Artificial Intelligence in Finance and Quantitative Analysis

AI in FinTech: Metaverse, Web3, DeFi, NFT, Financial Services Innovation and Applications

1111AIFQA02
MBA, IM, NTPU (M6132) (Fall 2022)
Tue 2, 3, 4 (9:10-12:00) (B8F40)

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

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Associate Professor

Institute of Information Management, National Taipei University

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

2022-09-20

Syllabus

Week	Date	Subject/Topics
1	2022/09/13	Introduction to Artificial Intelligence in Finance and Quantitative Analysis
2	2022/09/20	AI in FinTech: Metaverse, Web3, DeFi, NFT, Financial Services Innovation and Applications
3	2022/09/27	Investing Psychology and Behavioral Finance
4	2022/10/04	Event Studies in Finance
5	2022/10/11	Case Study on AI in Finance and Quantitative Analysis I
6	2022/10/18	Finance Theory

Syllabus

Week	Date	Subject/Topics
7	2022/10/25	Data-Driven Finance
8	2022/11/01	Midterm Project Report
9	2022/11/08	Financial Econometrics
10	2022/11/15	AI-First Finance
11	2022/11/22	Industry Practices of AI in Finance and Quantitative Analysis
12	2022/11/29	Case Study on AI in Finance and Quantitative Analysis II

Syllabus

Week	Date	Subject/Topics
13	2022/12/06	Deep Learning in Finance; Reinforcement Learning in Finance
14	2022/12/13	Algorithmic Trading; Risk Management; Trading Bot and Event-Based Backtesting
15	2022/12/20	Final Project Report I
16	2022/12/27	Final Project Report II
17	2023/01/03	Self-learning
18	2023/01/10	Self-learning

AI in FinTech: Metaverse, Web3, DeFi, NFT, Financial Services Innovation and Applications

FinTech ABCD

AI

Block Chain

Cloud Computing

Big **D**ata

Decentralized Finance (DeFi)

Block Chain Financial Technology

Block Chain & Bitcoin (BTC)

Smart Contract & Ethereum (ETH)

Decentralized Application (DApp)

