NTPU
國立臺北大學
National Taipei University

Introduction to Artificial Intelligence in Finance and Quantitative Analysis

1121AIFQA01
MBA, IM, NTPU (M5276) (Fall 2023)
Tue 2, 3, 4 (9:10-12:00) (B3F17)

https://meet.google.com/paj-zhhj-mya

aws educate | Cloud Ambassador
2020 Cohort
aws academy Accredited Educator
aws certified Cloud Practitioner
aws certified Solutions Architect Associate

Min-Yuh Day, Ph.D,
Associate Professor

Institute of Information Management, National Taipei University

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

2023-09-12

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2020 Cohort

Associate Professor, Information Management, NTPU

Visiting Scholar, IIS, Academia Sinica

Ph.D., Information Management, NTU

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

Associate Director, Fintech and Green Finance Center, NTPU

Artificial Intelligence, Financial Technology, Big Data Analytics,
Data Mining and Text Mining, Electronic Commerce

國立臺北大學
National Taipei University

中央研究院 ACADEMIA SINICA 1928

Course Syllabus
National Taipei University
Academic Year 112, 1st Semester (Fall 2023)

- **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) (M5276)
- **Time & Place: Tue, 2, 3, 4, (9:10-12:00) (B3F17)**
- **Google Meet:** https://meet.google.com/paj-zhhj-mya

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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, Financial Services Innovation and Applications
  3. Investing Psychology and Behavioral Finance
  4. Event Studies in Finance
  5. Finance Theory
  6. Data-Driven Finance
  7. Financial Econometrics
  8. AI-First Finance
  9. Deep Learning in Finance
  10. Reinforcement Learning in Finance
  11. Algorithmic Trading, Risk Management, Trading Bot and Event-Based Backtesting
  12. 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	2023/09/12	Introduction to Artificial Intelligence in Finance and Quantitative Analysis
2	2023/09/19	AI in FinTech: Metaverse, Web3, DeFi, NFT, Financial Services Innovation and Applications
3	2023/09/26	Investing Psychology and Behavioral Finance
4	2023/10/03	Event Studies in Finance
5	2023/10/10	National Day (Day off)
6	2023/10/17	Case Study on AI in Finance and Quantitative Analysis I

Syllabus

Week	Date	Subject/Topics
7	2023/10/24	Finance Theory and Data-Driven Finance
8	2023/10/31	Midterm Project Report
9	2023/11/07	Financial Econometrics
10	2023/11/14	AI-First Finance
11	2023/11/21	Industry Practices of AI in Finance and Quantitative Analysis
12	2023/11/28	Case Study on AI in Finance and Quantitative Analysis II

Syllabus

Week	Date	Subject/Topics
13	2023/12/05	Deep Learning in Finance; Reinforcement Learning in Finance
14	2023/12/12	Algorithmic Trading; Risk Management; Trading Bot and Event-Based Backtesting
15	2023/12/19	Final Project Report I
16	2023/12/26	Final Project Report II

Teaching Methods and Activities

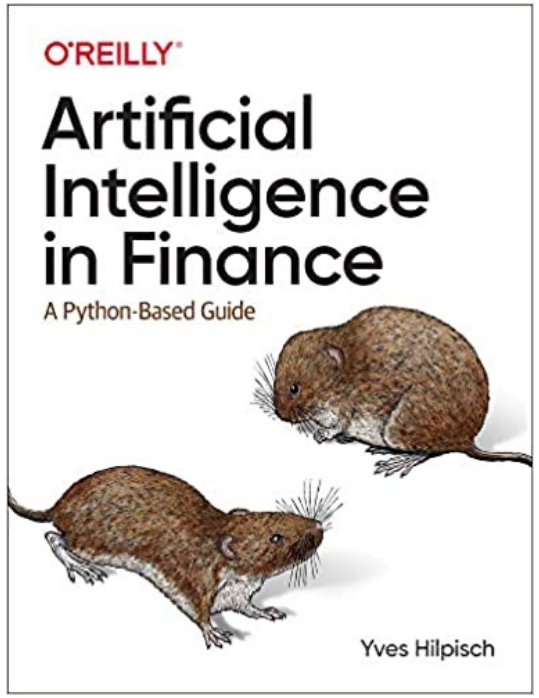
- Lecture
- Discussion
- Practicum

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

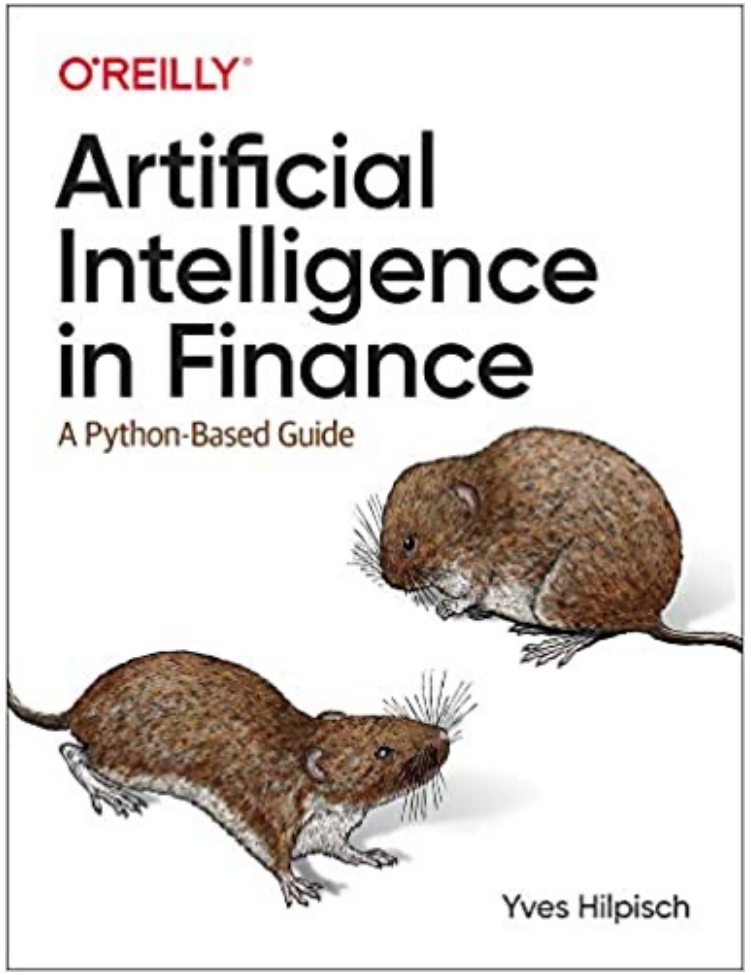
Reference Books

- 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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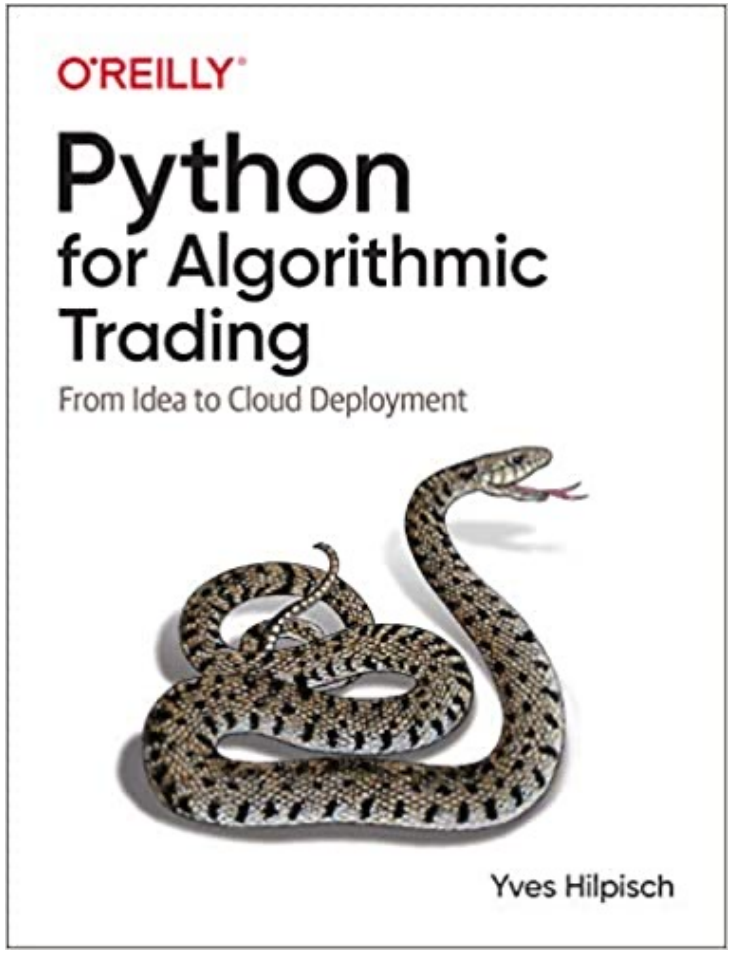
Python for Algorithmic Trading:

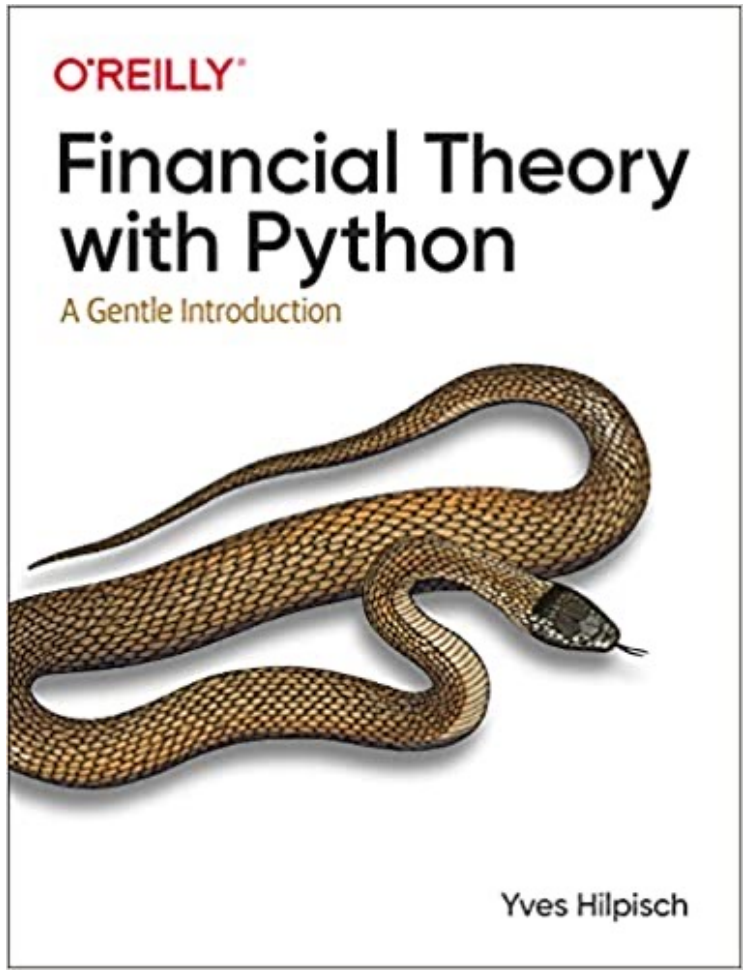
From Idea to Cloud Deployment,

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

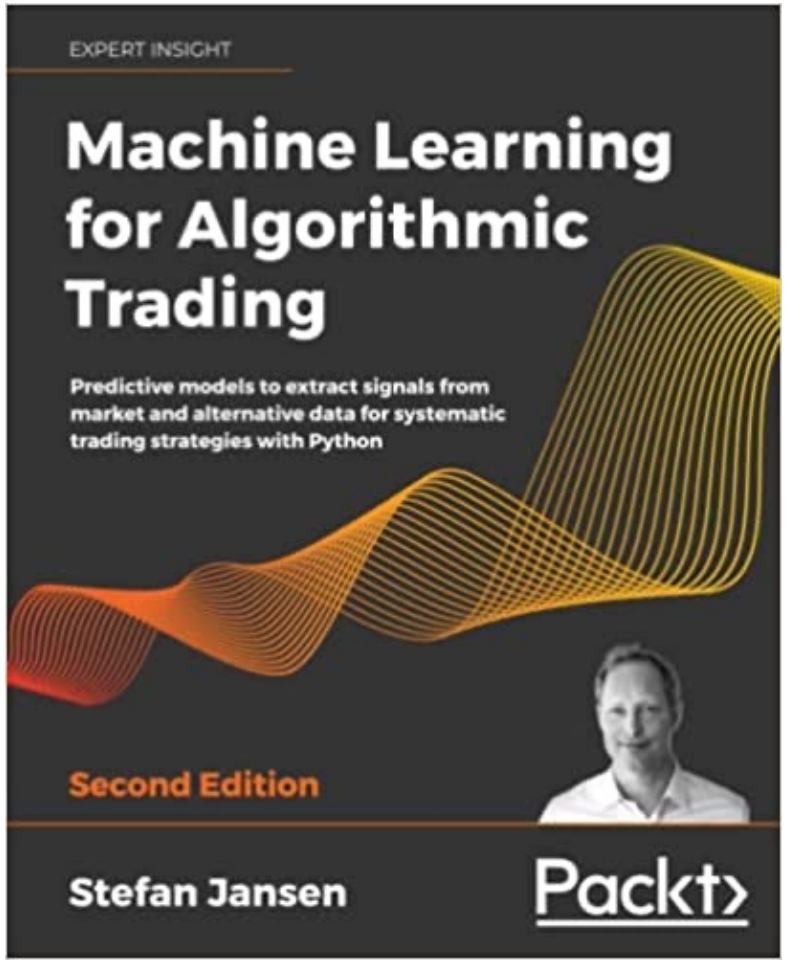


Source: https://www.amazon.com/Financial-Theory-Python-Gentle-Introduction/dp/1098104358

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.



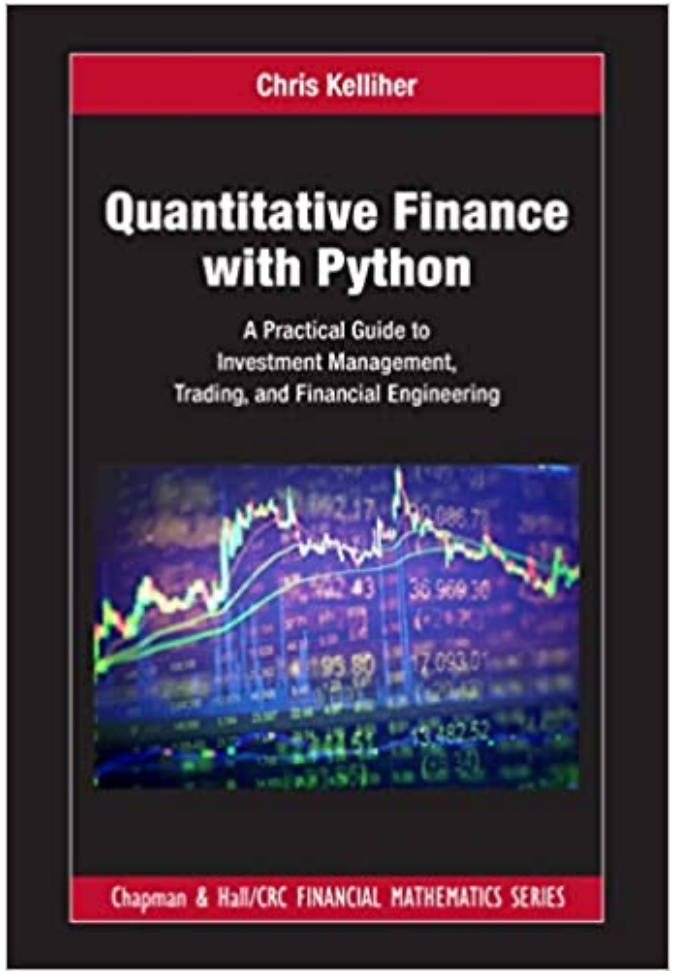
Source: https://www.amazon.com/Machine-Learning-Algorithmic-Trading-alternative/dp/1839217715/

Chris Kelliher (2022),

Quantitative Finance With Python:

A Practical Guide to Investment Management, Trading, and Financial Engineering,

Chapman and Hall/CRC.

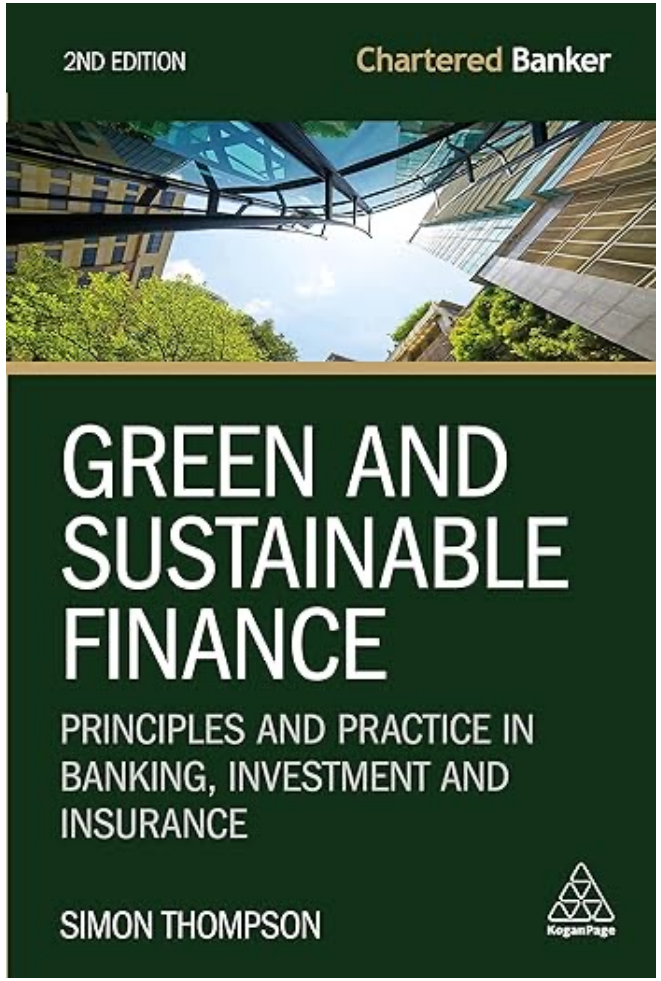


Source: https://www.amazon.com/Quantitative-Finance-Python-Engineering-Mathematics/dp/1032014431/

Simon Thompson (2023),

Green and Sustainable Finance:

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

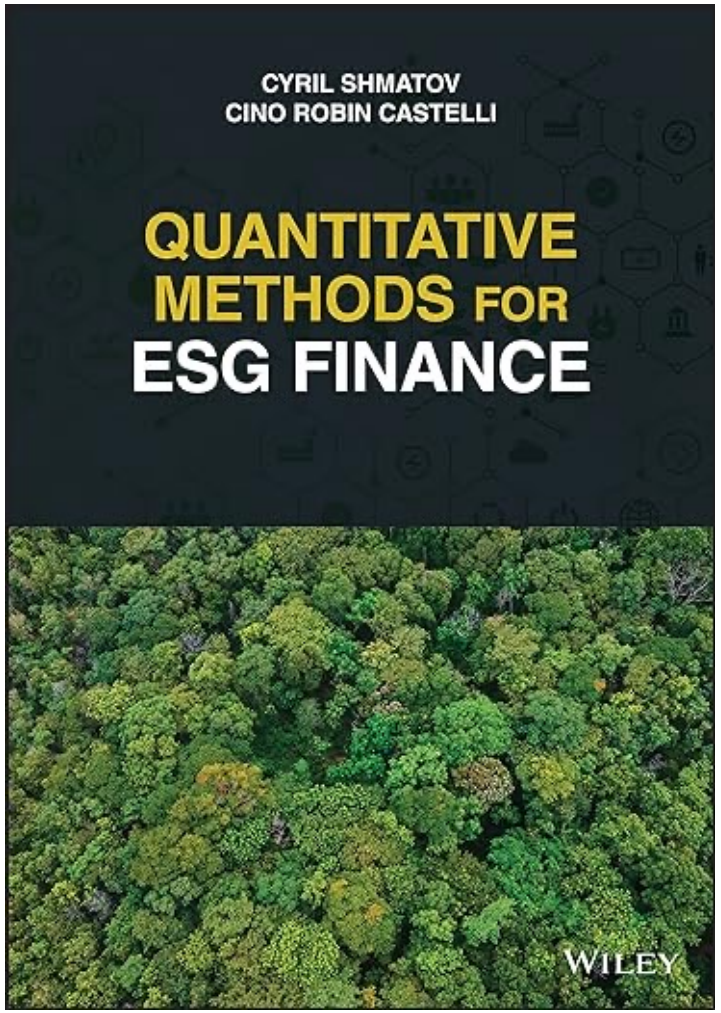


Source: https://www.amazon.com/Green-Sustainable-Finance-Principles-Investment/dp/1398609242/

Cino Robin Castelli, Cyril Shmatov (2022),

Quantitative Methods for ESG Finance,

Wiley

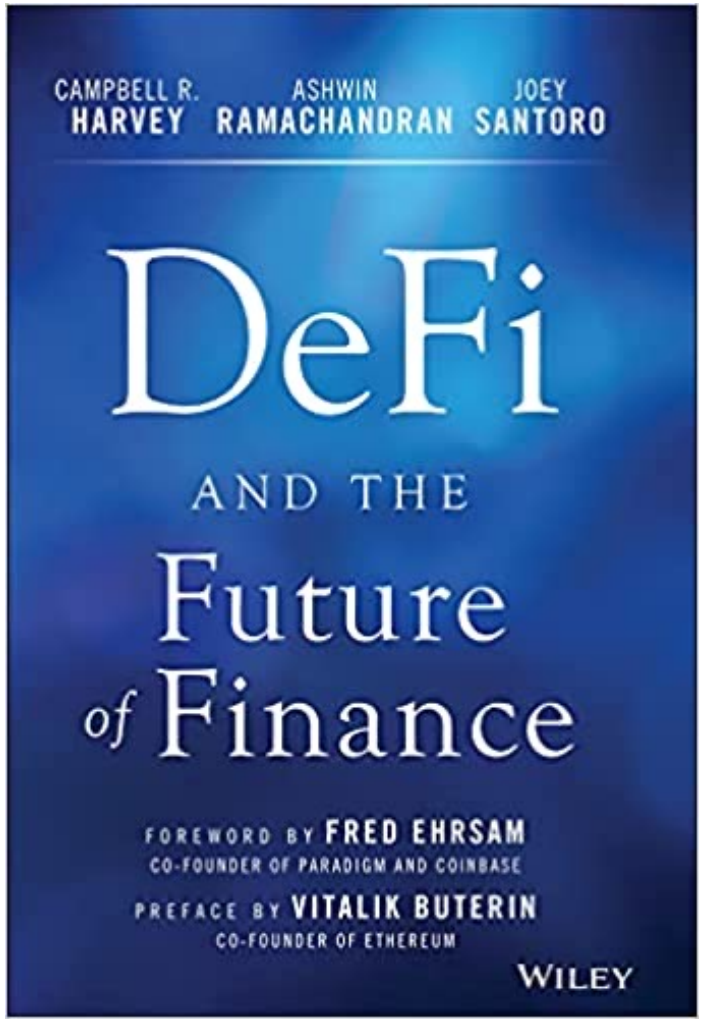


Source: https://www.amazon.com/Quantitative-Methods-Finance-Robin-Castelli/dp/1119903807/

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

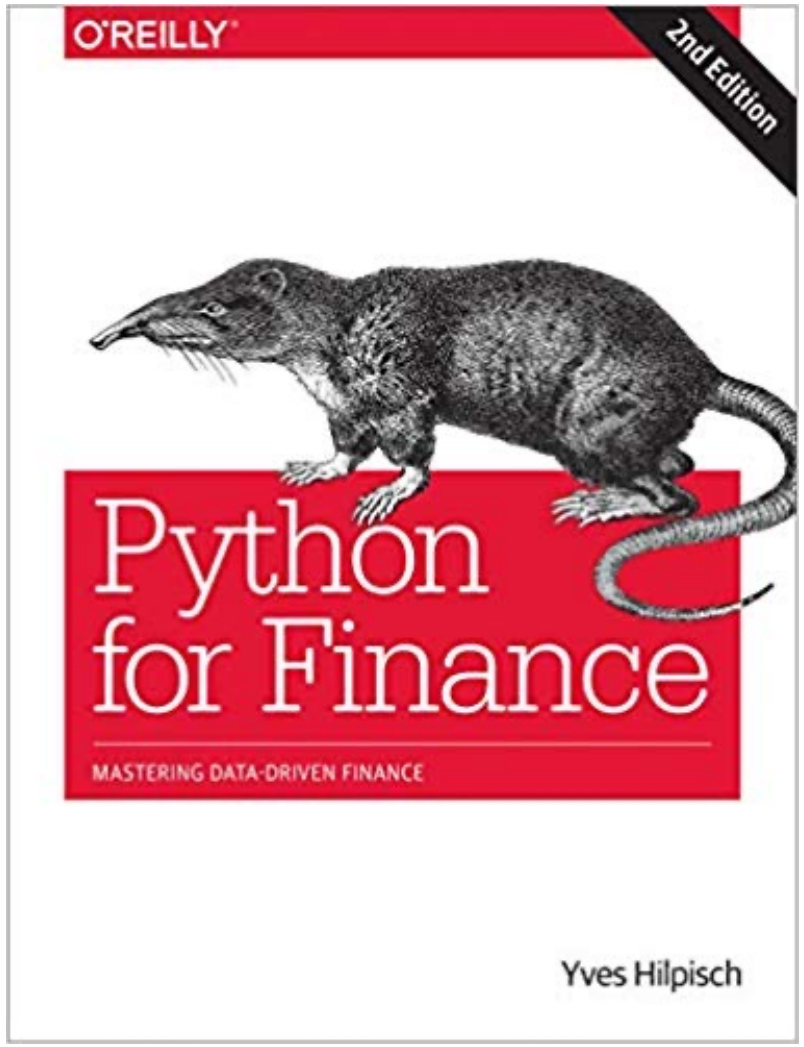
DeFi and the Future of Finance,

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:

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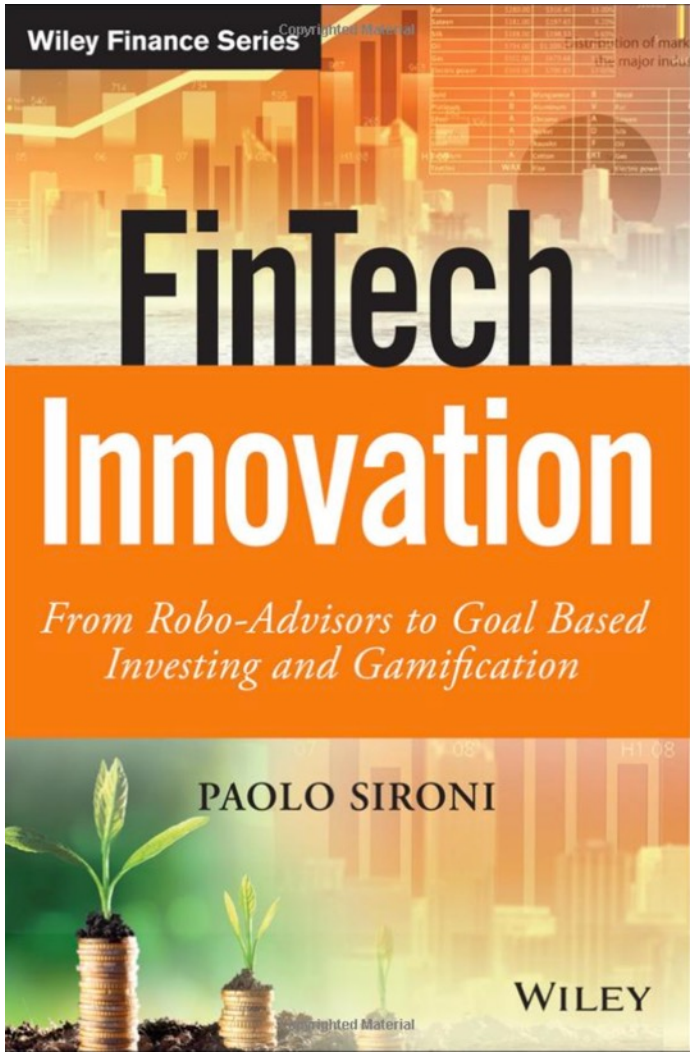


Source: https://www.amazon.com/FinTech-Innovation-Robo-Advisors-Investing-Gamification/dp/1119226988

Doron Kliger and Gregory Gurevich (2014),

Event Studies for Financial Research:

A Comprehensive Guide,

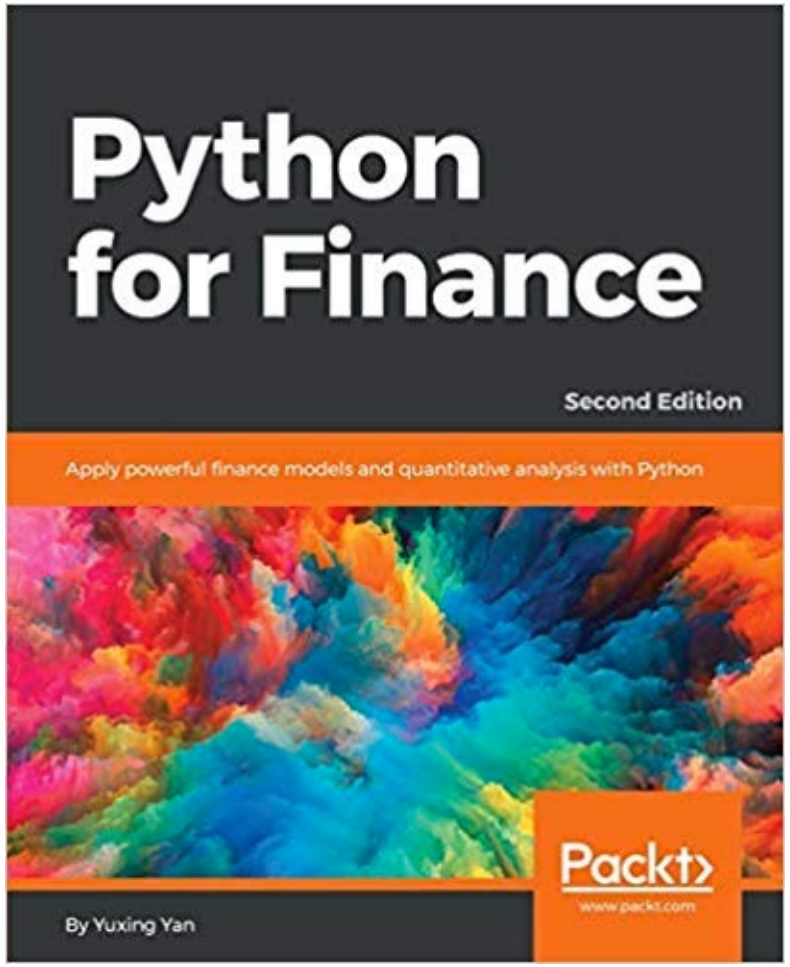
Palgrave Macmillan

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

Yuxing Yan (2017),

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

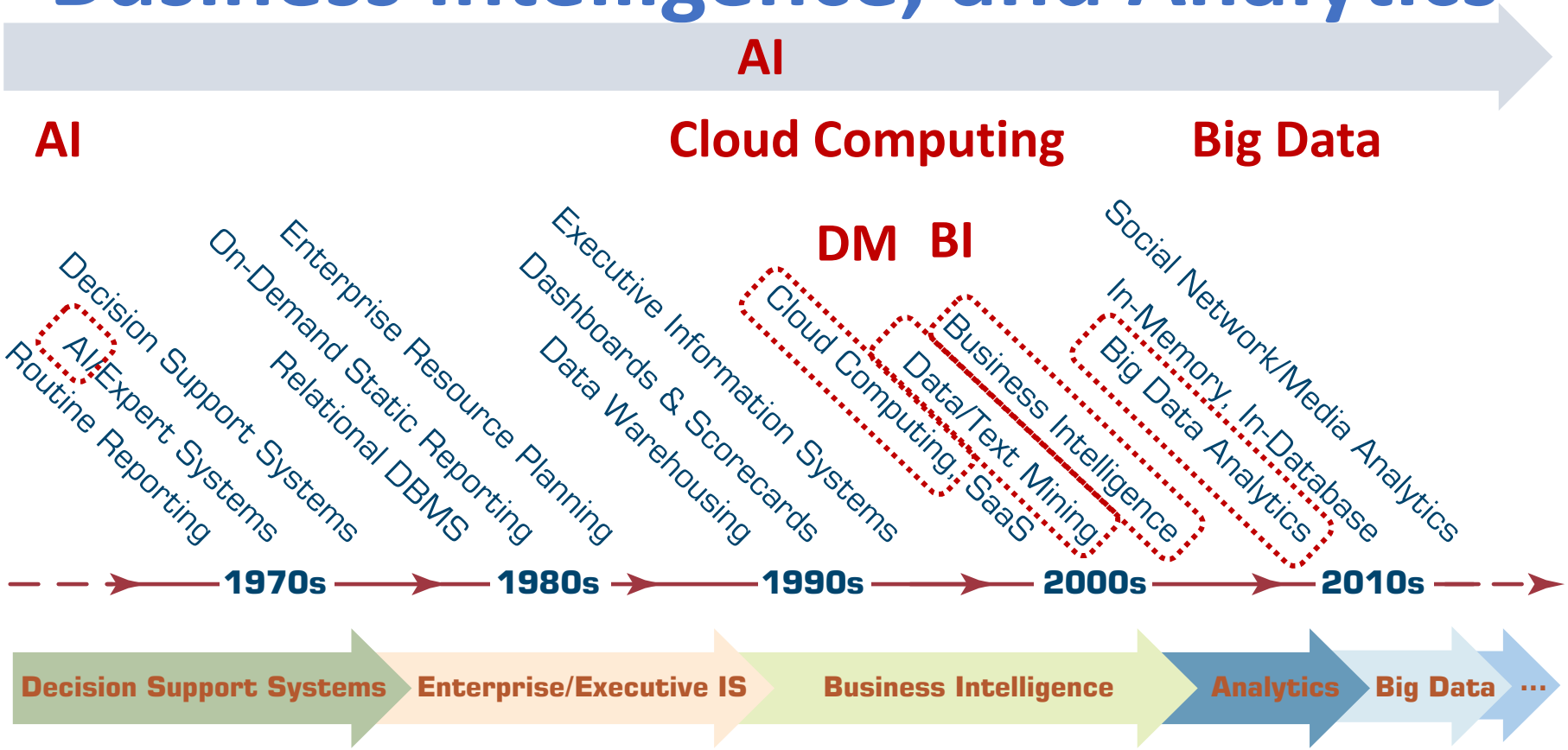
Packt Publishing



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

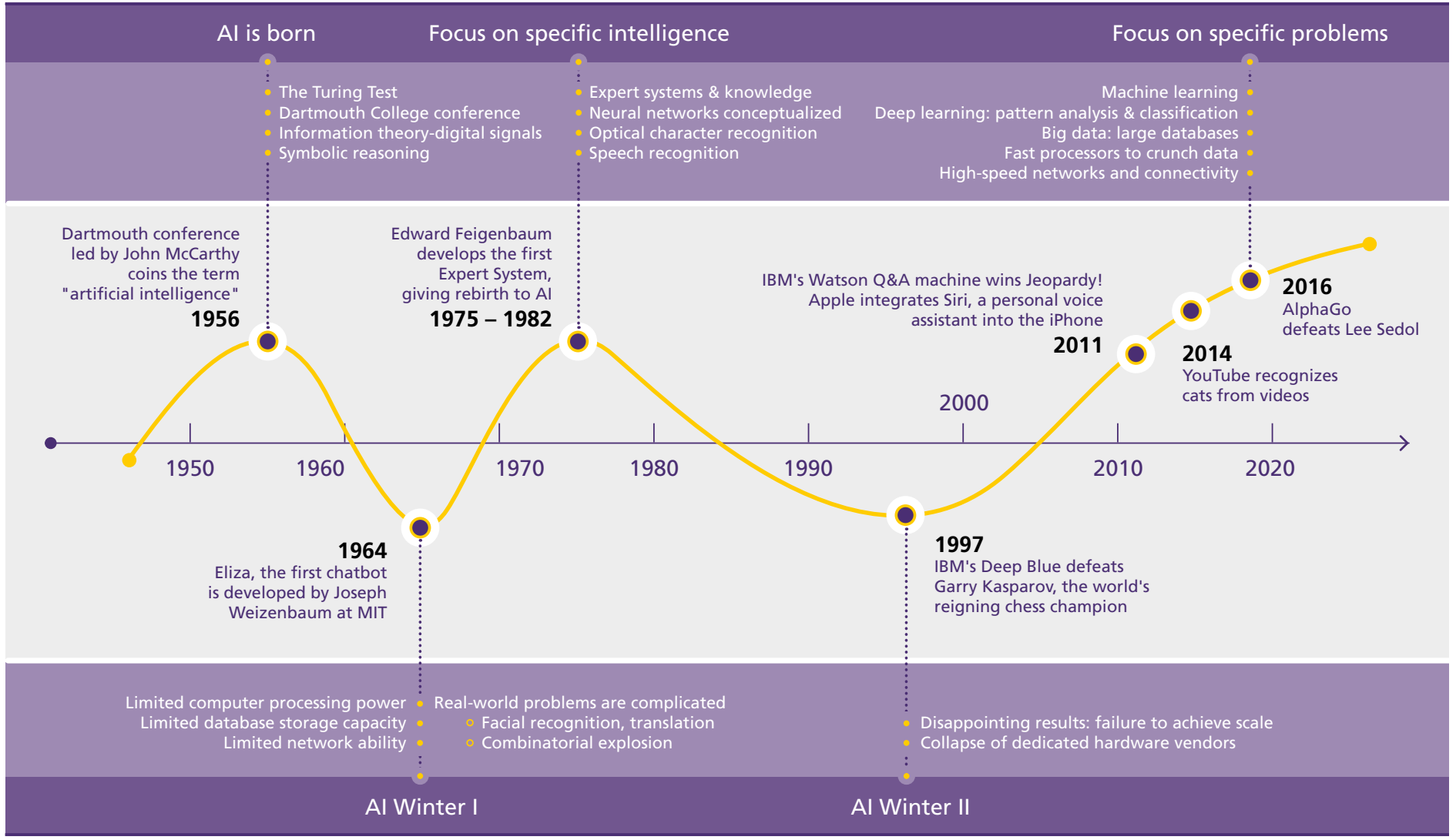
Artificial Intelligence (AI)

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

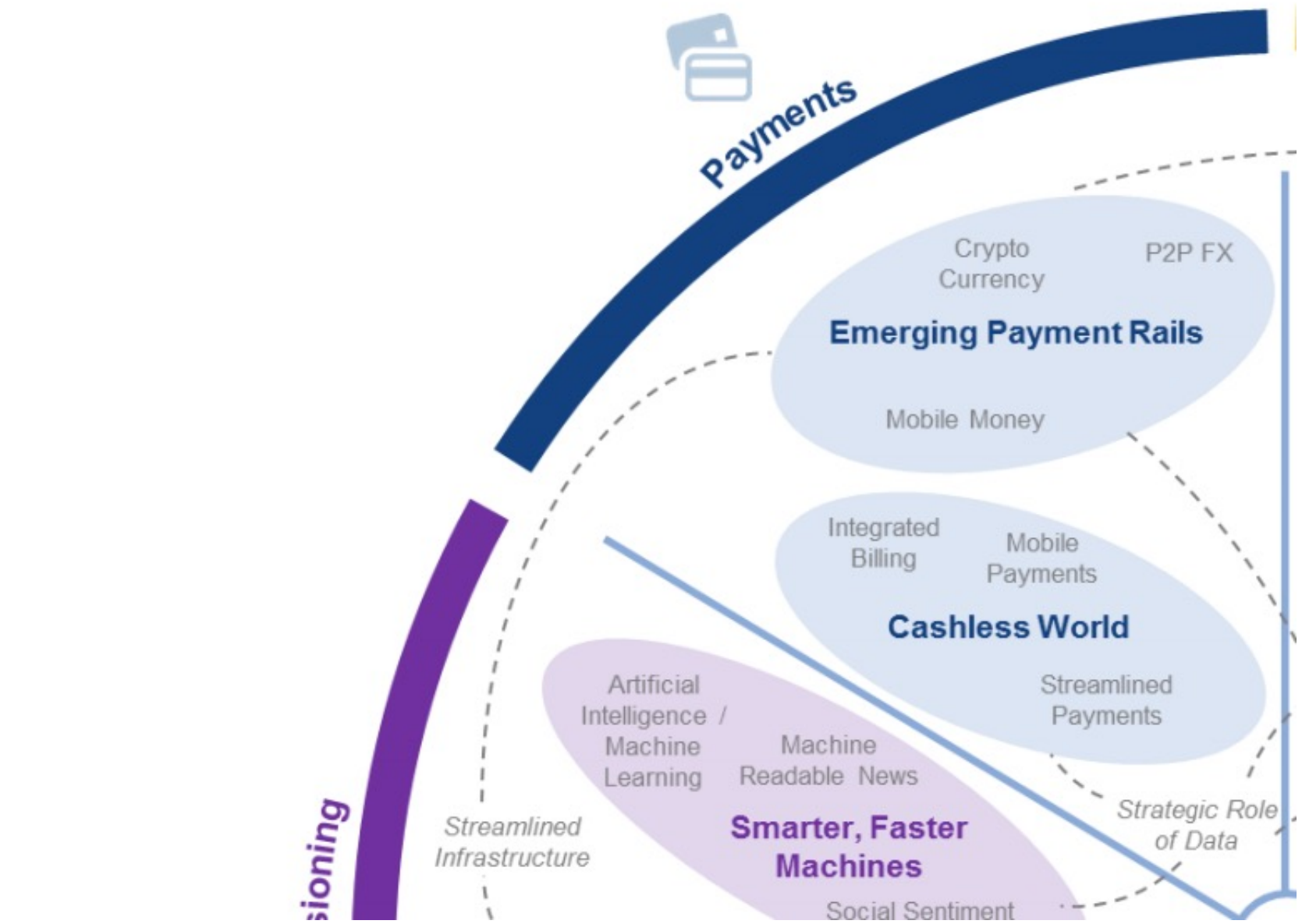
FinTech:

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

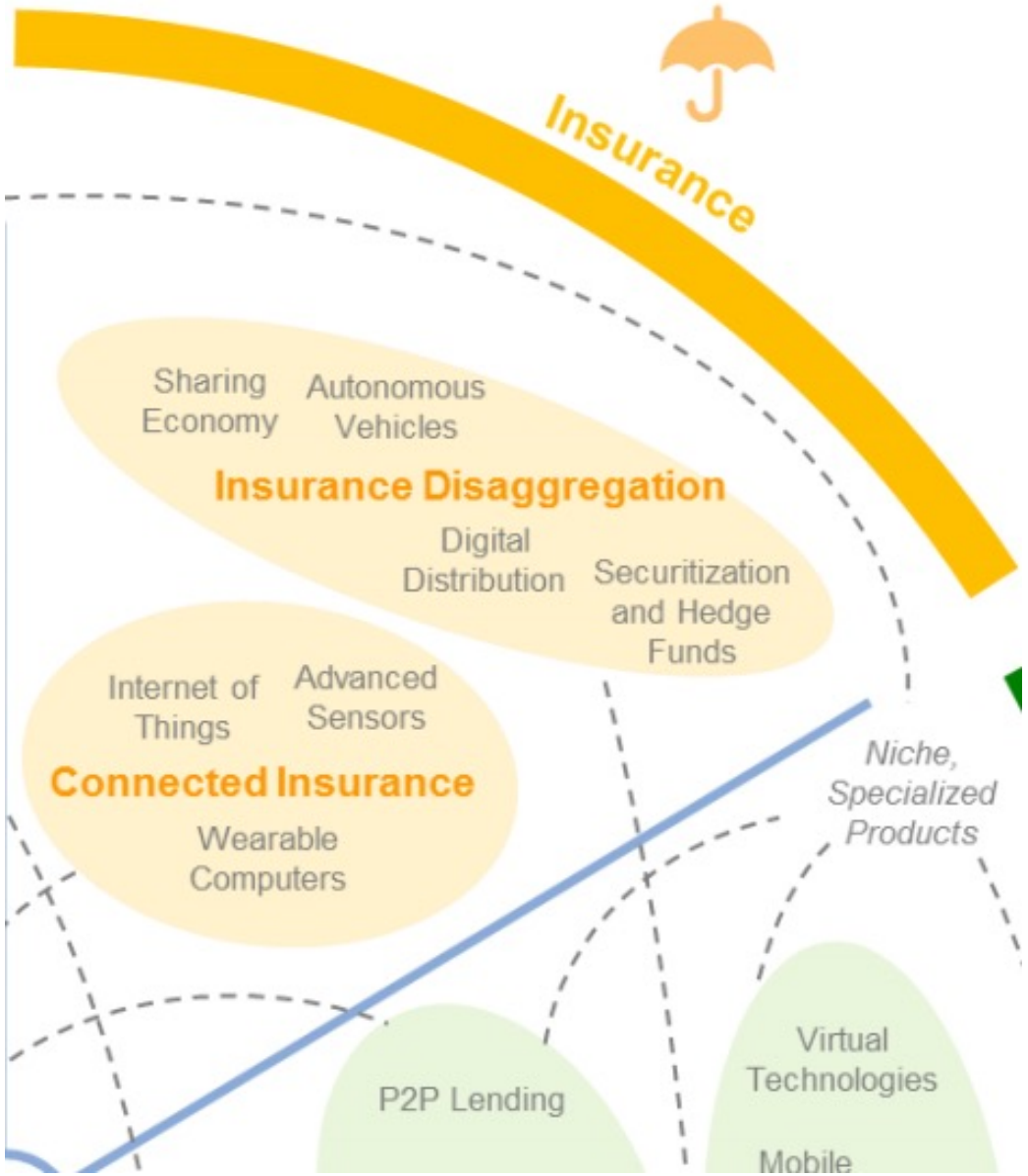
1 FinTech: Payment



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

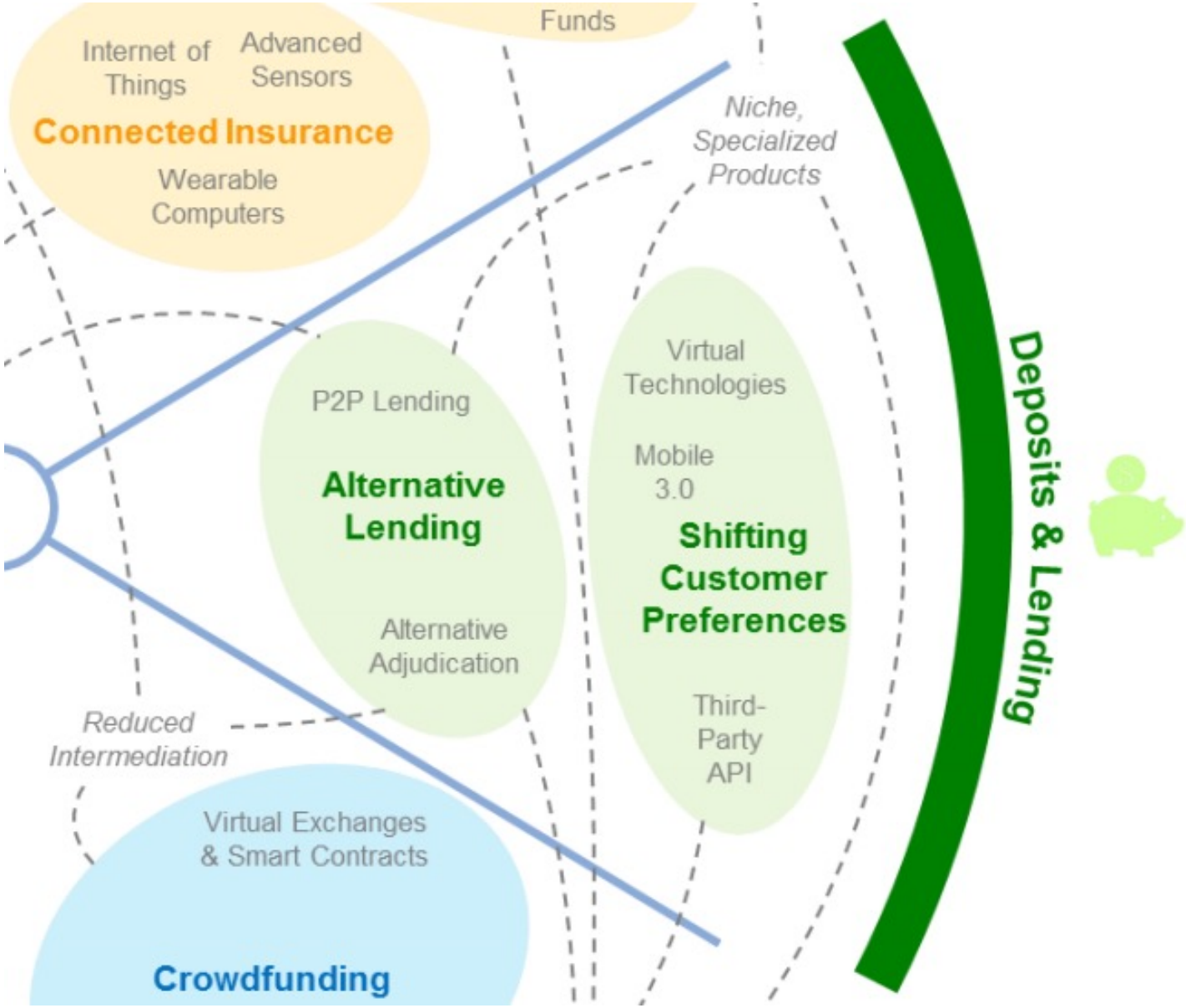
2

FinTech: Insurance



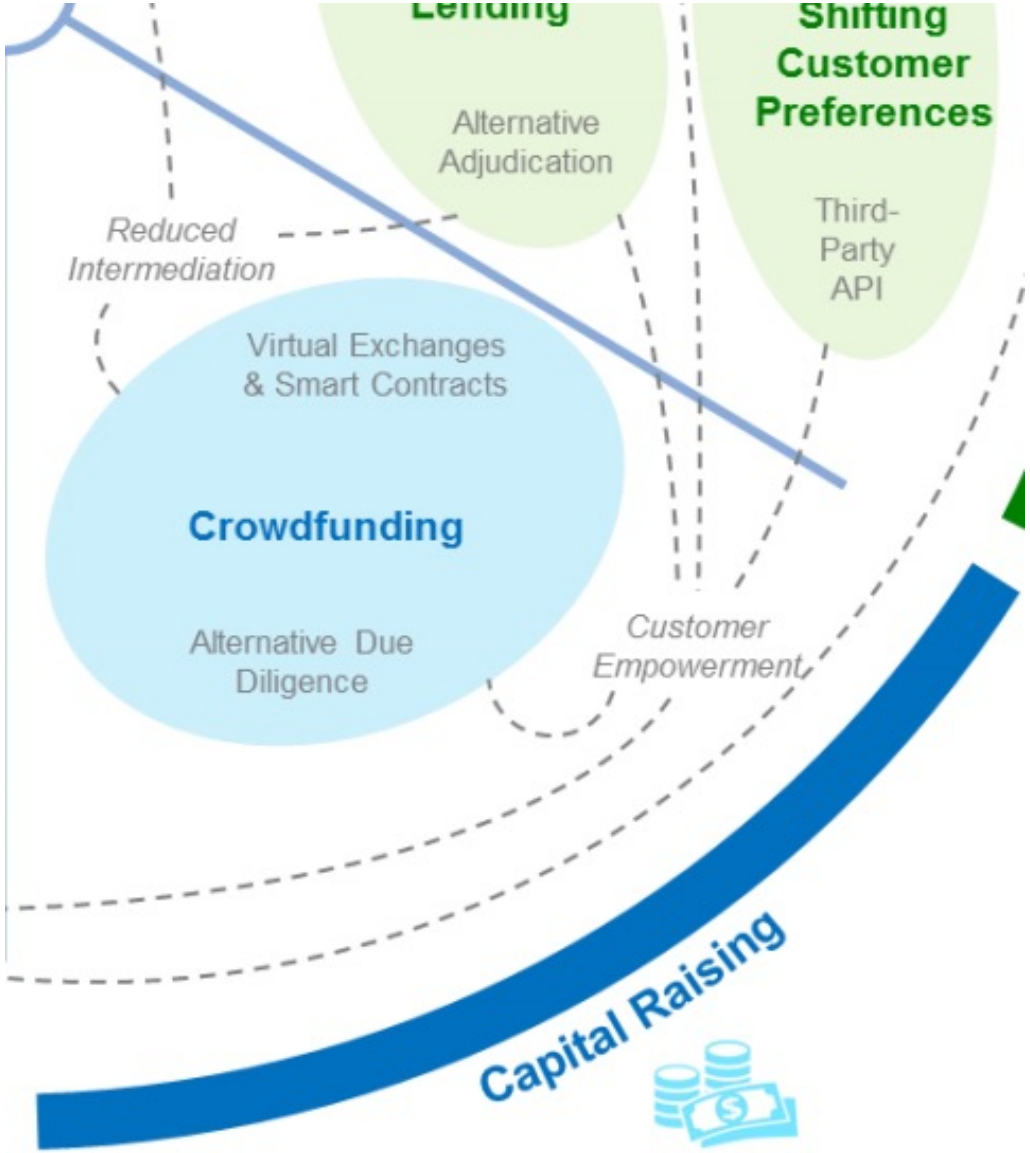
Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

