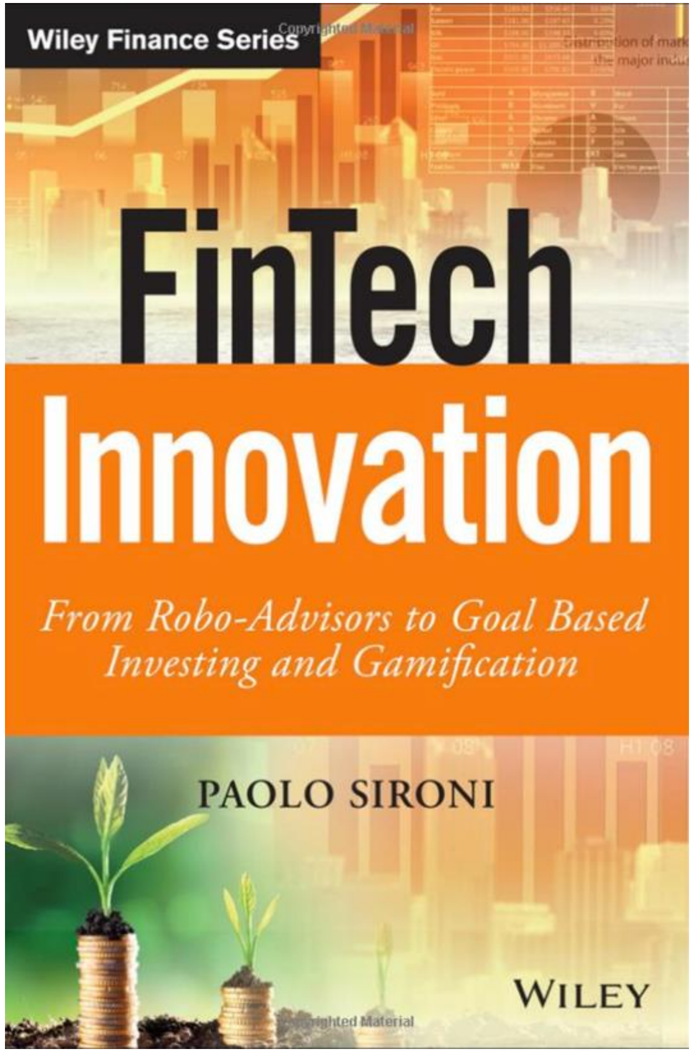
Source: https://www.amazon.com/Python-Finance-Mastering-Data-Driven/dp/1492024333

Paolo Sironi (2016)

FinTech Innovation:

From Robo-Advisors to Goal Based Investing and Gamification,

Wiley



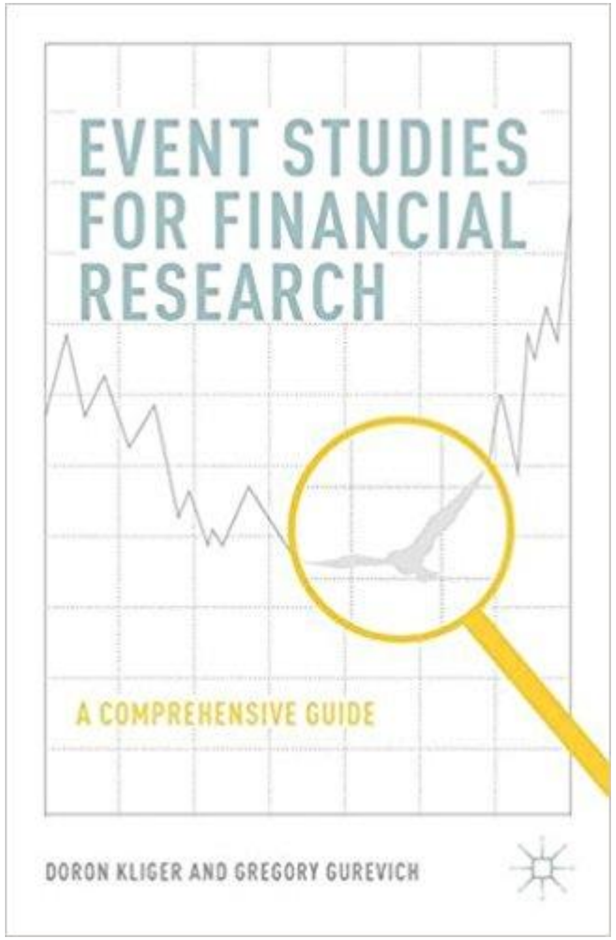
Source: https://www.amazon.com/FinTech-Innovation-Robo-Advisors-Investing-Gamification/dp/1119226988

Doron Kliger and Gregory Gurevich (2014),

Event Studies for Financial Research:

A Comprehensive Guide,

Palgrave Macmillan



Source: https://www.amazon.com/Event-Studies-Financial-Research-Comprehensive/dp/1137435380/

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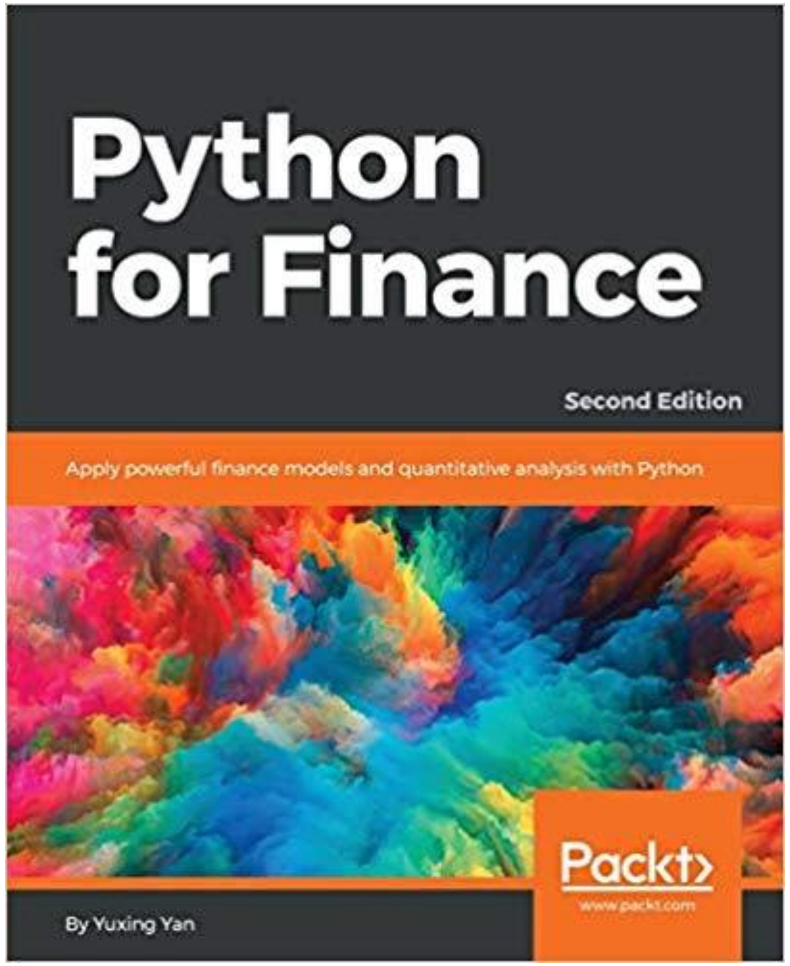
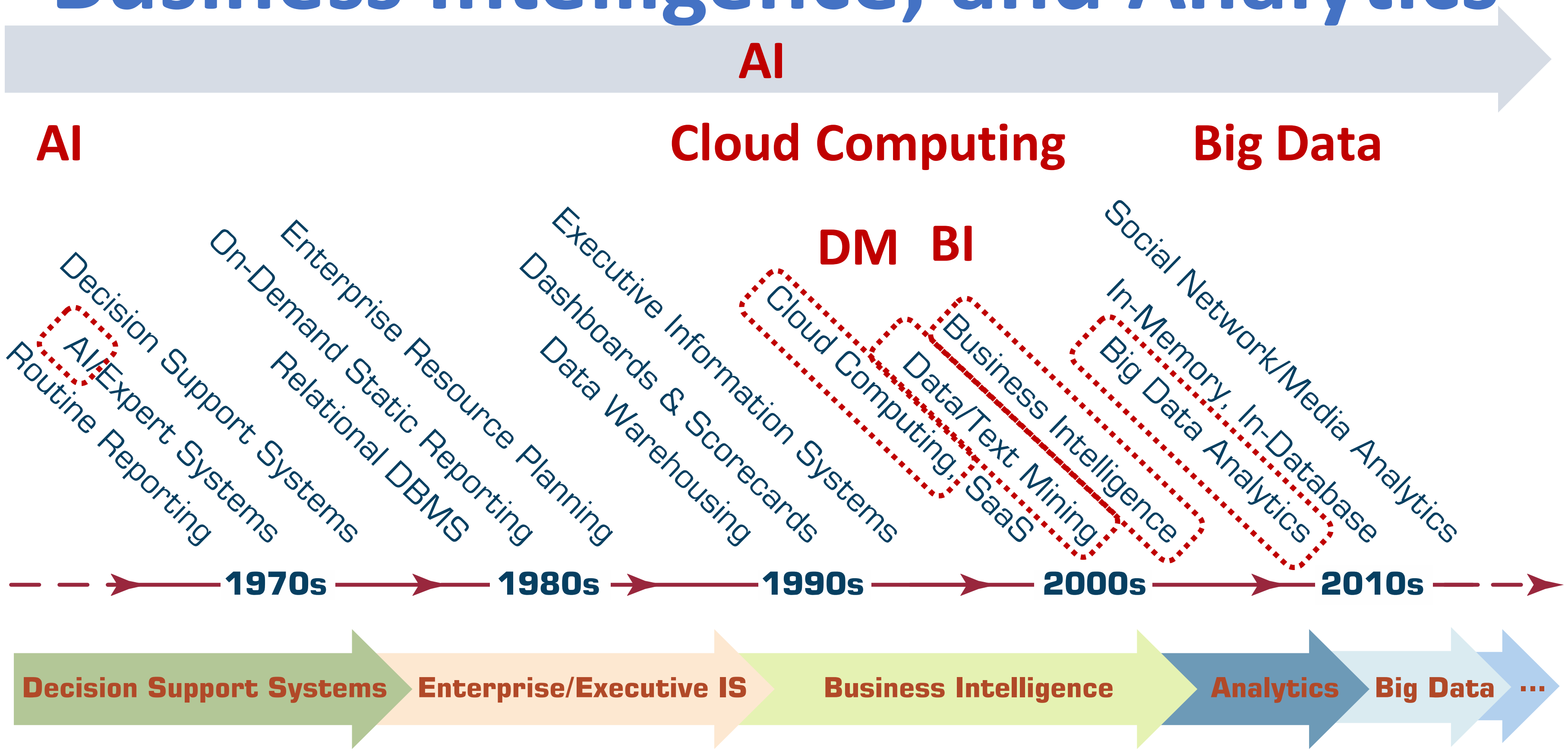
Python for Finance: Apply powerful finance models and quantitative analysis with Python, Second Edition, Packt Publishing



Source: https://www.amazon.com/Python-Finance-powerful-quantitative-analysis/dp/1787125696

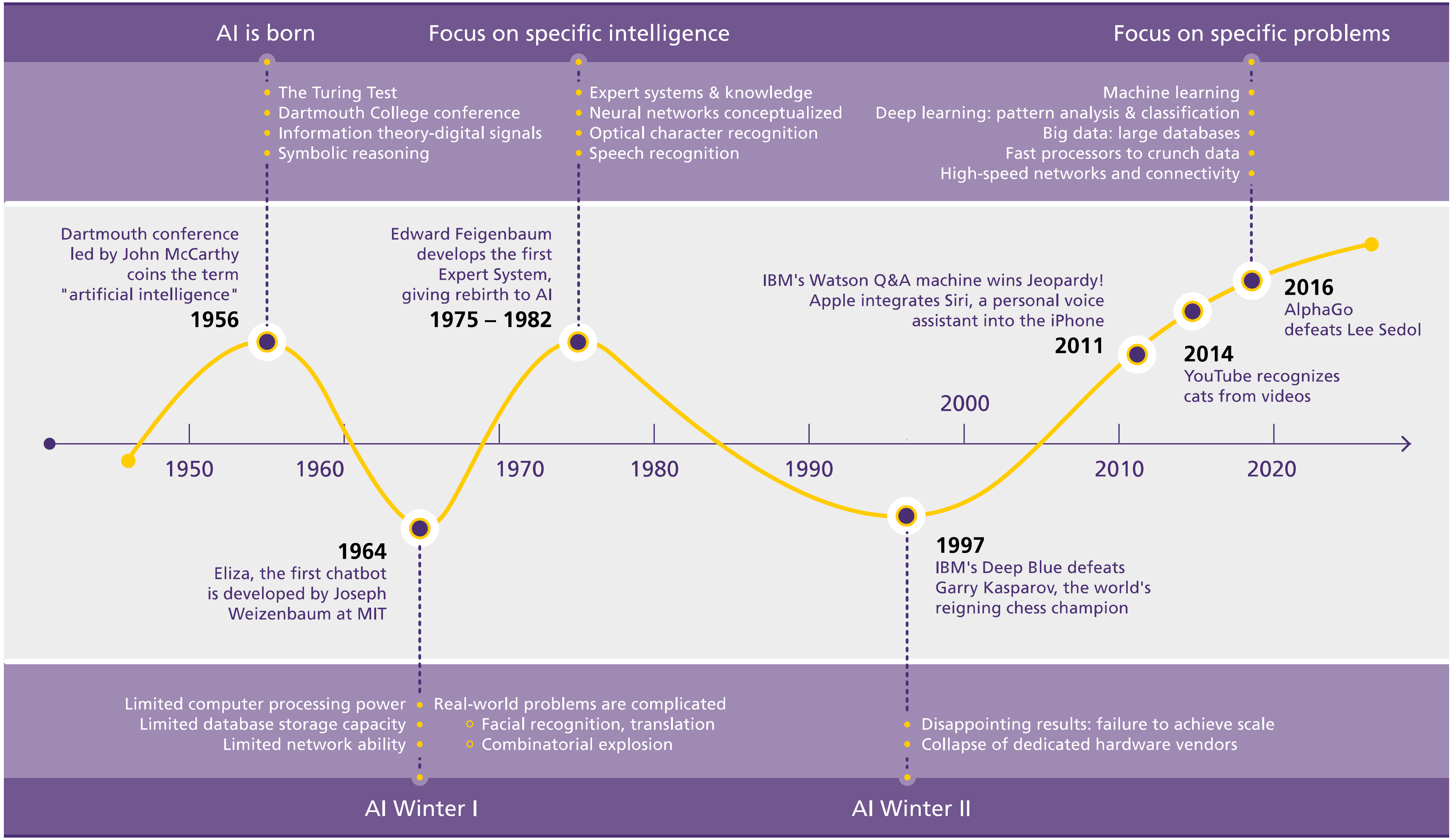
Artificial Intelligence (AI)

AI, Big Data, Cloud Computing
Evolution of Decision Support, Business Intelligence, and Analytics



Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

The Rise of AI



Source: DHL (2018), Artificial Intelligence in Logistics,
http://www.globalhha.com/doclib/data/upload/doc_con/5e50c53c5bf67.pdf/

Definition
of
Artificial Intelligence
(A.I.)

Artificial Intelligence

"… the **science** and

engineering

of

making

intelligent machines"

(John McCarthy, 1955)

Source: https://digitalintelligencetoday.com/artificial-intelligence-defined-useful-list-of-popular-definitions-from-business-and-science/

Artificial Intelligence

"… technology that thinks and acts like humans"

Source: https://digitalintelligencetoday.com/artificial-intelligence-defined-useful-list-of-popular-definitions-from-business-and-science/

Artificial Intelligence

"… intelligence exhibited by machines or software"

Source: https://digitalintelligencetoday.com/artificial-intelligence-defined-useful-list-of-popular-definitions-from-business-and-science/

4 Approaches of AI

Thinking Humanly	Thinking Rationally
Acting Humanly	Acting Rationally

Source: Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson

4 Approaches of AI

2. Thinking Humanly: The Cognitive Modeling Approach	3. Thinking Rationally: The "Laws of Thought" Approach
1. Acting Humanly: The Turing Test Approach (1950)	4. Acting Rationally: The Rational Agent Approach

Source: Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson

AI Acting Humanly: The Turing Test Approach

(Alan Turing, 1950)

- Knowledge Representation
- Automated Reasoning
- Machine Learning (ML)
  - Deep Learning (DL)
- Computer Vision (Image, Video)
- Natural Language Processing (NLP)
- Robotics

Source: Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson

FinTech

Financial Technology

FinTech

Financial Technology
FinTech

“providing financial services by making use of software and modern technology”

Source: https://www.fintechweekly.com/fintech-definition

Financial Revolution with Fintech

Source: http://www.hedgethink.com/fintech/european-fintech-top-100/

FinTech: Financial Services Innovation

Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

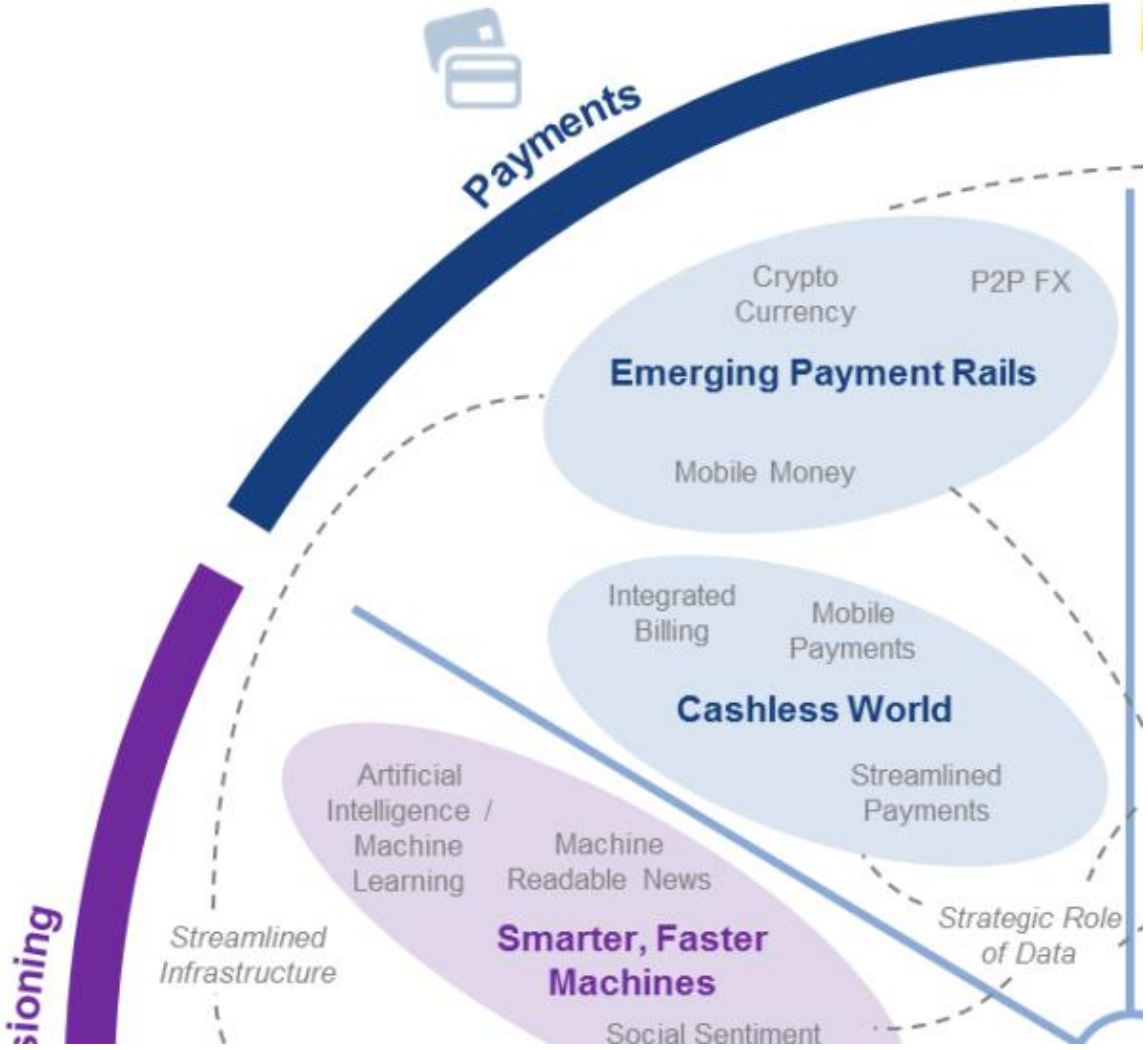
FinTech:
Financial Services Innovation

1. Payments
2. Insurance
3. Deposits & Lending
4. Capital Raising
5. **Investment Management**
6. **Market Provisioning**

Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

1

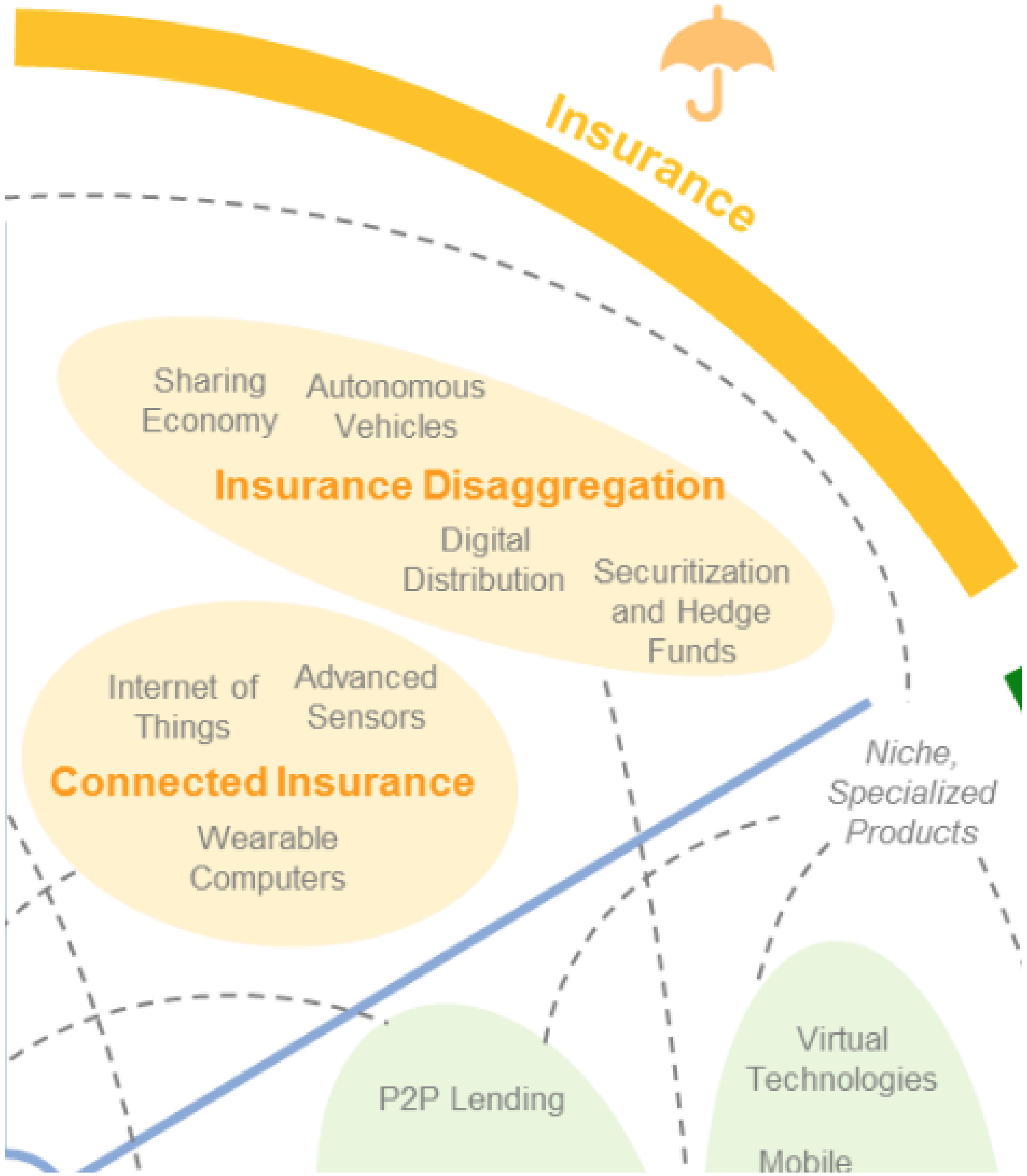
FinTech: Payment



Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

2

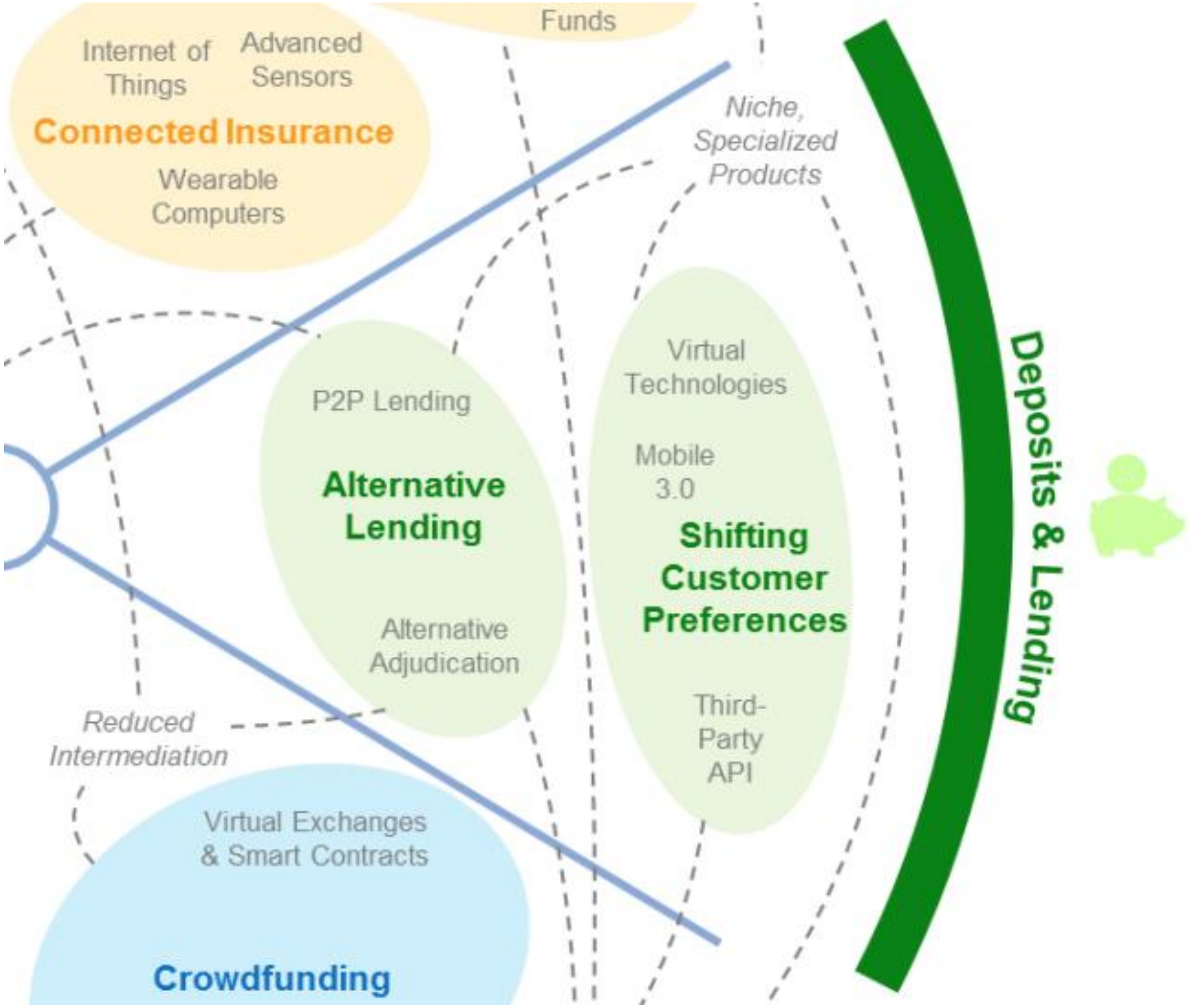
FinTech: Insurance



Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

3

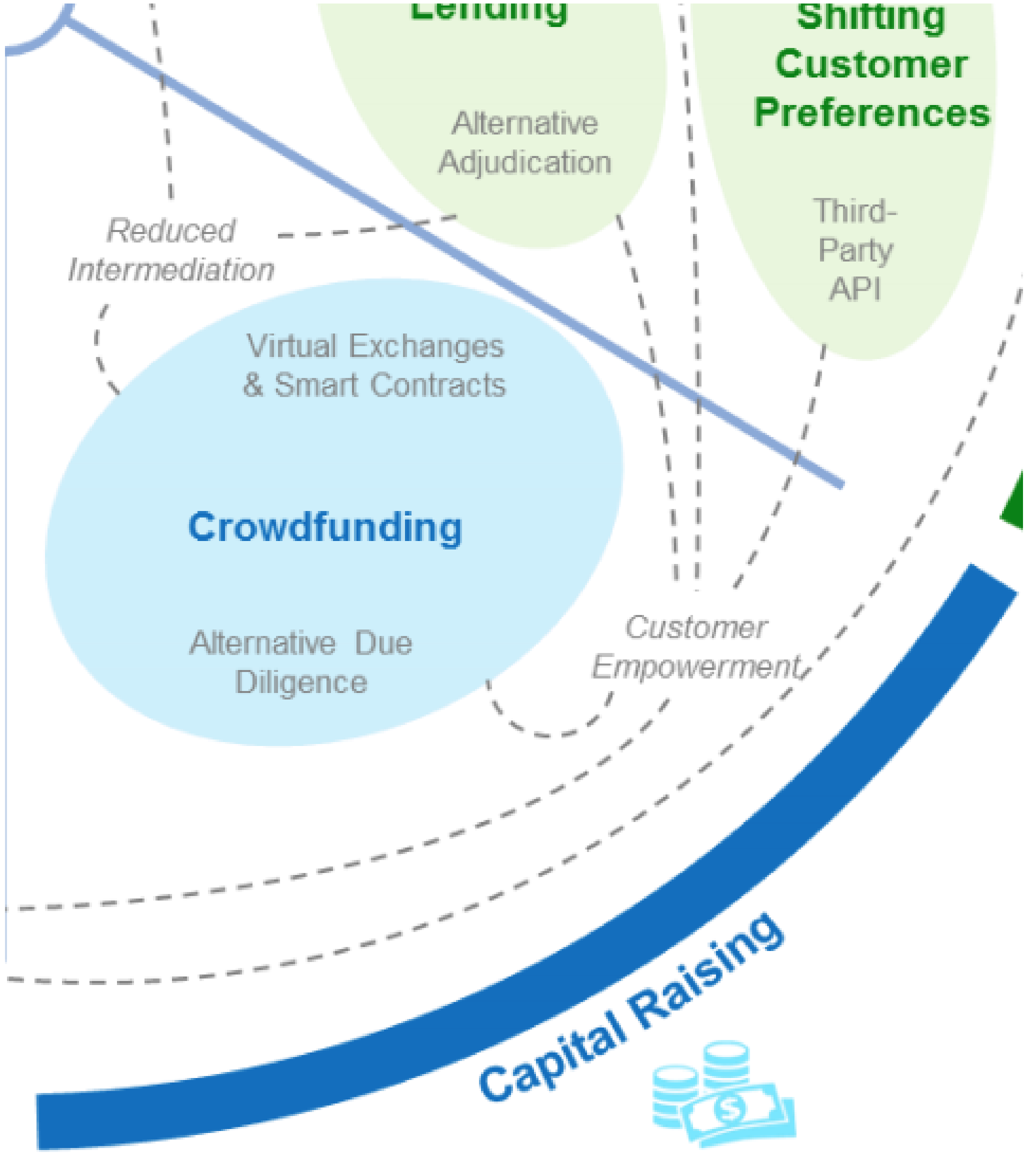
FinTech: Deposits & Lending



Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

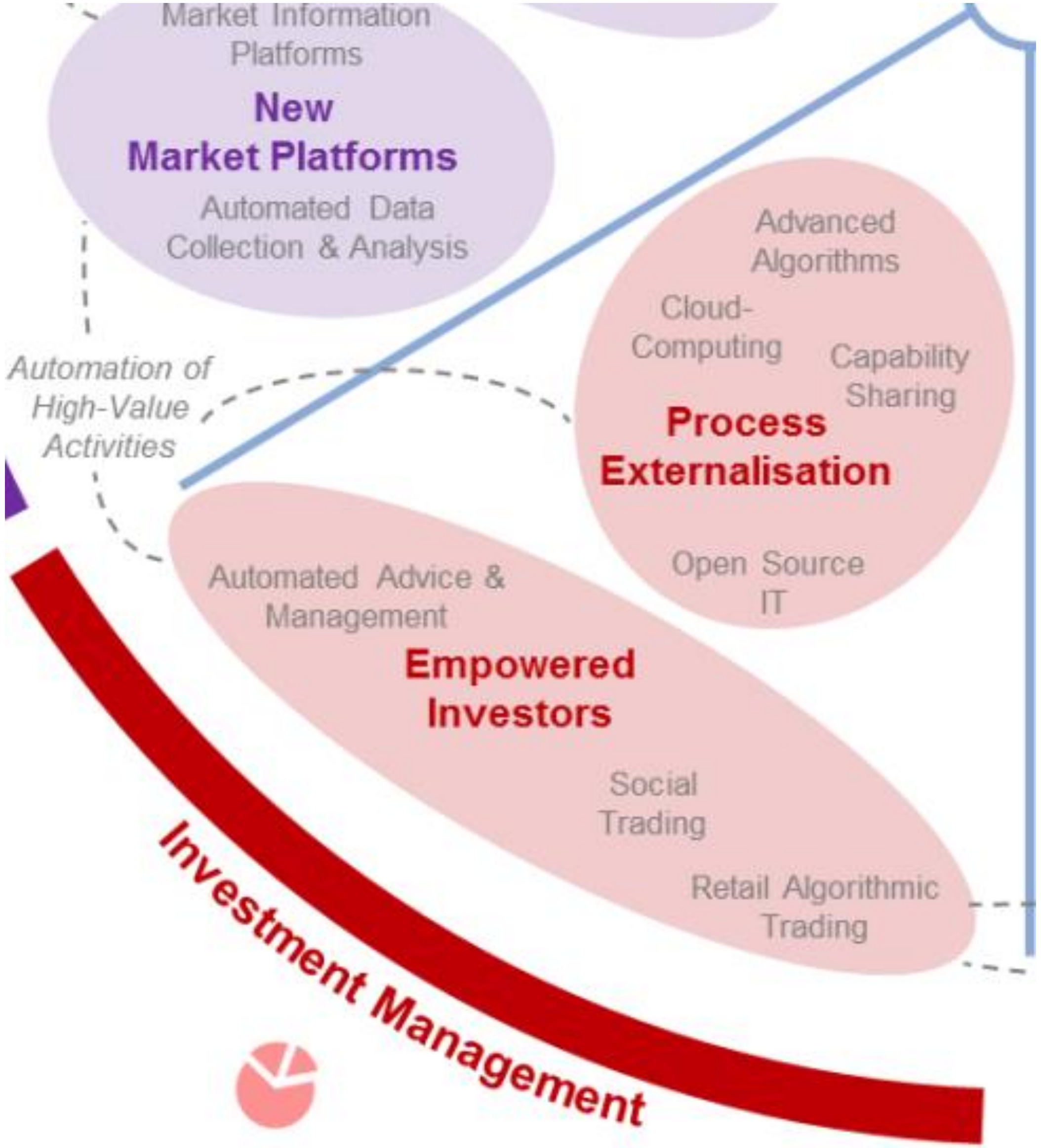
4

FinTech: Capital Raising



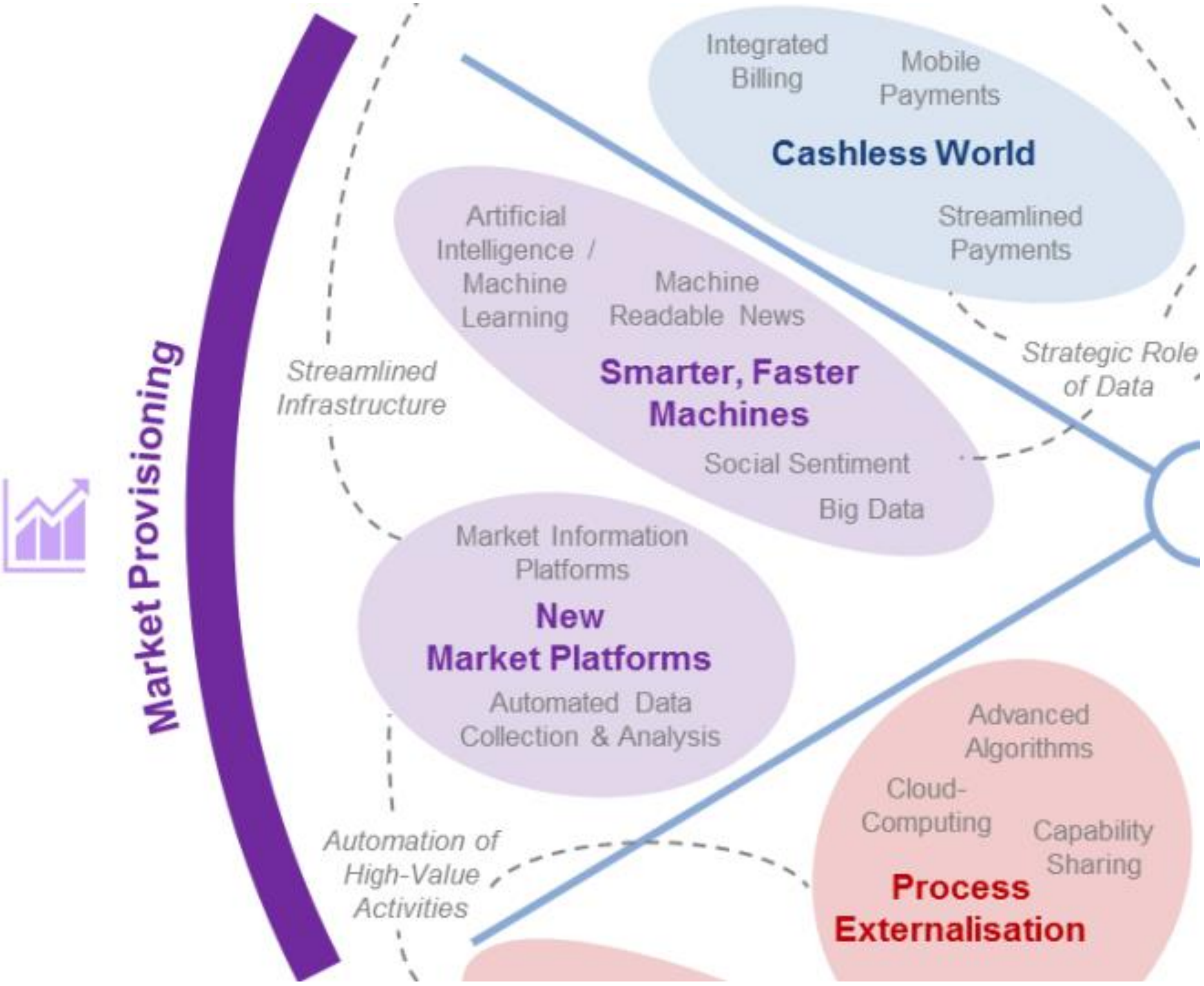
Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

5 FinTech: Investment Management



Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

6 FinTech: Market Provisioning

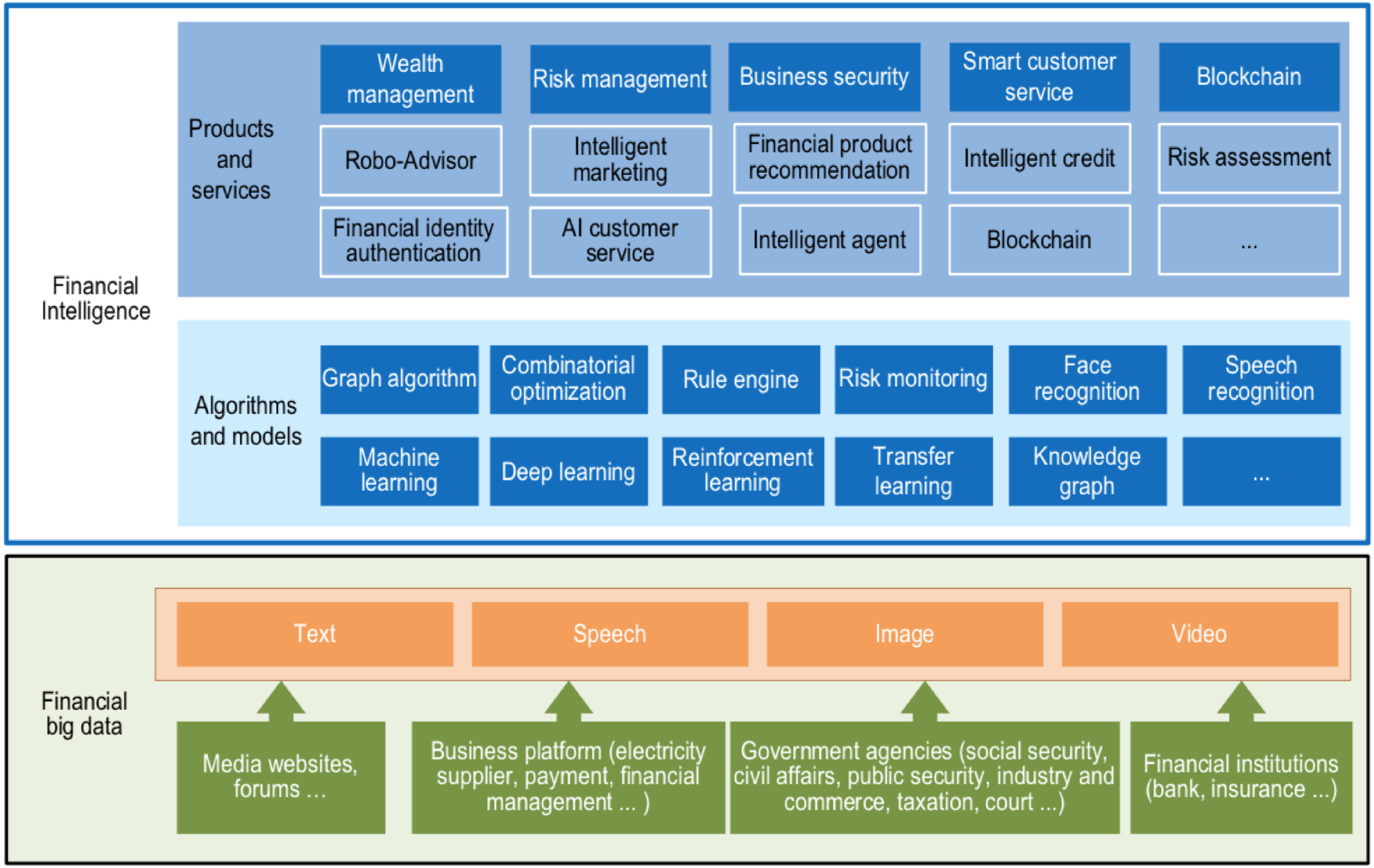


Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

AI
in
FinTech

FinBrain: when Finance meets AI 2.0

(Zheng et al., 2019)



Source: Xiao-lin Zheng, Meng-ying Zhu, Qi-bing Li, Chao-chao Chen, and Yan-chao Tan (2019), "Finbrain: When finance meets AI 2.0." Frontiers of Information Technology & Electronic Engineering 20, no. 7, pp. 914-924

AI 2.0

a new generation of AI based on the novel information environment of major changes and the development of new goals.

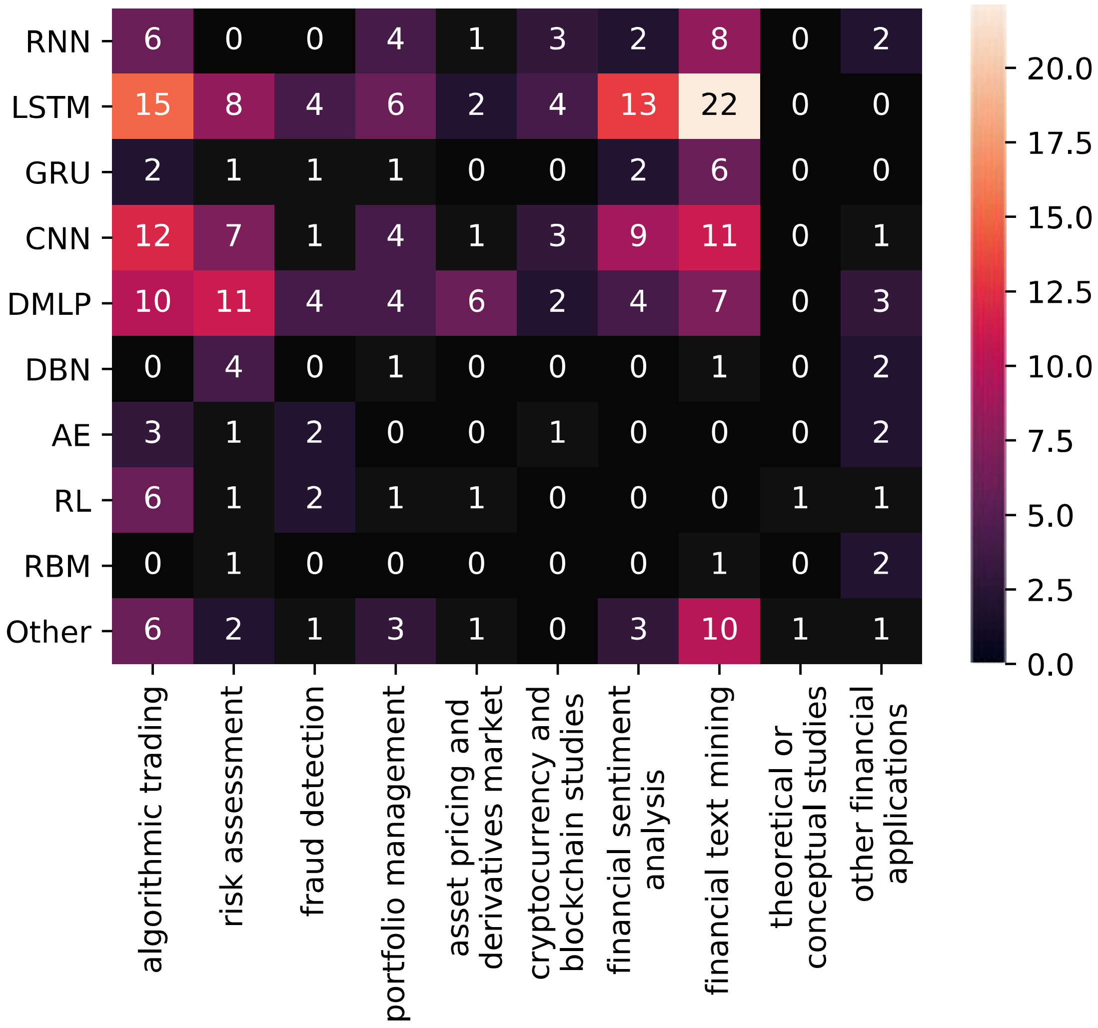
Yunhe Pan (2016), "Heading toward artificial intelligence 2.0." Engineering 2, no. 4, 409-413.