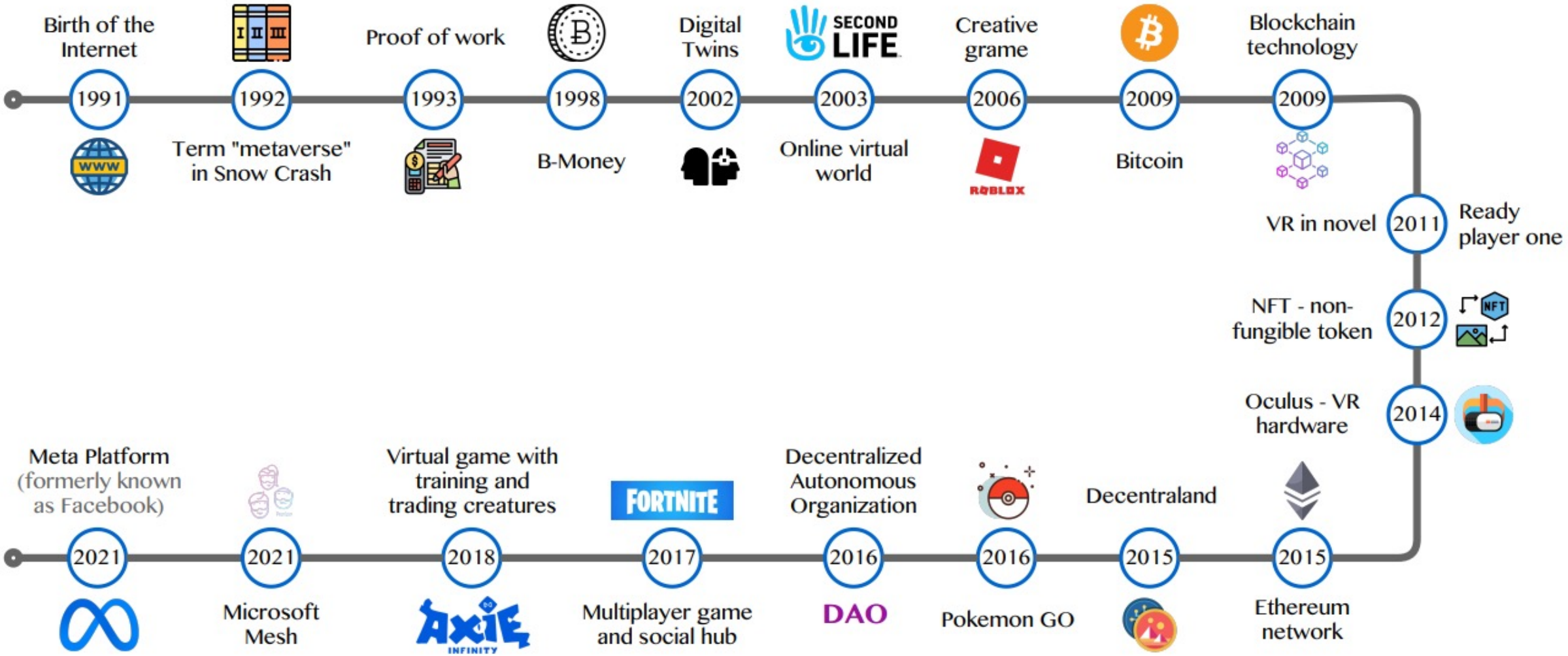
Metaverse

Web3

DeFi

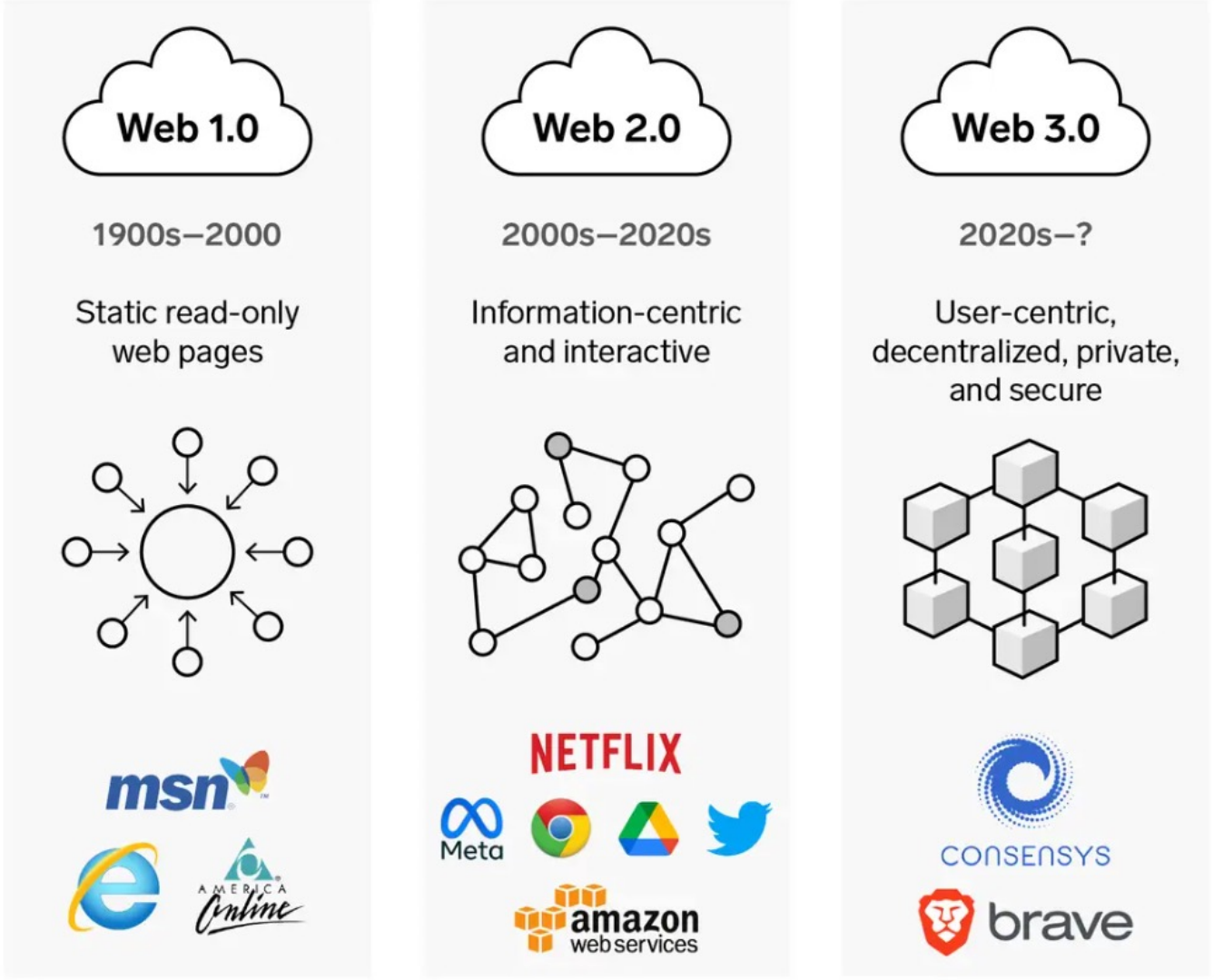
NFT

Metaverse Development from 1991 to 2021



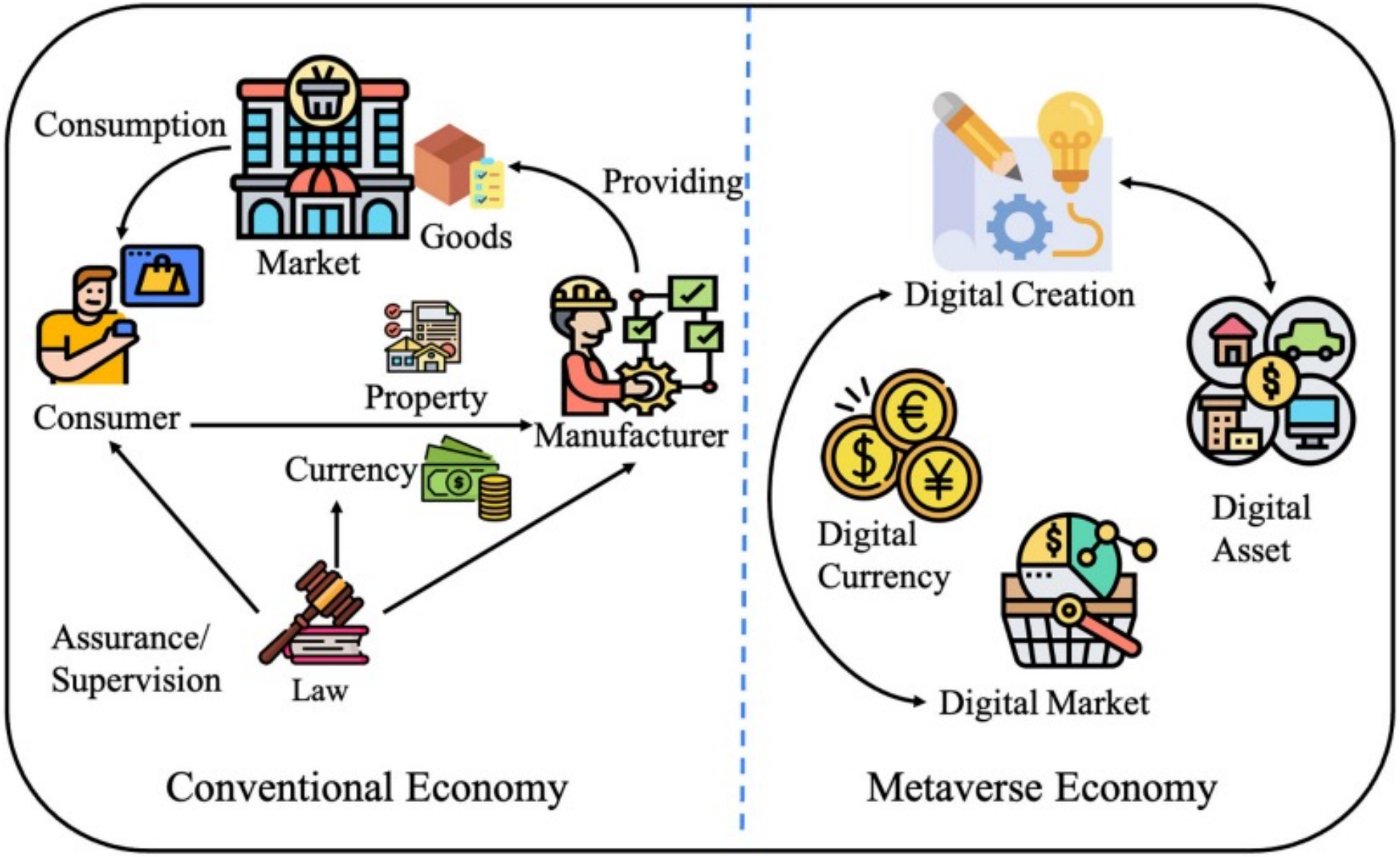
Source: Huynh-The, Thien, Quoc-Viet Pham, Xuan-Qui Pham, Thanh Thi Nguyen, Zhu Han, and Dong-Seong Kim (2022). "Artificial Intelligence for the Metaverse: A Survey." arXiv preprint arXiv:2202.10336.

Web3: Decentralized Web Internet Evolution



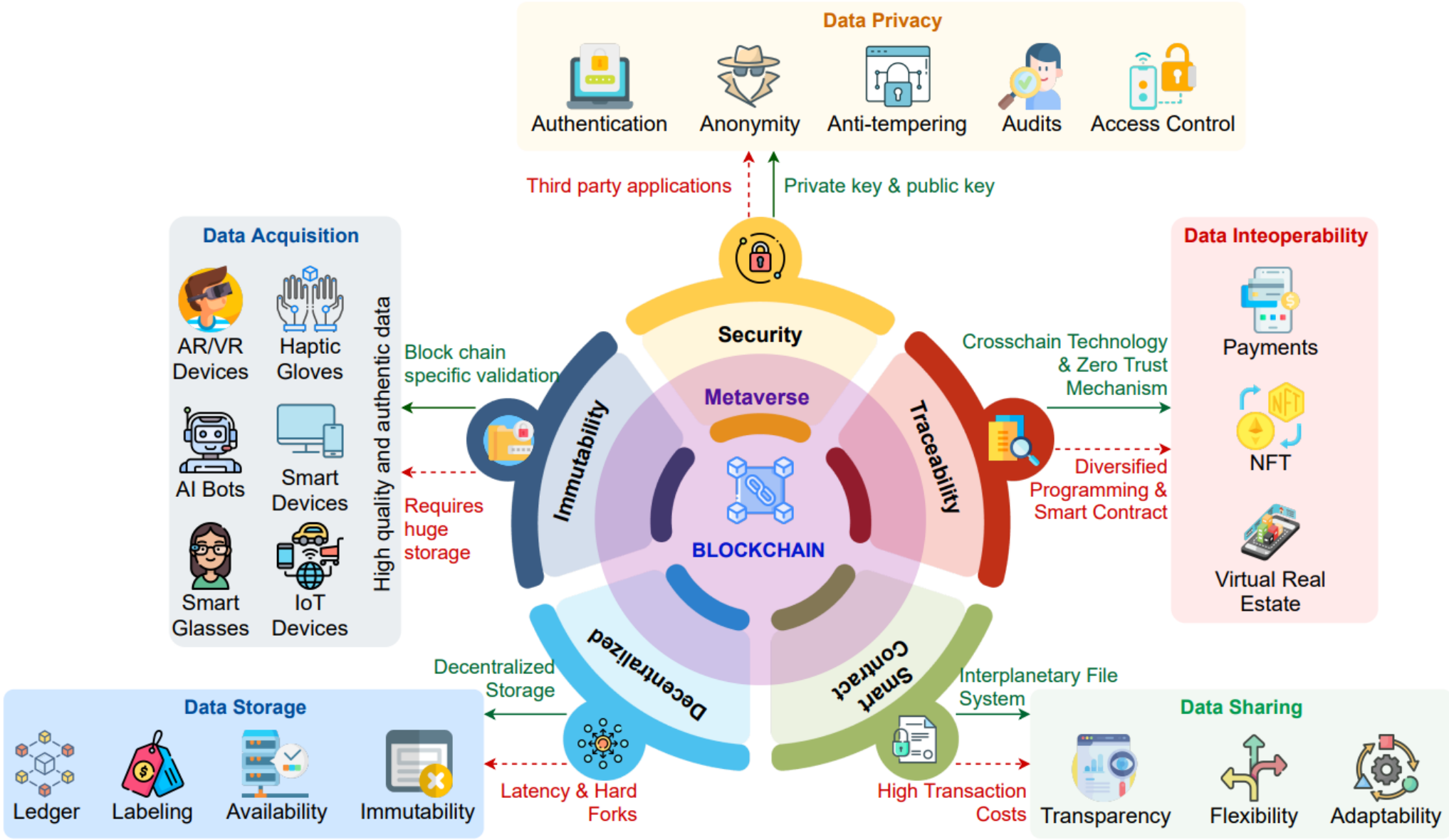
Source: https://www.businessinsider.com/personal-finance/what-is-web3