3 FinTech: Deposits & Lending



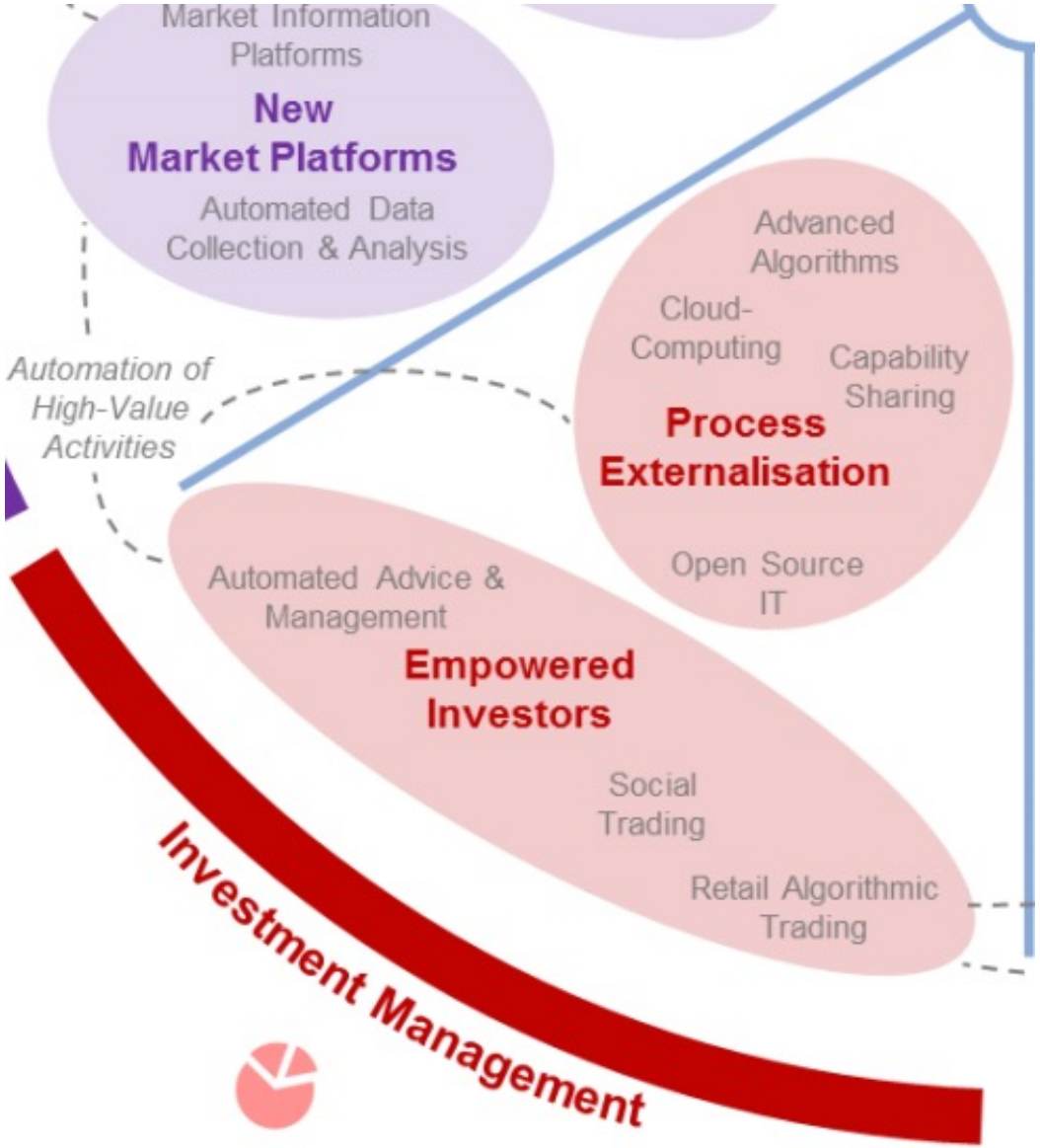
Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

4 FinTech: Capital Raising



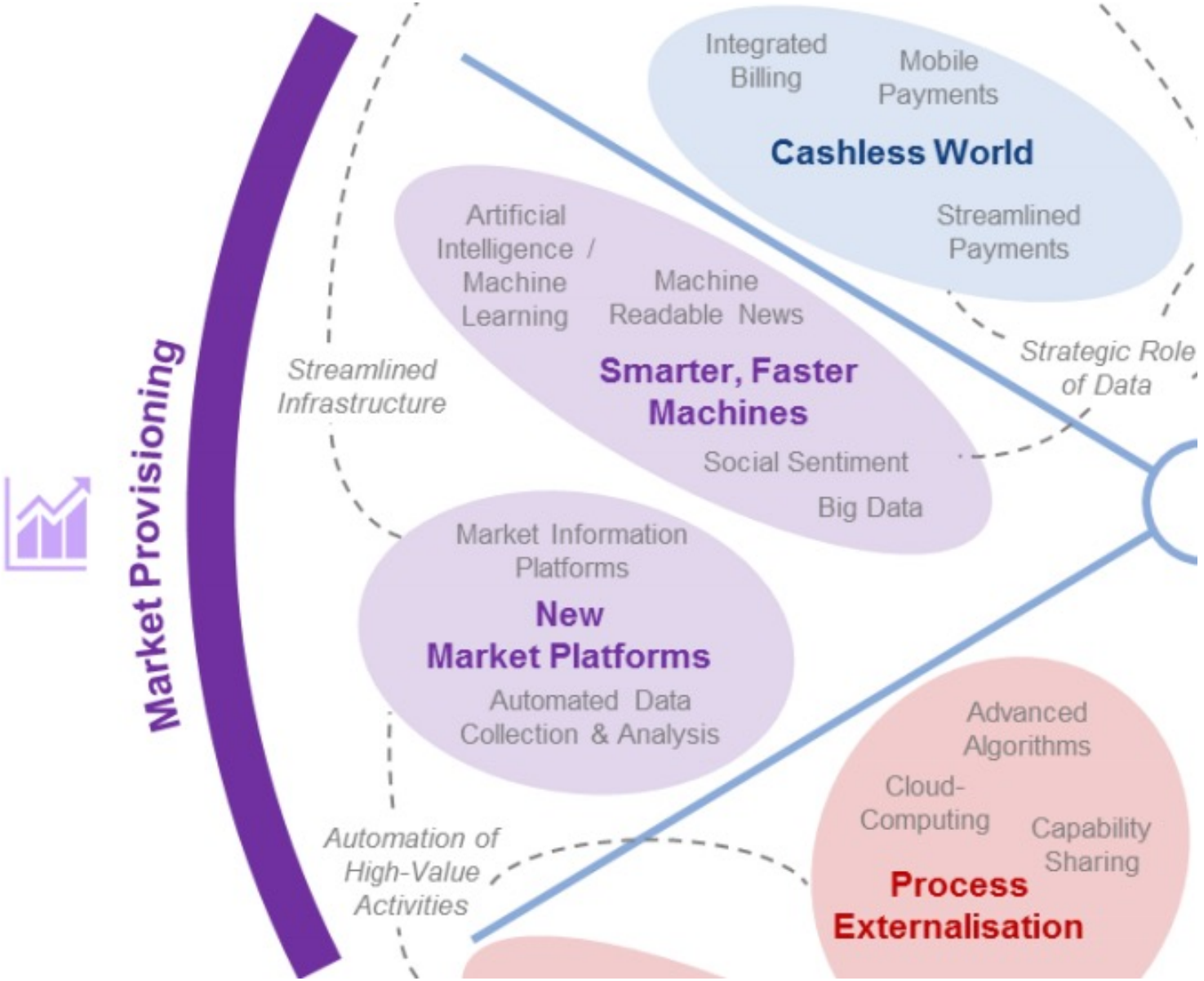
Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

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

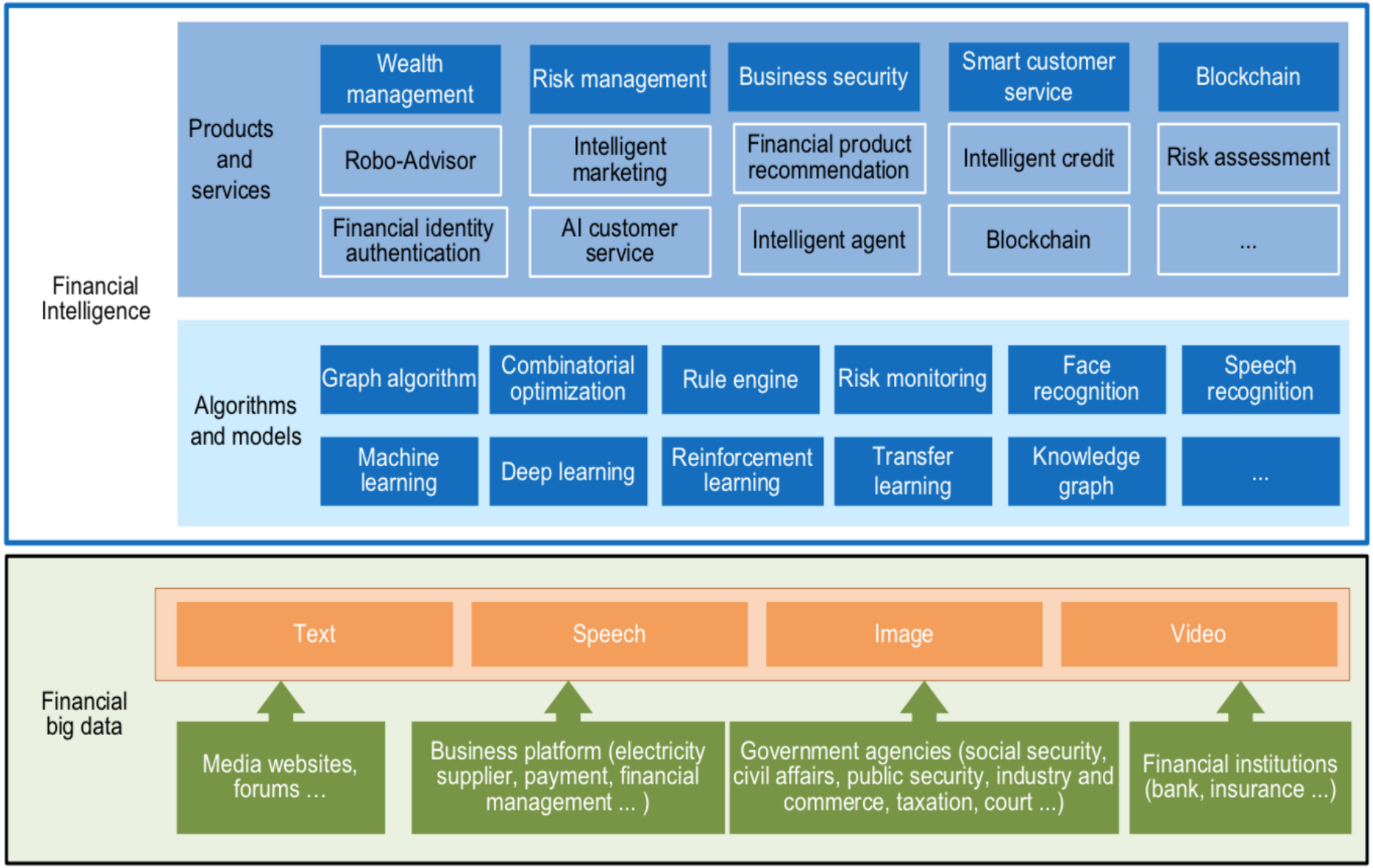
AI

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.

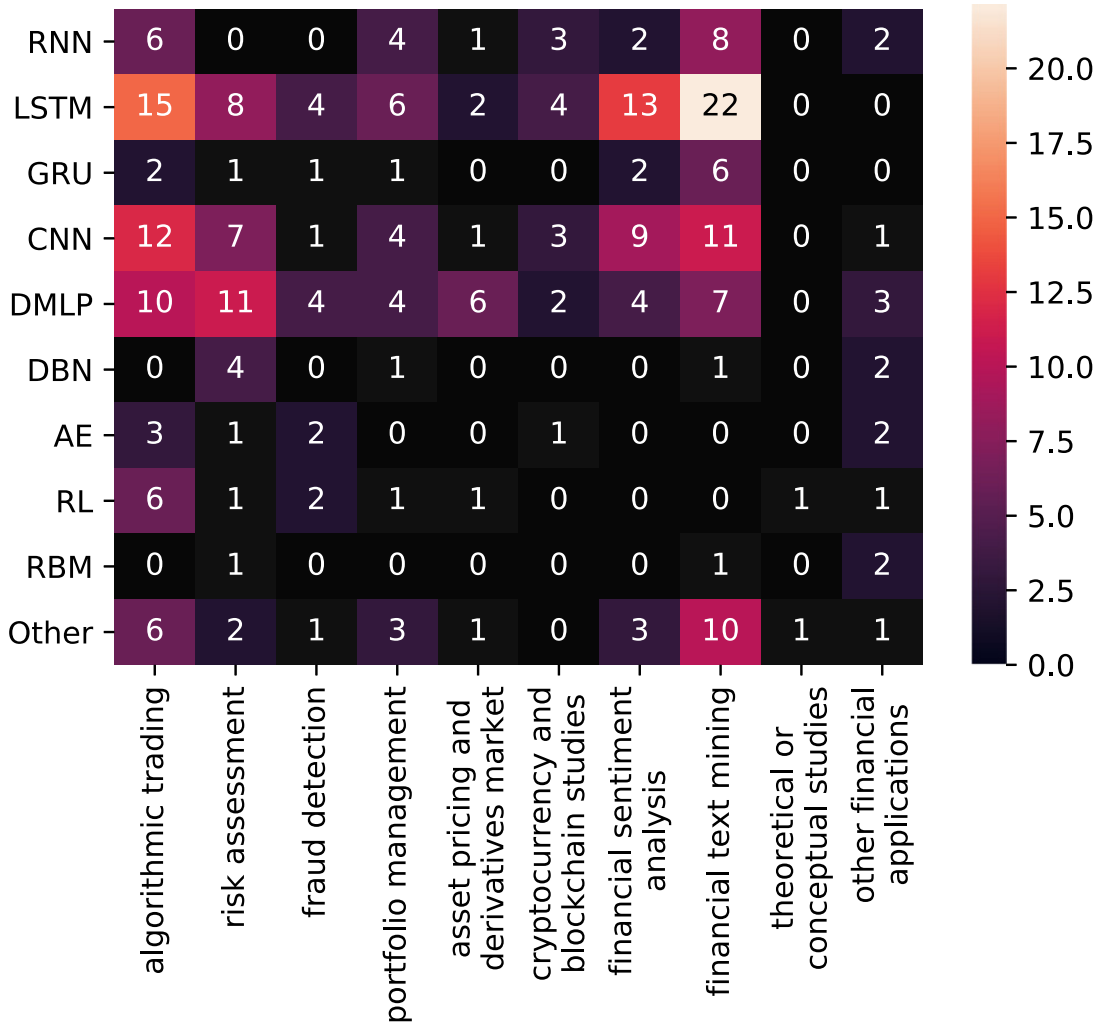
Yunhe Pan (2016), "Heading toward artificial intelligence 2.0." Engineering 2, no. 4, 409-413.

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

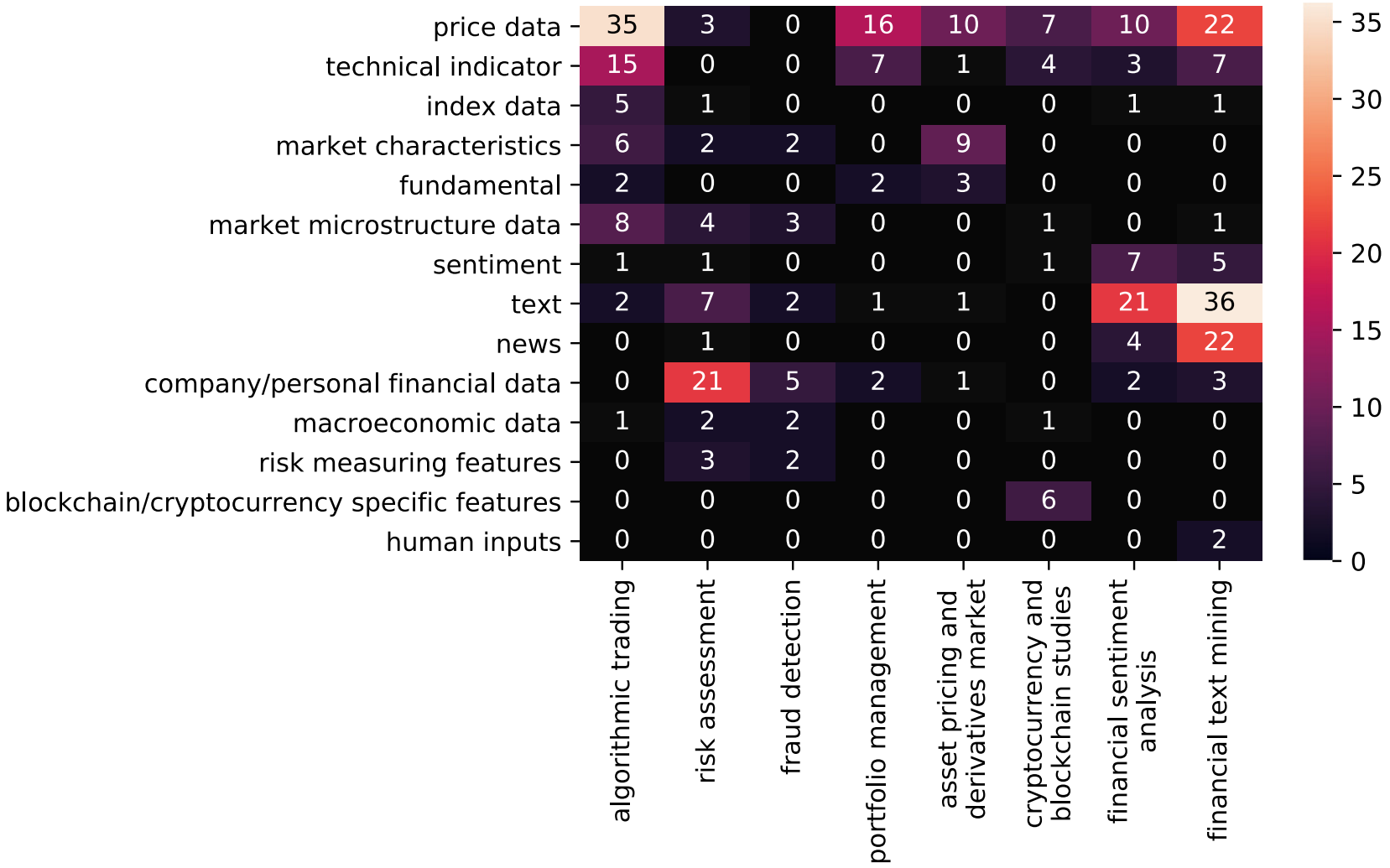
Source: Xiao-lin Zheng, Meng-ying Zhu, Qi-bing Li, Chao-chao Chen, and Yan-chao Tan (2019), "Finbrain: When finance meets AI 2.0." Frontiers of Information Technology & Electronic Engineering 20, no. 7, pp. 914-924

Deep learning for financial applications: Topic-Model Heatmap



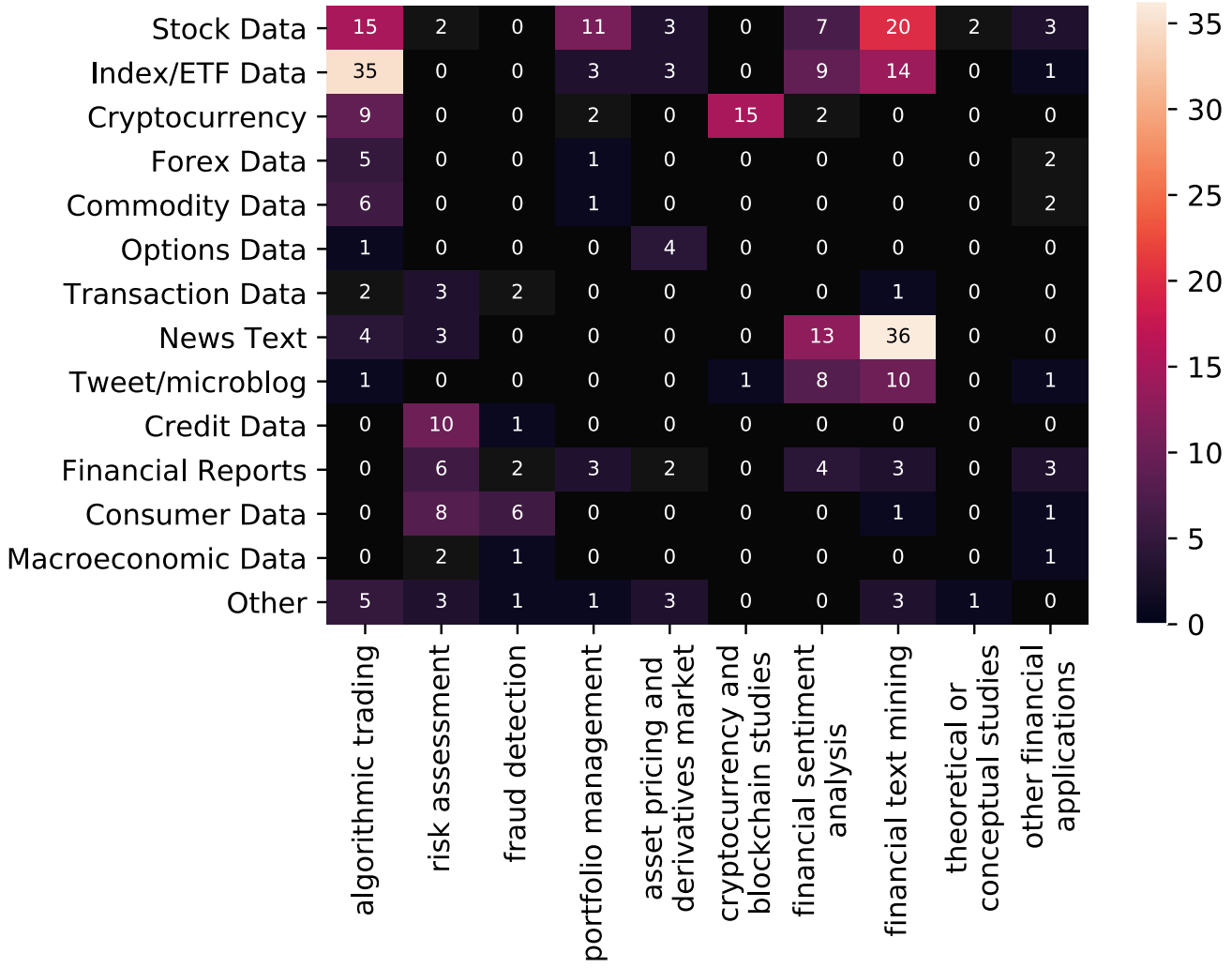
Source: Ahmet Murat Ozbayoglu, Mehmet Ugur Gudelek, and Omer Berat Sezer (2020). "Deep learning for financial applications: A survey." Applied Soft Computing (2020): 106384.