Technology-driven Financial Industry Development

Development stage	Driving technology	Main landscape	Inclusive finance	Relationship between technology and finance
Fintech 1.0 (financial IT)	Computer	Credit card, ATM, and CRMS	Low	Technology as a tool
Fintech 2.0 (Internet finance)	Mobile Internet	Marketplace lending, third-party payment, crowdfunding, and Internet insurance	Medium	Technology-driven change
Fintech 3.0 (financial intelligence)	AI, Big Data, Cloud Computing, Blockchain	Intelligent finance	High	Deep fusion

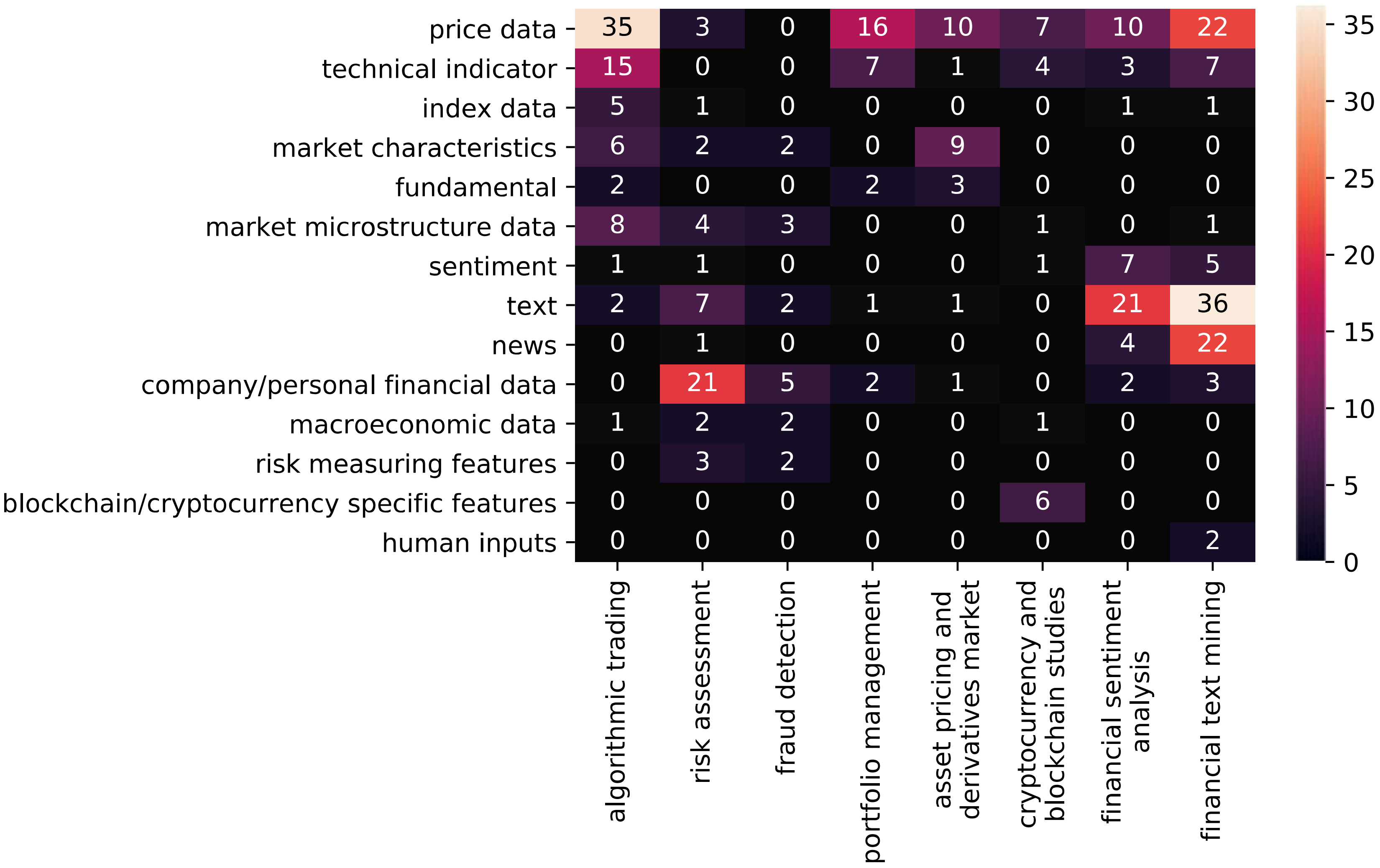
Source: Xiao-lin Zheng, Meng-ying Zhu, Qi-bing Li, Chao-chao Chen, and Yan-chao Tan (2019), "Finbrain: When finance meets AI 2.0." Frontiers of Information Technology & Electronic Engineering 20, no. 7, pp. 914-924

Deep learning for financial applications: Topic-Model Heatmap



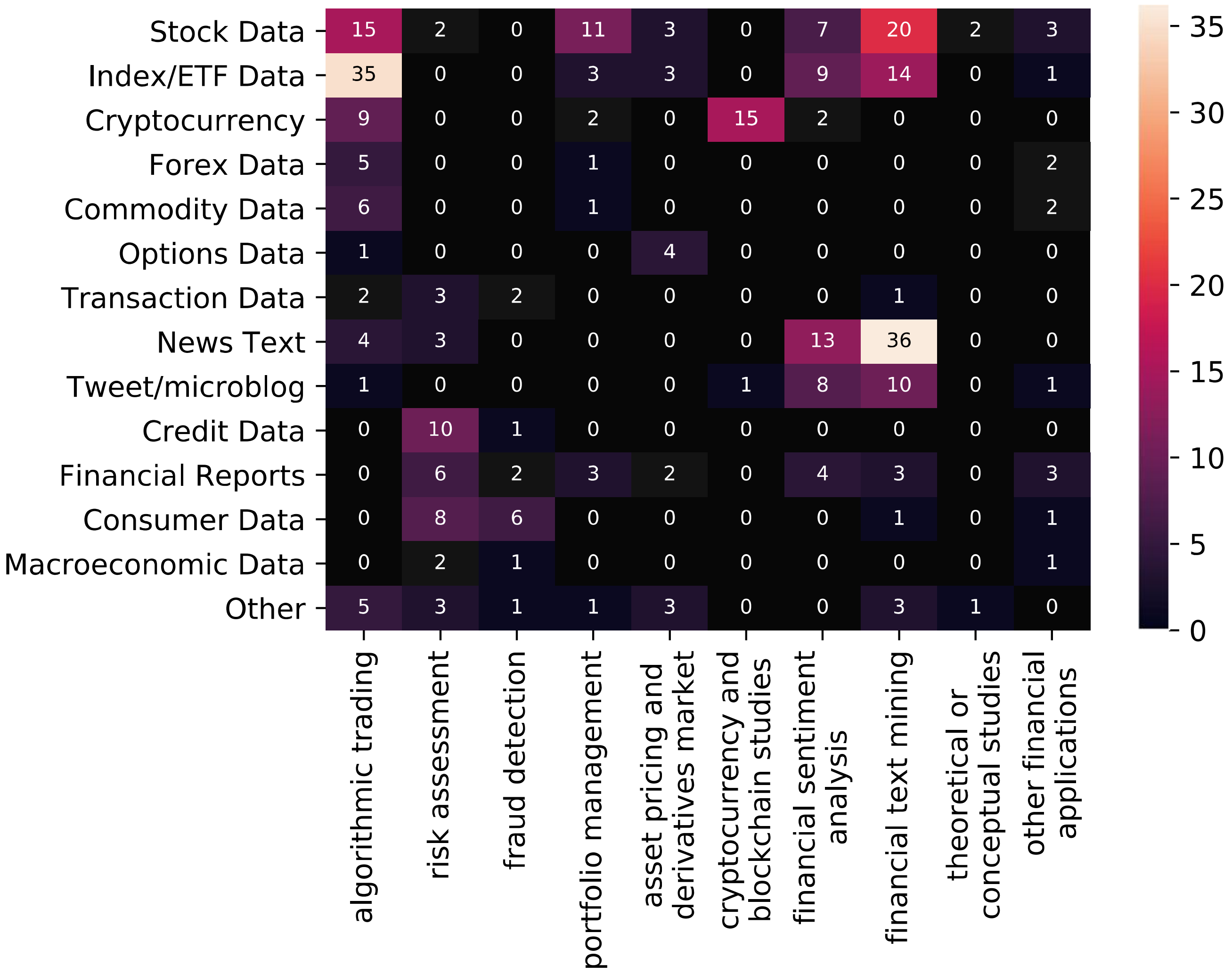
Source: Ahmet Murat Ozbayoglu, Mehmet Ugur Gudelek, and Omer Berat Sezer (2020). "Deep learning for financial applications: A survey." Applied Soft Computing (2020): 106384.

Deep learning for financial applications: Topic-Feature Heatmap



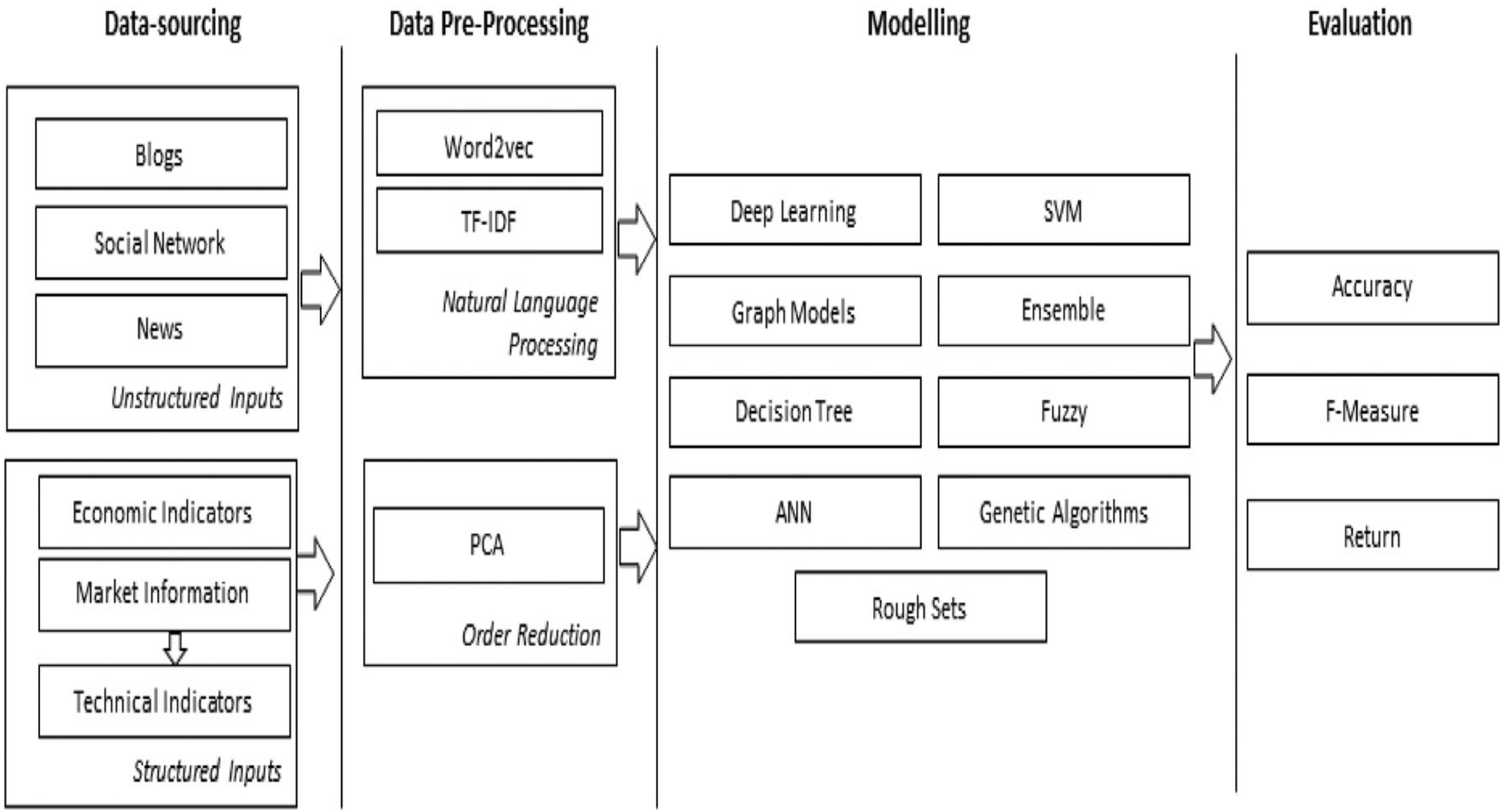
Source: Ahmet Murat Ozbayoglu, Mehmet Ugur Gudelek, and Omer Berat Sezer (2020). "Deep learning for financial applications: A survey." Applied Soft Computing (2020): 106384.

Deep learning for financial applications: Topic-Dataset Heatmap



Source: Ahmet Murat Ozbayoglu, Mehmet Ugur Gudelek, and Omer Berat Sezer (2020). "Deep learning for financial applications: A survey." Applied Soft Computing (2020): 106384.

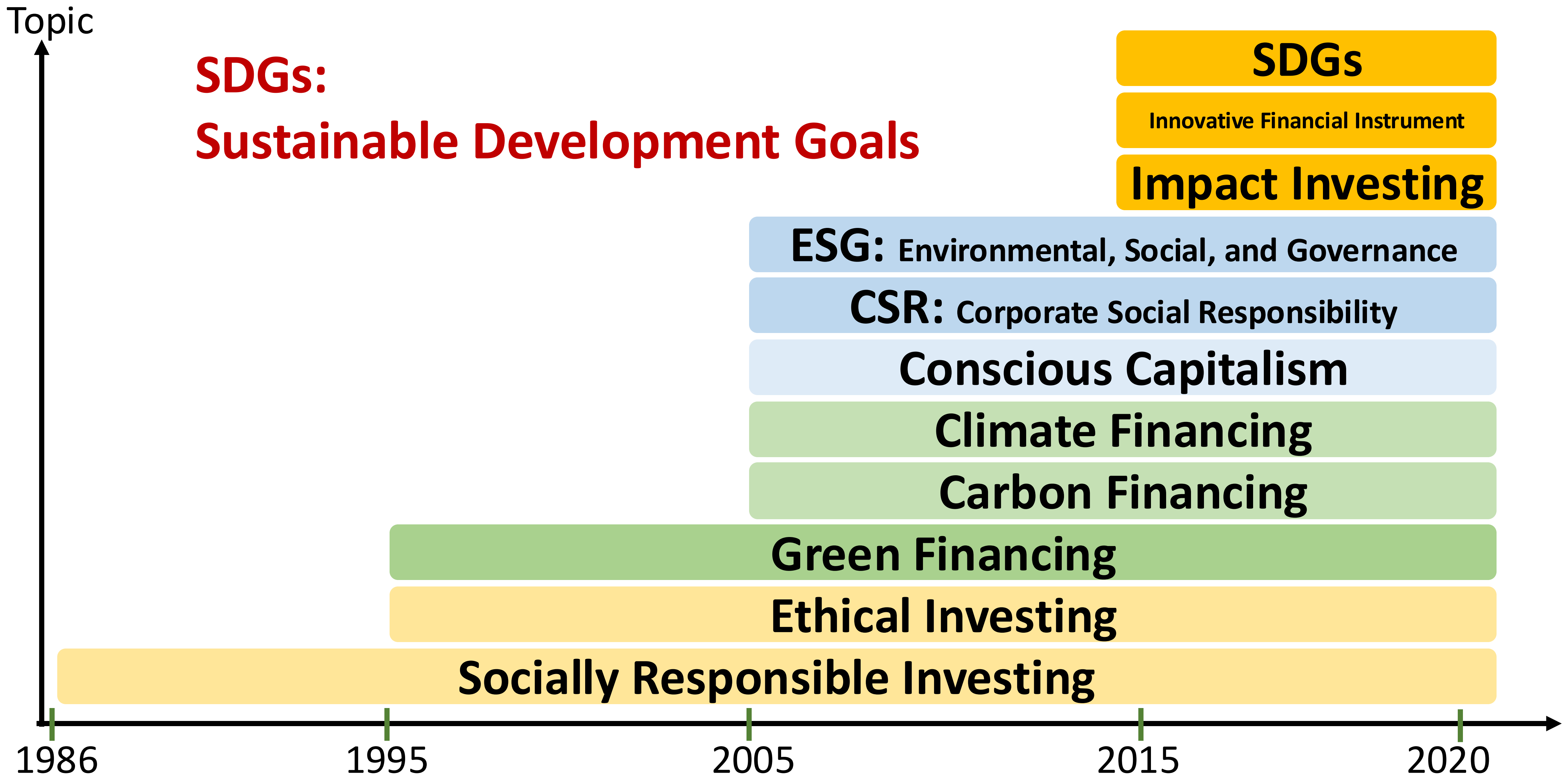
Stock Market Movement Forecast:
Phases of the stock market modeling



Source: O. Bustos and A. Pomares-Quimbaya (2020), "Stock Market Movement Forecast: A Systematic Review." Expert Systems with Applications (2020): 113464.

Green Finance and Sustainable Finance

Evolution of Sustainable Finance Research



Source: Kumar, S., Sharma, D., Rao, S., Lim, W. M., & Mangla, S. K. (2022). Past, present, and future of sustainable finance: Insights from big data analytics through machine learning of scholarly research. Annals of Operations Research, 1-44.

AI for Environmental, Social, and Governance (AI4ESG)

Source: Nenad Tomašev, Julien Cornebise, Frank Hutter, Shakir Mohamed, Angela Picciariello, Bec Connelly, Danielle Belgrave et al. (2020) "AI for social good: unlocking the opportunity for positive impact." Nature Communications 11, no. 1: 1-6.

AI for Social Good (AI4SG)

Source: Nenad Tomašev, Julien Cornebise, Frank Hutter, Shakir Mohamed, Angela Picciariello, Bec Connelly, Danielle Belgrave et al. (2020) "AI for social good: unlocking the opportunity for positive impact." Nature Communications 11, no. 1: 1-6.

Sustainability
SDGs
CSR
ESG

Sustainable Development Goals (SDGs)

Source: https://sdgs.un.org/goals

Sustainable Development Goals (SDGs) and 5P

Partnership

Peace

Prosperity

People

Planet

Source: Folke, Carl, Reinette Biggs, Albert V. Norström, Belinda Reyers, and Johan Rockström. "Social-ecological resilience and biosphere-based sustainability science." Ecology and Society 21, no. 3 (2016).

Green Finance

Generic term
implying use or diversion
of financial resources
to deploy and support projects
with long term positive impact
on the environment

Source: Bhattacharyya, Rupsha. "Green finance for energy transition, climate action and sustainable development: overview of concepts, applications, implementation and challenges." Green Finance 4, no. 1 (2022): 1-35.

Sustainable Finance

Finances

deployed in support of projects that ensure just, sustainable and inclusive growth or attainment of one or more sustainable development goals

Source: Bhattacharyya, Rupsha. "Green finance for energy transition, climate action and sustainable development: overview of concepts, applications, implementation and challenges." Green Finance 4, no. 1 (2022): 1-35.

Carbon Finance

Financial instruments
based on
economic value of carbon emissions
which an organization cannot avoid but which it offsets by funding other compensatory projects that contribute to carbon emissions reduction

Source: Bhattacharyya, Rupsha. "Green finance for energy transition, climate action and sustainable development: overview of concepts, applications, implementation and challenges." Green Finance 4, no. 1 (2022): 1-35.

Climate Finance

Finances deployed
in support of low carbon and
climate resilient projects
that help in climate change mitigation and
adaptation efforts,
particularly in the
energy and infrastructure sectors

Source: Bhattacharyya, Rupsha. "Green finance for energy transition, climate action and sustainable development: overview of concepts, applications, implementation and challenges." Green Finance 4, no. 1 (2022): 1-35.

ESG Investing

Investments considering the broad range of environmental (e.g. climate change, pollution biodiversity loss), social (e.g. working conditions, human rights, salary or compensation structures) and governance (e.g. board composition, diversity and inclusion, taxes) characteristics of the projects or companies being invested in; ethical and business sustainability considerations are integral part of financing

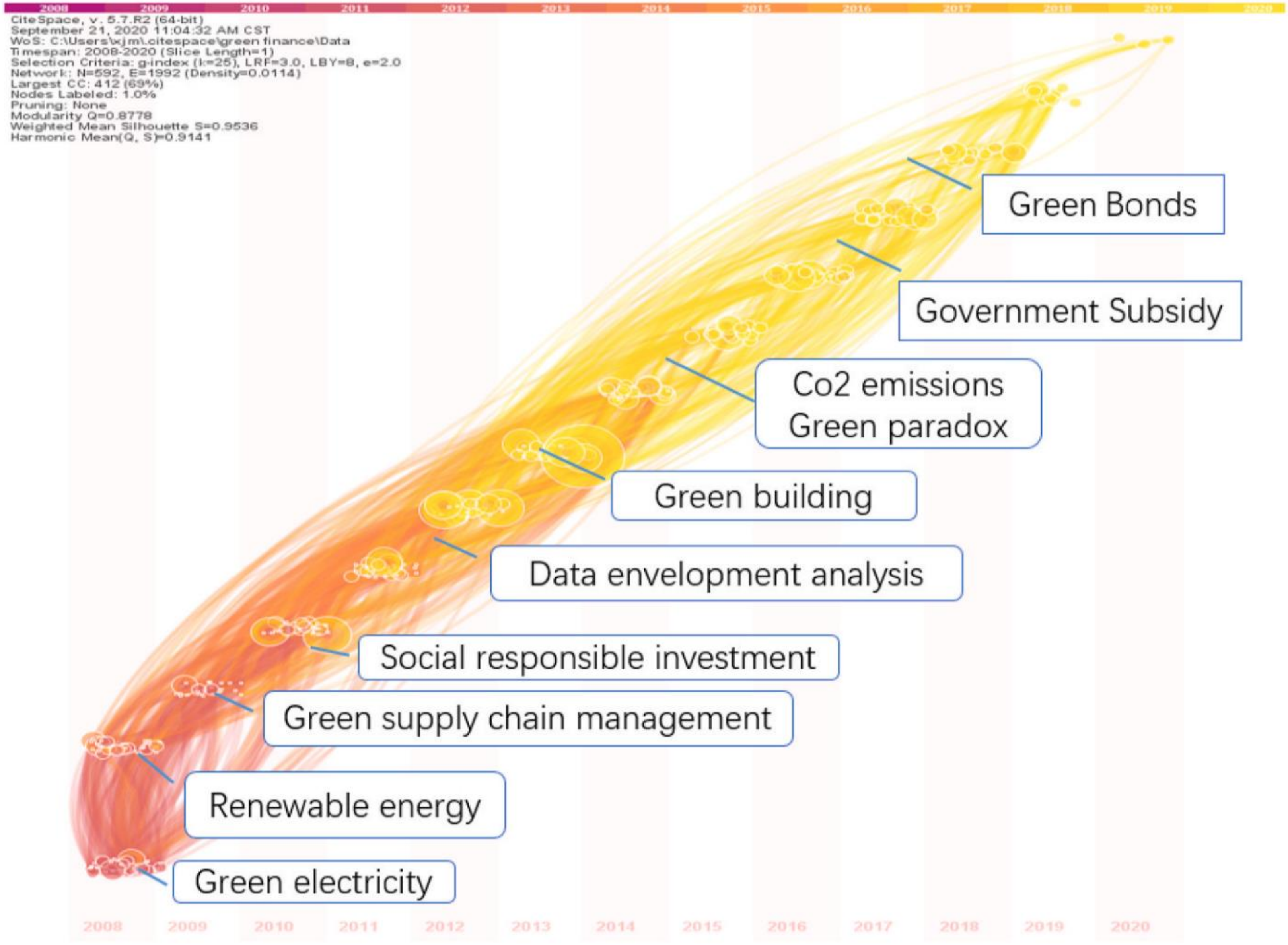
Source: Bhattacharyya, Rupsha. "Green finance for energy transition, climate action and sustainable development: overview of concepts, applications, implementation and challenges." Green Finance 4, no. 1 (2022): 1-35.