Metaverse Economy



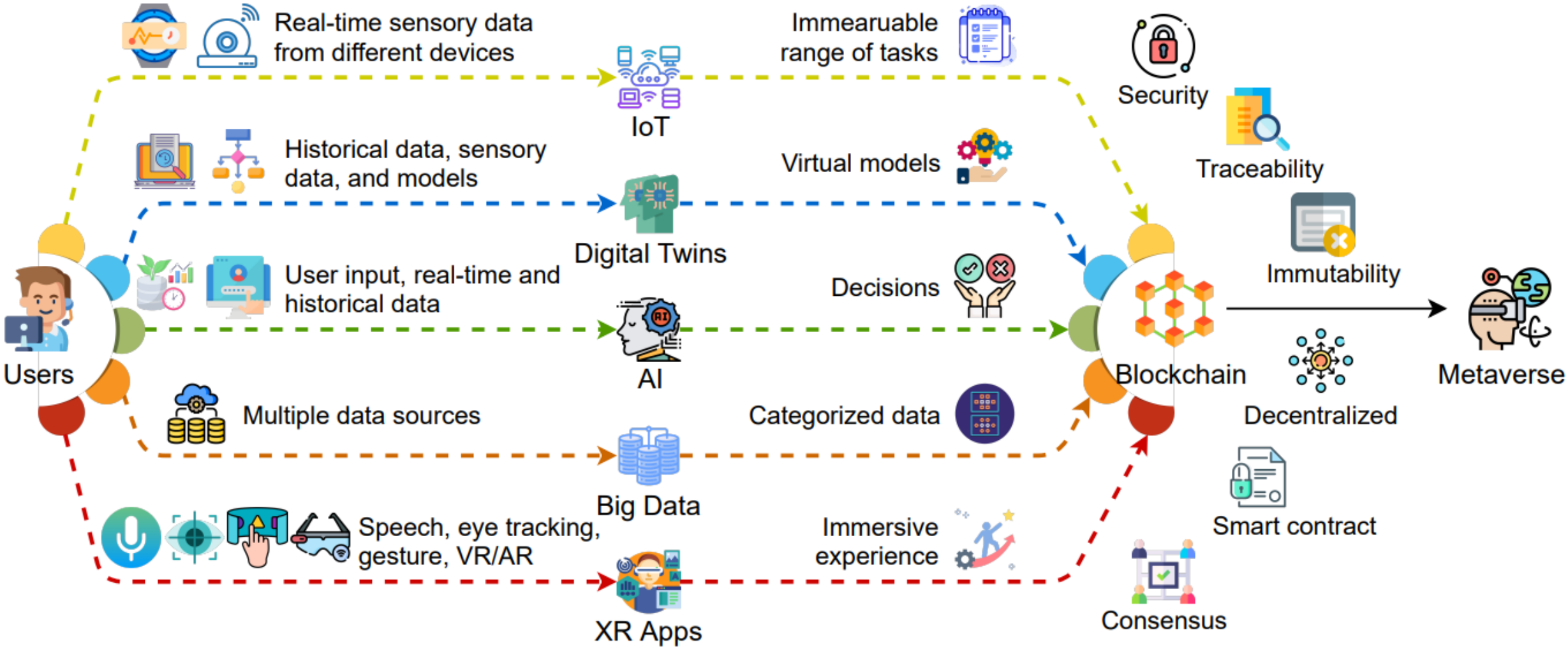
Source: Yang, Qinglin, Yetong Zhao, Huawei Huang, Zehui Xiong, Jiawen Kang, and Zibin Zheng (2022). "Fusing blockchain and AI with metaverse: A survey." IEEE Open Journal of the Computer Society 3 : 122-136.

Blockchain in the Metaverse



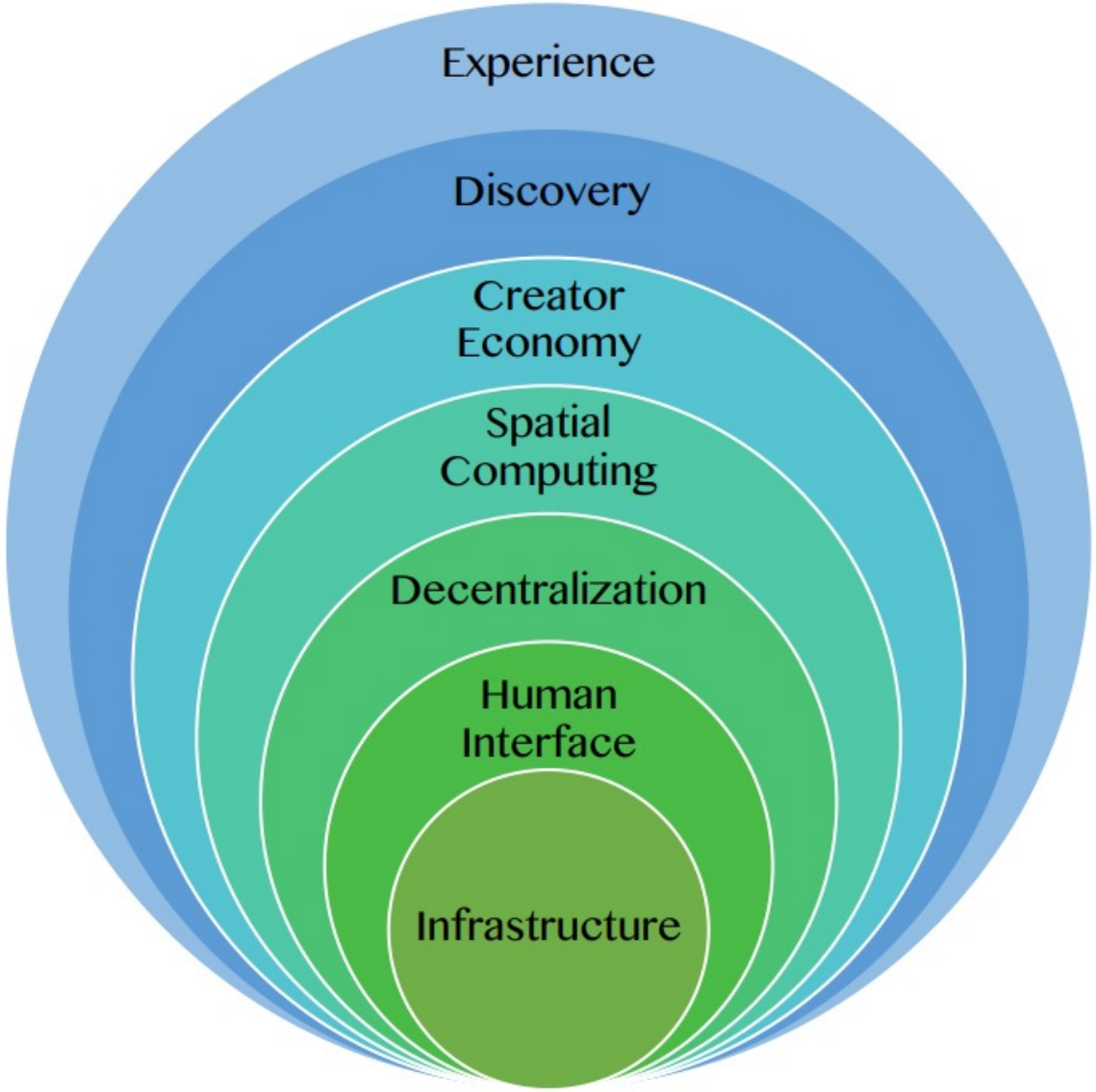
Source: Gadekallu, Thippa Reddy, Thien Huynh-The, Weizheng Wang, Gokul Yenduri, Pasika Ranaweera, Quoc-Viet Pham, Daniel Benevides da Costa, and Madhusanka Liyanage (2022). "Blockchain for the Metaverse: A Review." arXiv preprint arXiv:2203.09738..