Deep learning for financial applications: Topic-Feature Heatmap



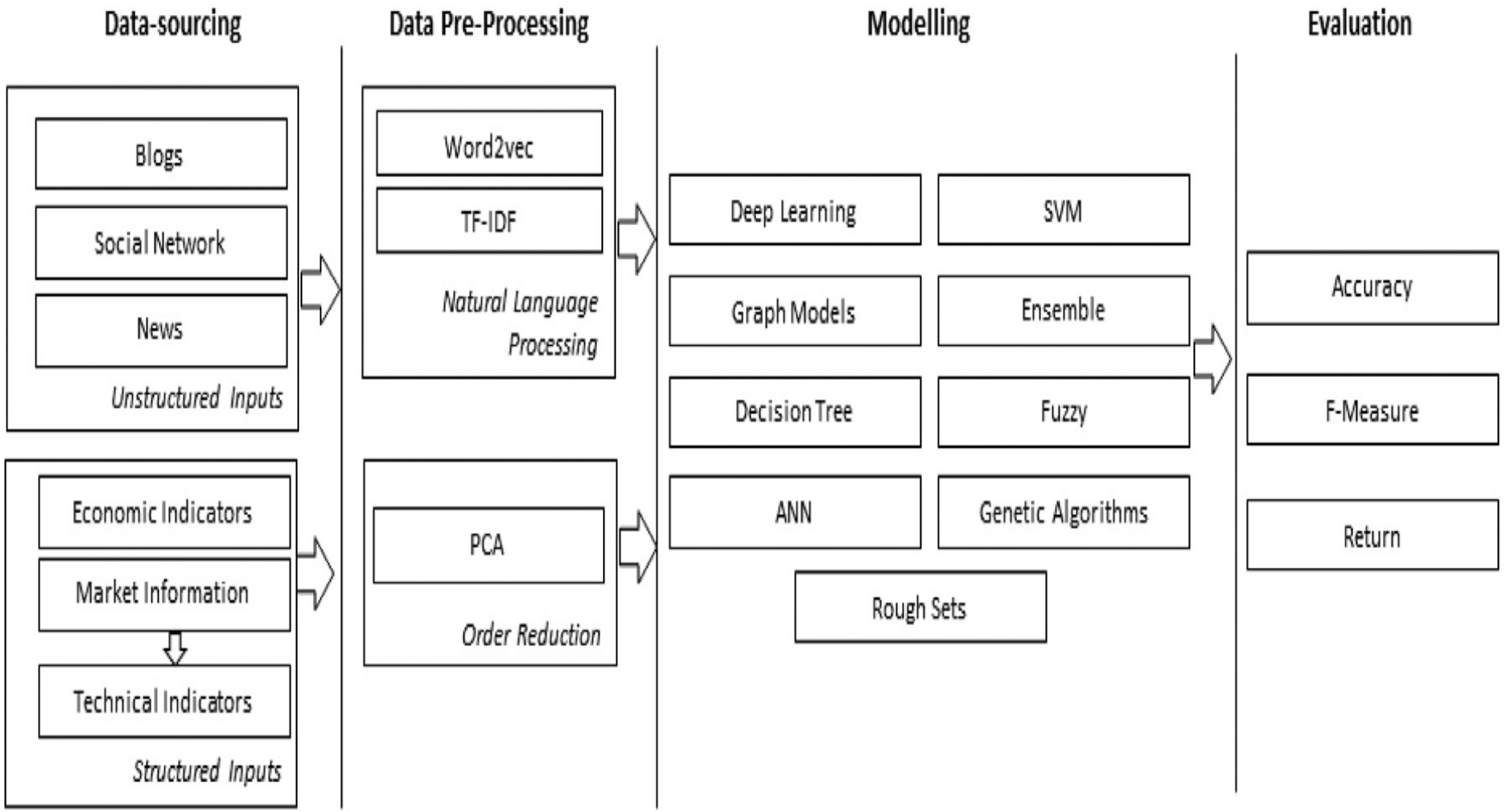
Source: Ahmet Murat Ozbayoglu, Mehmet Ugur Gudelek, and Omer Berat Sezer (2020). "Deep learning for financial applications: A survey." Applied Soft Computing (2020): 106384.

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.

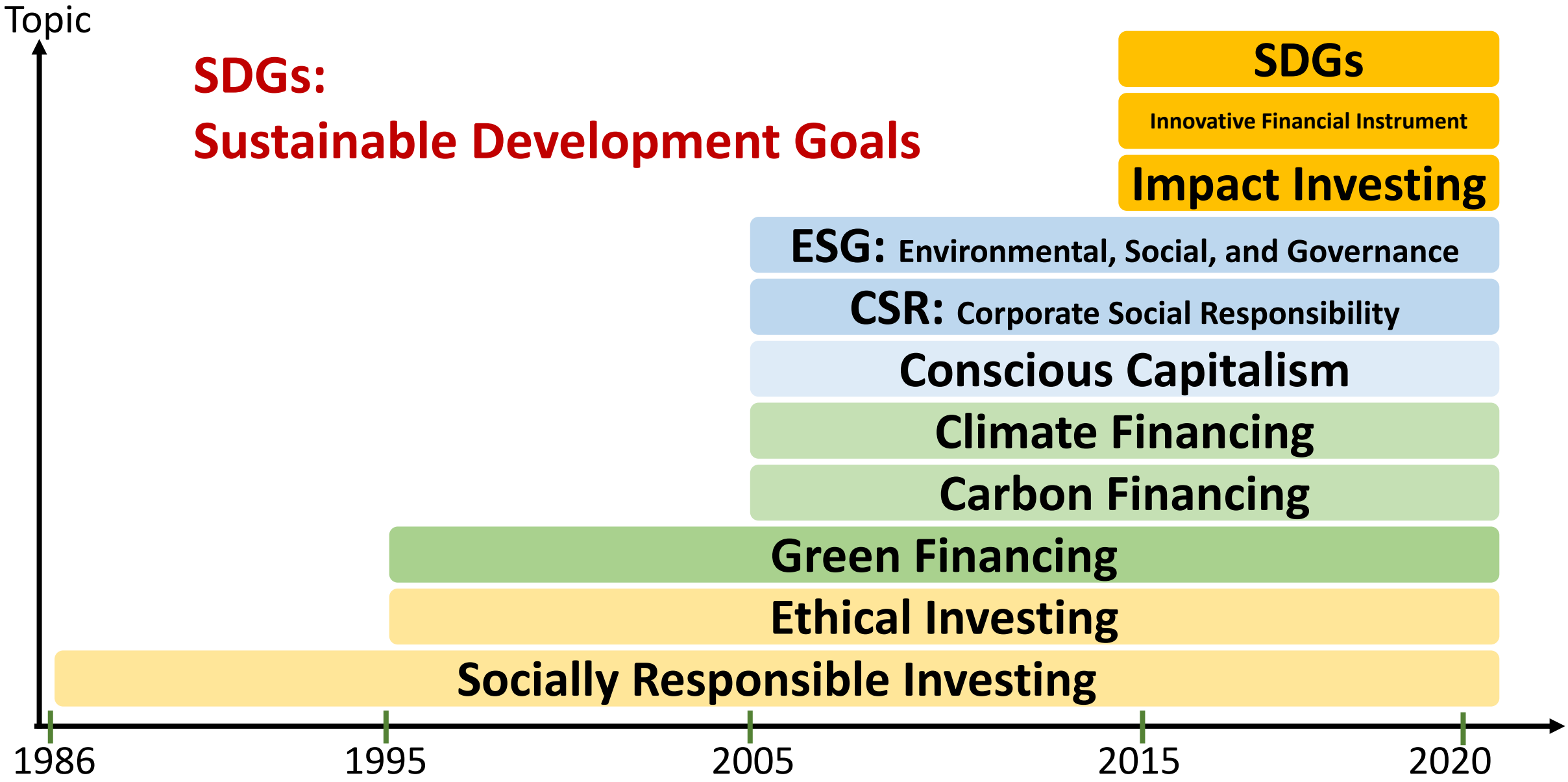
Stock Market Movement Forecast:
Phases of the stock market modeling



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

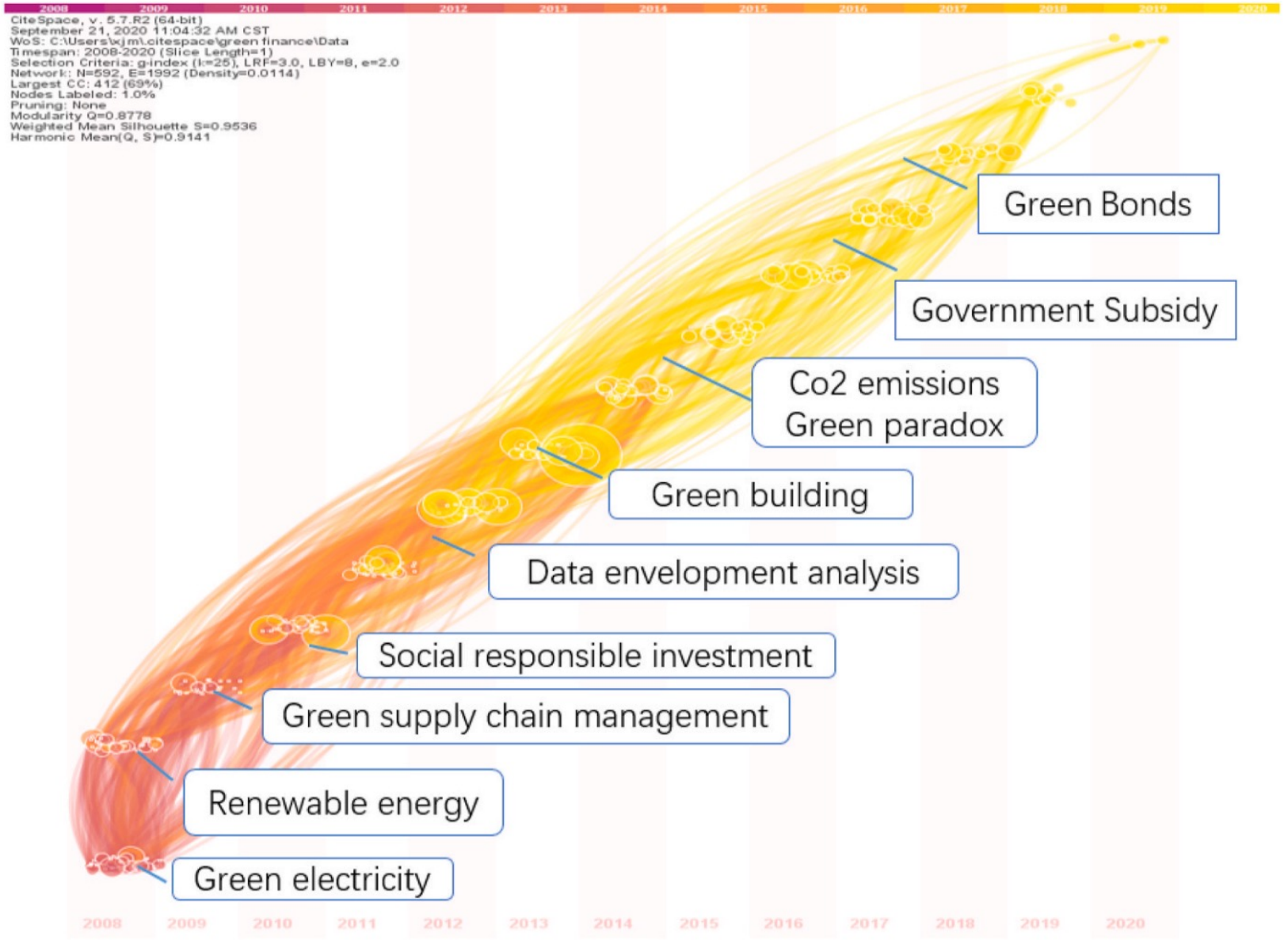
Source: Bhattacharyya, Rupsha. "Green finance for energy transition, climate action and sustainable development: overview of concepts, applications, implementation and challenges." Green Finance 4, no. 1 (2022): 1-35.

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

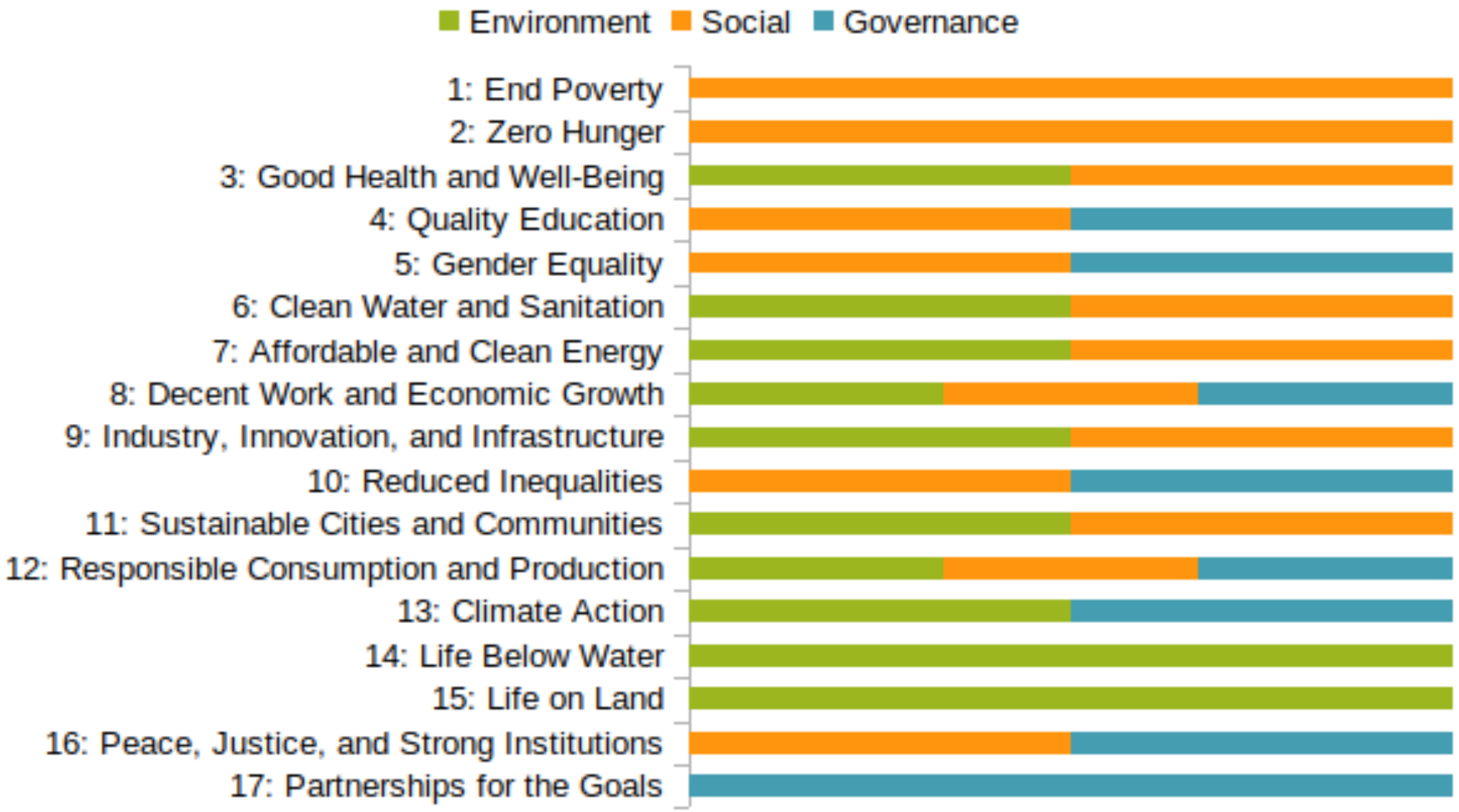
Governance

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 No poverty	2 Zero hunger	3 Good health and well-being	4 Quality education	5 Gender equality	6 Clean water and sanitation	7 Affordable and clean energy	8 Decent work and economic growth	9 Industry, innovation and infrastructure	10 Reduces inequalities	11 Sustainable cities and communities	12 Responsible consumption and production	13 Climate action	14 Life below water	15 Life on land	16 Peace, justice and strong institutions	17 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

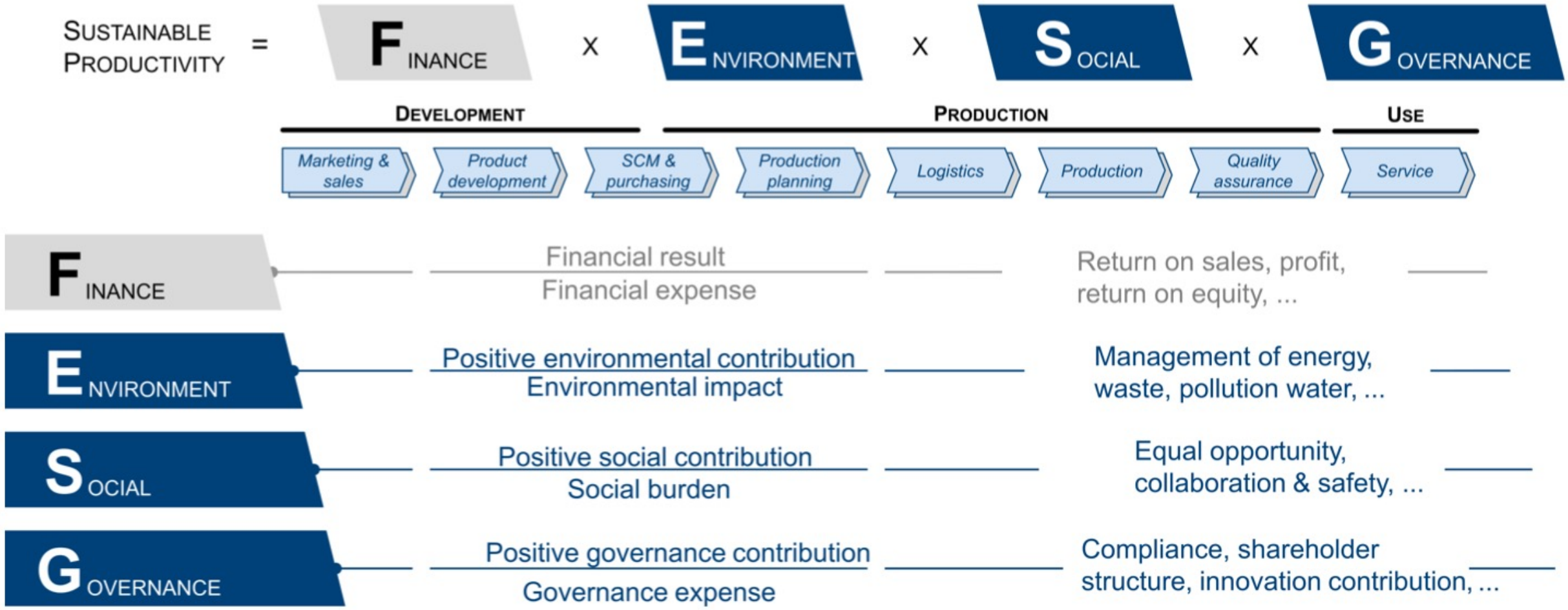
Dimension	Code characteristics					
Primary objective[1]	Develop new (AI) methods *(11/95)*	Compare (AI) methods *(39/95)*	Apply (AI) methods *(53/95)*	Develop new system *(20/95)*	Other objective *(4/95)*	
Sustainability dimension	Economic *(23/95)*		Ecological *(17/95)*		Social *(72/95)*	
Sustainable 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'.

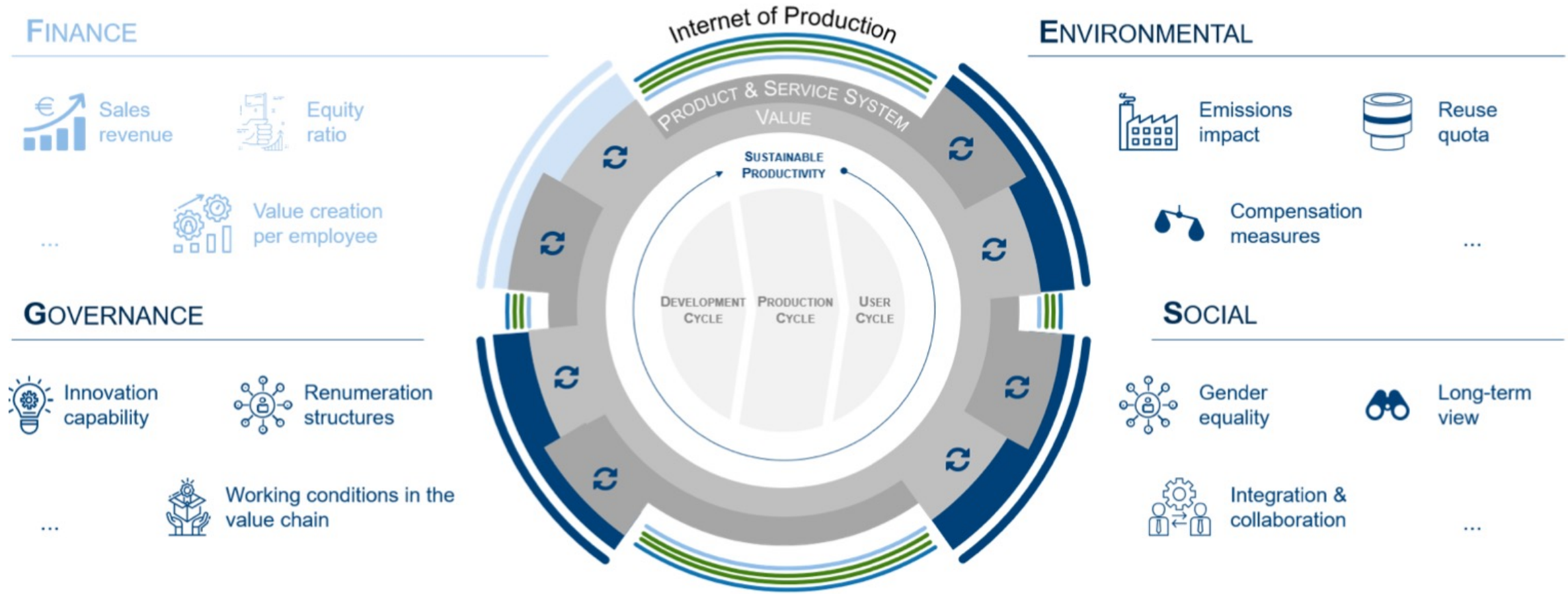
Source: Schoormann, T., Strobel, G., Möller, F., Petrik, D., & Zschech, P. (2023). Artificial Intelligence for Sustainability—A Systematic Review of Information Systems Literature. Communications of the Association for Information Systems, 52(1), 8.

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

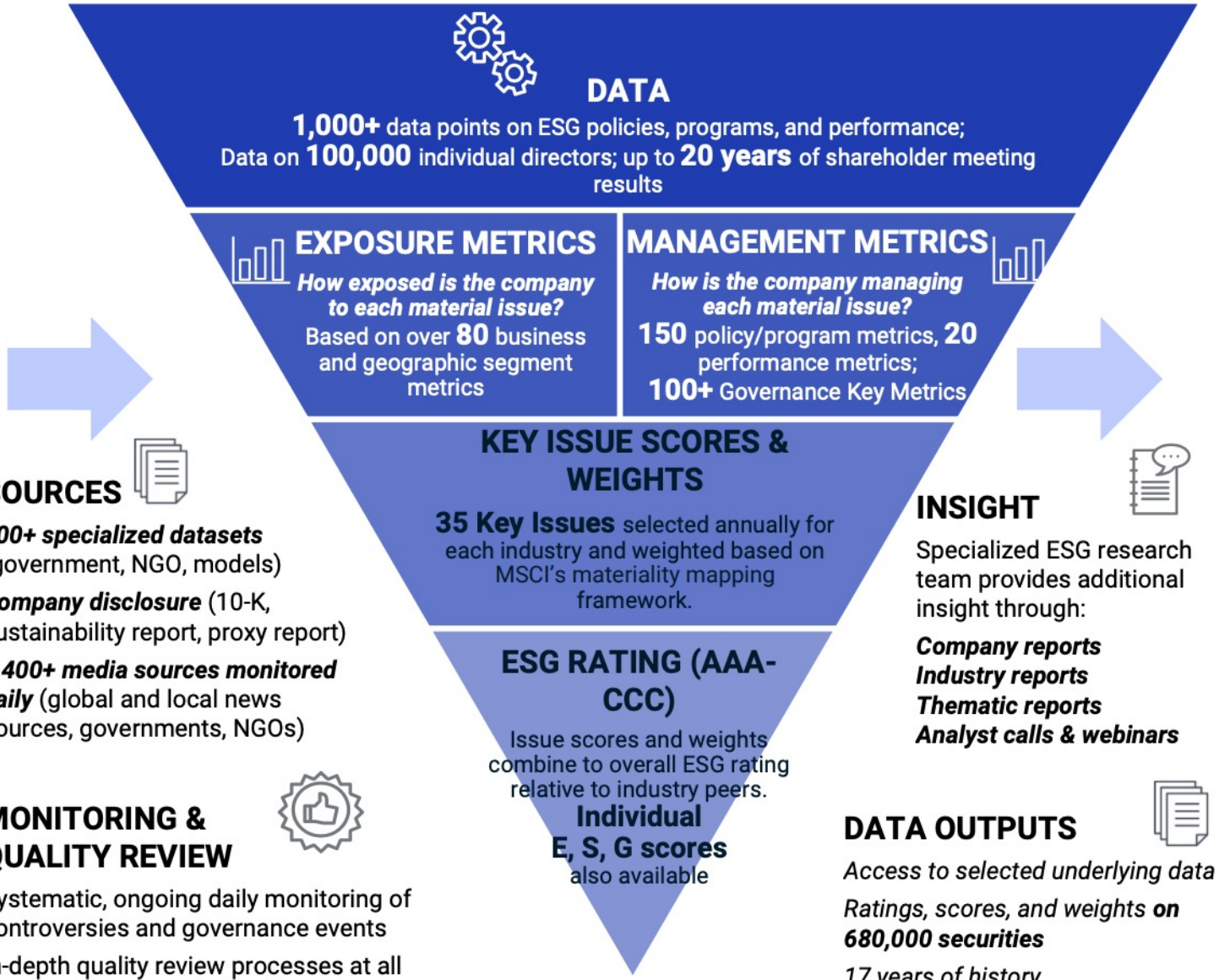


Source: Huang, Ziqi, Yang Shen, Jiayi Li, Marcel Fey, and Christian Brecher (2021). "A survey on AI-driven digital twins in Industry 4.0: Smart manufacturing and advanced robotics." Sensors 21, no. 19: 6340.