Impact Investing

**Investing in projects
that solve a social or environmental problem;
the focus is on the positive impact
rather than the
means used to produce that impact**

Source: Bhattacharyya, Rupsha. "Green finance for energy transition, climate action and sustainable development: overview of concepts, applications, implementation and challenges." Green Finance 4, no. 1 (2022): 1-35.

Dynamic Trends of Green Finance and Energy Policy



Source: Wang, Moran, Xuerong Li, and Shouyang Wang. (2021) "Discovering research trends and opportunities of green finance and energy policy: A data-driven scientometric analysis." Energy Policy 154 (2021): 112295.

ESG:

Environmental

Social

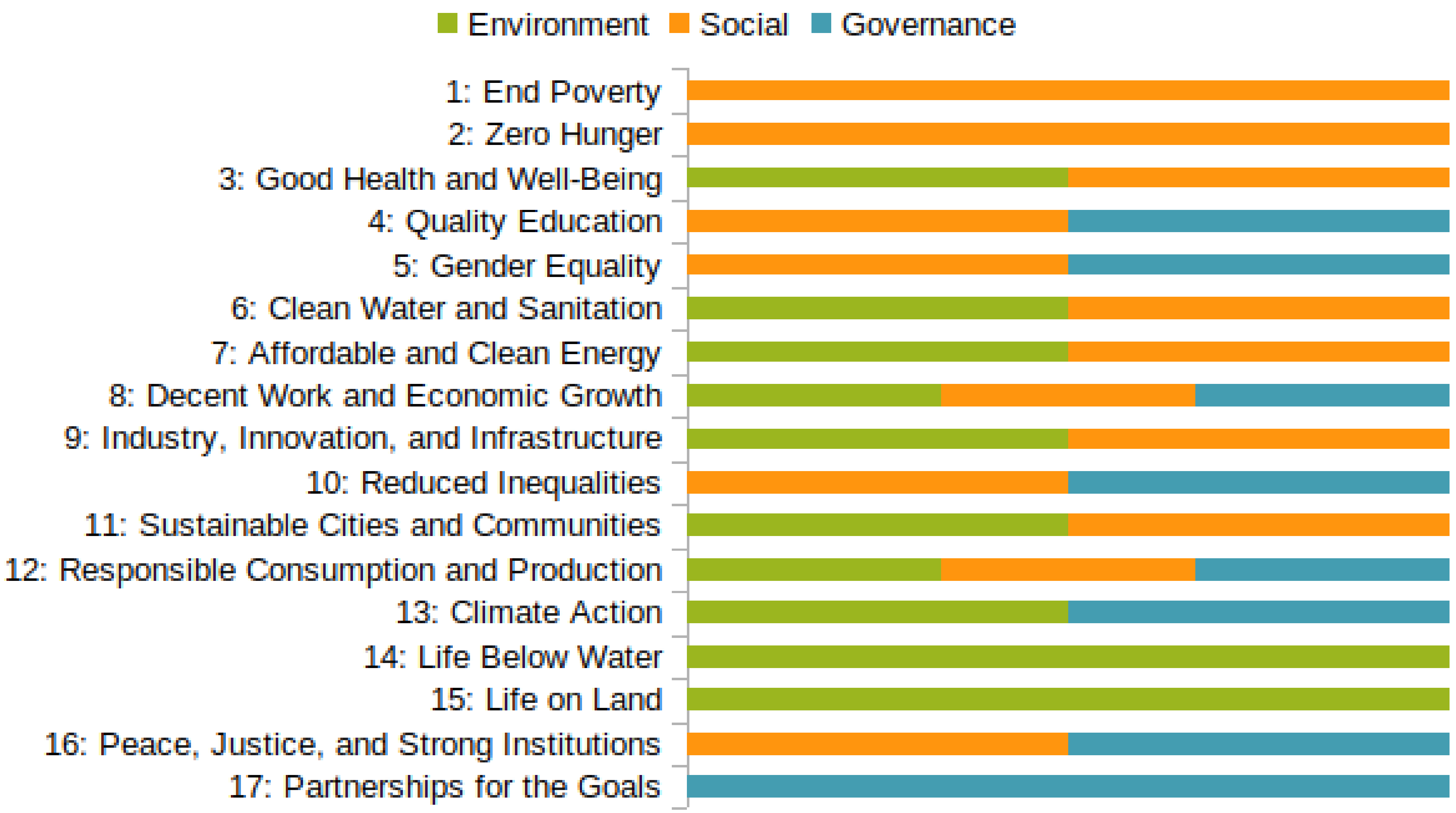
Governance

CSR:
Corporate
Social
Responsibility

ESG to 17 SDGs

Source: Henrik Skaug Sætra (2021) "A Framework for Evaluating and Disclosing the ESG Related Impacts of AI with the SDGs." Sustainability 13, no. 15 (2021): 8503.

ESG to 17 SDGs



Source: https://sustainometric.com/esg-to-sdgs-connected-paths-to-a-sustainable-future/

Generative AI
for
ESG Applications

AI and Sustainability Development Goals (SDGs)

SDGs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	No poverty	Zero hunger	Good health and well-being	Quality education	Gender equality	Clean water and sanitation	Affordable and clean energy	Decent work and economic growth	Industry, innovation and infrastructure	Reduces inequalities	Sustainable cities and communities	Responsible consumption and production	Climate action	Life below water	Life on land	Peace, justice and strong institutions	Partnerships for the goals
Economic								●	●	●	○						●
Ecological		○					○				○	○	●	●	●		
Social	●	●	●	●	●	●	●				●	●				●	
Positive impact of AI*	100%	76%	69%	10%0	56%	100%	100%	92%	100%	90%	100%	82%	80%	90%	100%	58%	26%

Note: ● adopted from Vinuesa et al. (2020), ○ added based on our analysis.
*The assessment of AI's possible positive impact is based on a consensus-based expert elicitation process (Vinuesa et al., 2020).

Source: Schoormann, T., Strobel, G., Möller, F., Petrik, D., & Zschech, P. (2023).
Artificial Intelligence for Sustainability—A Systematic Review of Information Systems Literature. Communications of the Association for Information Systems, 52(1), 8.

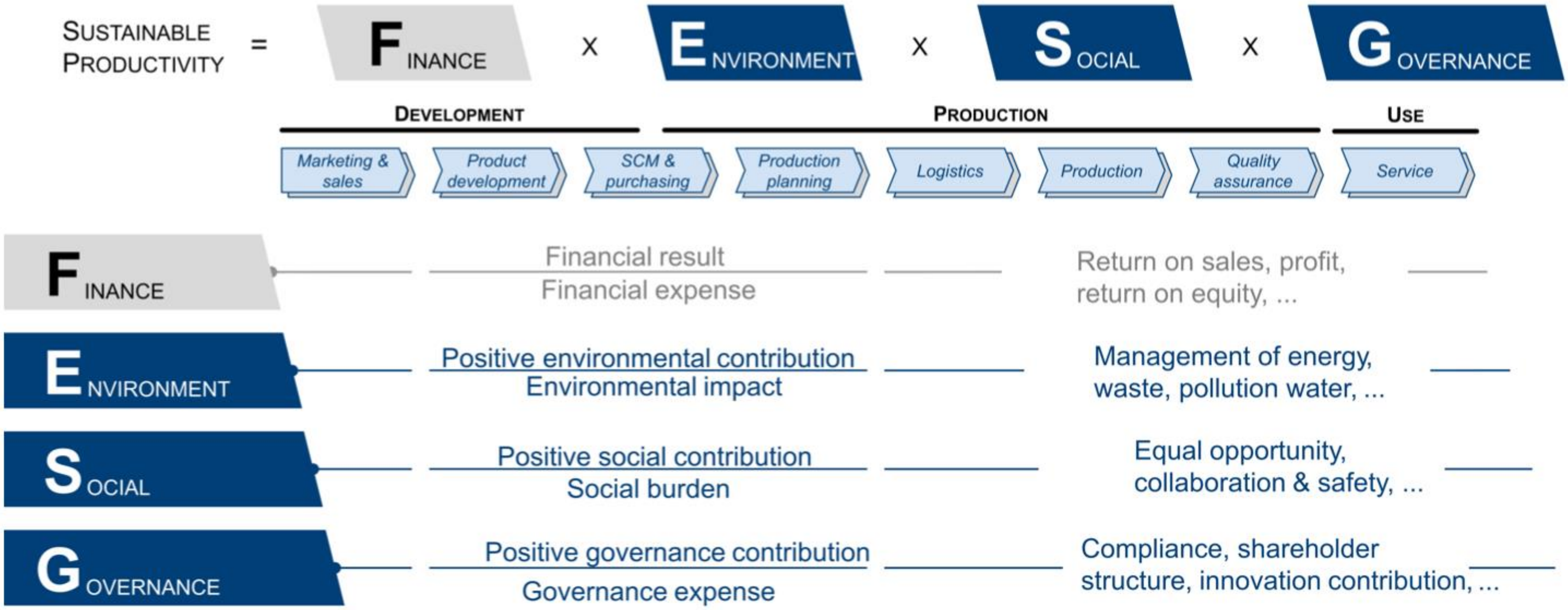
AI for Sustainability

Dimension	Code characteristics					
Primary objective[1]	Develop new (AI) methods *(11/95)*	Compare (AI) methods *(39/95)*	Apply (AI) methods *(53/95)*	Develop new system *(20/95)*	Other objective *(4/95)*	
Sustainability dimension	Economic *(23/95)*	Ecological *(17/95)*	Social *(72/95)*			
Sustainable Development Goals (SDGs)	SDG 1 *(0/95)*	SDG 2 *(2/95)*	SDG 3 *(55/95)*	SDG 4 *(6/95)*	SDG 5 *(0/95)*	SDG 6 *(0/95)*
	SDG 7 *(9/95)*	SDG 8 *(7/95)*	SDG 9 *(8/95)*	SDG 10 *(1/95)*	SDG 11 *(9/95)*	SDG 12 *(8/95)*
	SDG 13 *(2/95)*	SDG 14 *(0/95)*	SDG 15 *(2/95)*	SDG 16 *(11/95)*	SDG 17 *(0/95)*	
Data source	Reviews *(12/95)*	Social media/ Online forums *(31/95)*	Health records *(21/95)*	Environment/ Weather *(10/95)*	Energy *(5/95)*	
Data source plurality	Single source *(50/95)*	Multiple sources *(44/95)*	N/A *(1/95)*			
Data sensitivity	Publicly available data *(64/95)*	Internal data *(16/95)*	Other *(11/95)*	N/A *(9/95)*		
Manual labeling	Yes *(32/95)*	No *(63/95)*				
Technology	ML *(91/95)*	NLP *(42/95)*	CV *(12/95)*	Other *(21/95)*		
Type of learning for ML approach	Supervised learning *(85/95)*	Unsupervised learning *(23/95)*				
Neural vs. non-neural	Non-neural *(45/95)*	Neural *(50/95)*	Deep learning *(38/95)*			
Evaluation	Technical evaluation *(83/95)*	Domain evaluation *(25/95)*				
Paradigm	DSR/ADR *(30/95)*	Non-DSR/ADR *(64/95)*				
	0-9	10-29	30-54	55-69	70-95	

Notes: Code dimensions are not mutually exclusive; one article can be classified into one or more code characteristics; [1] 'Compare' does include 'apply'.

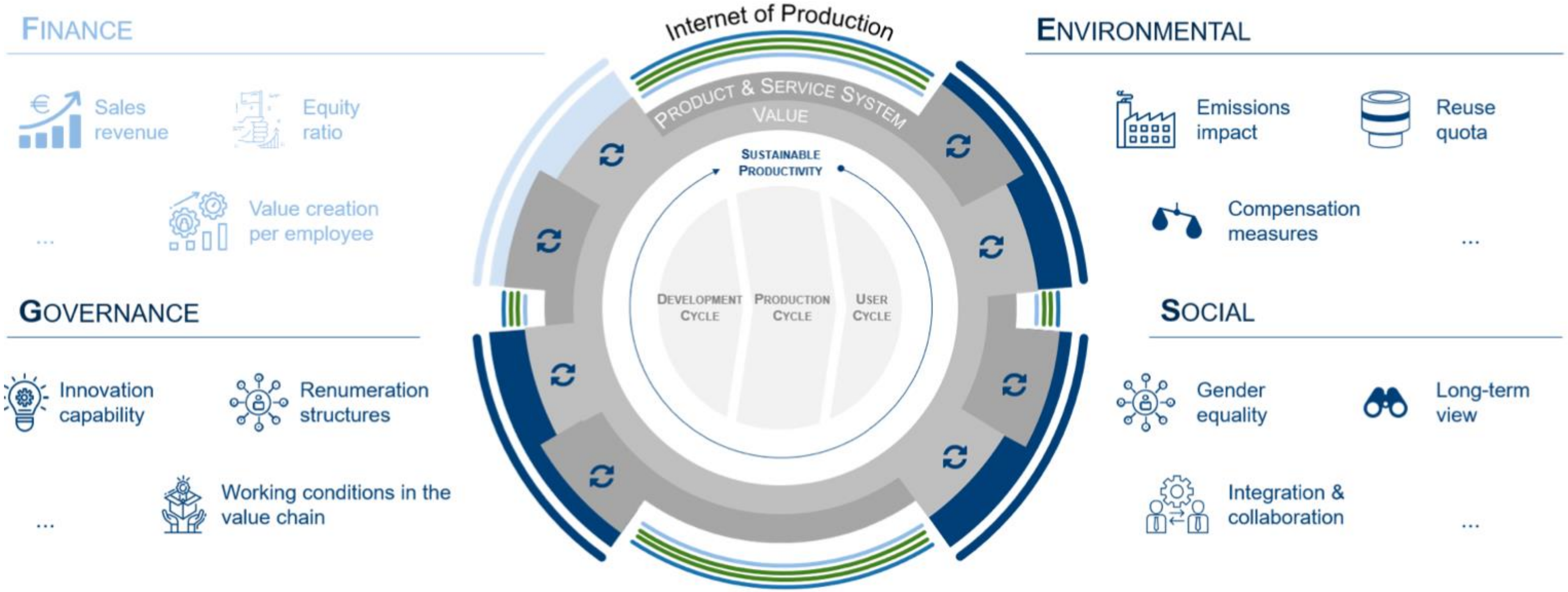
Source: Schoormann, T., Strobel, G., Möller, F., Petrik, D., & Zschech, P. (2023).
Artificial Intelligence for Sustainability—A Systematic Review of Information Systems Literature. Communications of the Association for Information Systems, 52(1), 8.

Sustainable Productivity: Finance ESG



Source: Huang, Ziqi, Yang Shen, Jiayi Li, Marcel Fey, and Christian Brecher (2021). "A survey on AI-driven digital twins in Industry 4.0: Smart manufacturing and advanced robotics." Sensors 21, no. 19: 6340.

Sustainable Resilient Manufacturing
ESG

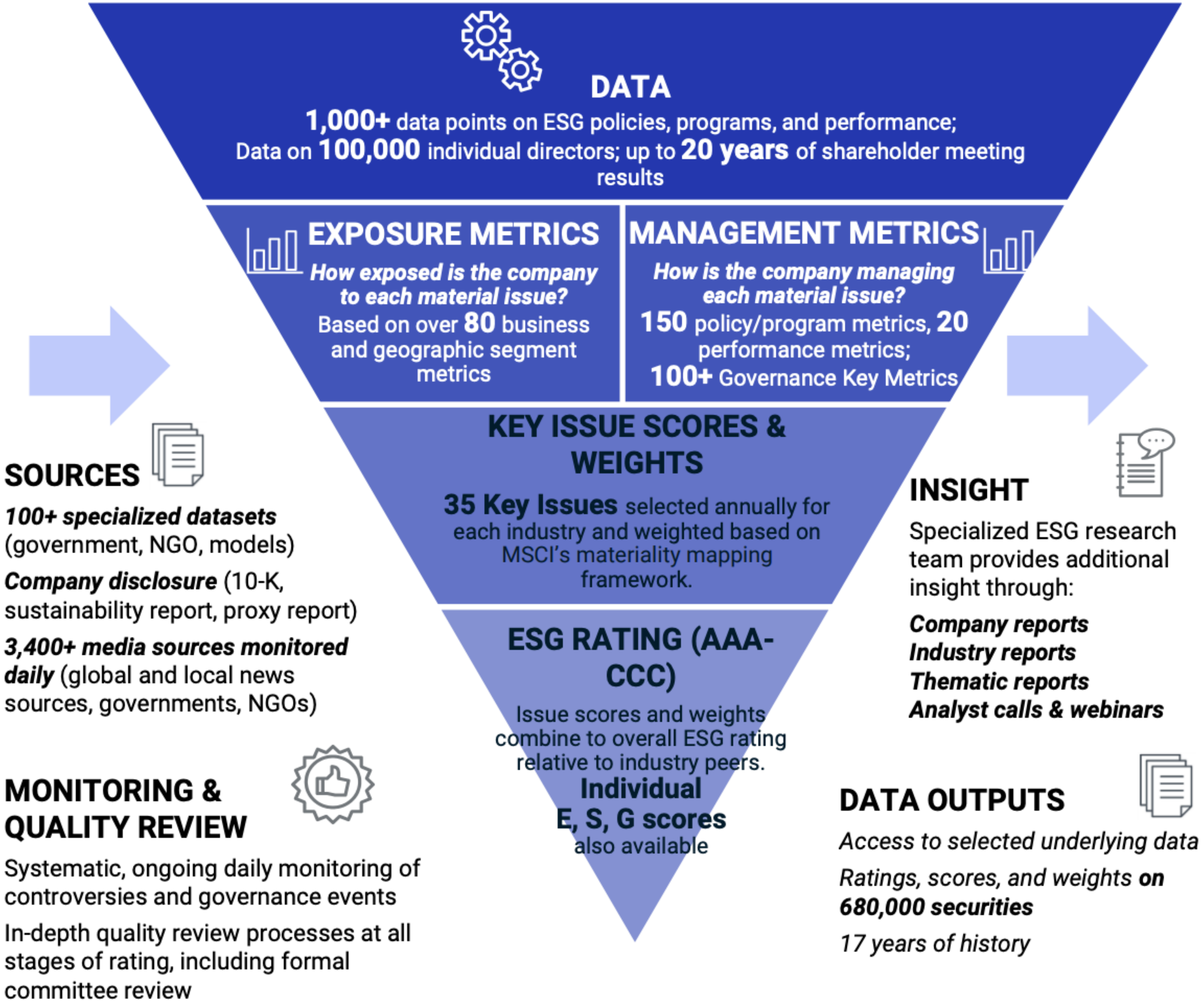


Source: Huang, Ziqi, Yang Shen, Jiayi Li, Marcel Fey, and Christian Brecher (2021). "A survey on AI-driven digital twins in Industry 4.0: Smart manufacturing and advanced robotics." Sensors 21, no. 19: 6340.