Blockchain for Key Enabling Technologies of the Metaverse



Source: Gadekallu, Thippa Reddy, Thien Huynh-The, Weizheng Wang, Gokul Yenduri, Pasika Ranaweera, Quoc-Viet Pham, Daniel Benevides da Costa, and Madhusanka Liyanage (2022). "Blockchain for the Metaverse: A Review." arXiv preprint arXiv:2203.09738..

Seven Layers of a Metaverse Platform



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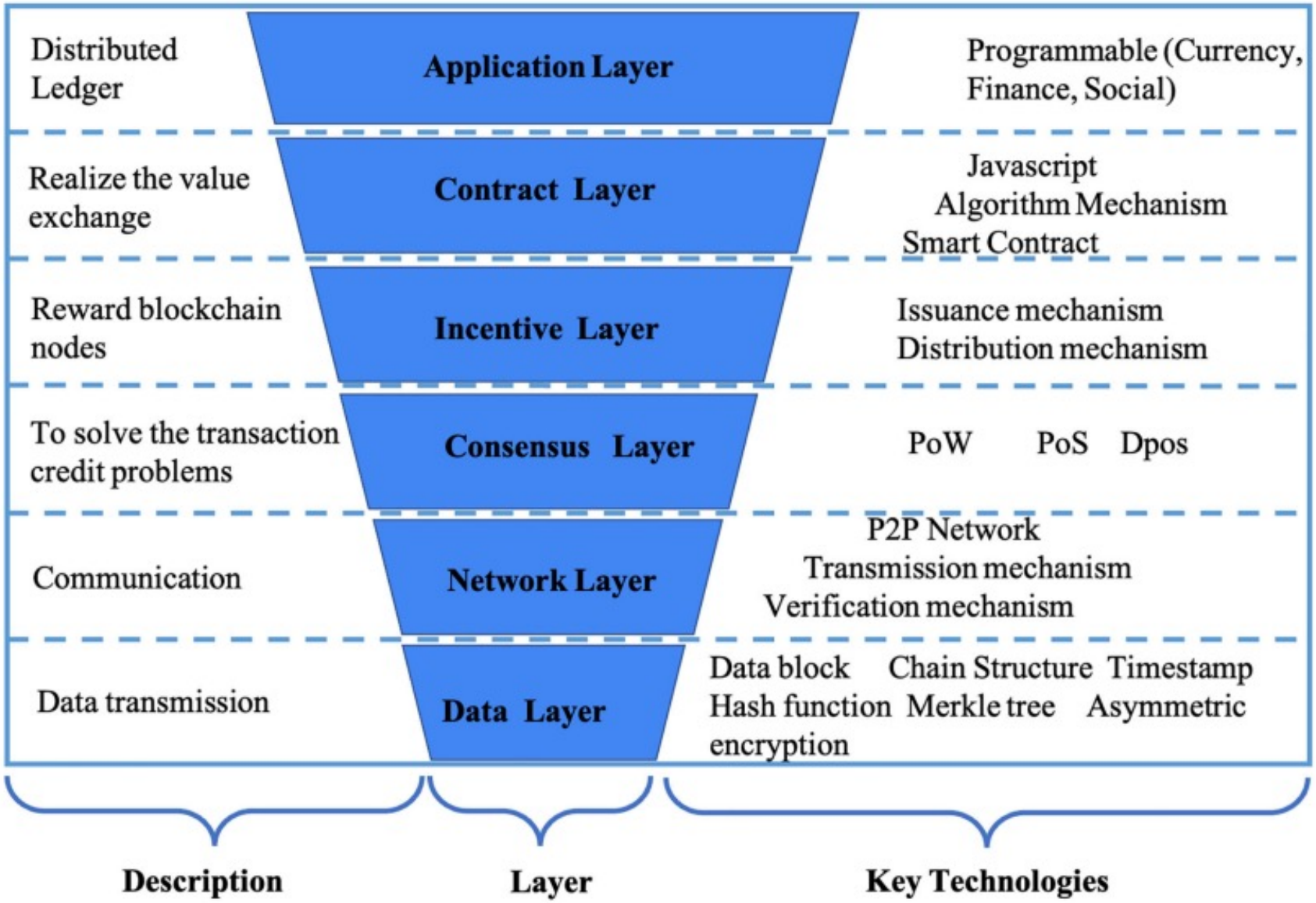
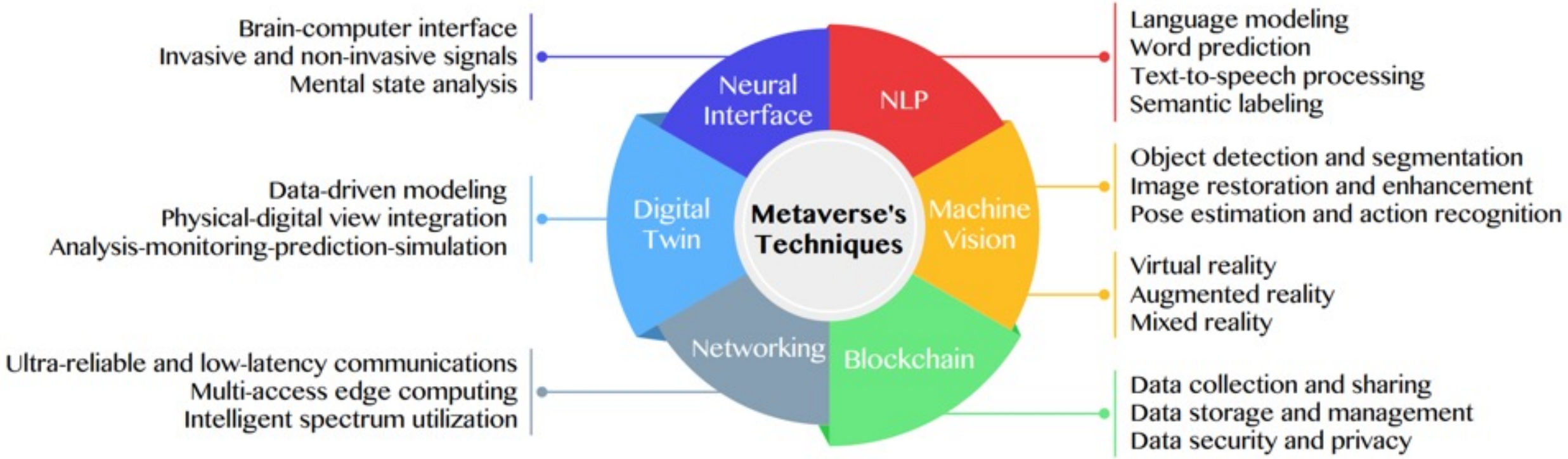
Layered Architecture of Blockchain



Source: Yang, Qinglin, Yetong Zhao, Huawei Huang, Zehui Xiong, Jiawen Kang, and Zibin Zheng (2022). "Fusing blockchain and AI with metaverse: A survey." IEEE Open Journal of the Computer Society 3 : 122-136.