ESG Indexes

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

MSCI ESG Rating Framework



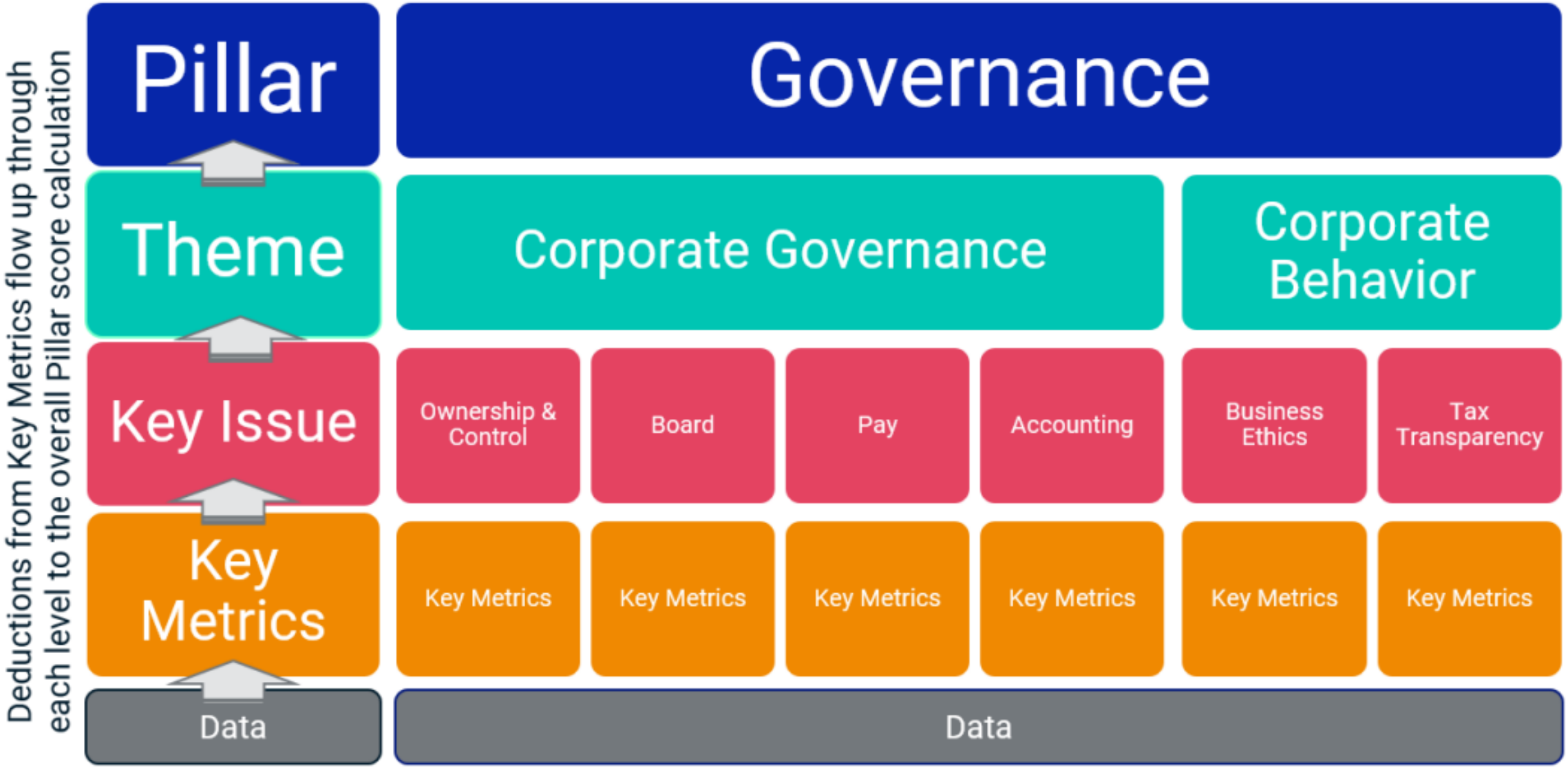
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

MSCI ESG Key Issue Hierarchy

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

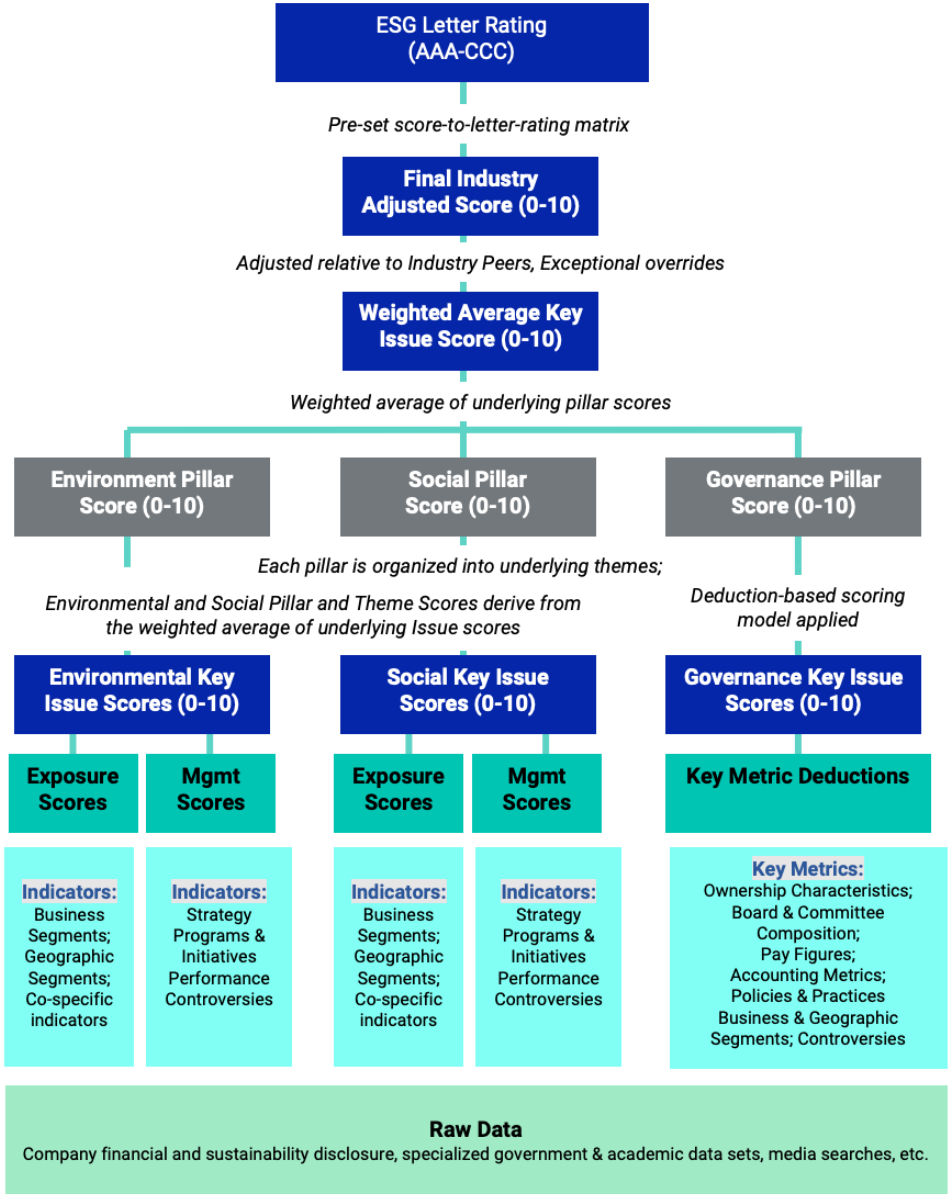
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

MSCI Governance Model Structure



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

MSCI Hierarchy of ESG Scores



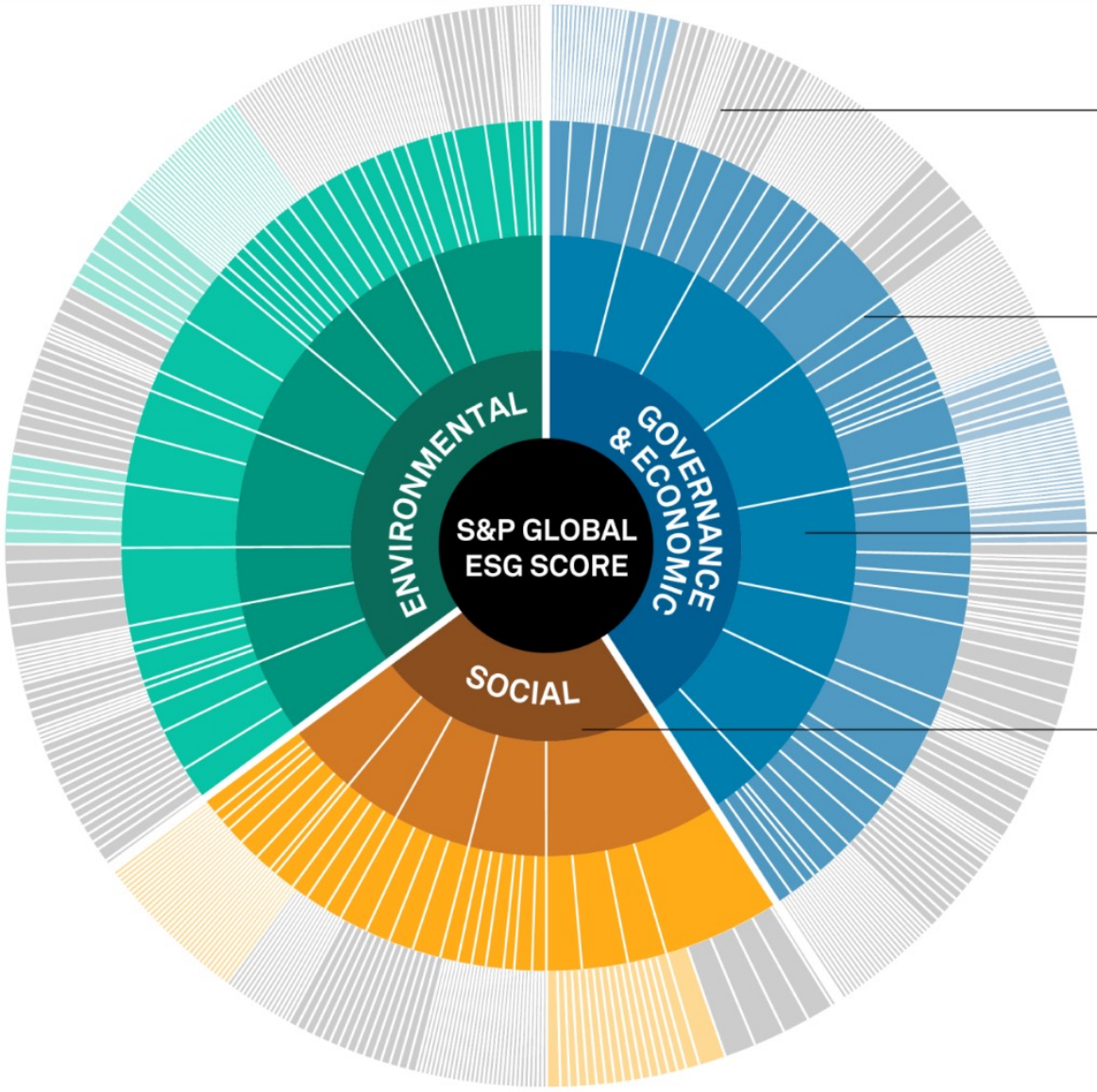
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

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

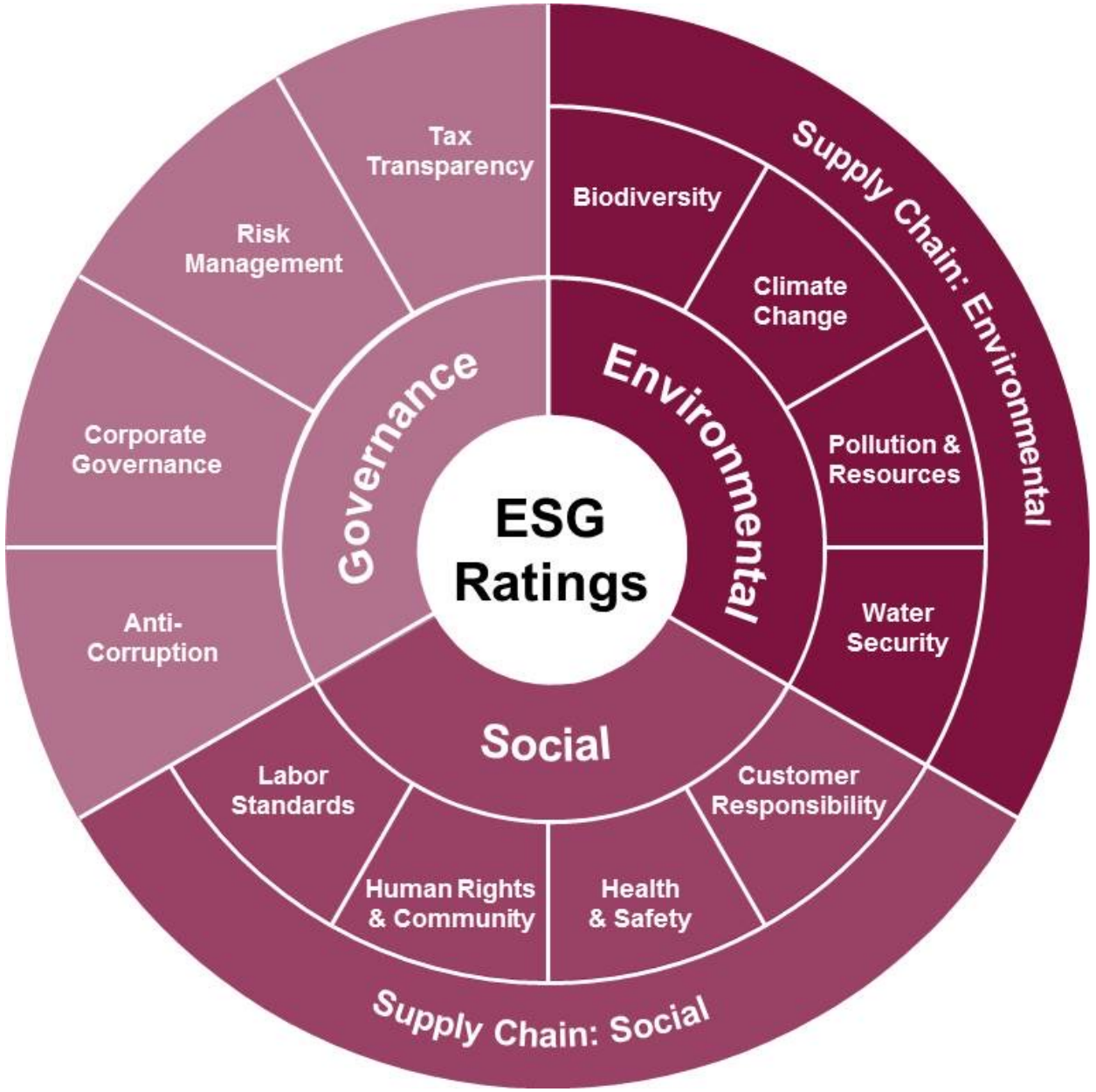
Weighted criteria scores
Adjusted for corporate ESG controversies where applicable

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
a Morningstar company

Sustainalytics ESG Risk Ratings

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

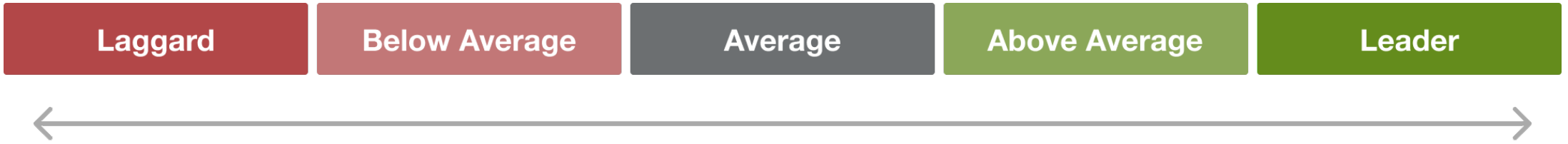
TruValue Labs

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.**



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

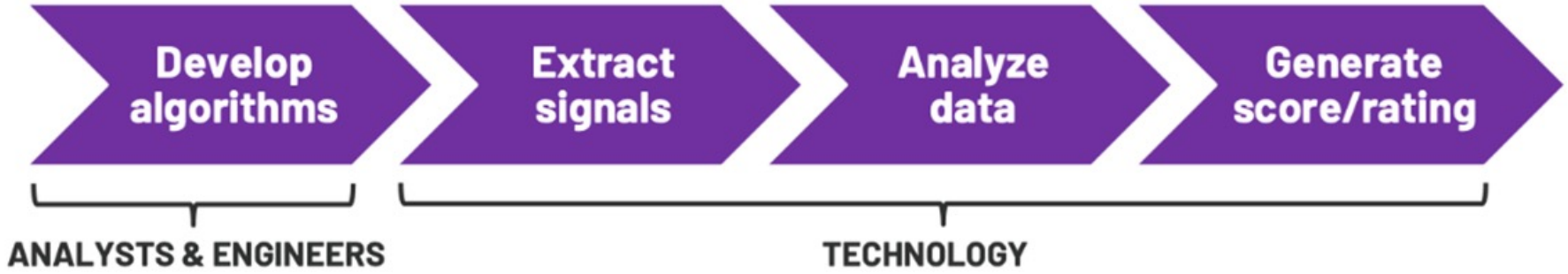
Sustainalytics

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

AI-driven ESG research

Derives signals from unstructured data

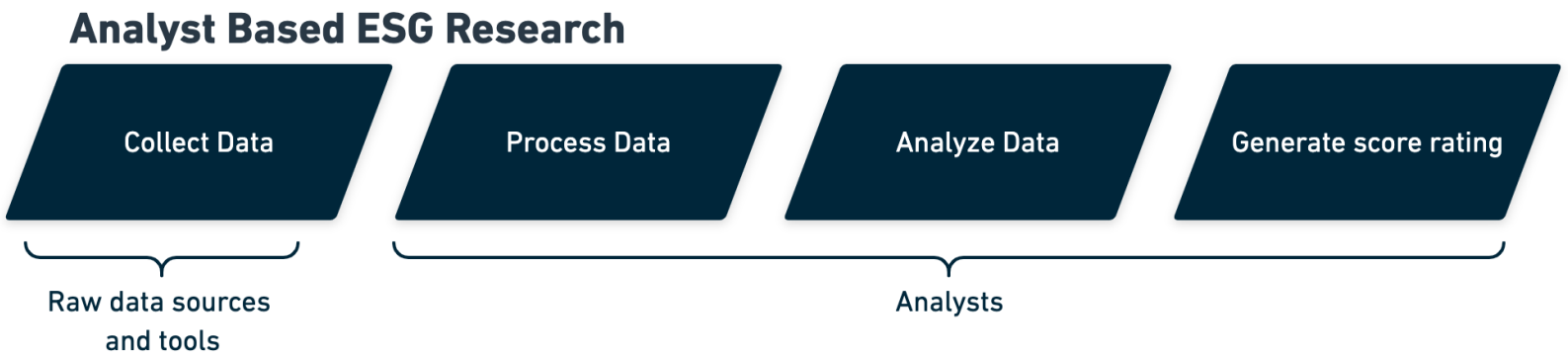
Truvalue Labs



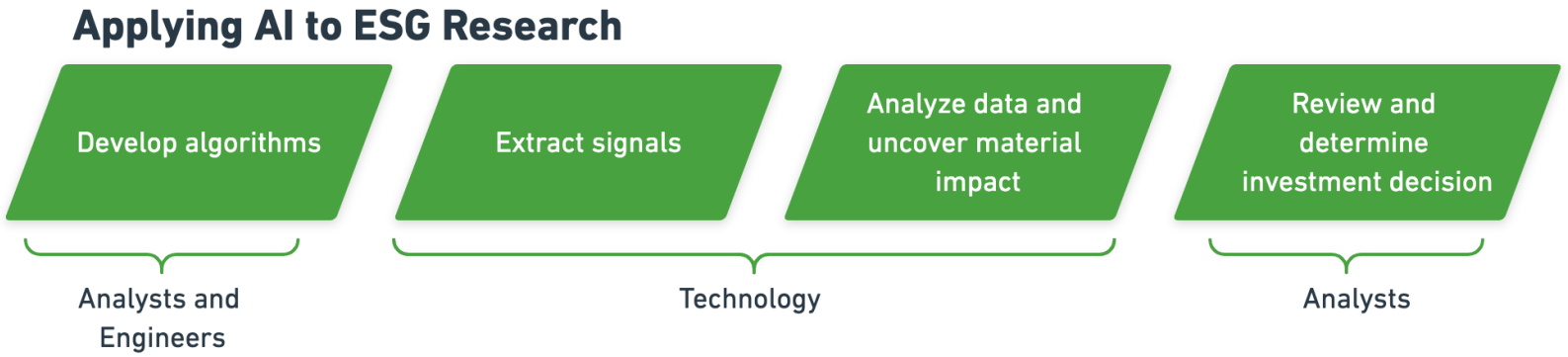
Analyst expertise at the beginning of the process produces consistent results

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

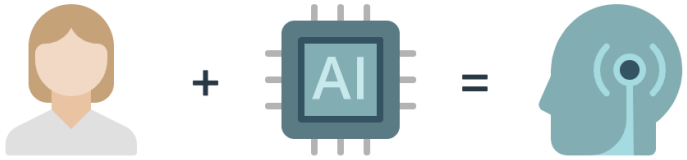


AI based ESG Research



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

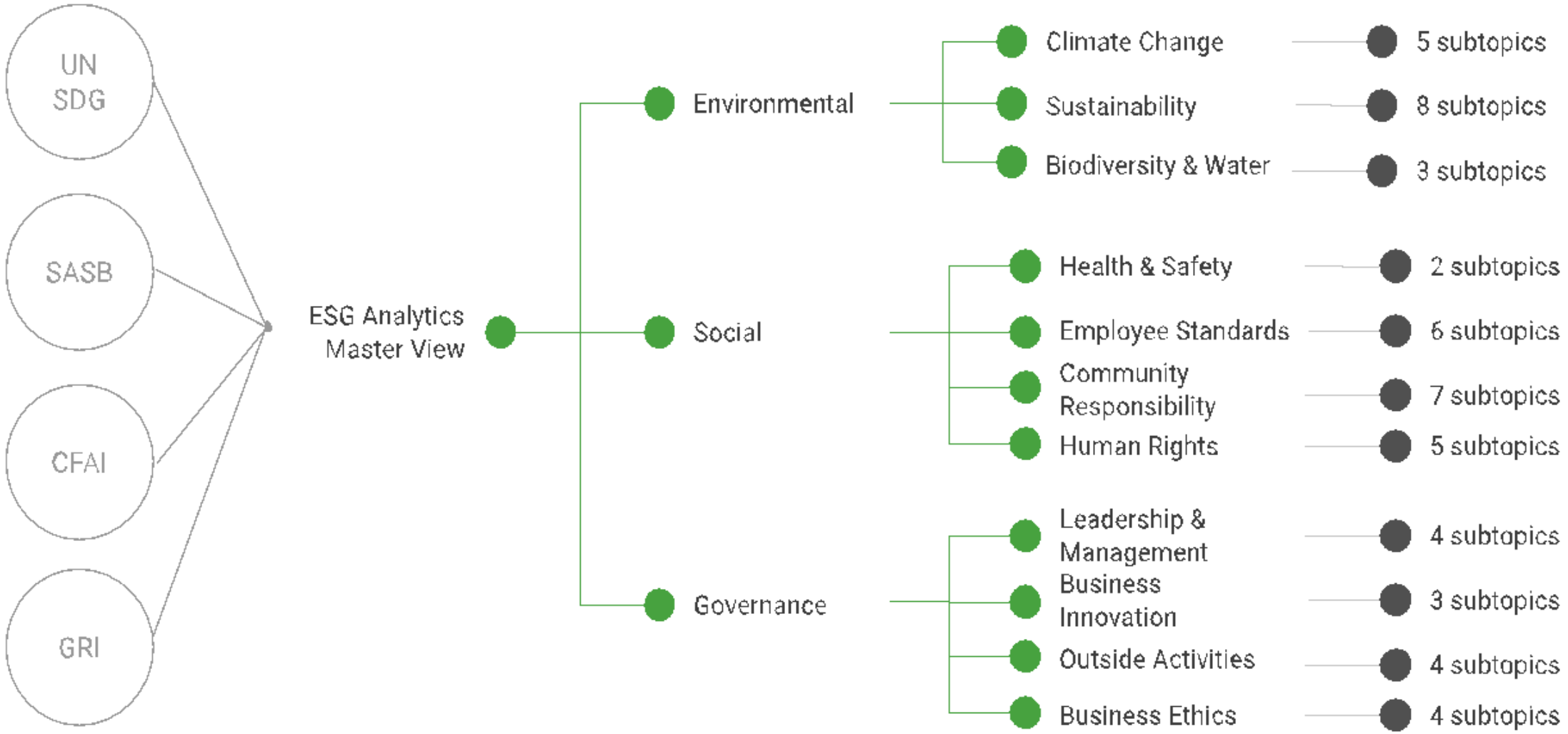
Combining analysts with AI creates gives you the full picture



ESG ANALYTICS
Invest where it matters.