ESG Indexes

- MSCI ESG Index
- Dow Jones Sustainability Indices (DJSI)
- FTSE ESG Index

MSCI ESG Rating Framework



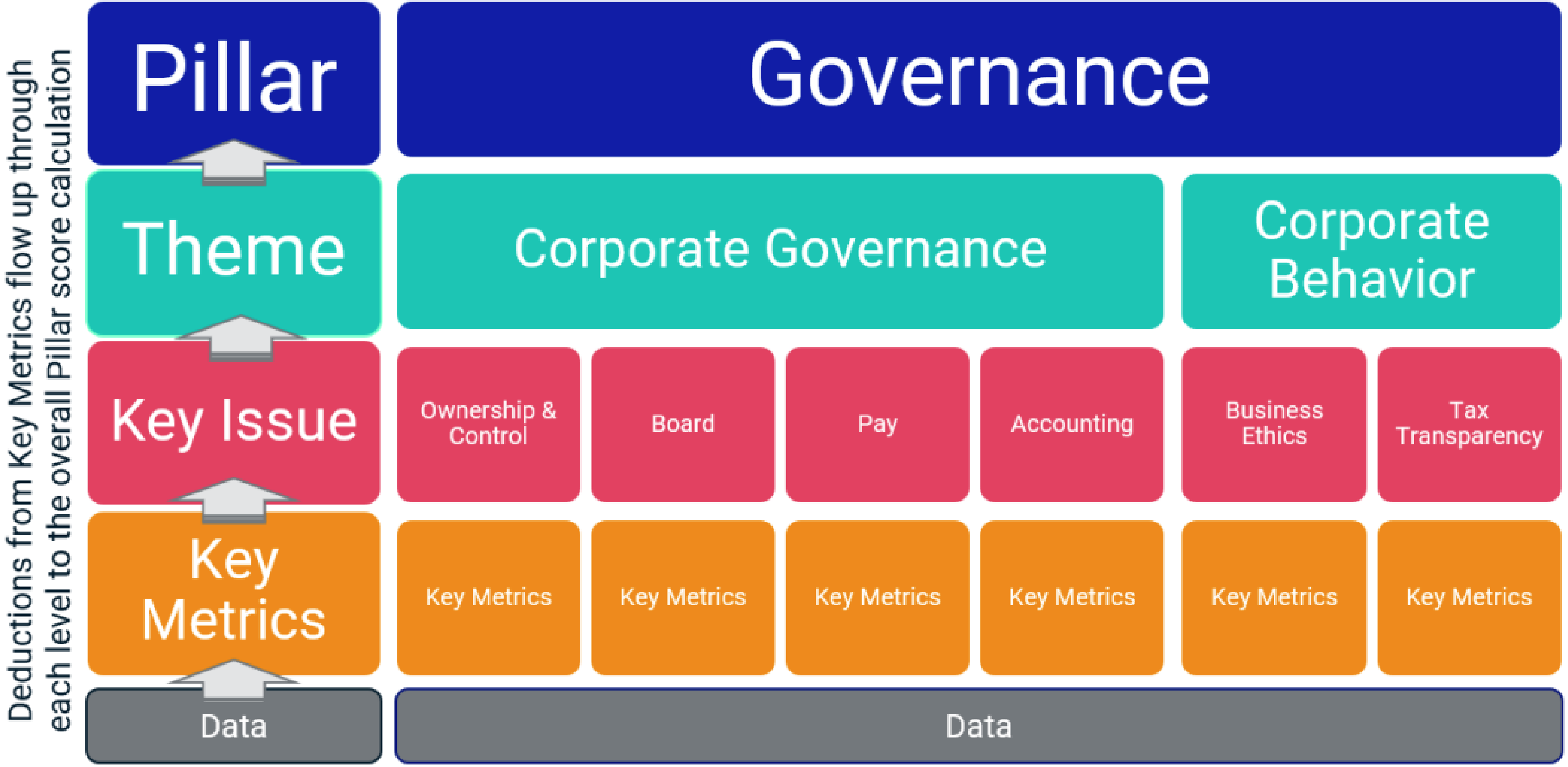
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

MSCI ESG Key Issue Hierarchy

3 Pillars	10 Themes	35 ESG Key Issues	
Environment	Climate Change	Carbon Emissions Product Carbon Footprint	Financing Environmental Impact Climate Change Vulnerability
	Natural Capital	Water Stress Biodiversity & Land Use	Raw Material Sourcing
	Pollution & Waste	Toxic Emissions & Waste Packaging Material & Waste	Electronic Waste
	Environmental Opportunities	Opportunities in Clean Tech Opportunities in Green Building	Opportunities in Renewable Energy
Social	Human Capital	Labor Management Health & Safety	Human Capital Development Supply Chain Labor Standards
	Product Liability	Product Safety & Quality Chemical Safety Consumer Financial Protection	Privacy & Data Security Responsible Investment Health & Demographic Risk
	Stakeholder Opposition	Controversial Sourcing Community Relations	
	Social Opportunities	Access to Communications Access to Finance	Access to Health Care Opportunities in Nutrition & Health
Governance	Corporate Governance	Ownership & Control Board	Pay Accounting
	Corporate Behavior	Business Ethics Tax Transparency	

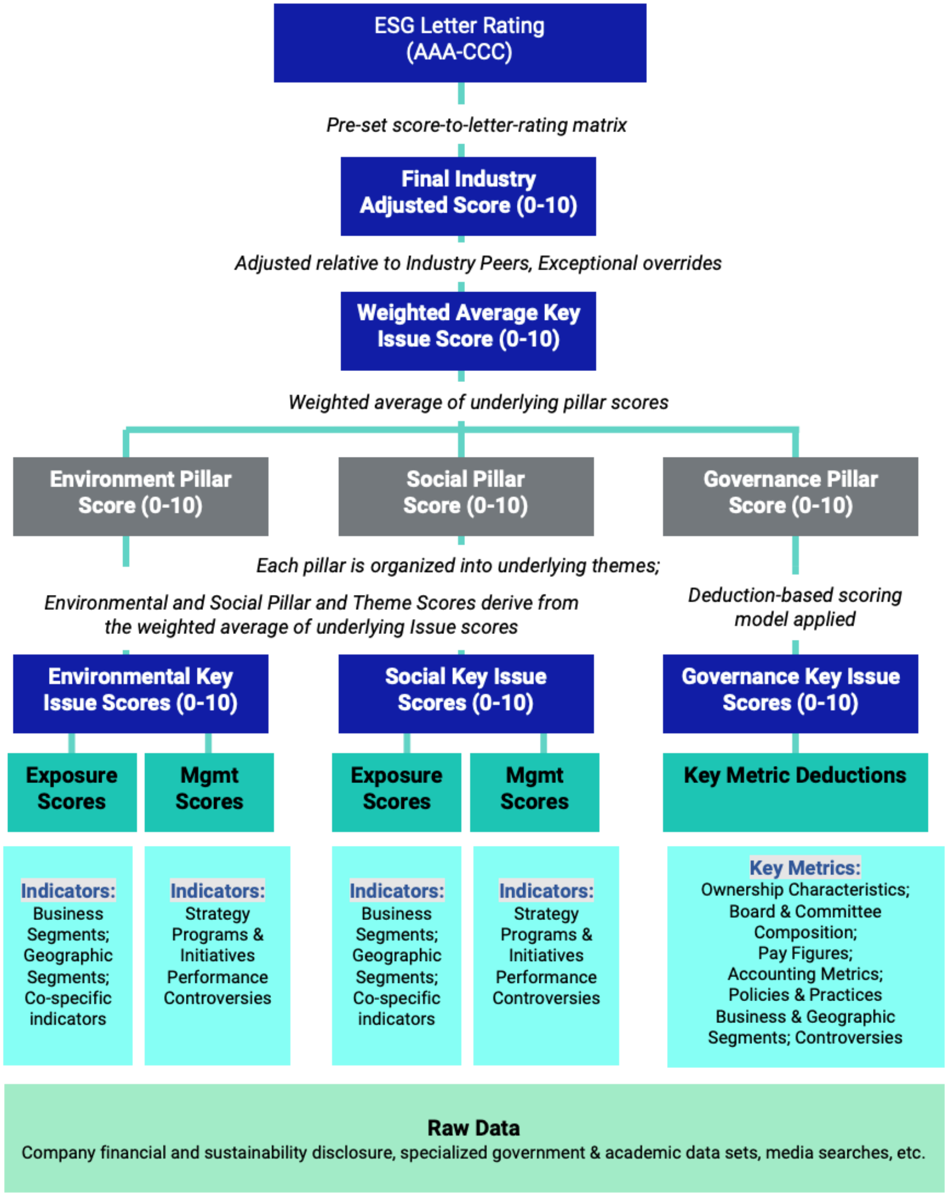
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

MSCI Governance Model Structure



Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

MSCI Hierarchy of ESG Scores



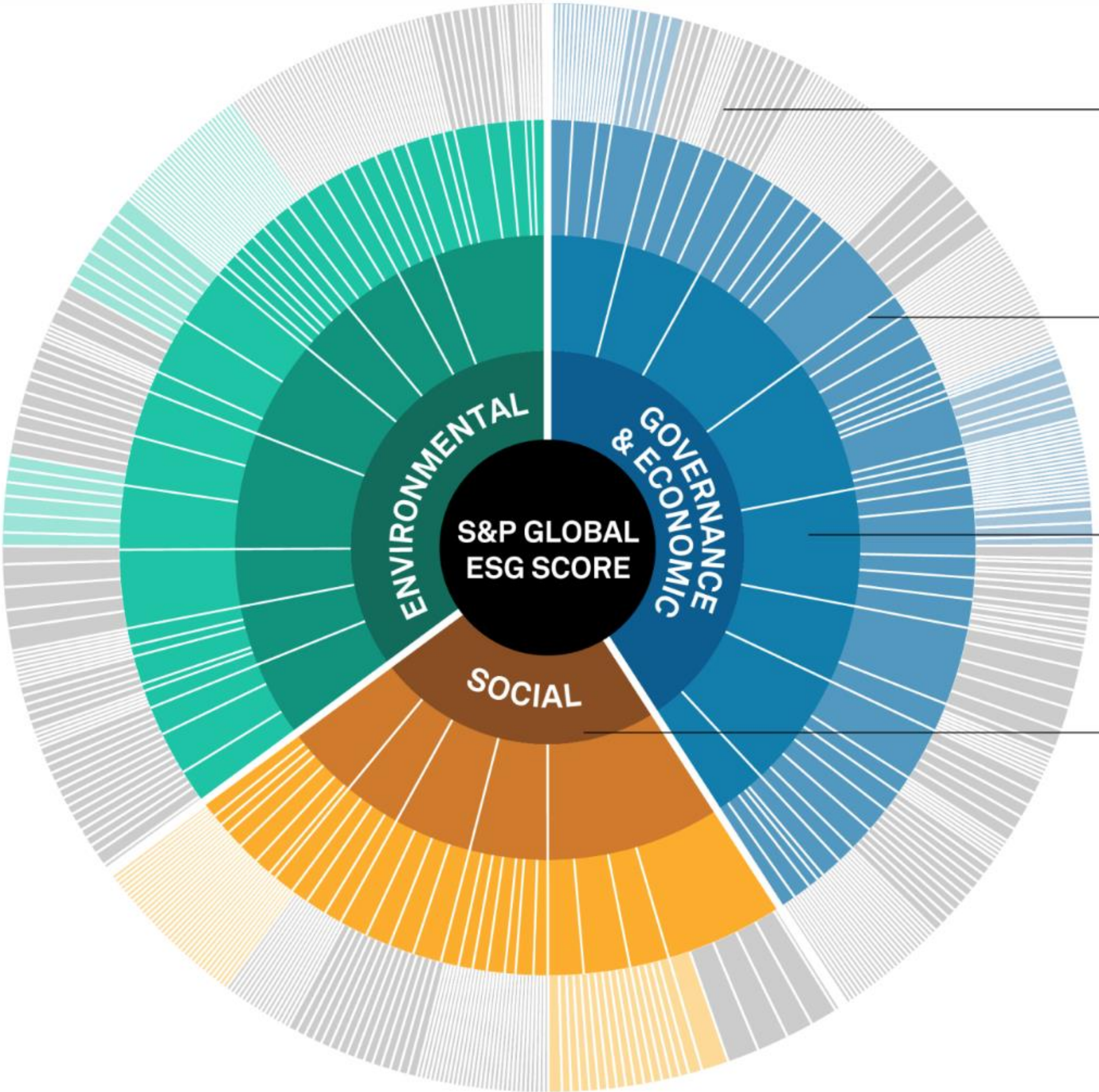
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

DJSI S&P Global ESG Score

8,000
Companies

90%
Global market capitalization

340,000+
Current Research Universe and Active Securities



Approx.
1,000
Datapoints

Assessed values, text, checkboxes, documents
Sources: Web-based questionnaire and company documents

130+
Questions

Weighted data point scores
Up to 50% industry-specific

Ave.
30+
Criteria scores

Weighted question scores
61 industry specific approaches, with tailored questions, criteria and related weightings

3
Dimension scores

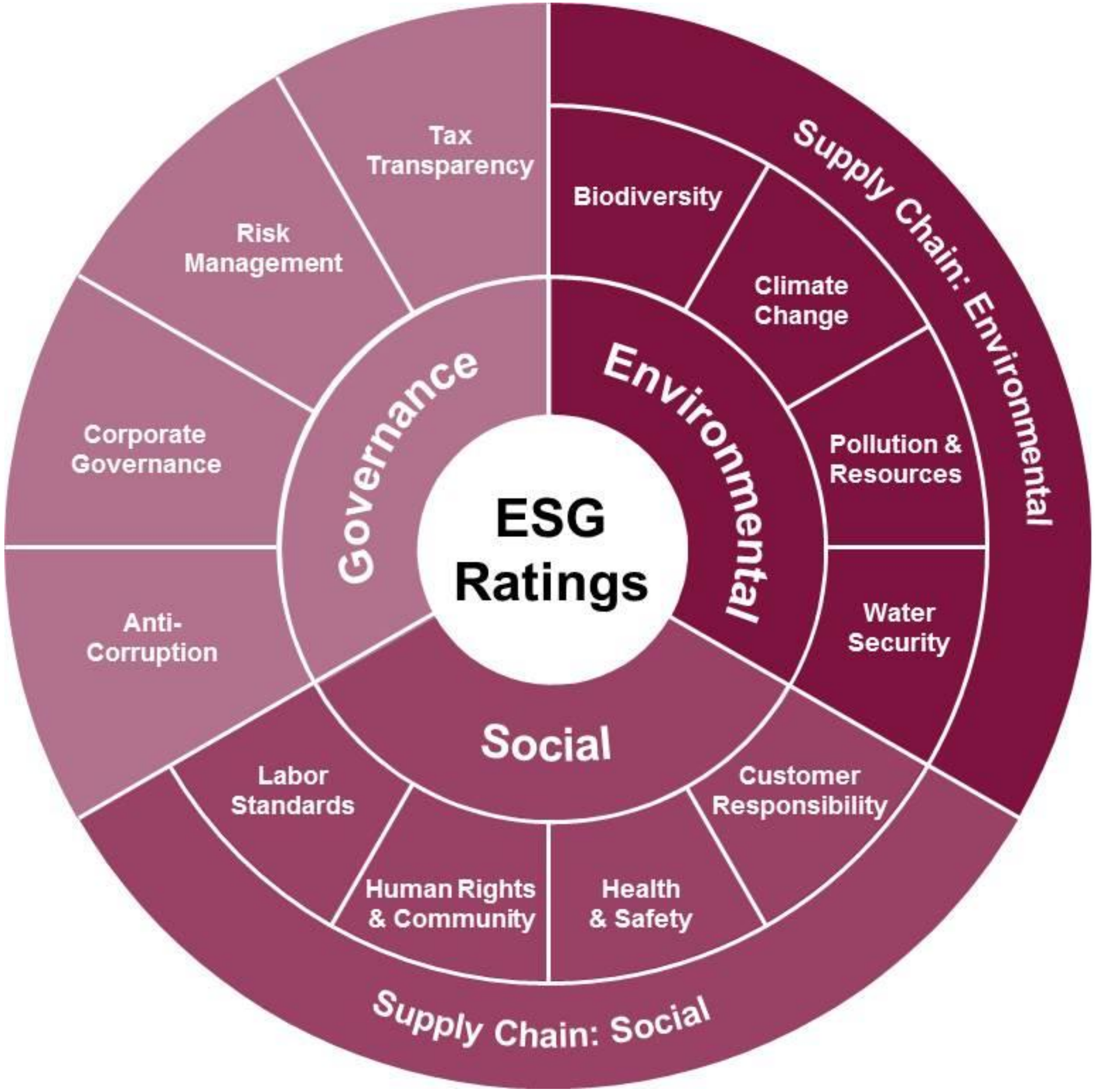
Weighted criteria scores
Adjusted for corporate ESG controversies where applicable

1
S&P Global ESG Score

Sum of weighted dimension scores

Source: DJSI, S&P Global Corporate Sustainability Assessment (CSA), https://www.spglobal.com/esg/solutions/data-intelligence-esg-scores

FTSE Russell ESG Ratings



Source: https://www.ftserussell.com/data/sustainability-and-esg-data/esg-ratings

Sustainalytics ESG Risk Ratings

SUSTAINALYTICS
a Morningstar company

Analyst-based approach

Sustainalytics’ ESG Risk Ratings measure a company’s exposure to industry-specific material ESG risks and how well a company is managing those risks.

Negligible	Low	Medium	High	Severe
0 - 10	10 - 20	20 - 30	30 - 40	40+

Source: https://www.sustainalytics.com/esg-data

TruValue Labs

FACTSET

Truvalue ESG Ranks

Machine-based approach

- Truvalue Labs applies AI to analyze over 100,000 sources and uncover ESG risks and opportunities hidden in unstructured text.
- The ESG Ranks data service produces an overall company rank based on industry percentile leveraging the 26 ESG categories defined by the Sustainability Accounting Standards Board (SASB).
- The data feed covers 20,000+ companies with more than 13 years of history.

Laggard	Below Average	Average	Above Average	Leader

Source: :https://developer.truvaluelabs.com/data/esg-ranks

Analyst-driven vs. AI-driven ESG

Analyst-driven ESG research

Derives ratings in a structured data model

Sustainalytics

Analyst role at the end of the process allows subjectivity to color results

AI-driven ESG research

Derives signals from unstructured data

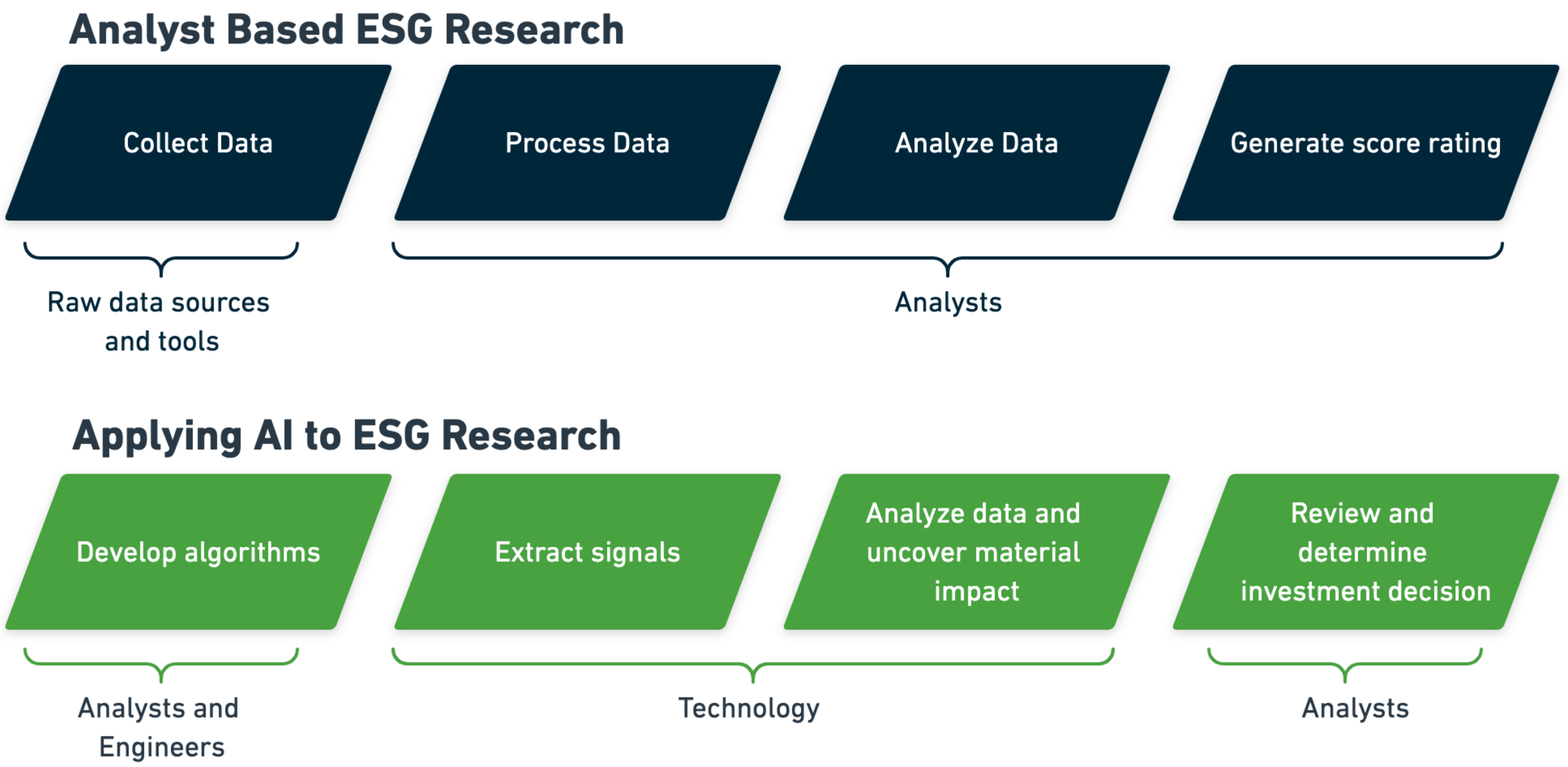
Truvalue Labs

Analyst expertise at the beginning of the process produces consistent results

Source: Mark Tulay (2020), Man vs. machine: A tale of two sustainability ratings systems, GreenBiz, https://www.greenbiz.com/article/man-vs-machine-tale-two-sustainability-ratings-systems

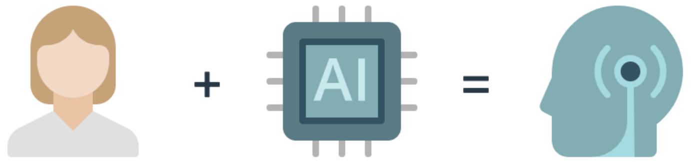
Analyst based ESG Research

AI based ESG Research



It would take an analyst over 5 years to do what our AI can in 1 week

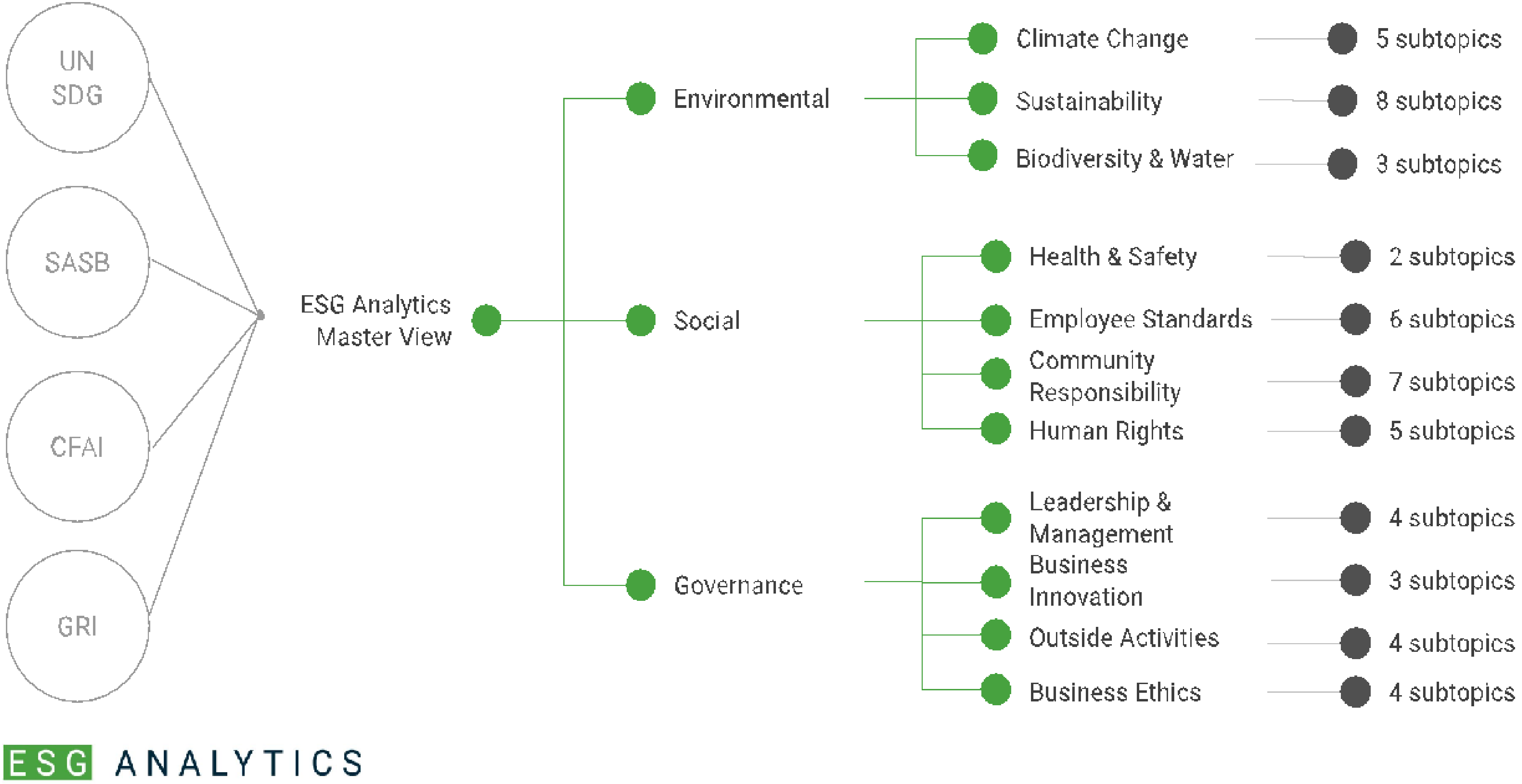
Combining analysts with AI creates gives you the full picture



ESG ANALYTICS
Invest where it matters.