Primary Technical Aspects in the Metaverse

AI with ML algorithms and DL architectures is advancing the user experience in the virtual world



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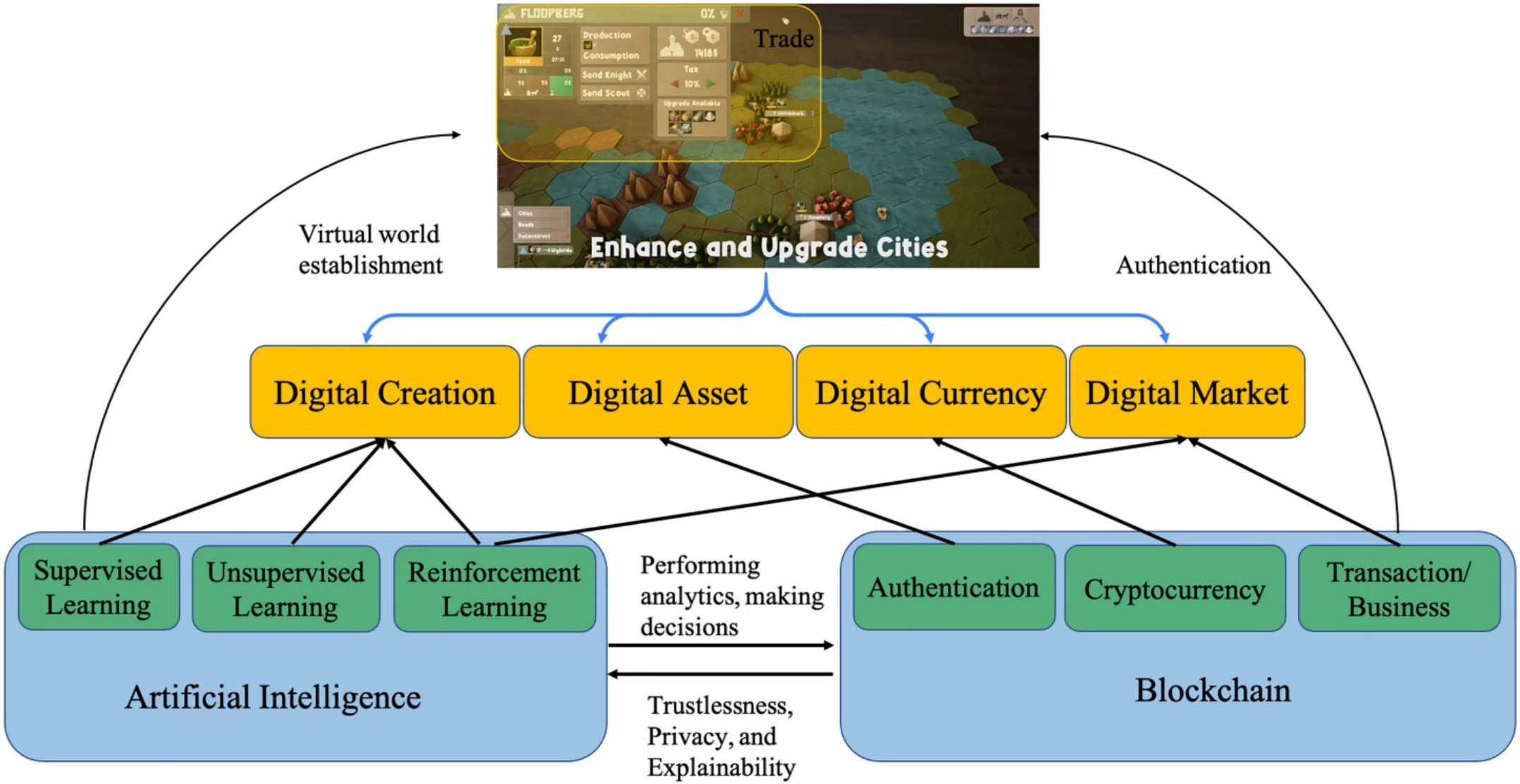
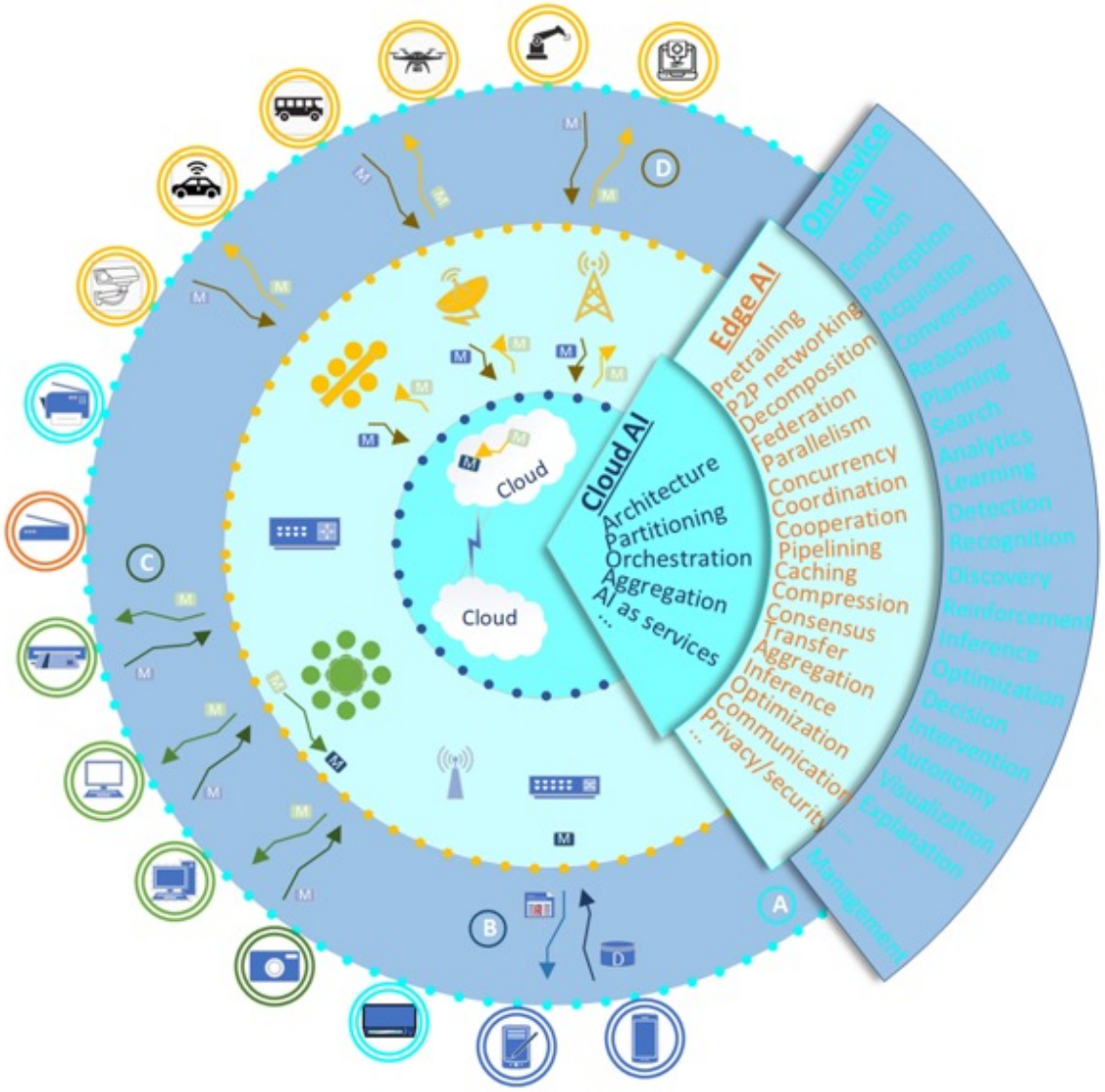
Fusion of AI and Blockchain in Metaverse



Source: Yang, Qinglin, Yetong Zhao, Huawei Huang, Zehui Xiong, Jiawen Kang, and Zibin Zheng (2022). "Fusing blockchain and AI with metaverse: A survey." IEEE Open Journal of the Computer Society 3 : 122-136.