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

ESG Analytics: NLP Taxonomy

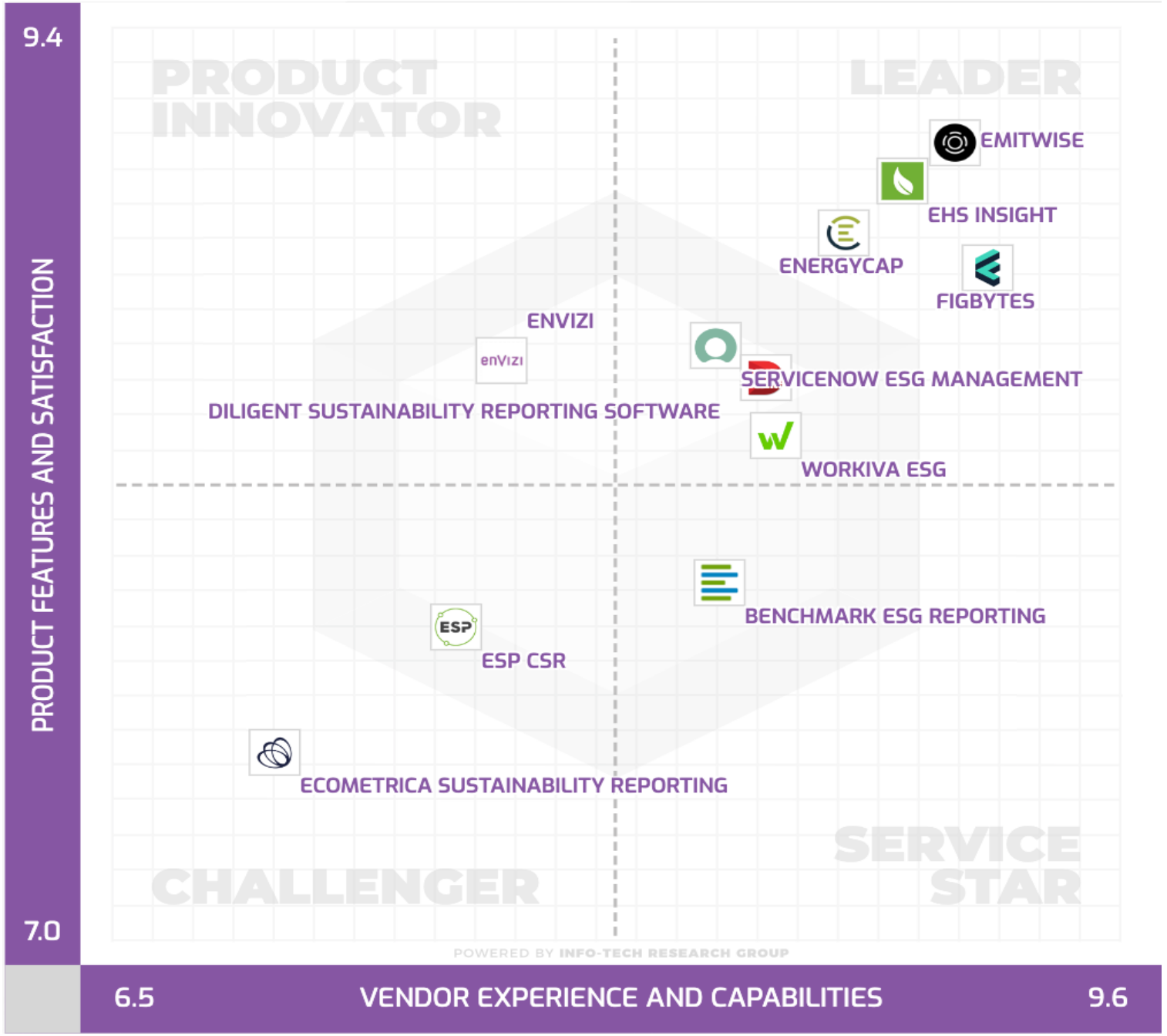


ESG ANALYTICS

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.**

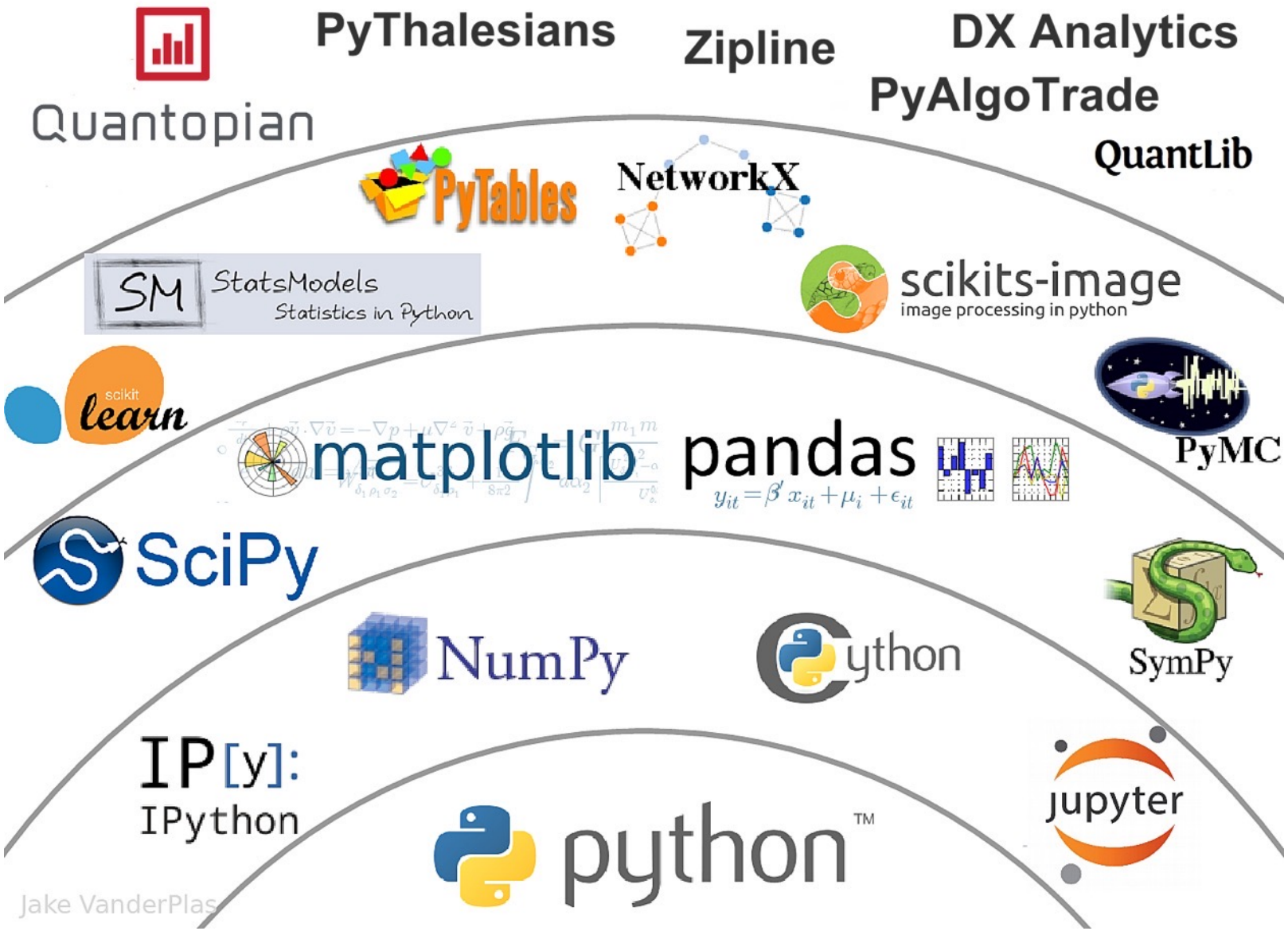
Source: https://www.softwarereviews.com/categories/environmental-social-and-governance-reporting

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.**

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

yhilpisch / aiif Public

https://github.com/yhilpisch/aiif

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Code | Issues | Pull requests | Actions | Projects | Wiki | Security | Insights

main | 1 branch | 0 tags | Go to file | Code

yves Code updates for TF 2.3. e334251 on Dec 8, 2020 4 commits

code	Code updates for TF 2.3.	11 months ago
.gitignore	Code updates for TF 2.3.	11 months ago
LICENSE.txt	Code updates.	11 months ago
README.md	Code updates.	11 months ago

README.md

Artificial Intelligence in Finance

About this Repository

This repository provides Python code and Jupyter Notebooks accompanying the **Artificial Intelligence in Finance** book published by O'Reilly.

O'REILLY

About

Jupyter Notebooks and code for the book Artificial Intelligence in Finance (O'Reilly) by Yves Hilpisch.

home.tpq.io/books/aiif

Readme

View license

Releases

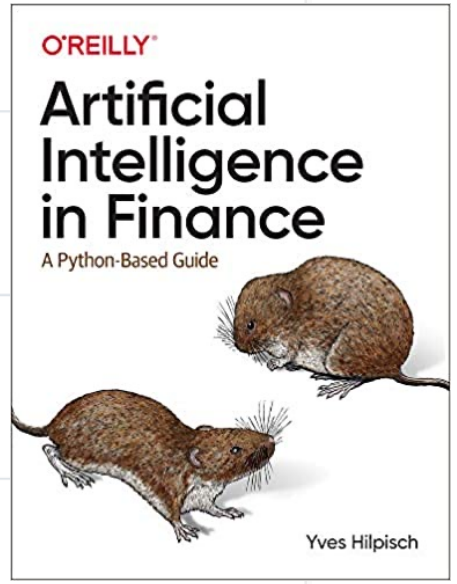
No releases published

Packages

No packages published

Languages

Jupyter Notebook 97.4% Python 2.6%



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

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

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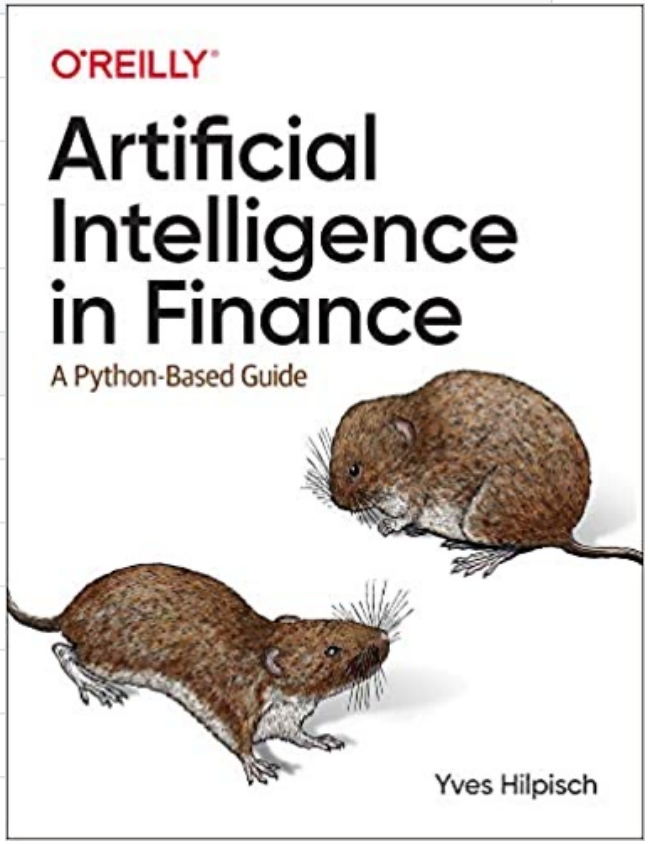
main | aiif / code / https://github.com/yhilpisch/aiif/tree/main/code | Go to file

yves Code updates for TF 2.3. e334251 on Dec 8, 2020 History

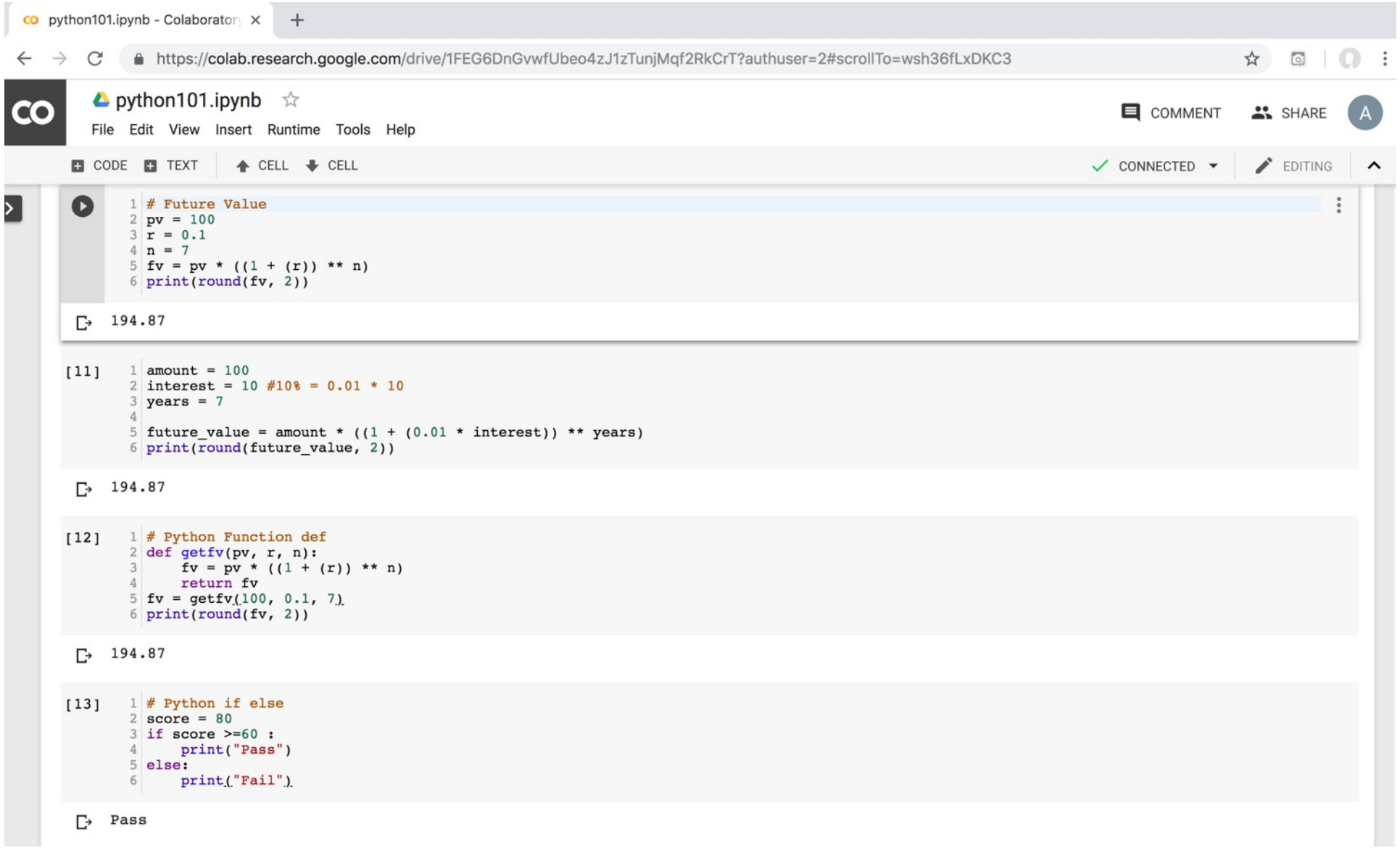
..	
oanda	Code updates for TF 2.3.
01_artificial_intelligence.ipynb	Code updates for TF 2.3.
02_superintelligence.ipynb	Code updates for TF 2.3.
03_normative_finance.ipynb	Code updates for TF 2.3.
04_data_driven_finance_a.ipynb	Initial commit.
04_data_driven_finance_b.ipynb	Initial commit.
05_machine_learning.ipynb	Code updates for TF 2.3.
06_ai_first_finance.ipynb	Code updates for TF 2.3.
07_dense_networks.ipynb	Code updates for TF 2.3.
08_recurrent_networks.ipynb	Code updates for TF 2.3.
09_reinforcement_learning_a.ipynb	Code updates.
09_reinforcement_learning_b.ipynb	Code updates for TF 2.3.



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

Python in Google Colab (Python101)

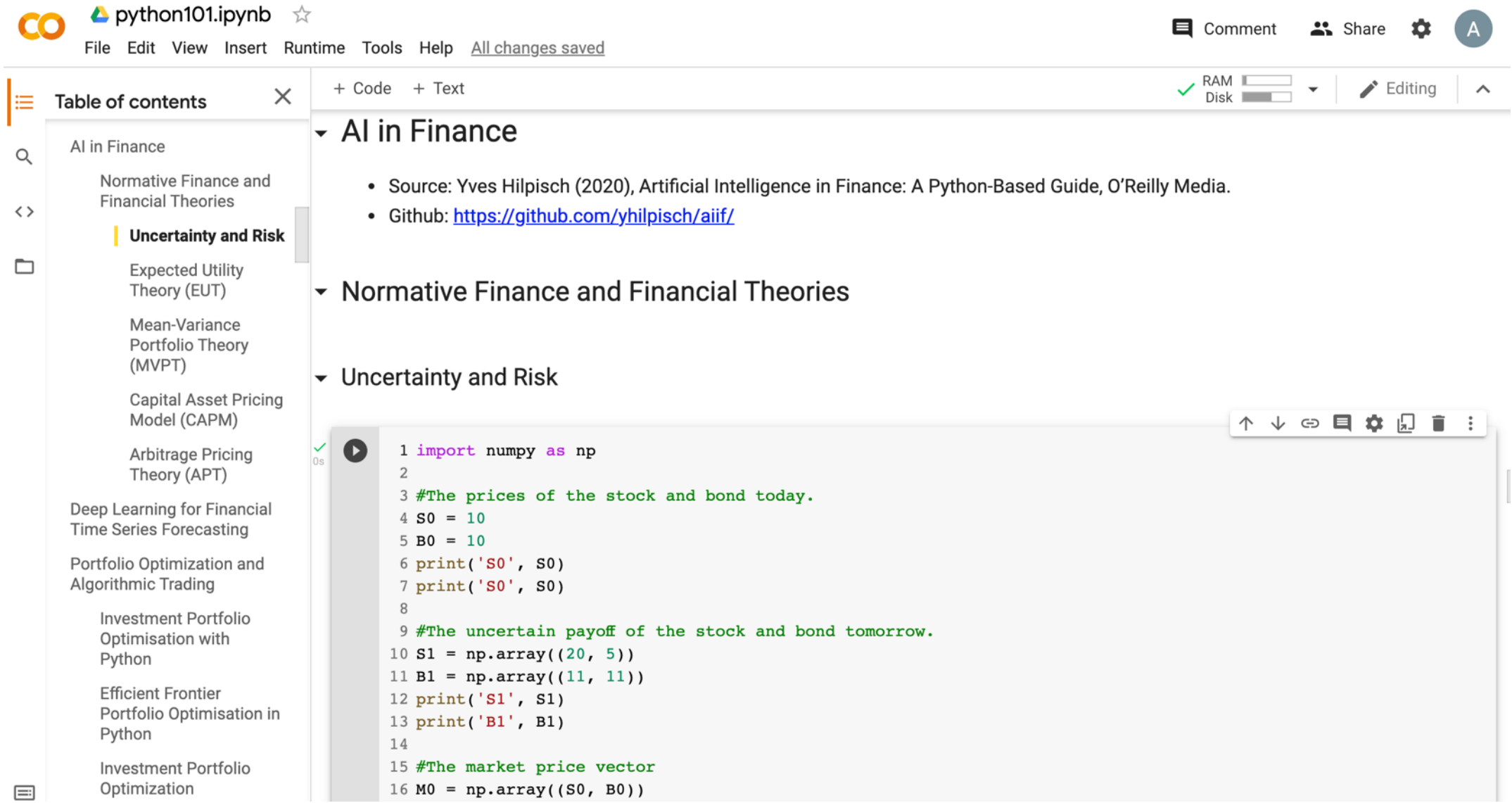
https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT



https://tinyurl.com/aintpupython101

Python in Google Colab (Python101)

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



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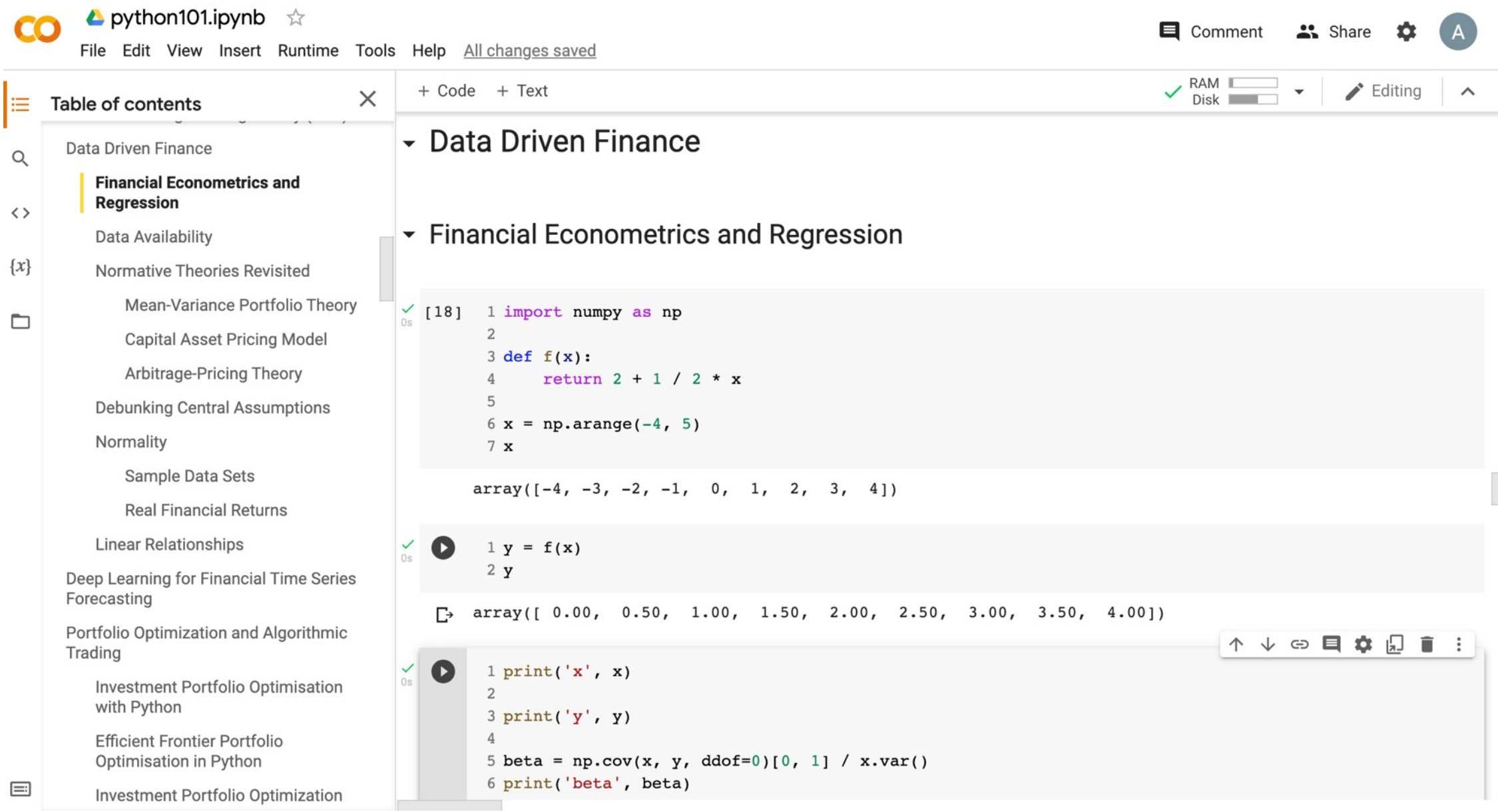