Source: https://www.esganalytics.io/insights/how-data-is-accelerating-esg

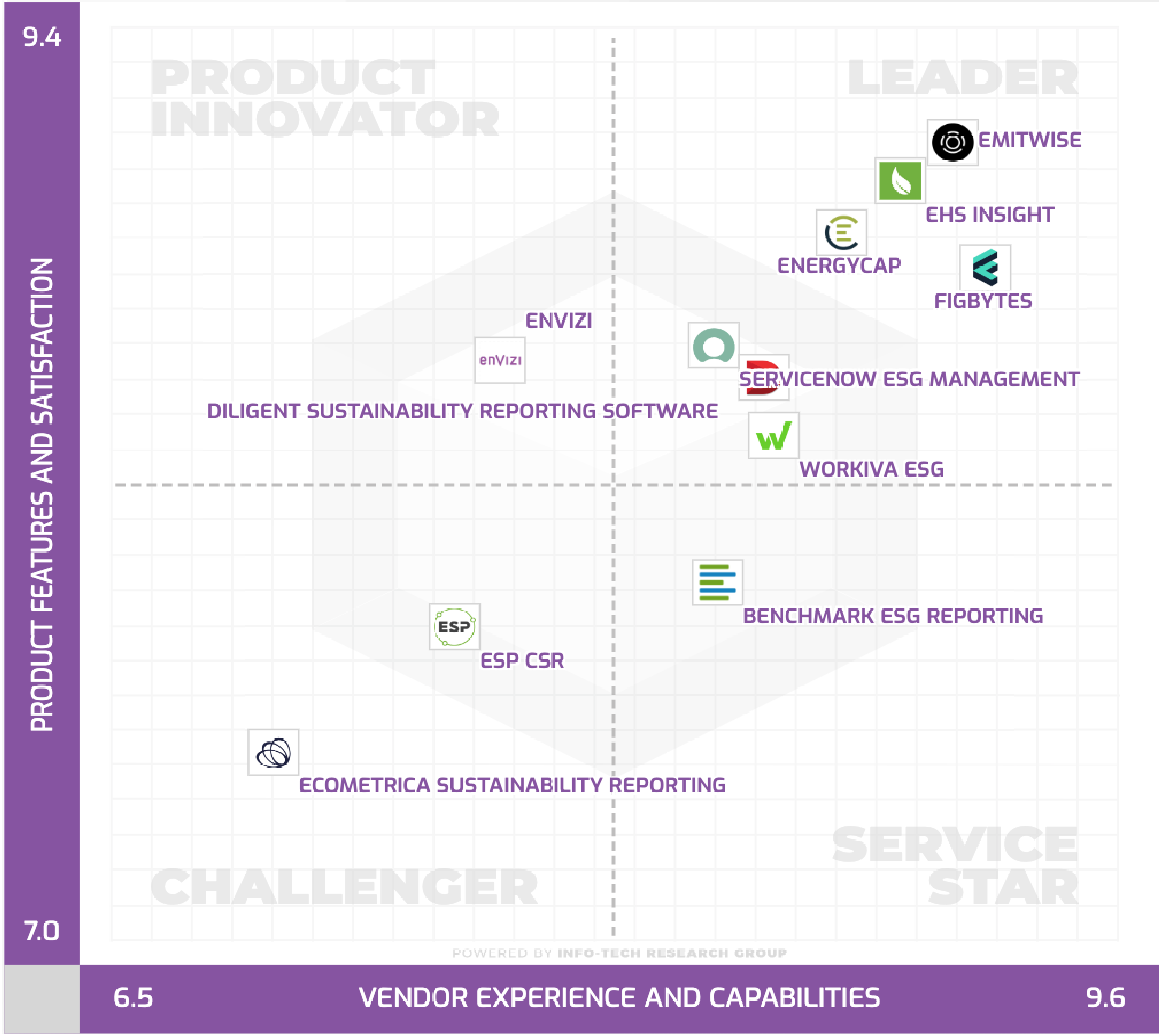
ESG Analytics: NLP Taxonomy



Source: https://www.esganalytics.io/insights/how-data-is-accelerating-esg

Top ESG Reporting Software

Environmental, Social and Governance (ESG) Reporting software or **Sustainability software** helps organizations **manage** their **operational data**, **evaluate** their **impact** on the **environment** and **provide reporting** to **perform audits**.



Source: https://www.softwarereviews.com/categories/environmental-social-and-governance-reporting

ESG Reporting Software: Emitwise

- **Emitwise is the carbon management platform for companies with complex manufacturing supply chains to confidently understand, track and reduce their complete carbon footprint.**
- **Combining 100 years of carbon accounting experience and machine learning technology, we accelerate climate action by increasing the accuracy of scope 3 emissions.**
- **The platform empowers manufacturers and their supply chains to make carbon-led business decisions that lower risk, increase profitability and deliver ambitious climate action.**

9.2	9.3	+99	94%
COMPOSITE SCORE	CX SCORE	EMOTIONAL FOOTPRINT	LIKELINESS TO RECOMMEND

Source: https://www.softwarereviews.com/categories/environmental-social-and-governance-reporting

ESG Reporting Software: Workiva ESG

- **Workiva is a cloud native platform that simplifies the complexities of reporting and compliance.**
- **Workiva ESG is the end-to-end platform that allows you to integrate financial data, nonfinancial data, and XBRL.**
- **Workiva, the platform that streamlines your entire ESG process.**
- **Automate data collection, utilize frameworks, and directly connect to all your ESG reports. in meaningful glossy reports, accurate survey responses, and regulatory filings with integrated XBRL tagging.**

8.4
COMPOSITE SCORE

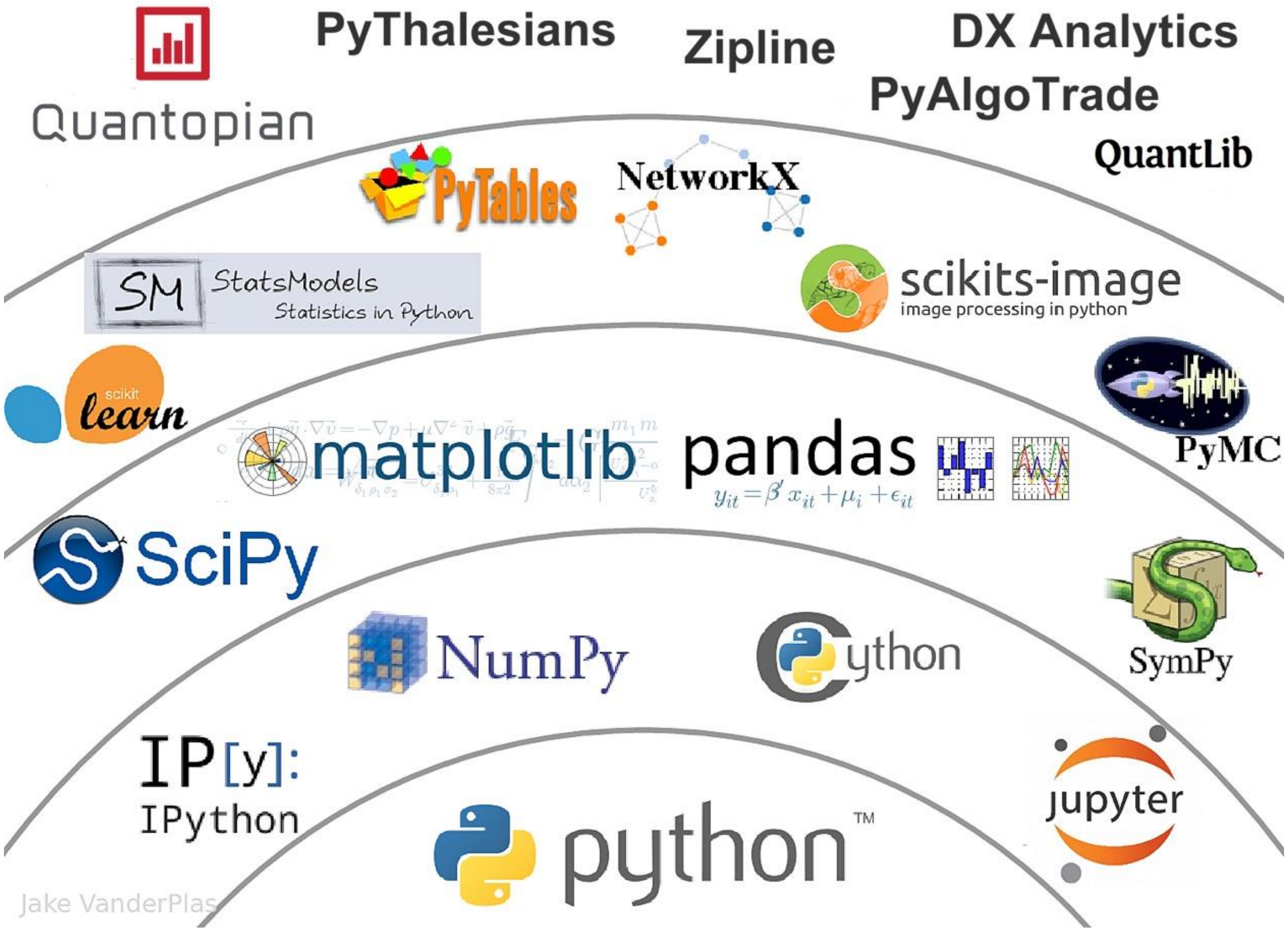
8.7
CX SCORE

+92
EMOTIONAL FOOTPRINT

89%
LIKELINESS TO RECOMMEND

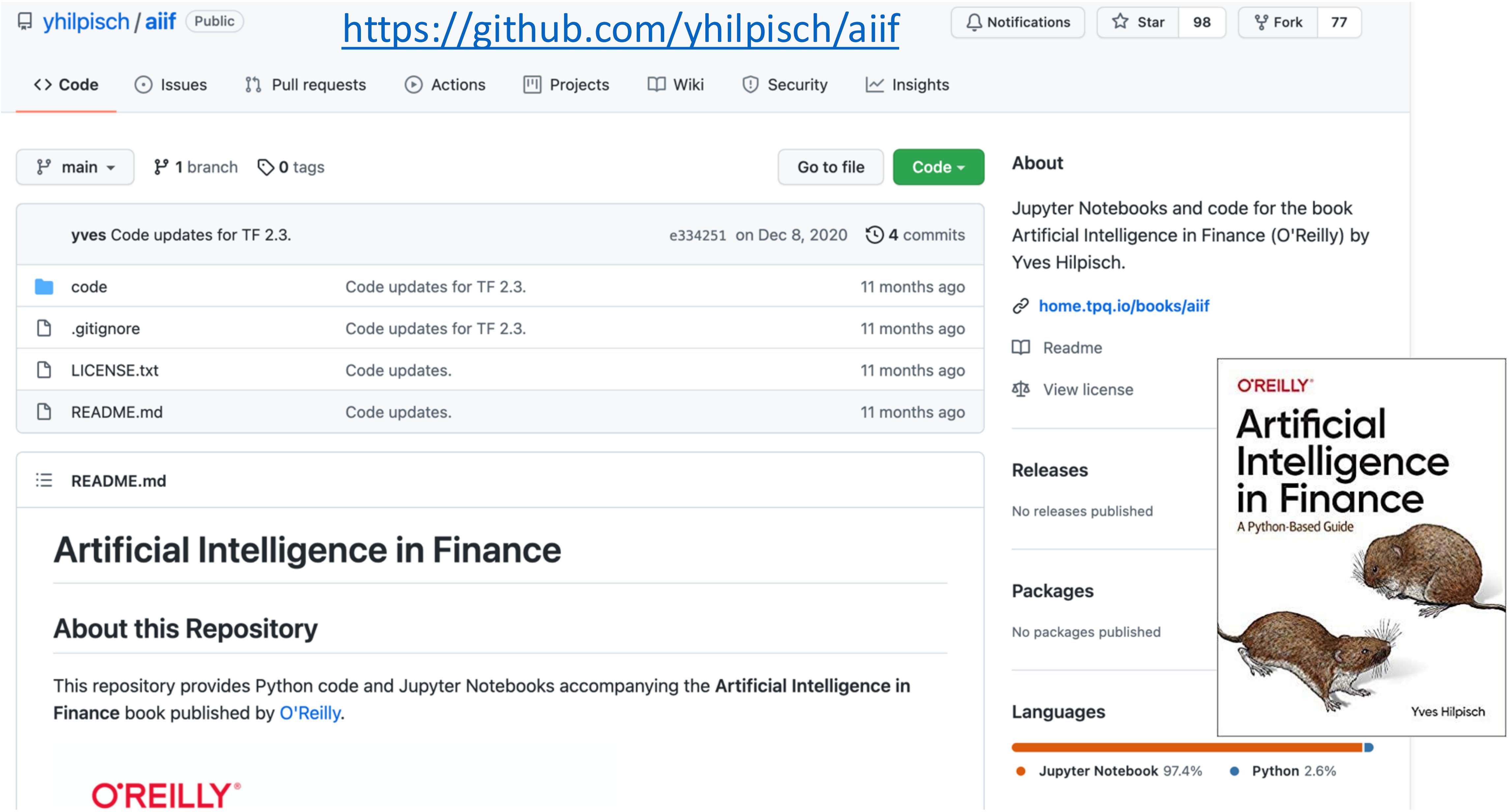
Source: https://www.softwarereviews.com/categories/environmental-social-and-governance-reporting

The Quant Finance PyData Stack



Source: http://nbviewer.jupyter.org/format/slides/github/quantopian/pyfolio/blob/master/pyfolio/examples/overview_slides.ipynb#/5

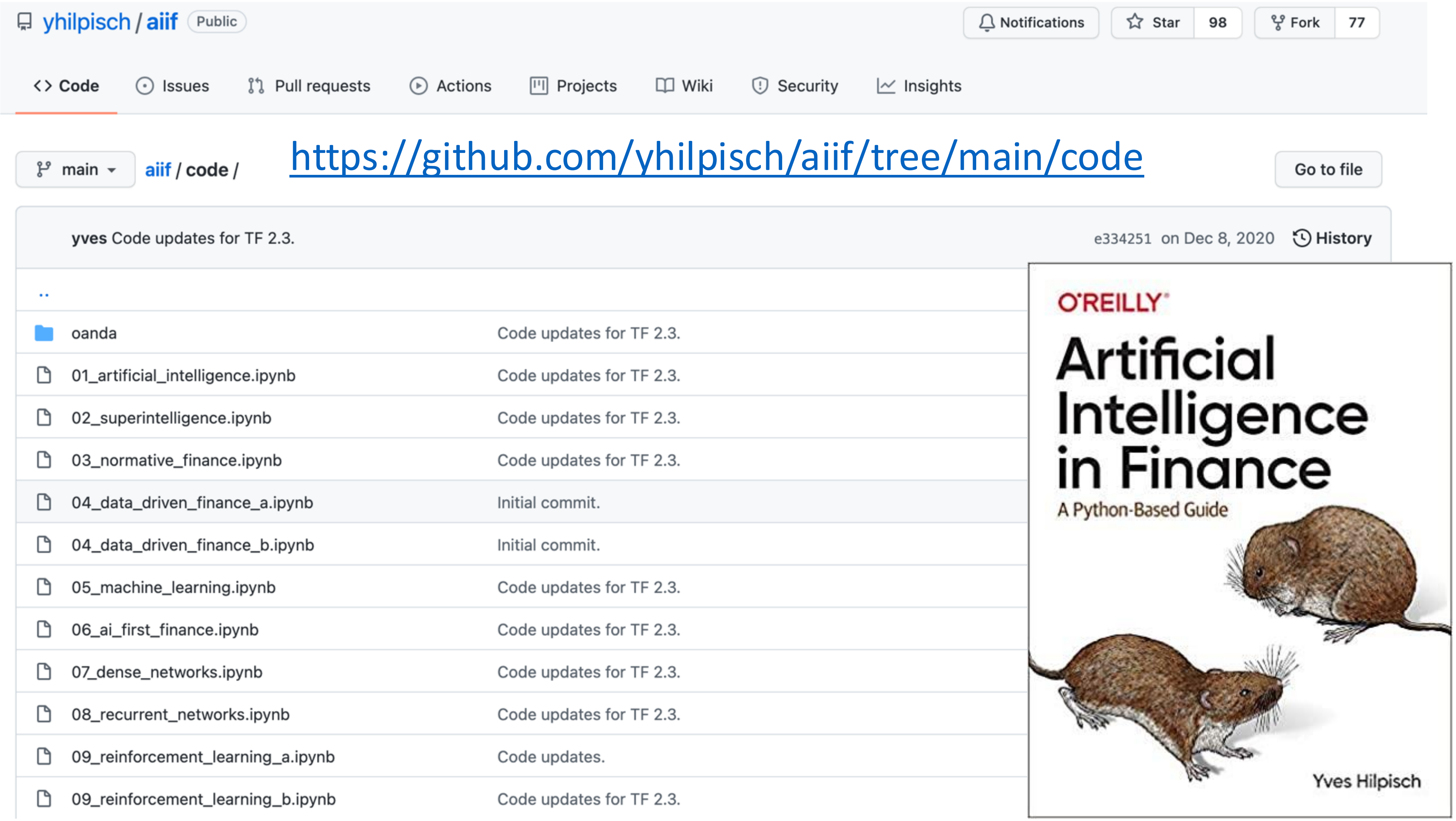
Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly



Source: https://github.com/yhilpisch/aiif

Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O’Reilly

https://github.com/yhilpisch/aiif/tree/main/code



Source: https://github.com/yhilpisch/aiif/tree/main/code

Python in Google Colab (Python101)

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT

python101.ipynb - Colaboratory

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT?authuser=2#scrollTo=wsh36fLxDKC3

python101.ipynb

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```
# Future Value
pv = 100
r = 0.1
n = 7
fv = pv * ((1 + (r)) ** n)
print(round(fv, 2))
```

```
194.87
```

[11]

```
amount = 100
interest = 10 #10% = 0.01 * 10
years = 7

future_value = amount * ((1 + (0.01 * interest)) ** years)
print(round(future_value, 2))
```

```
194.87
```

[12]

```
# Python Function def
def getfv(pv, r, n):
    fv = pv * ((1 + (r)) ** n)
    return fv
fv = getfv(100, 0.1, 7)
print(round(fv, 2))
```

```
194.87
```

[13]

```
# Python if else
score = 80
if score >=60 :
    print("Pass")
else:
    print("Fail")
```