DeAI:

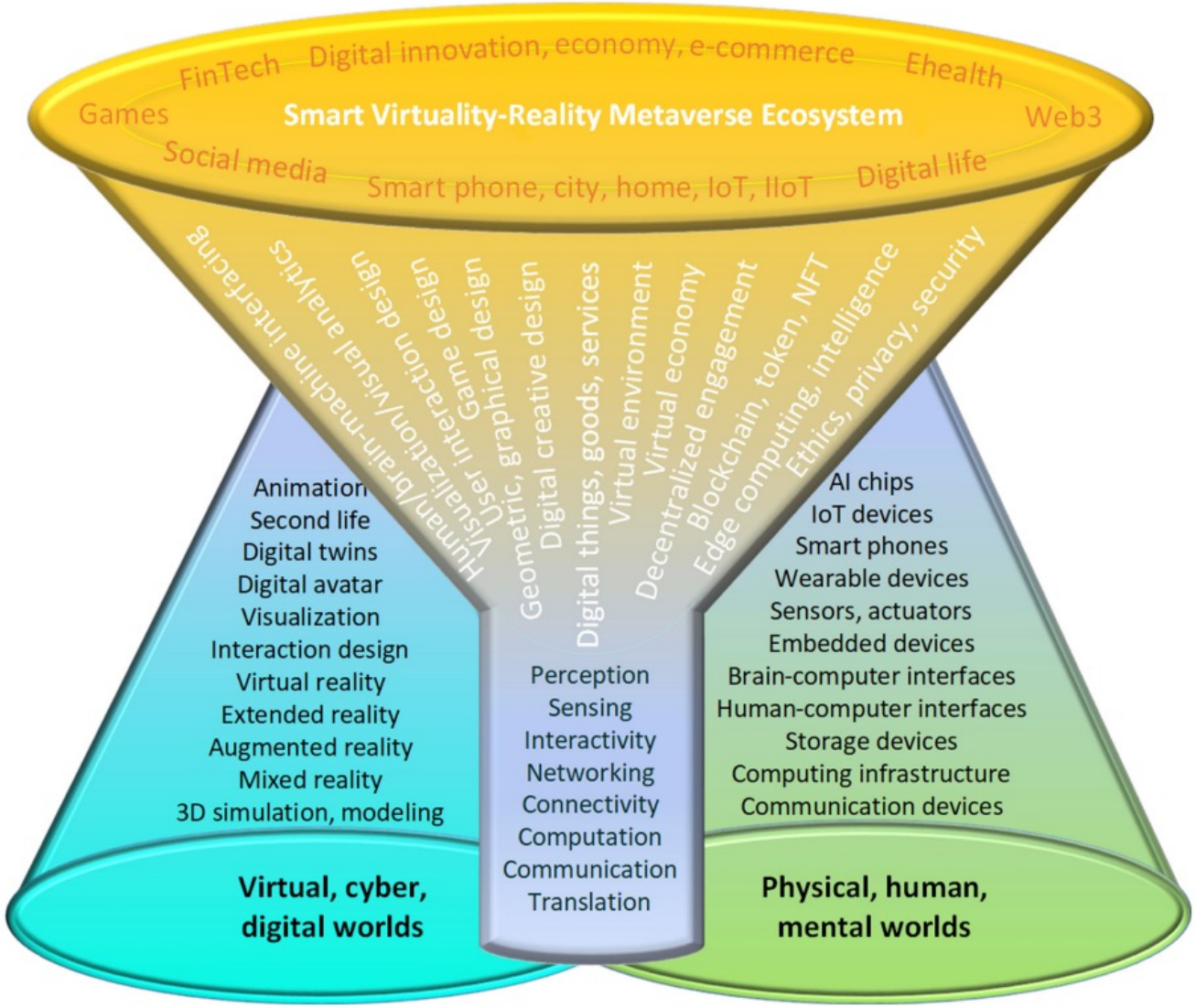
Synthesizing On-device AI, Edge AI, and Cloud AI



Source: Cao, Longbing (2022). "Decentralized ai: Edge intelligence and smart blockchain, metaverse, web3, and desci." IEEE Intelligent Systems 37, no. 3: 6-19.

Smart Virtuality-Reality Metaverse Ecosystem:

Metasynthesizing DeAI, Metaverse, Blockchain, Web3



Source: Cao, Longbing (2022). "Decentralized ai: Edge intelligence and smart blockchain, metaverse, web3, and desci." IEEE Intelligent Systems 37, no. 3: 6-19.

The difference between AR, MR, and VR under the umbrella of XR

XR

Extended Reality

Entire experience spectrum from fully virtual to fully real

VR

Virtual Reality

User is completely immersed into a virtual world

MR

Mixed Reality

Environment aware 2D/3D content is overlaid onto the physical space

AR

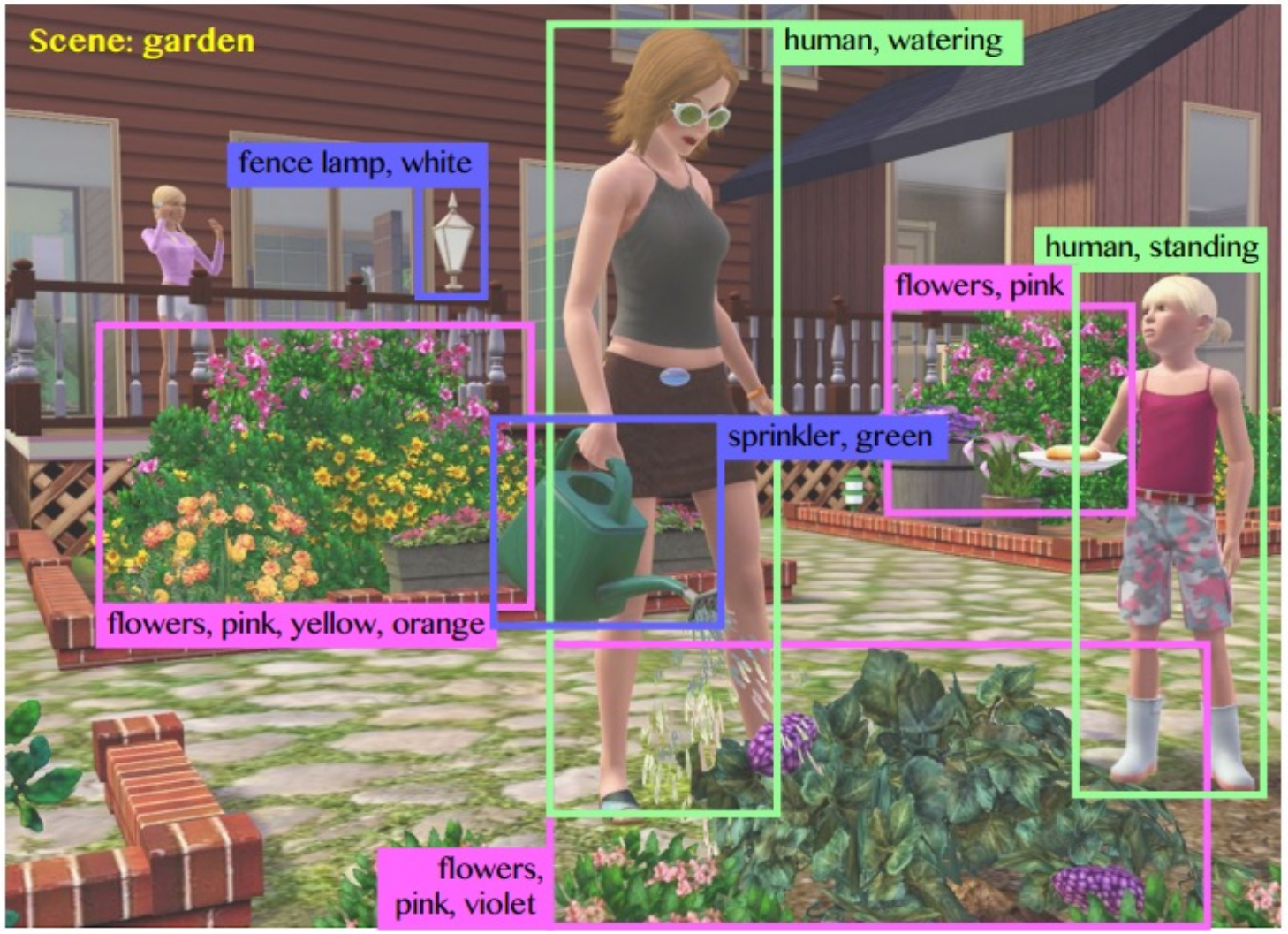
Augmented Reality

Non-environment aware 2D/3D content is overlaid onto the physical space

Source: Huynh-The, Thien, Quoc-Viet Pham, Xuan-Qui Pham, Thanh Thi Nguyen, Zhu Han, and Dong-Seong Kim (2022). "Artificial Intelligence for the Metaverse: A Survey." arXiv preprint arXiv:2202.10336.