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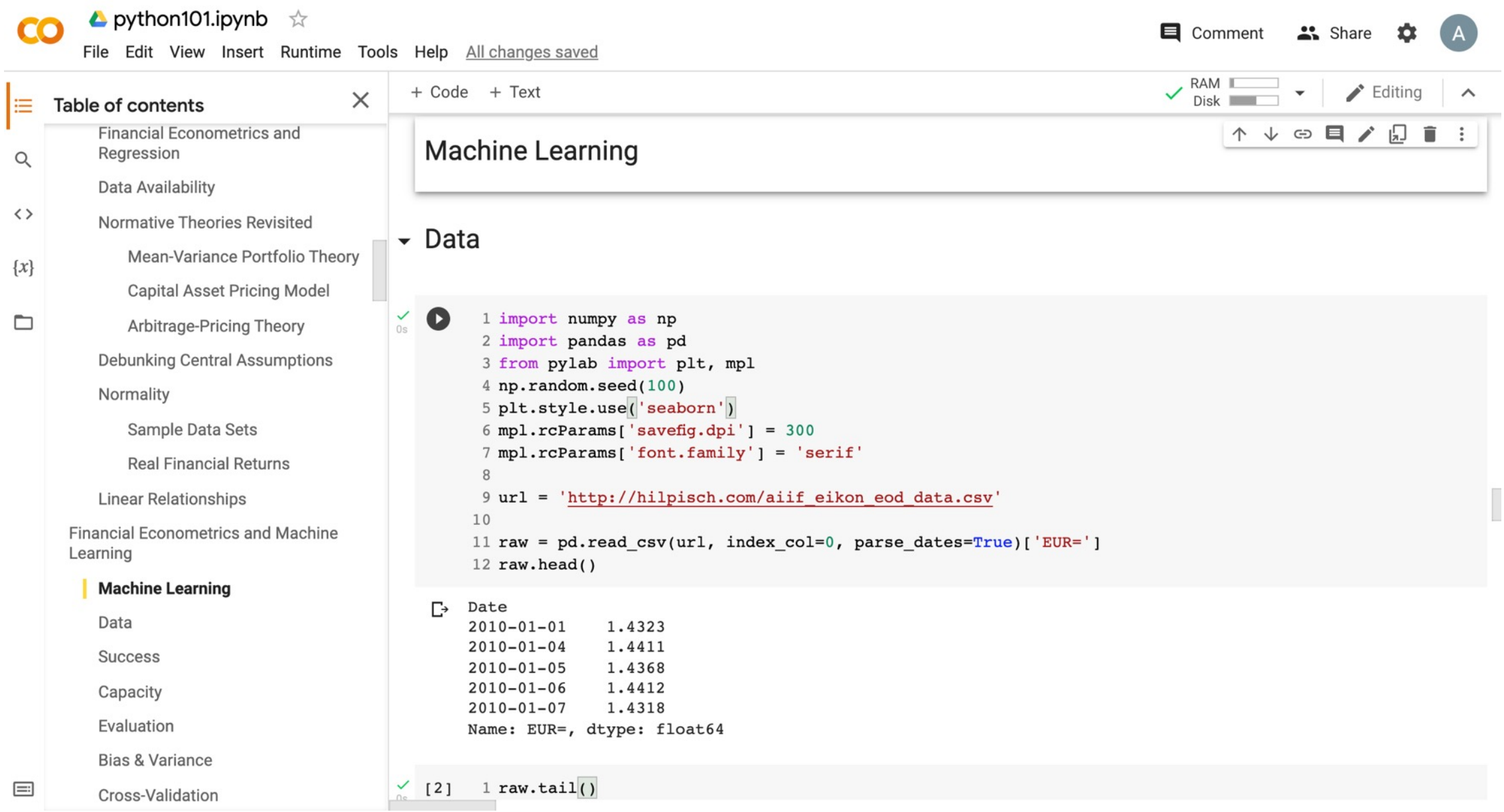

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Python in Google Colab (Python101)

python101.ipynb

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- Financial Econometrics and Machine Learning
- Machine Learning
- Data
- Success
- Capacity
- Evaluation
- Bias & Variance
- Cross-Validation
- AI-First Finance
- **Efficient Markets**
- Market Prediction Based on Returns Data
- Market Prediction With More Features
- Market Prediction Intraday

+ Code + Text RAM Disk Editing

Efficient Markets

```
1 import numpy as np
2 import pandas as pd
3 from pylab import plt, mpl
4 plt.style.use('seaborn')
5 mpl.rcParams['savefig.dpi'] = 300
6 mpl.rcParams['font.family'] = 'serif'
7 pd.set_option('precision', 4)
8 np.set_printoptions(suppress=True, precision=4)
9
10 url = 'http://hilpisch.com/aiif_eikon_eod_data.csv'
11 data = pd.read_csv(url, index_col=0, parse_dates=True).dropna()
12 (data / data.iloc[0]).plot(figsize=(10, 6), cmap='coolwarm')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f29f972f210>
```

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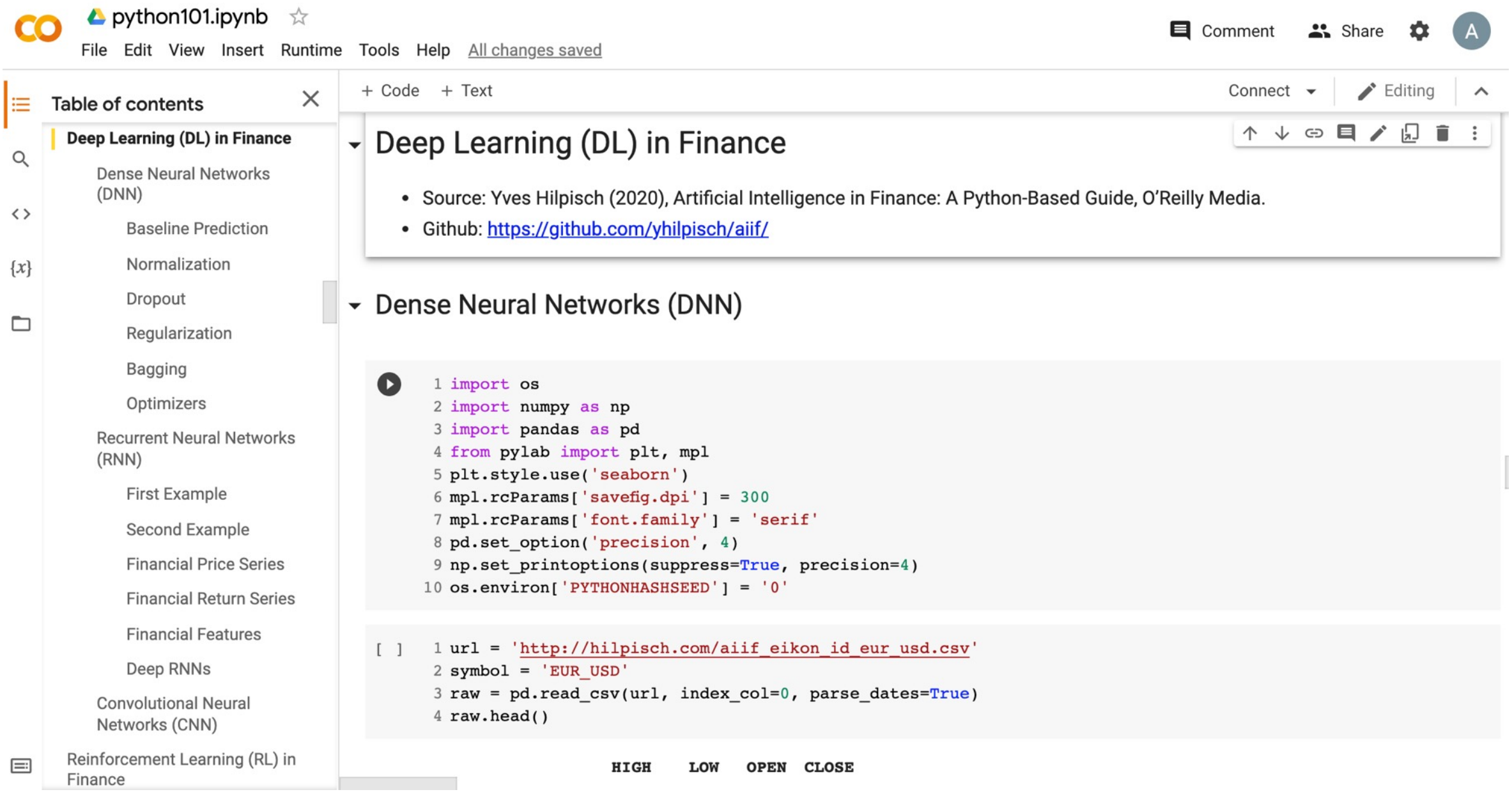

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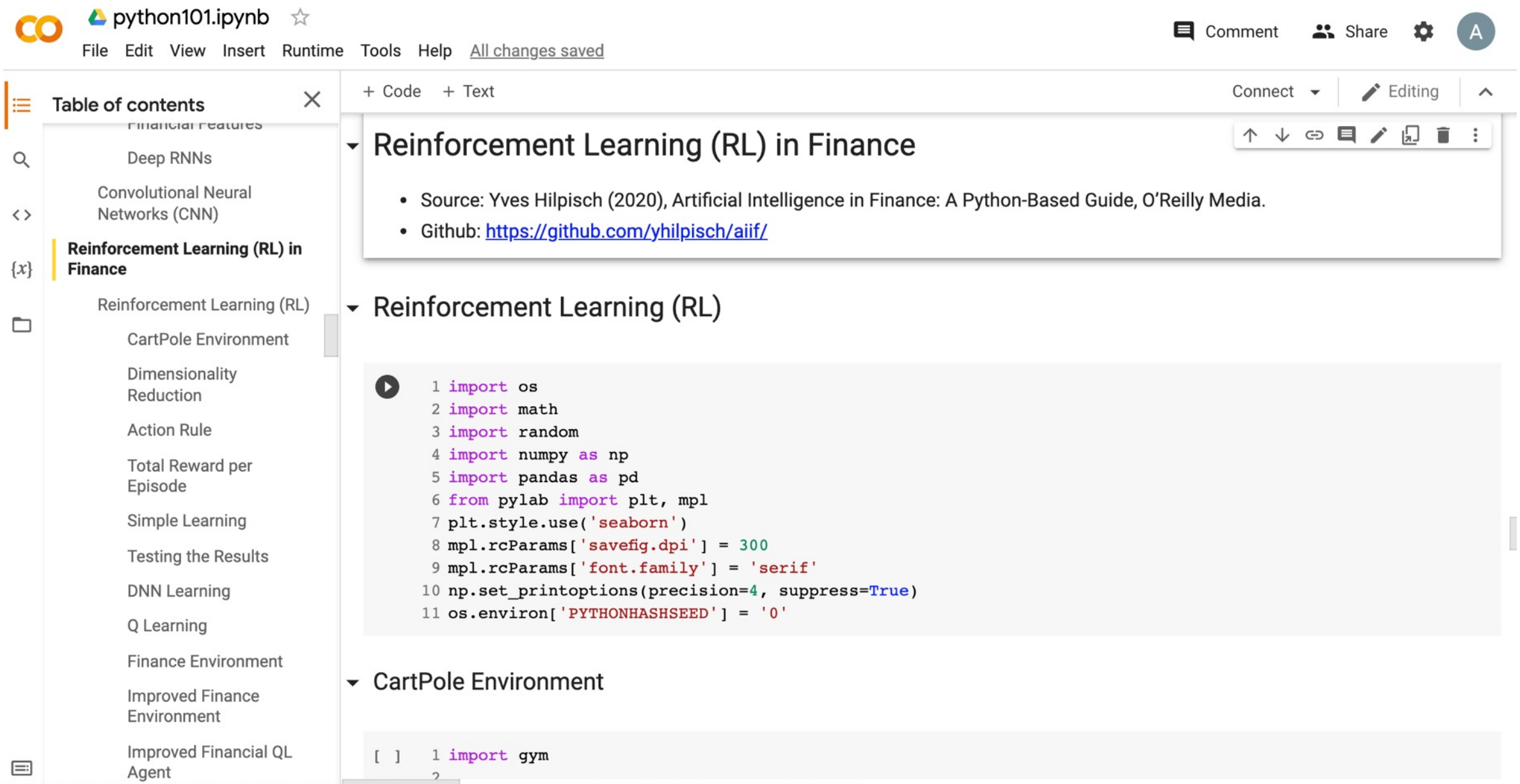

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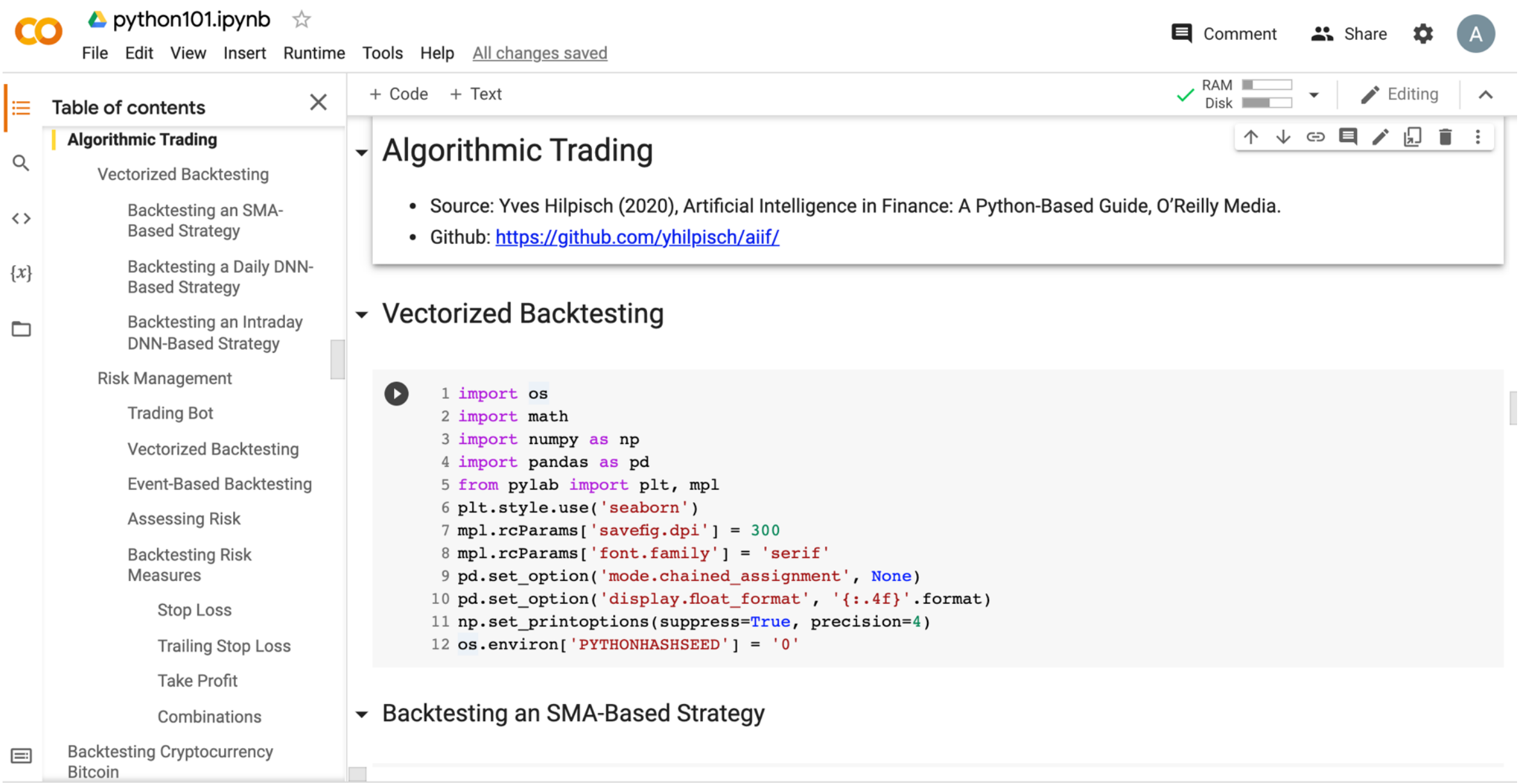

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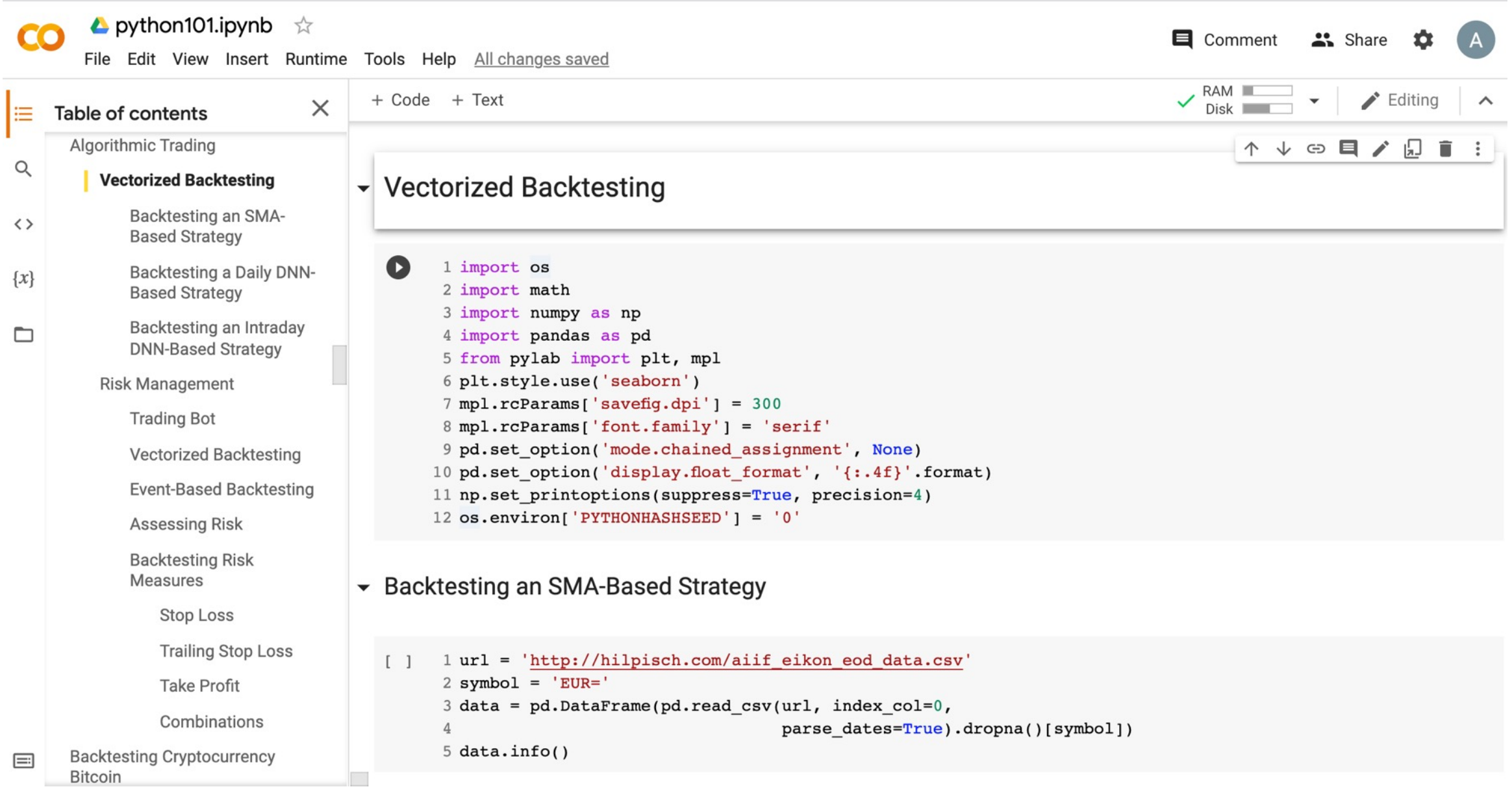

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Python in Google Colab (Python101)

python101.ipynb

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- Algorithmic Trading
- **Vectorized Backtesting**
  - Backtesting an SMA-Based Strategy
  - Backtesting a Daily DNN-Based Strategy
  - Backtesting an Intraday DNN-Based Strategy
- Risk Management
  - Trading Bot
  - Vectorized Backtesting
  - Event-Based Backtesting
  - Assessing Risk
  - Backtesting Risk Measures
    - Stop Loss
    - Trailing Stop Loss
    - Take Profit
    - Combinations
- Backtesting Cryptocurrency Bitcoin

+ Code + Text

RAM Disk Editing

```
[ ]  1 data['r'] = np.log(data[symbol] / data[symbol].shift(1))
     2 data.dropna(inplace=True)
     3 data['s'] = data['p'] * data['r']
     4 data[['r', 's']].sum().apply(np.exp)  # gross performance
     5 data[['r', 's']].sum().apply(np.exp) - 1  # net performance
     6 data[['r', 's']].cumsum().apply(np.exp).plot(figsize=(10, 6))
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fd9f404fed0>
```

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+ Code + Text

RAM Disk Editing

```
1 test['s_'] = np.where(test['p'].diff() != 0,
2                       test['s'] - pc, test['s'])
3 # test['s_'].iloc[0] -= pc
4 test['s_'].iloc[-1] -= pc
5 test[['r', 's', 's_']].sum().apply(np.exp)
6 test[['r', 's', 's_']].sum().apply(np.exp) - 1
7 test[['r', 's', 's_']].cumsum().apply(np.exp).plot(figsize=(10, 6))
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fd901d89910>
```

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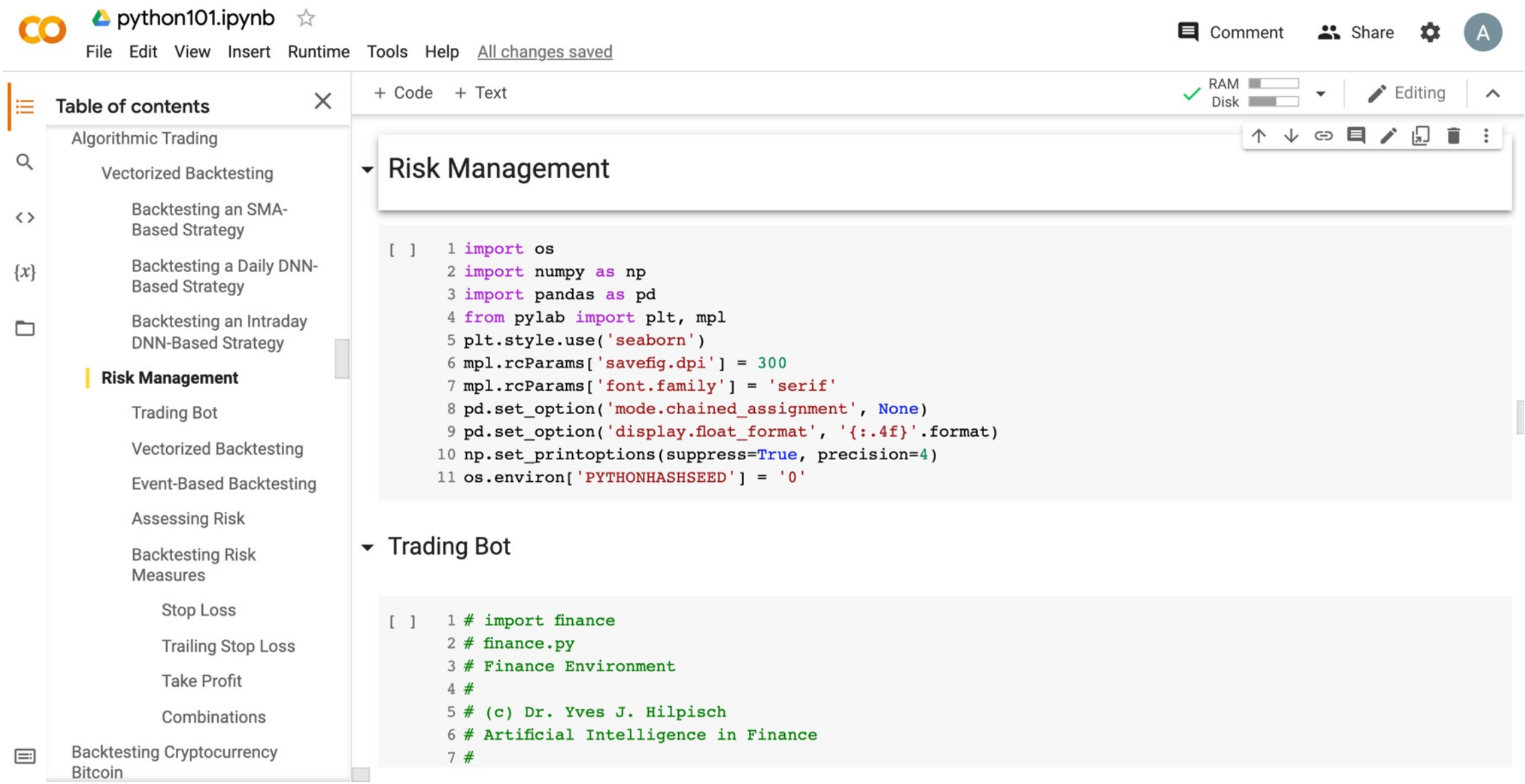