```
Pass
```

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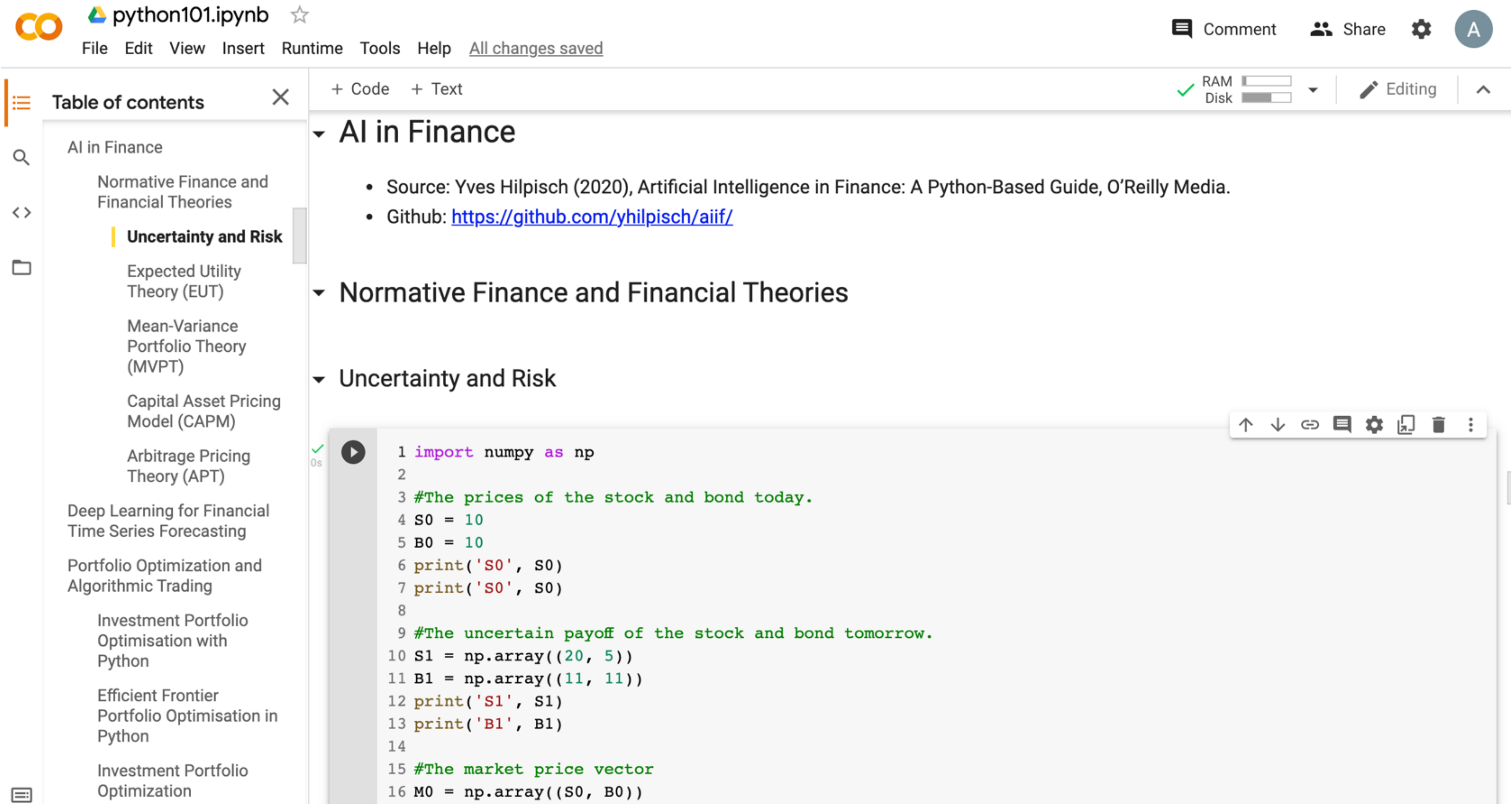
https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT



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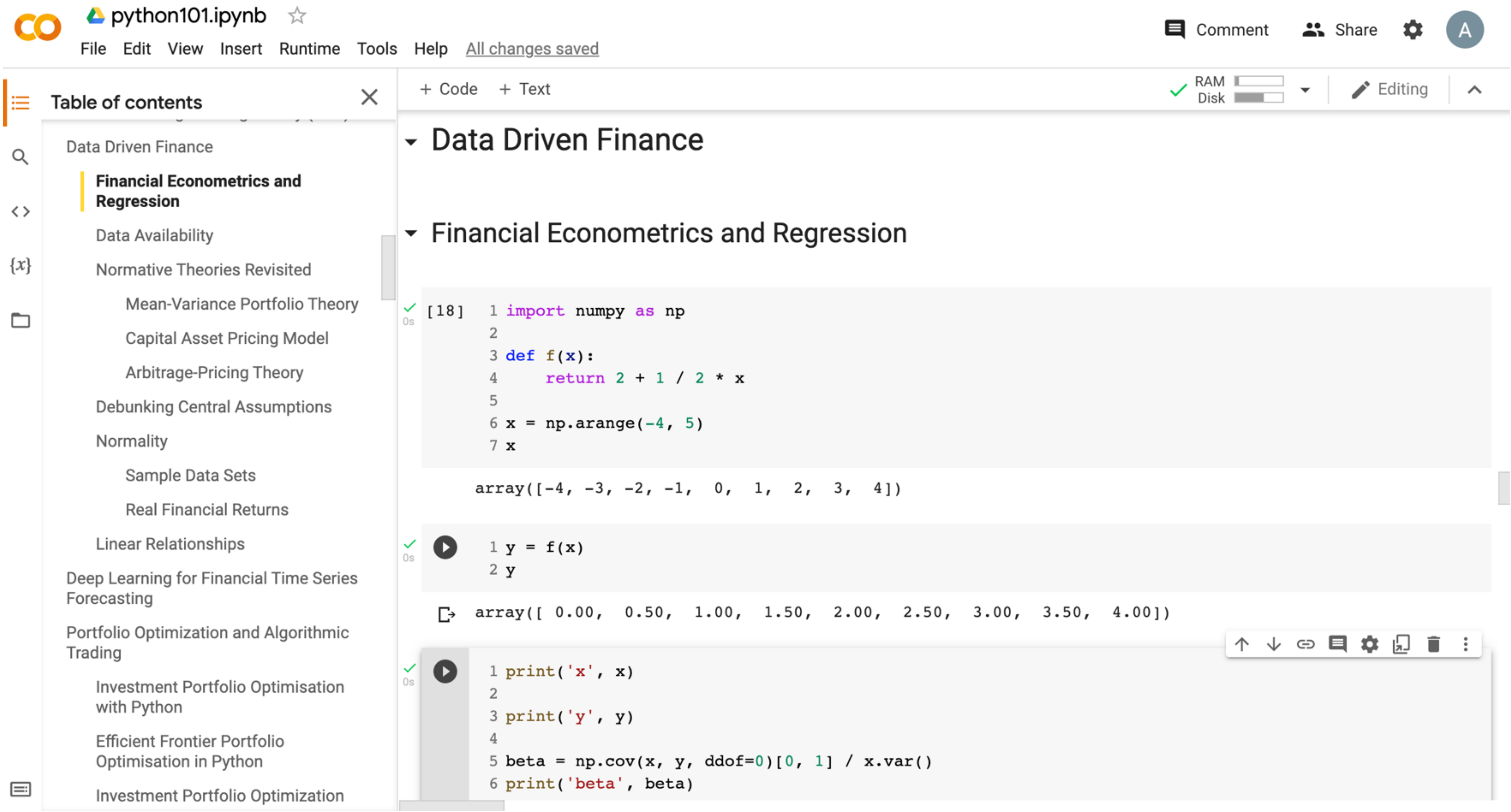

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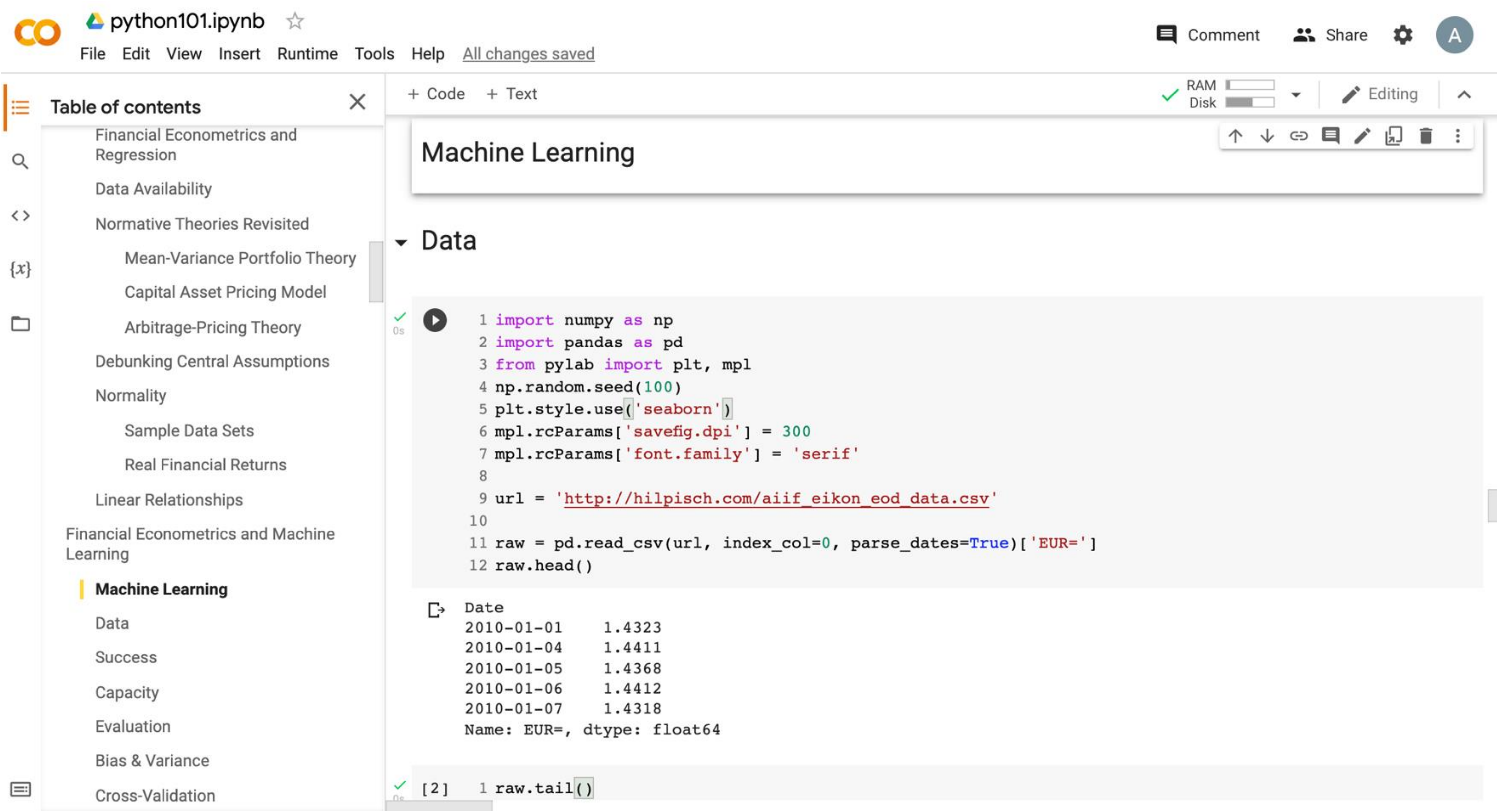

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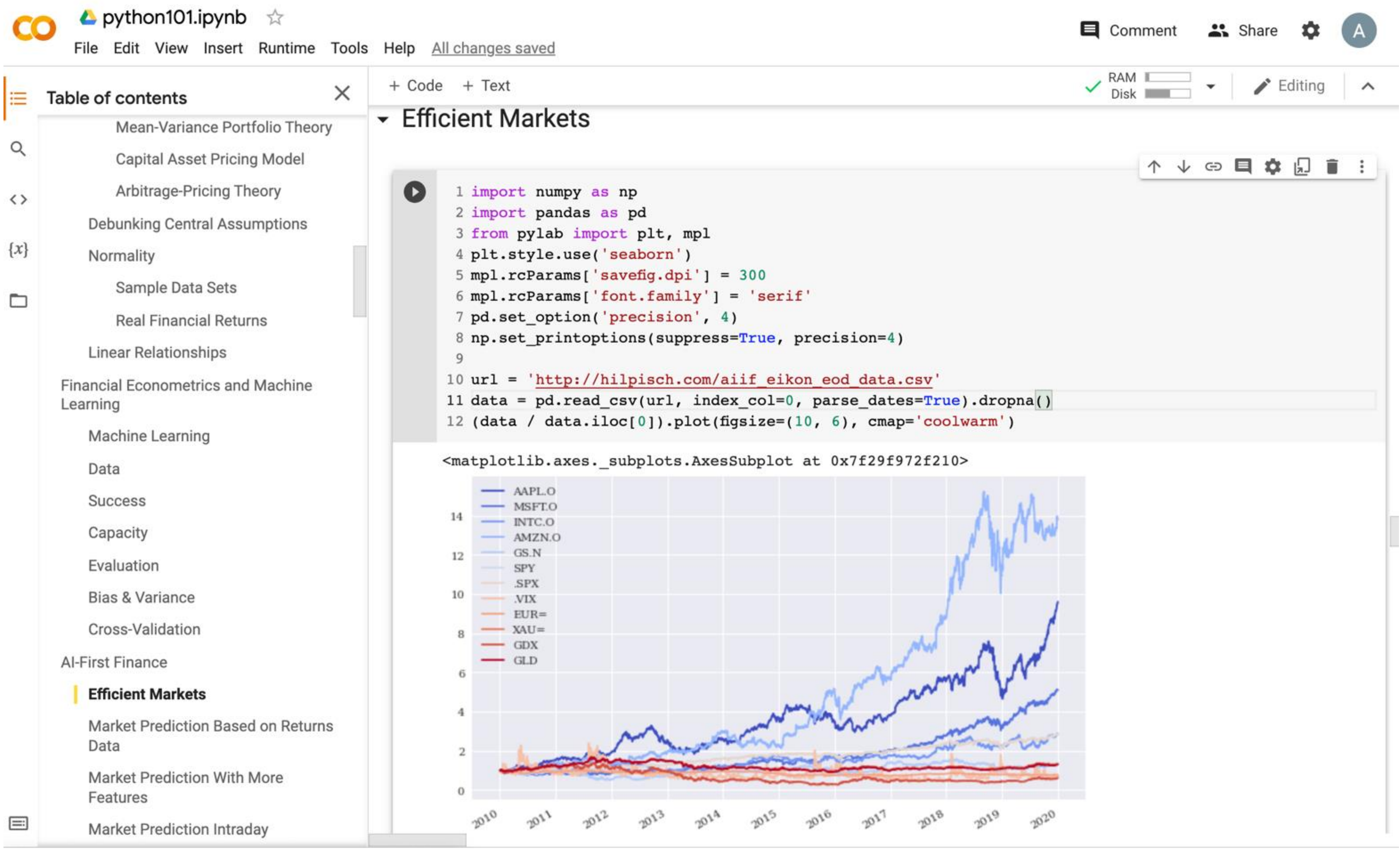

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Deep Learning (DL) in Finance

- Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.
- Github: https://github.com/yhilpisch/aiif/

Dense Neural Networks (DNN)

```
import os
import numpy as np
import pandas as pd
from pylab import plt, mpl
plt.style.use('seaborn')
mpl.rcParams['savefig.dpi'] = 300
mpl.rcParams['font.family'] = 'serif'
pd.set_option('precision', 4)
np.set_printoptions(suppress=True, precision=4)
os.environ['PYTHONHASHSEED'] = '0'
```

[ ]

```
url = 'http://hilpisch.com/aiif_eikon_id_eur_usd.csv'
symbol = 'EUR_USD'
raw = pd.read_csv(url, index_col=0, parse_dates=True)
raw.head()
```

HIGH	LOW	OPEN	CLOSE

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Reinforcement Learning (RL) in Finance

- Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.
- Github: https://github.com/yhilpisch/aiif/

Reinforcement Learning (RL)

```python
import os
import math
import random
import numpy as np
import pandas as pd
from pylab import plt, mpl
plt.style.use('seaborn')
mpl.rcParams['savefig.dpi'] = 300
mpl.rcParams['font.family'] = 'serif'
np.set_printoptions(precision=4, suppress=True)
os.environ['PYTHONHASHSEED'] = '0'
```

CartPole Environment

```python
import gym
```

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Algorithmic Trading

- Source: Yves Hilpisch (2020), Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly Media.
- Github: https://github.com/yhilpisch/aiif/

Vectorized Backtesting

```python
import os
import math
import numpy as np
import pandas as pd
from pylab import plt, mpl
plt.style.use('seaborn')
mpl.rcParams['savefig.dpi'] = 300
mpl.rcParams['font.family'] = 'serif'
pd.set_option('mode.chained_assignment', None)
pd.set_option('display.float_format', '{:.4f}'.format)
np.set_printoptions(suppress=True, precision=4)
os.environ['PYTHONHASHSEED'] = '0'
```

Backtesting an SMA-Based Strategy

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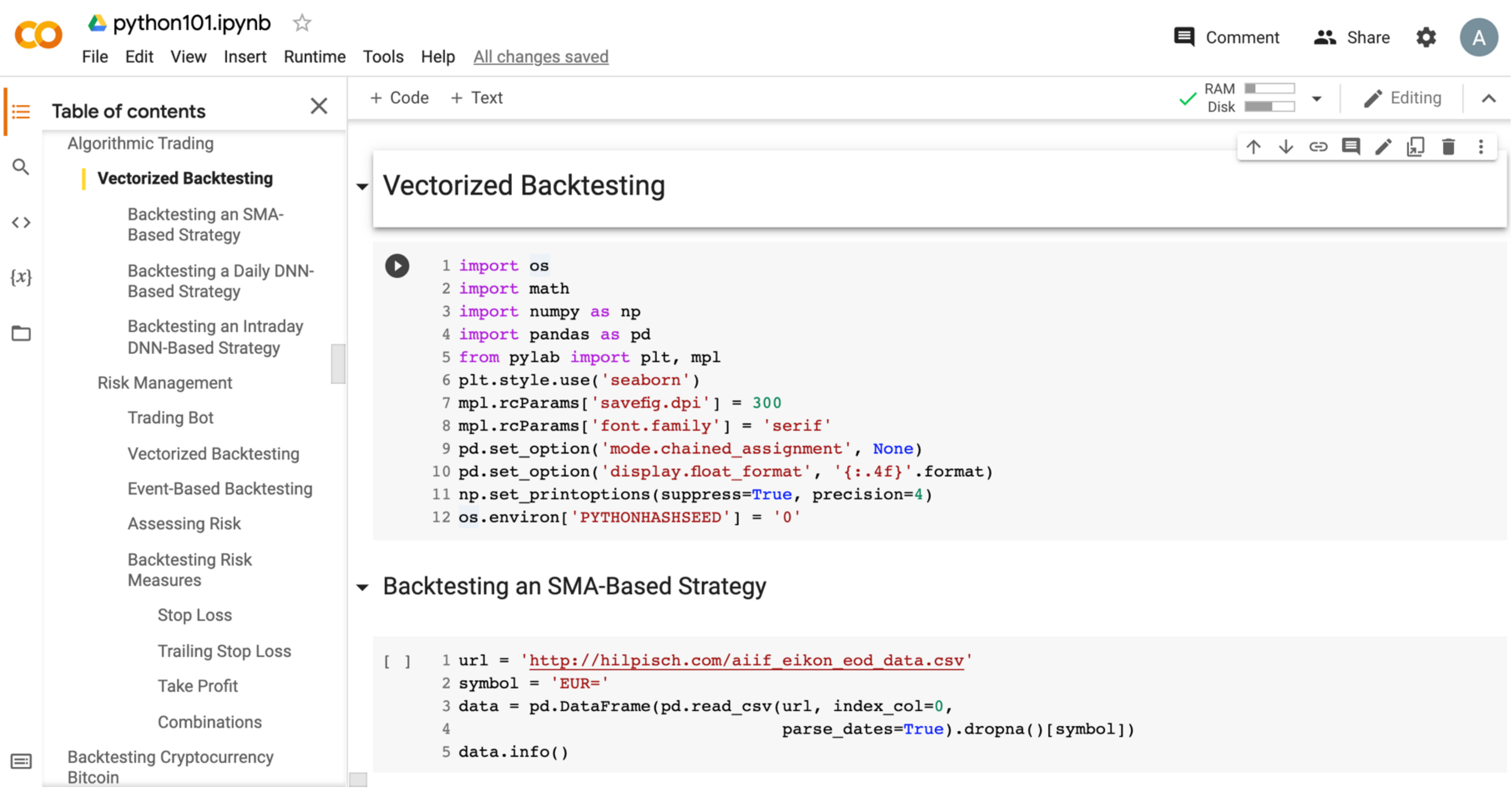

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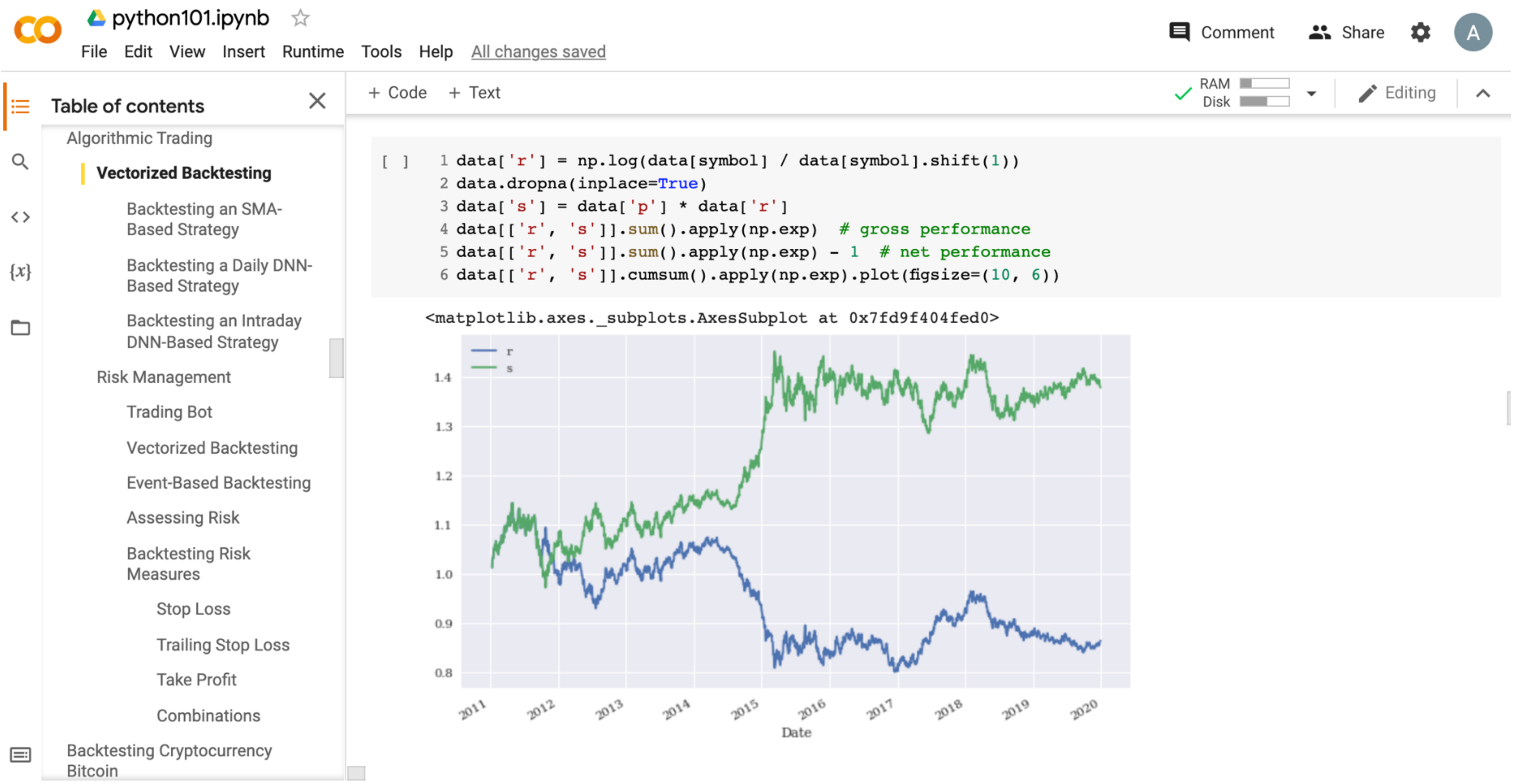

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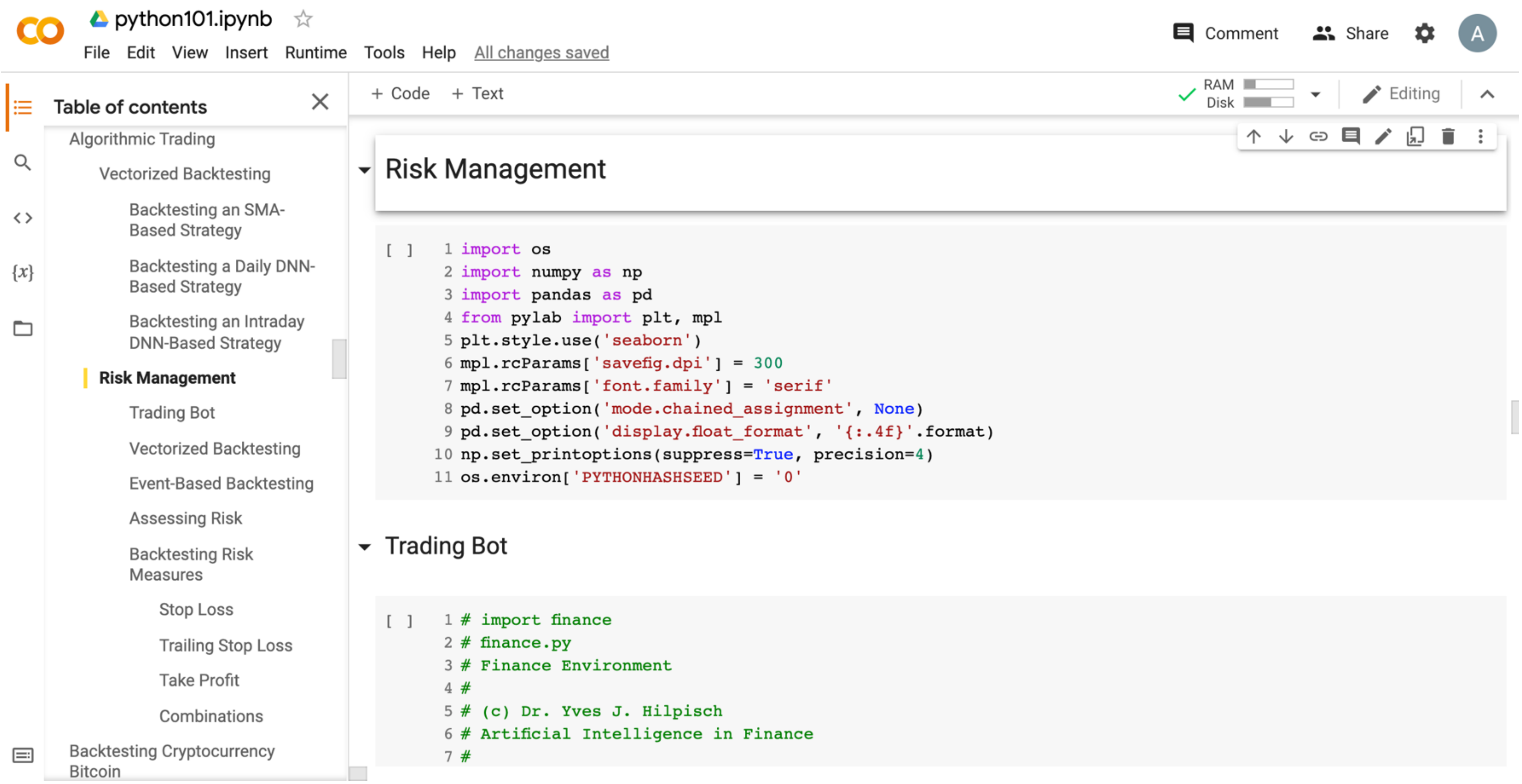

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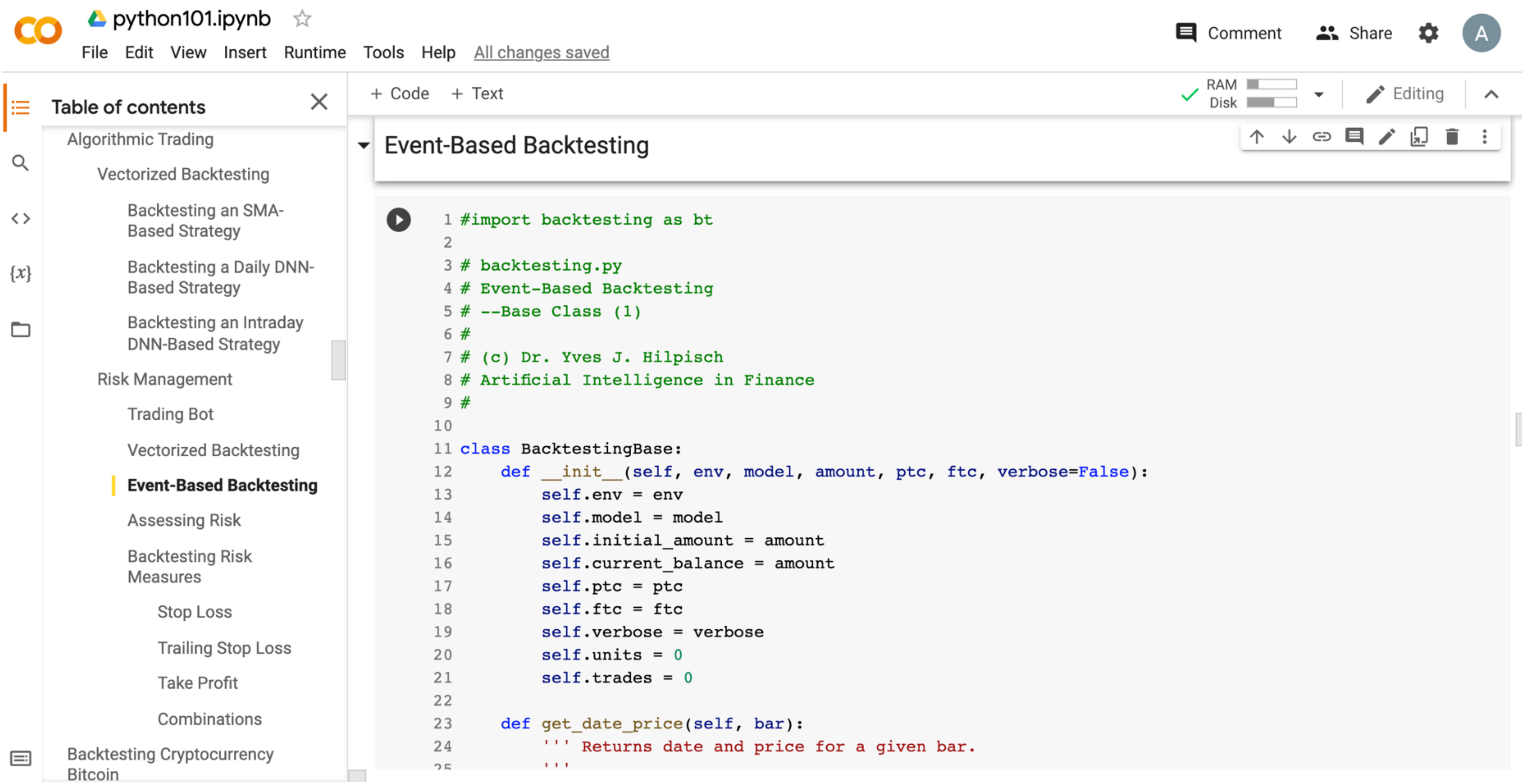

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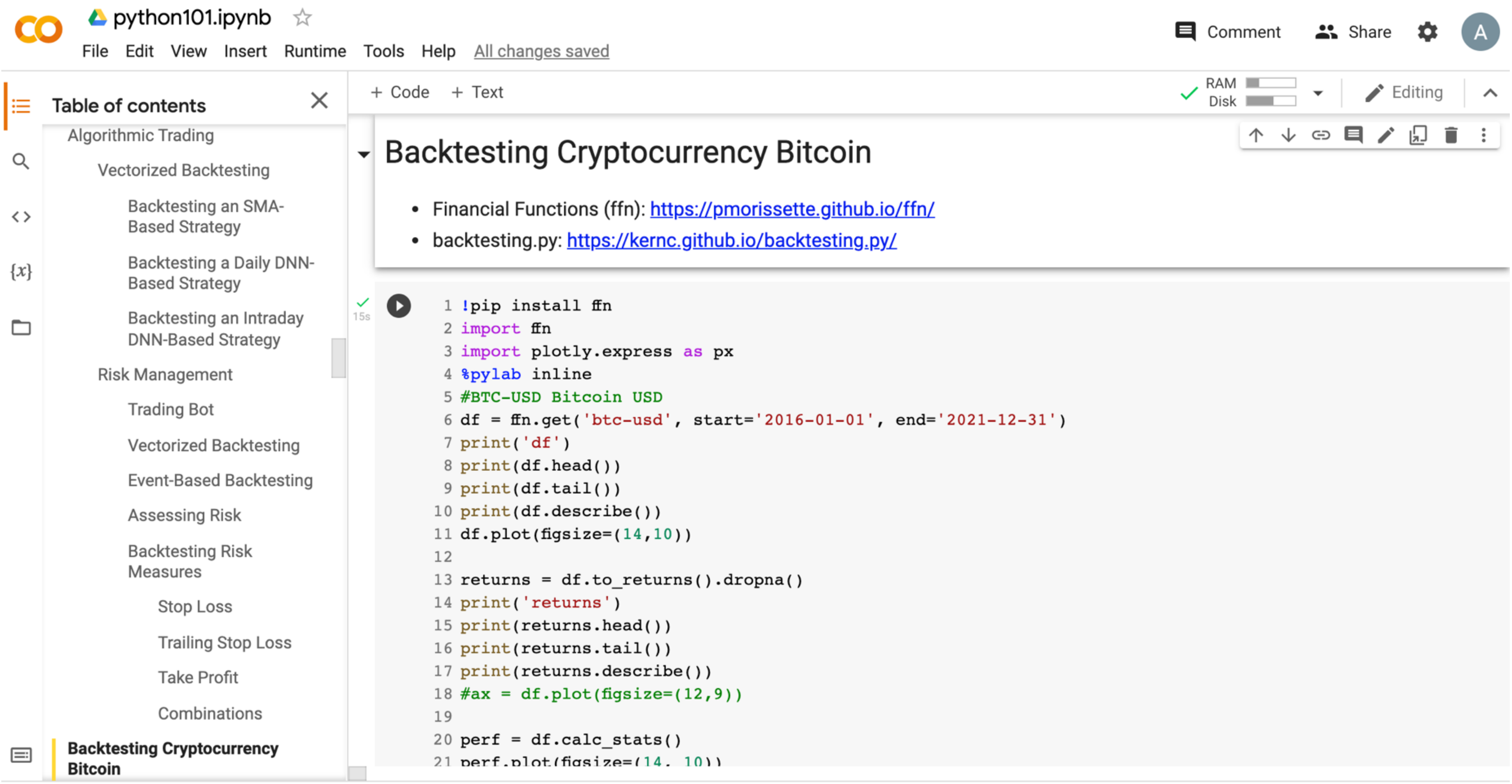
Combinations