Computer vision in the metaverse

with scene understanding, object detection, and human action/activity recognition



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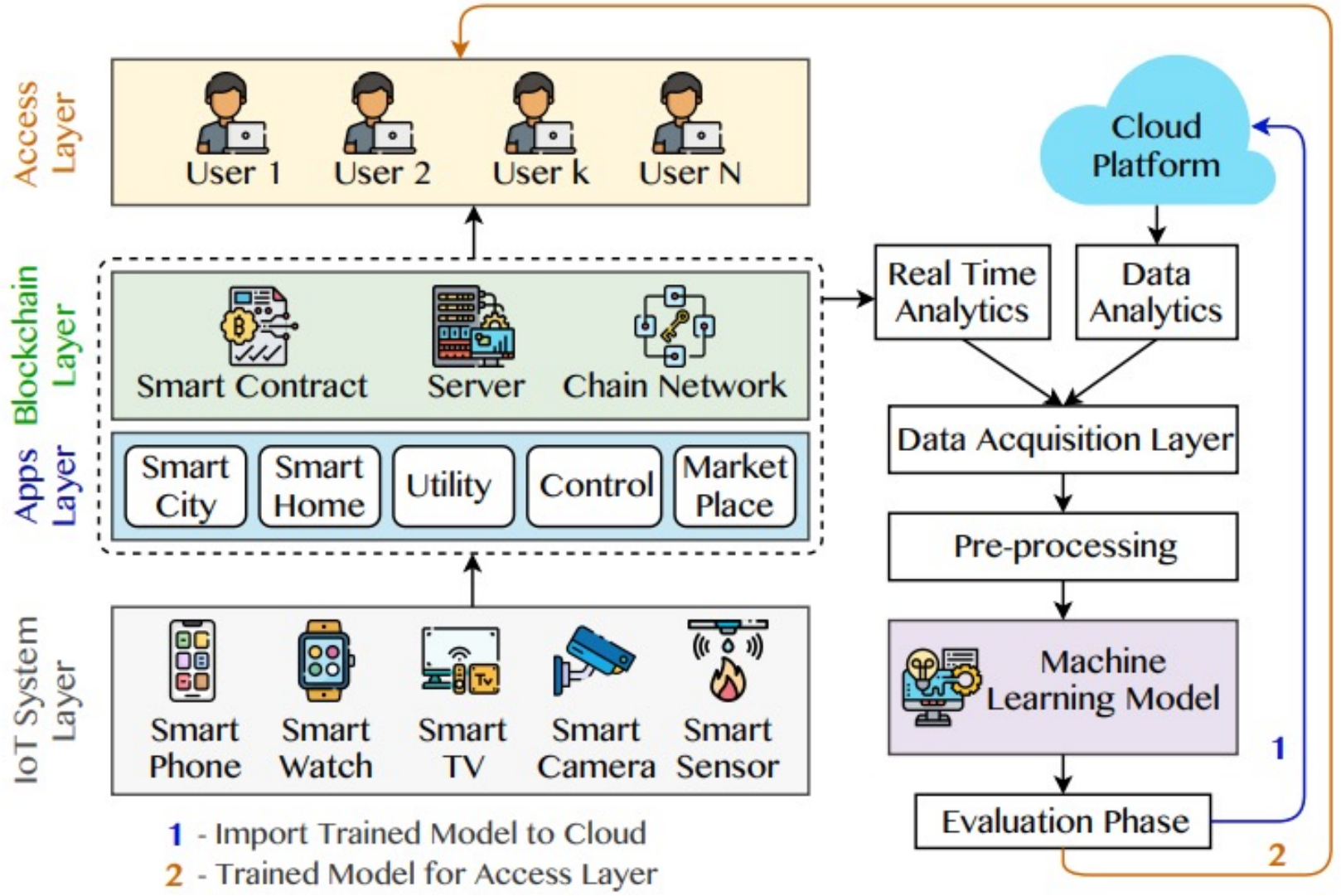
A Blockchain-based IoT Framework

with ML to enhance security and privacy



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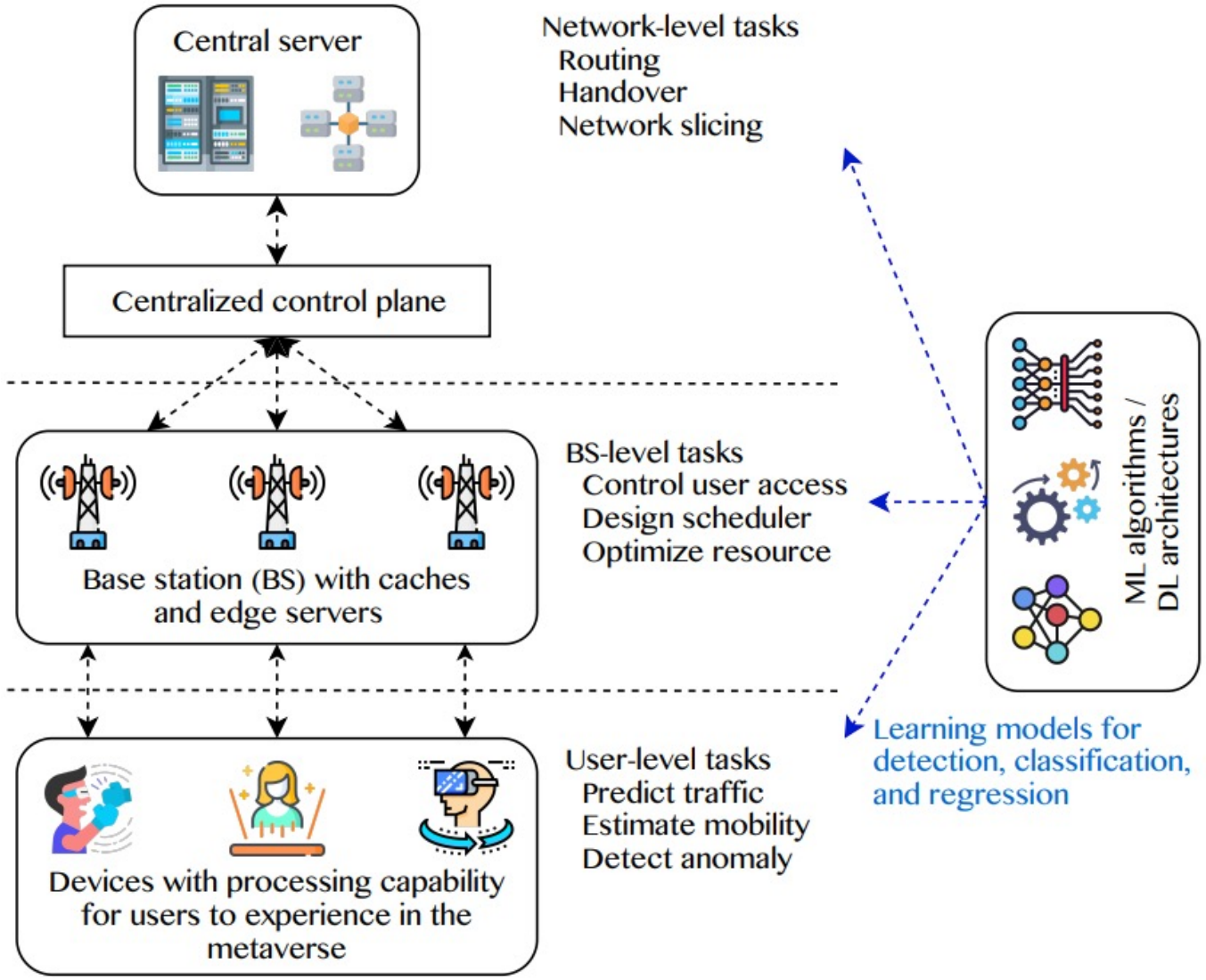
5G and beyond for Metaverse Services