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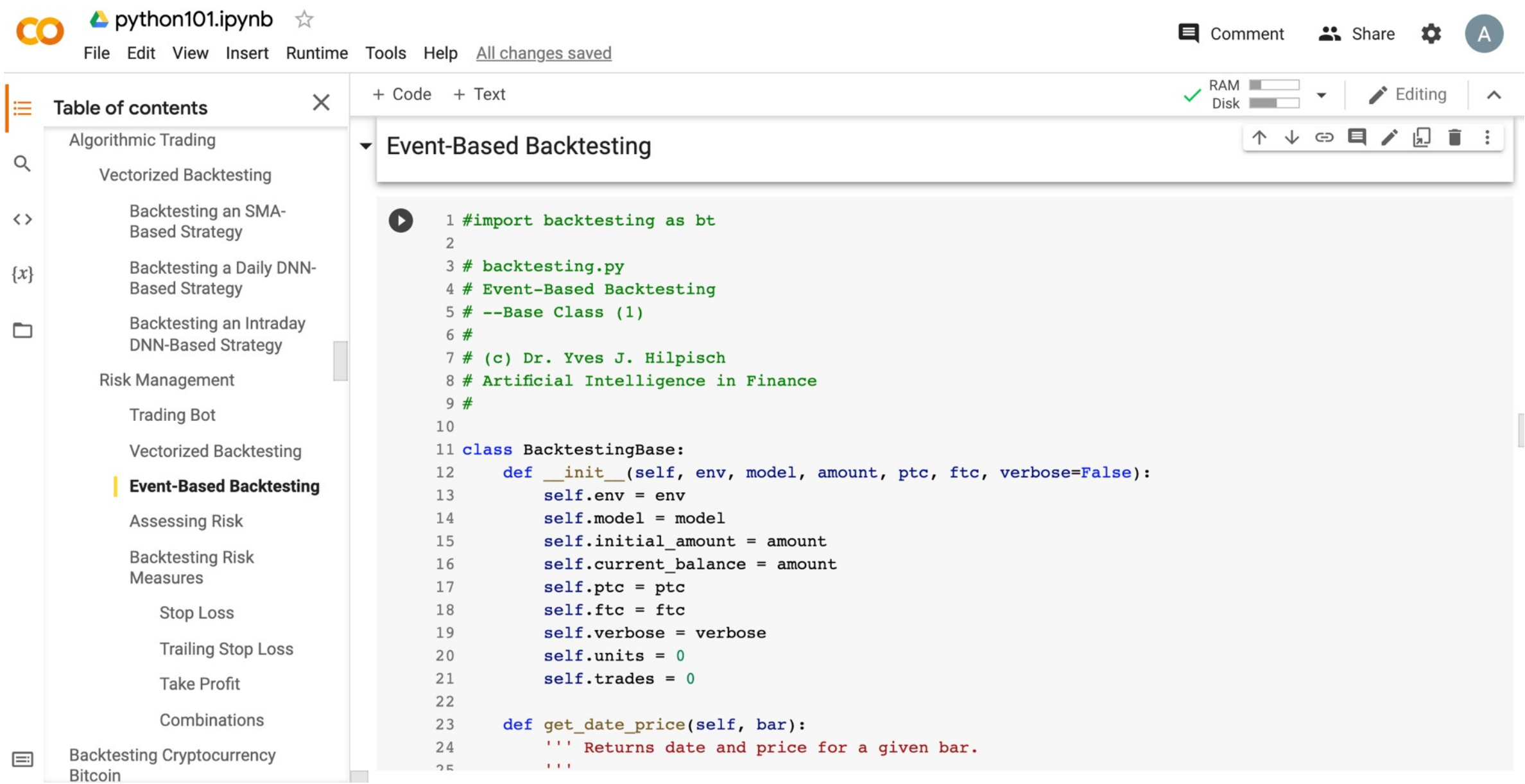

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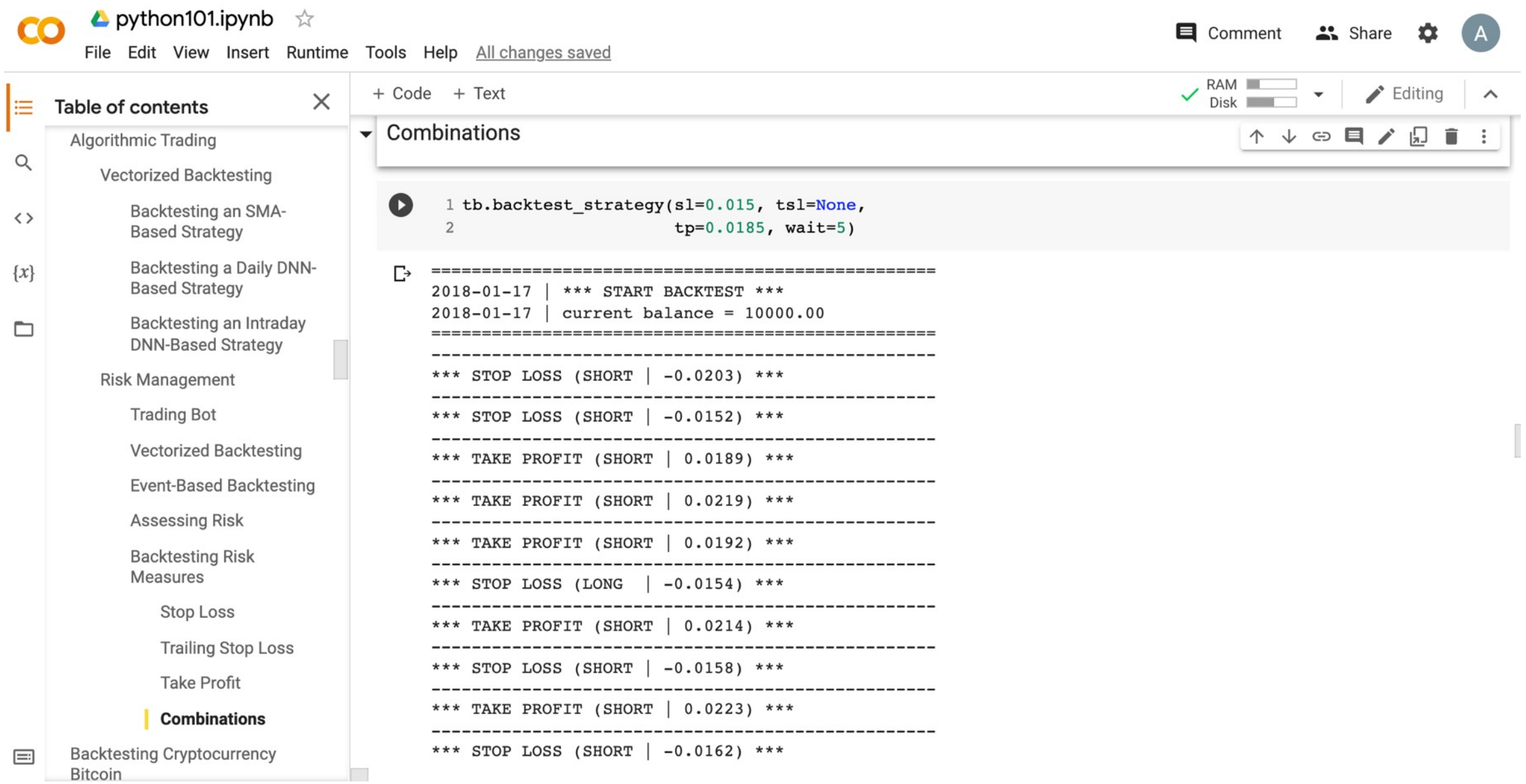

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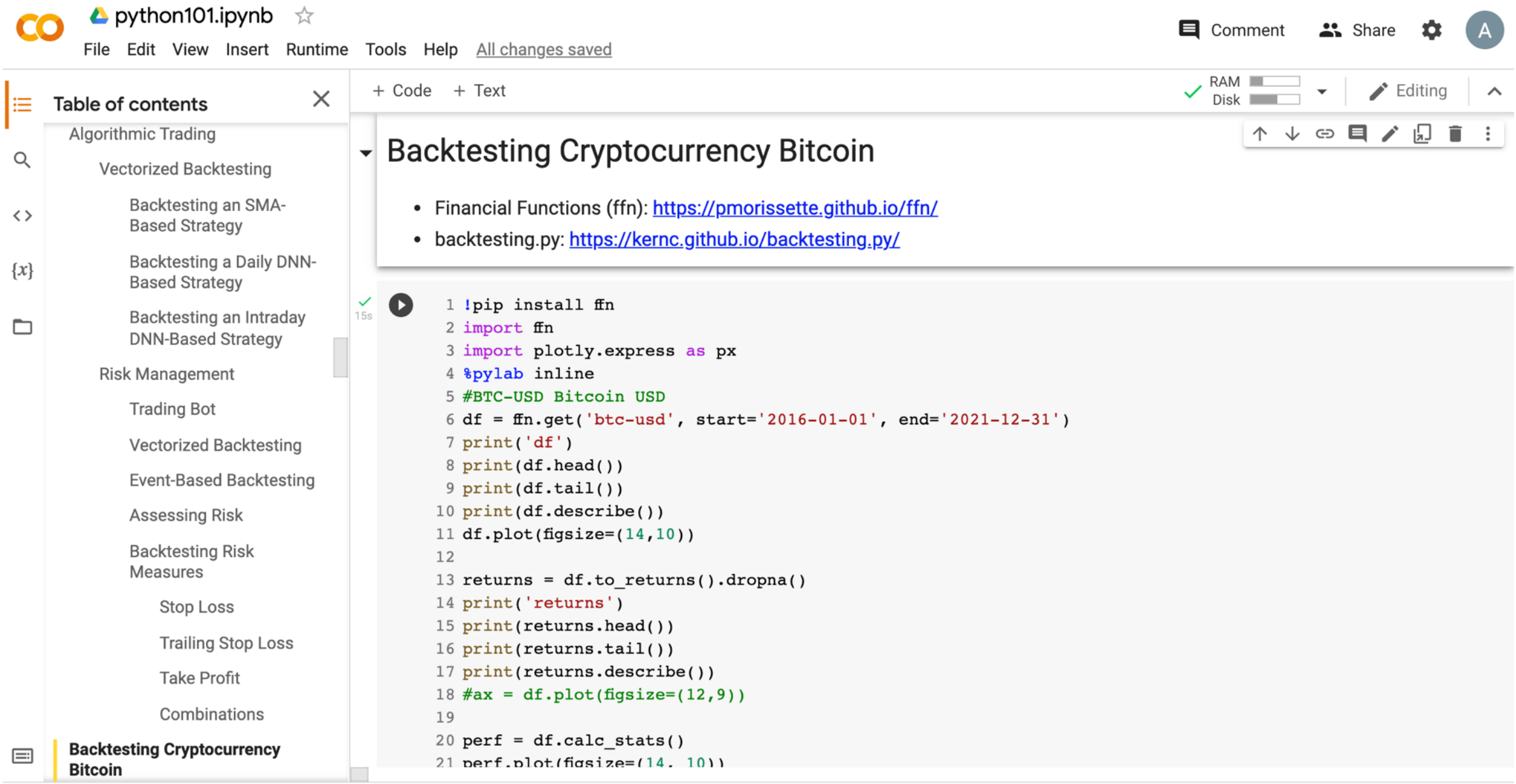

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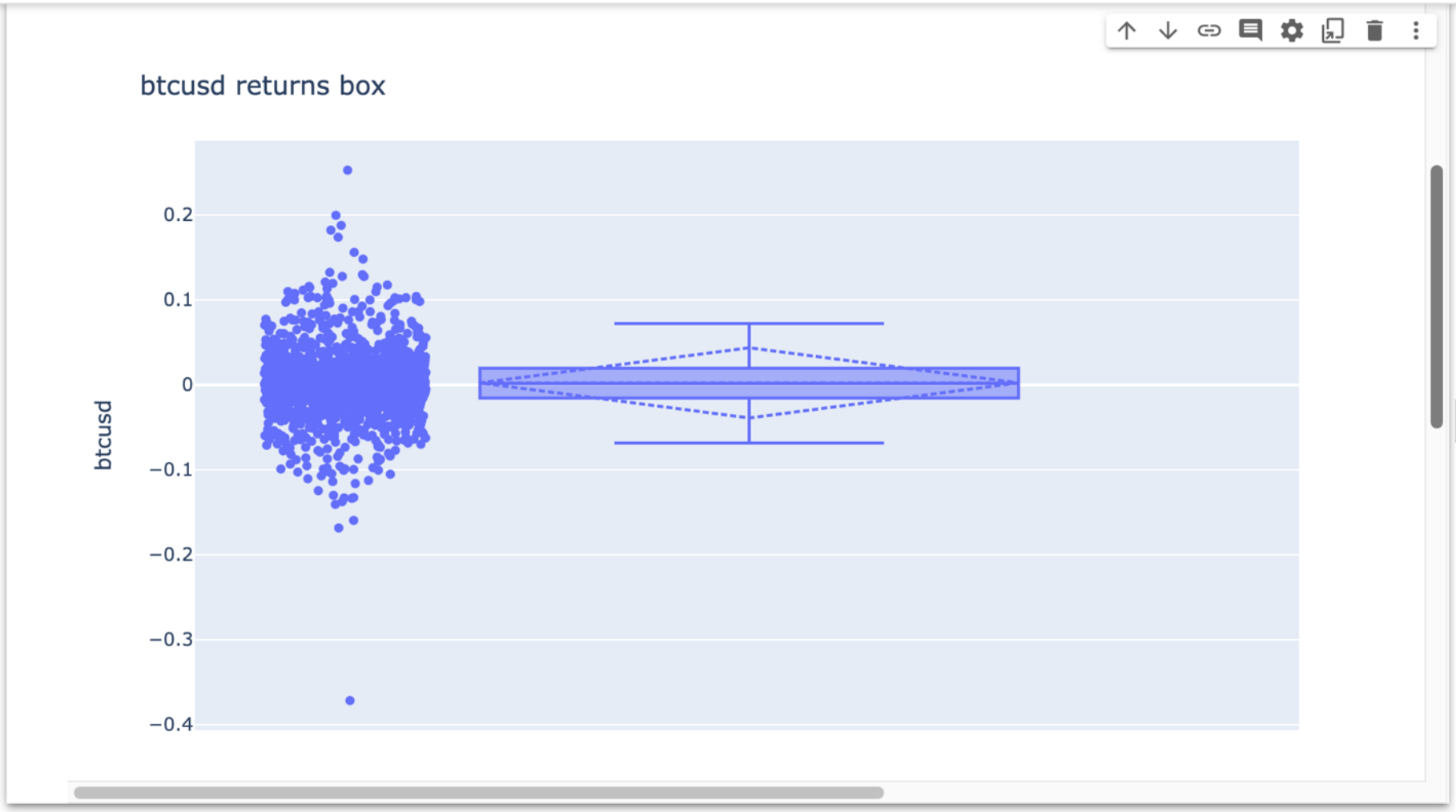

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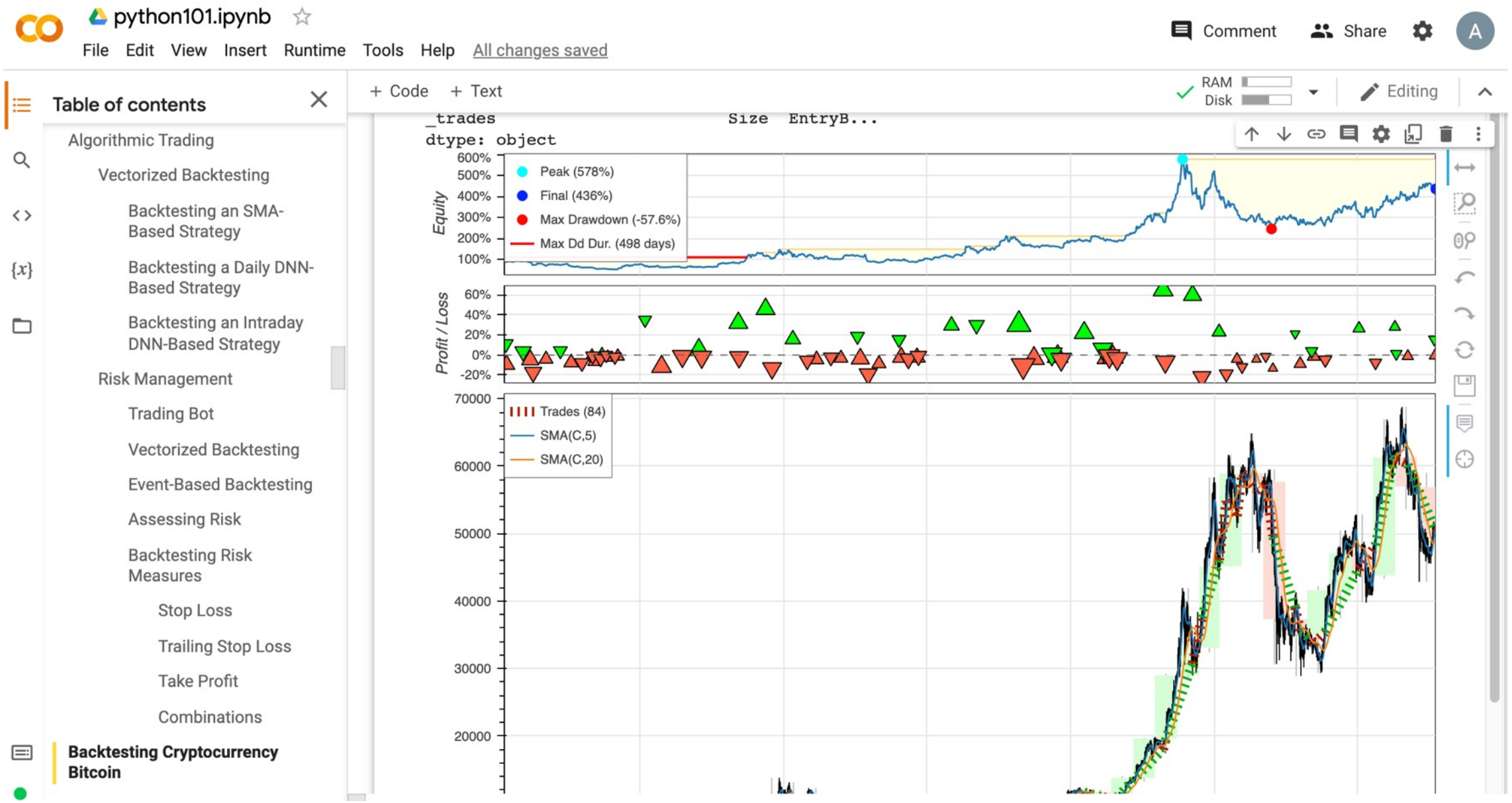

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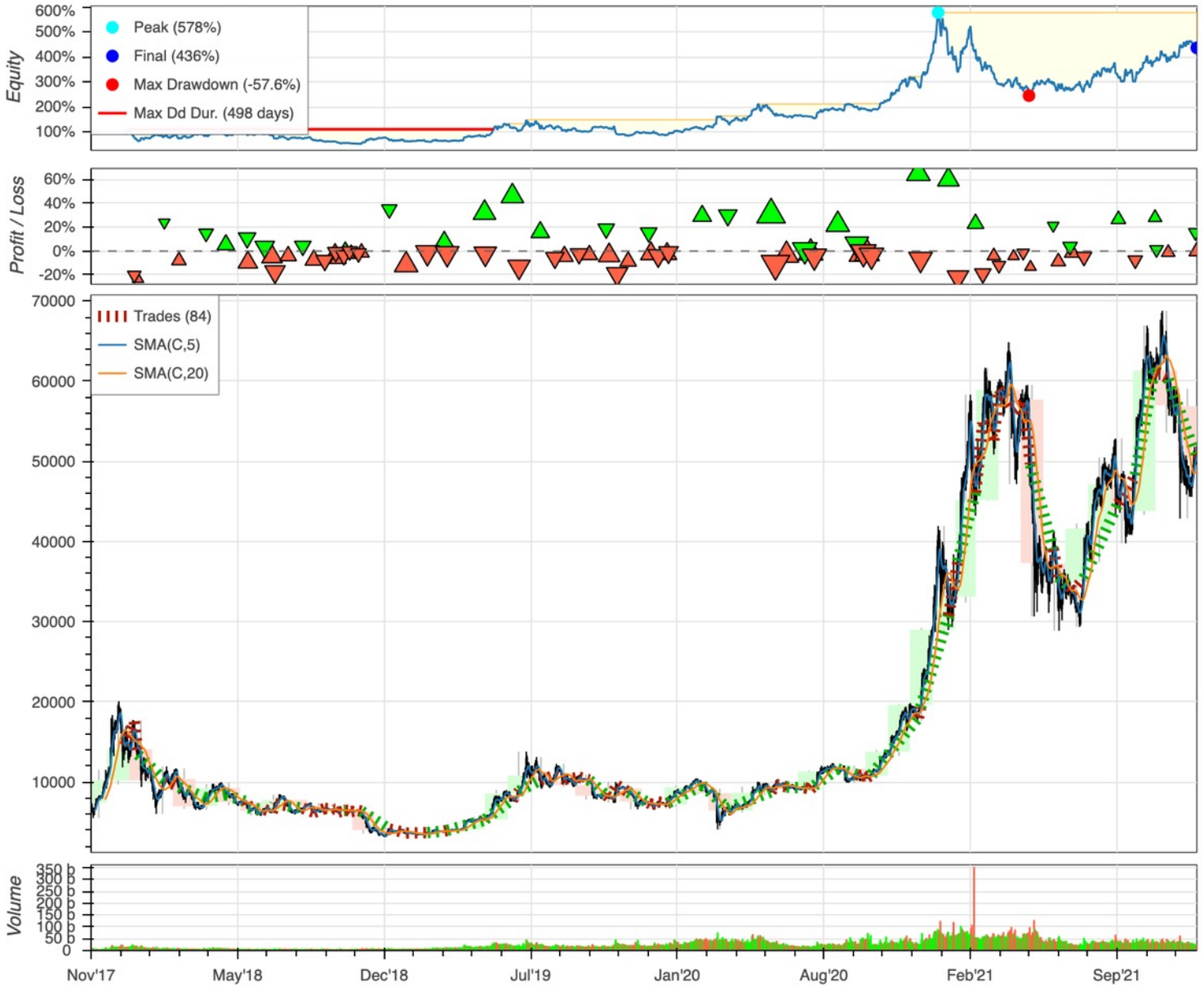

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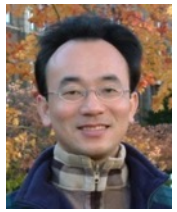
Teaching



- **Artificial Intelligence in Finance and Quantitative**
  - Fall 2021, Fall 2022, Fall 2023
- **Artificial Intelligence for Text Analytics**
  - Spring 2022, Fall 2023
- **Big Data Analytics**
  - Fall 2020, Spring 2023
- **Software Engineering**
  - Fall 2020, Fall, 2021, Spring 2022, Spring 2023
- **Artificial Intelligence**
  - Spring 2021, Fall 2022
- **Data Mining**
  - **Spring 2021**
- **Foundation of Business Cloud Computing**
  - Spring 2021, Spring 2022, Spring 2023
- **Python for Accounting Applications**
  - Fall 2023

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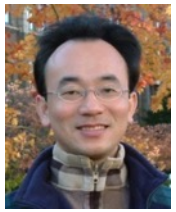
Research Projects



1. **Applying AI technology to construct knowledge graphs of cryptocurrency anti-money laundering: a few-shot learning model**
   - MOST, 110-2410-H-305-013-MY2, 2021/08/01~2023/07/31
2. **Fintech Green Finance for Carbon Market Index, Corporate Finance, and Environmental Policies.** Carbon Emission Sentiment Index with AI Text Analytics
   - NTPU, 112-NTPU_ORDA-F-003，2023/01/01~2024/12/31
3. **Digital Support, Unimpeded Communication: The Development, Support and Promotion of AI-assisted Communication Assistive Devices for Speech Impairment.** Multimodal Cross-lingual Task-Oriented Dialogue System for Inclusive Communication Support
   - NSTC 112-2425-H-305-002-, 2023/05/01-2026/04/30
4. **Establishment and Implement of Smart Assistive Technology for Dementia Care and Its Socio-Economic Impacts.** Intelligent, individualized and precise care with smart AT and system integration
   - NSTC, NSTC, 112-2627-M-038-001-, 2023/08/01~2024/07/31
5. **Use deep learning to identify commercially dental implant systems - observational study**
   - USTP-NTPU-TMU, USTP-NTPU-TMU-112-01, 2023/01/01~2023/12/31
6. **Metaverse AI Multimodal Cross-Language Task-Oriented Dialogue System**
   - ATEC Group x NTPU, NTPU-112A413E01, 2023/05/01~2026/04/30
7. **Metaverse Avatar Automatic Metadata Generation Module**
   - FormosaVerse x NTPU, NTPU-111A413E01, 2022/12/01~2023/11/30
8. **Pilot Study on Universal Data Processing for Code Generation Engine**
   - III x NTPU, NTPU-112A513E01, 2023/08/01~2023/12/22

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, Financial Services Innovation and Applications,
  3. Investing Psychology and Behavioral Finance
  4. Event Studies in Finance
  5. Finance Theory
  6. Data-Driven Finance
  7. Financial Econometrics
  8. AI-First Finance
  9. Deep Learning in Finance
  10. Reinforcement Learning in Finance
  11. Algorithmic Trading, Risk Management, Trading Bot and Event-Based Backtesting
  12. Case Study on AI in Finance and Quantitative Analysis.

AI in Finance and Quantitative Analysis

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