```python
tb.backtest_strategy(sl=0.015, tsl=None,
                     tp=0.0185, wait=5)
```

```
==================================================
2018-01-17 | *** START BACKTEST ***
2018-01-17 | current balance = 10000.00
==================================================
--------------------------------------------------
*** STOP LOSS (SHORT | -0.0203) ***
--------------------------------------------------
*** STOP LOSS (SHORT | -0.0152) ***
--------------------------------------------------
*** TAKE PROFIT (SHORT | 0.0189) ***
--------------------------------------------------
*** TAKE PROFIT (SHORT | 0.0219) ***
--------------------------------------------------
*** TAKE PROFIT (SHORT | 0.0192) ***
--------------------------------------------------
*** STOP LOSS (LONG  | -0.0154) ***
--------------------------------------------------
*** TAKE PROFIT (SHORT | 0.0214) ***
--------------------------------------------------
*** STOP LOSS (SHORT | -0.0158) ***
--------------------------------------------------
*** TAKE PROFIT (SHORT | 0.0223) ***
--------------------------------------------------
*** STOP LOSS (SHORT | -0.0162) ***
```

https://tinyurl.com/aintpupython101

Python in Google Colab (Python101)



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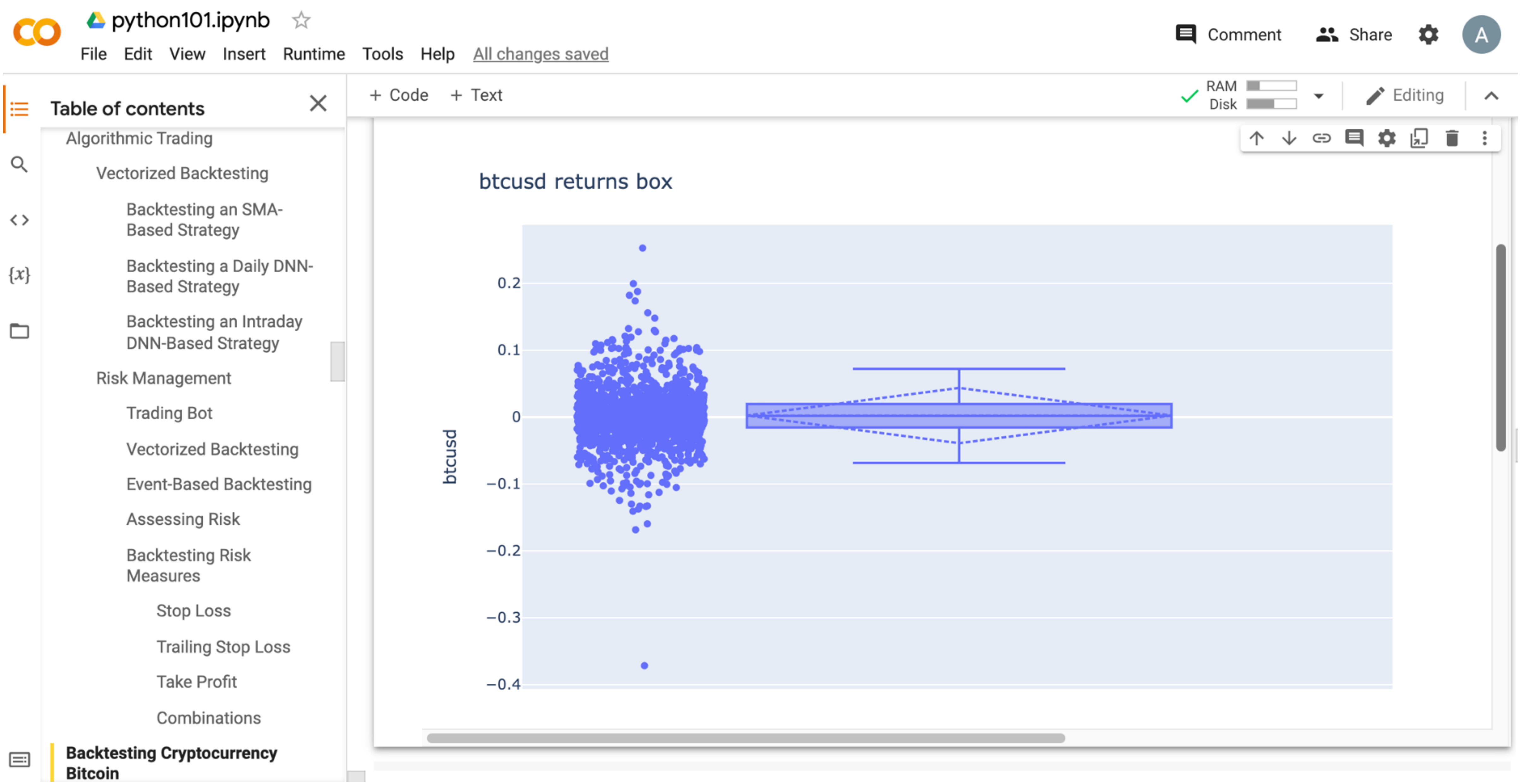
Python in Google Colab (Python101)



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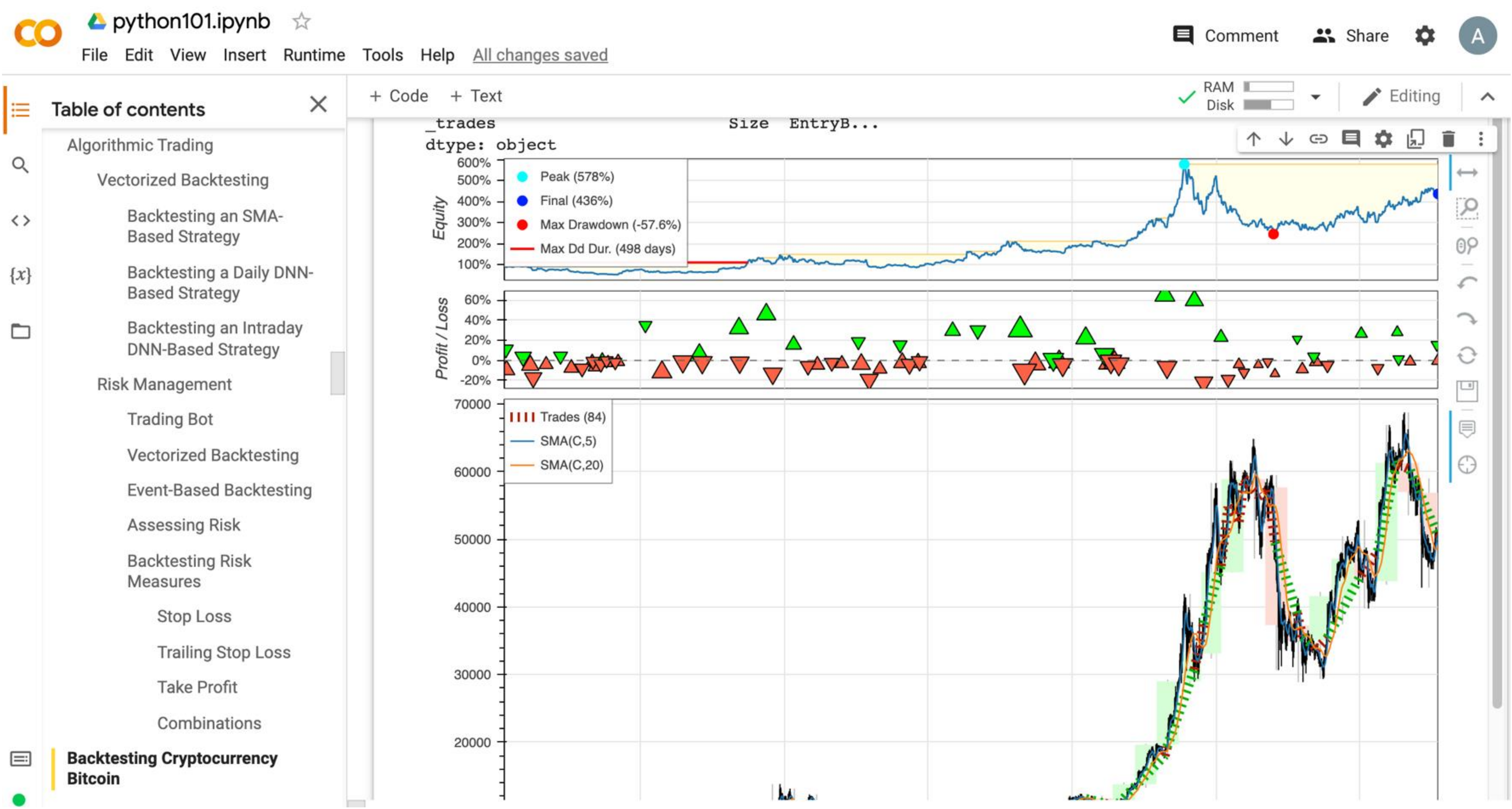
Python in Google Colab (Python101)



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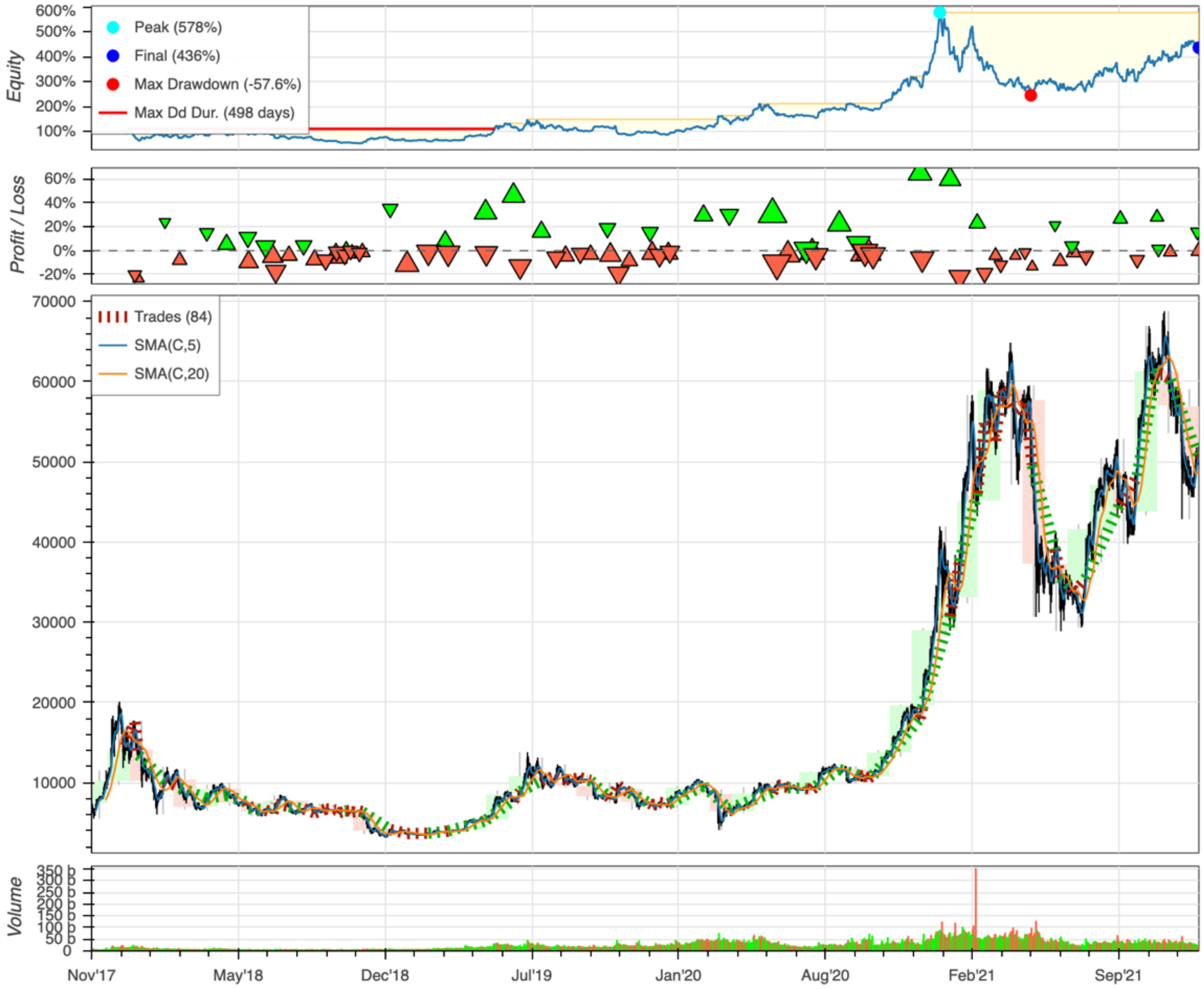

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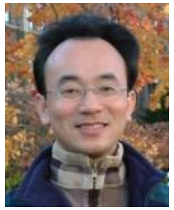
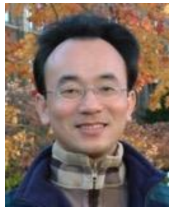
Teaching



- **Generative AI Innovative Applications**
  - Spring 2025
- **Artificial Intelligence in Finance and Quantitative**
  - Fall 2021, Fall 2022, Fall 2023, Spring 2025
- **Software Engineering**
  - Fall 2020, Fall, 2021, Spring 2022, Spring 2023, Spring 2024, Spring 2025
- **Artificial Intelligence**
  - Spring 2021, Fall 2022, Fall 2024
- **Sustainability and ESG Data Analytics**
  - Spring 2024, Fall 2024
- **Big Data Analytics**
  - Fall 2020, Spring 2023, Spring 2024
- **Artificial Intelligence for Text Analytics**
  - Spring 2022, Fall 2023
- **Python for Accounting Applications**
  - Fall 2023, Fall 2024
- **Foundation of Business Cloud Computing**
  - Spring 2021, Spring 2022, Spring 2023, Spring 2024

https://web.ntpu.edu.tw/~myday/teaching.htm



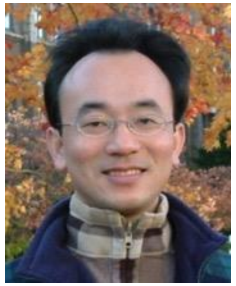
Research Projects

1. **Digital Support, Unimpeded Communication: The Development, Support and Promotion of AI-assisted Communication Assistive Devices for Speech Impairment (2/3).**
   Multimodal Cross-lingual Task-Oriented Dialogue System for Inclusive Communication Support
   - NSTC 113-2425-H-305-002-, 3 Years (2023/05/01-2026/04/30) Year 1: 2024/05/01~2025/04/30
2. **Research on speech processing, synthesis, recognition, and sentence construction of people with language disabilities. Multimodal Cross-lingual Task-Oriented Dialogue System**
   - NTPU, 114-NTPU_ORDA-F-004, 2023/01/01~2025/12/31
3. **Development of a Deep Learning for Dental Implant Detection in Panoramic Radiographs,**
   - USTP-NTPU-TMU-114-02, 2025/01/01~2025/12/31
4. **Metaverse AI Multimodal Cross-Language Task-Oriented Dialogue System**
   - ATEC Group, Fintech and Green Finance Center (FGFC, NTPU), NTPU-112A413E01, 2 Years (2023/05/01~2025/04/30)
5. **Establishment and Implement of Smart Assistive Technology for Dementia Care and Its Socio-Economic Impacts (3/3). Intelligent, individualized and precise care with smart AT and system integration**
   - NSTC, 113-2627-M-038-001-, 2024/08/01~2025/07/31

https://web.ntpu.edu.tw/~myday/cindex.htm#projects

Summary

- This course introduces the fundamental concepts, research issues, and hands-on practices of AI in Finance and Quantitative Analysis.
- Topics include:
  1. Introduction to Artificial Intelligence in Finance and Quantitative Analysis
  2. AI in FinTech: Metaverse, Web3, DeFi, NFT, Generative AI for Financial Innovation Applications
  3. Investing Psychology and Behavioral Finance
  4. Event Studies in Finance
  5. Finance Theory and Data-Driven Finance
  6. Financial Econometrics
  7. AI-First Finance
  8. Deep Learning in Finance; Reinforcement Learning in Finance; Generative AI in Finance
  9. Algorithmic Trading; Risk Management; Trading Bot and Event-Based Backtesting
  10. Industry Practices of AI in Finance and Quantitative Analysis
  11. Case Study on AI in Finance and Quantitative Analysis



AI in Finance and Quantitative Analysis

国立臺北大學
National Taipei University

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aws certified
Solutions Architect
Associate

aws certified
Cloud Practitioner

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