AI with ML algorithms and DL models contribute in multi-level tasks



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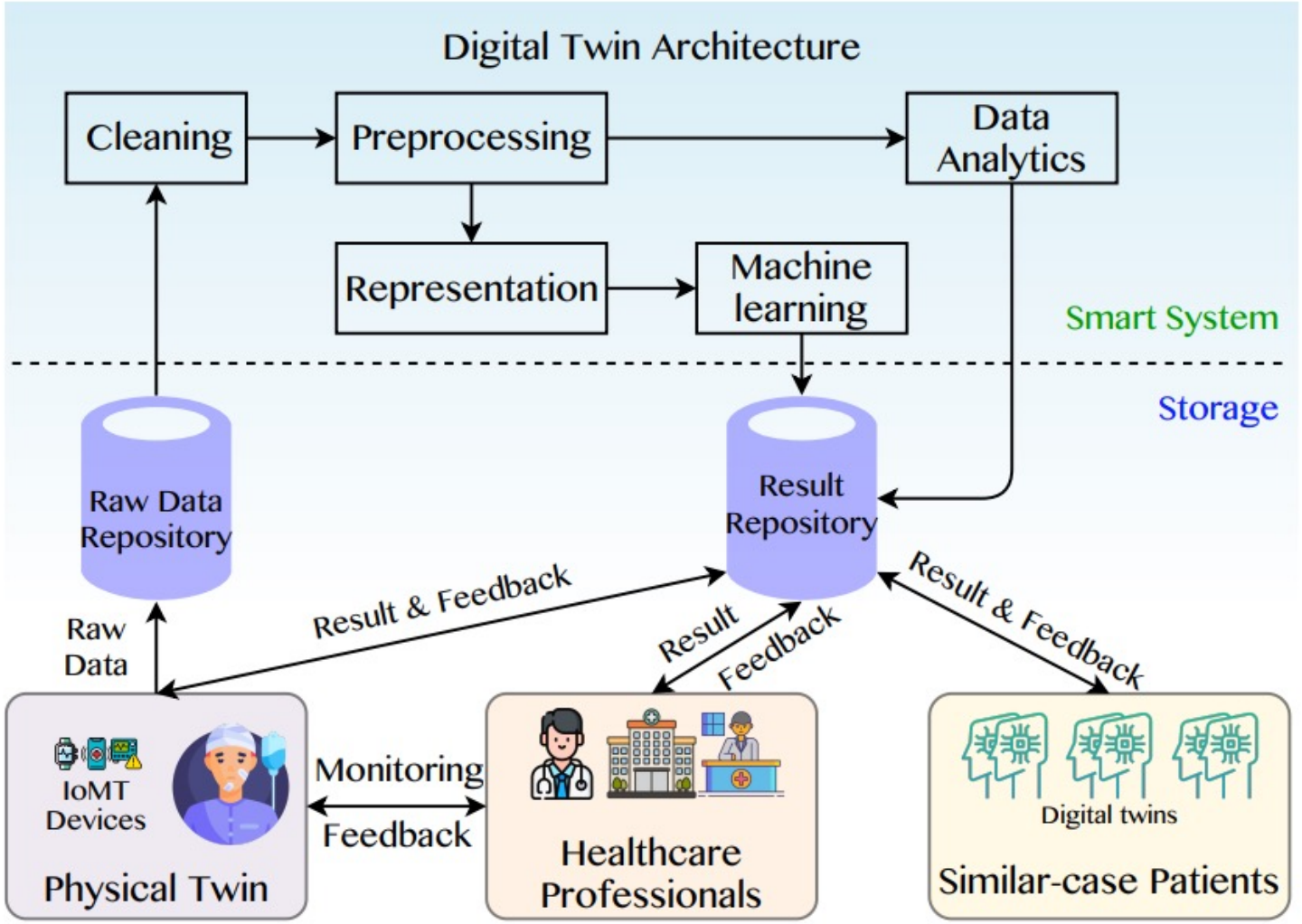
A Data-Driven Digital Twin Architecture

for intelligent healthcare systems using ML to process raw data of IoMedicalThings devices



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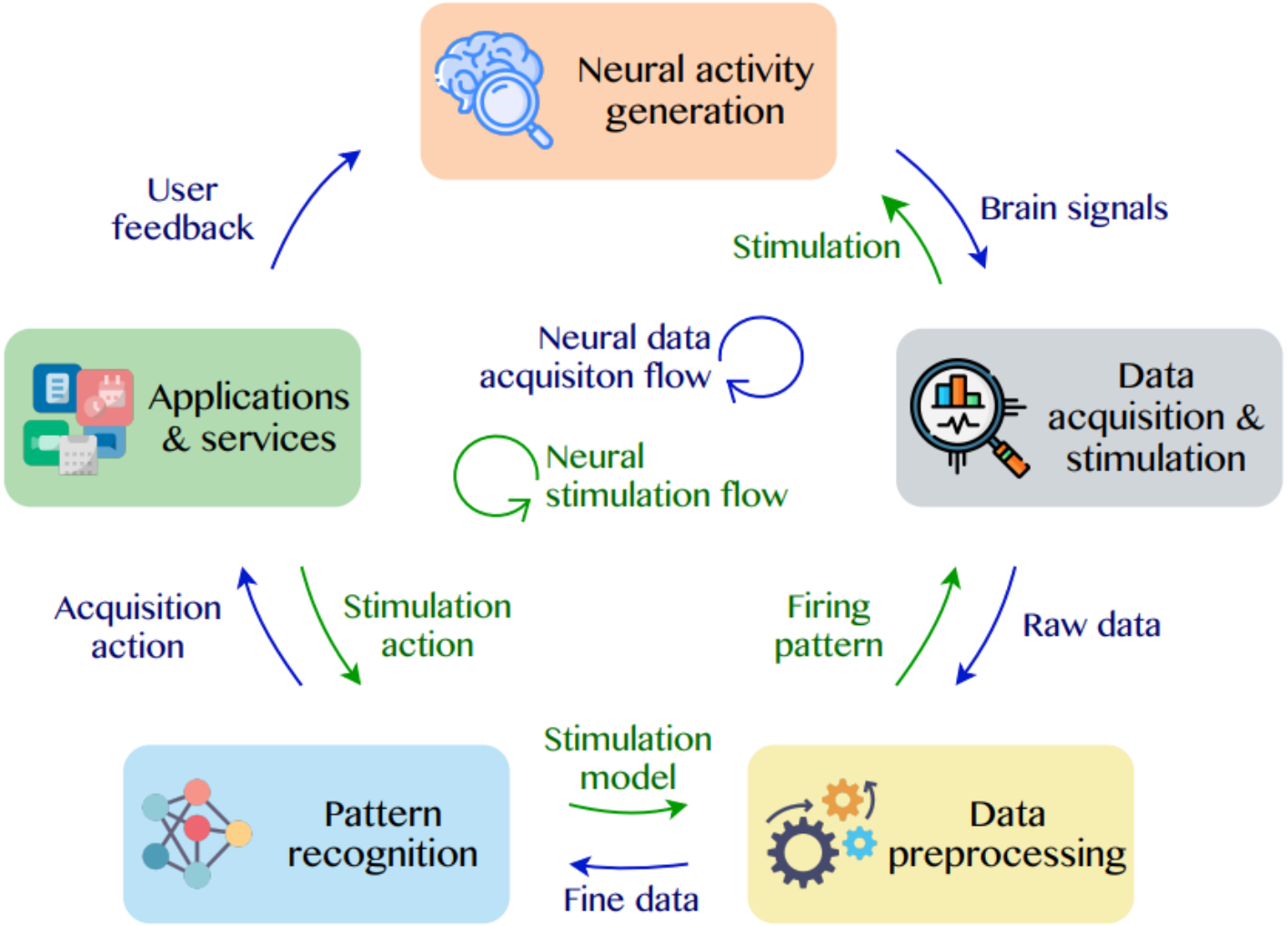
Brain-Machine Interfaces (BMIs)

for processing neural signals and responding neural stimulations



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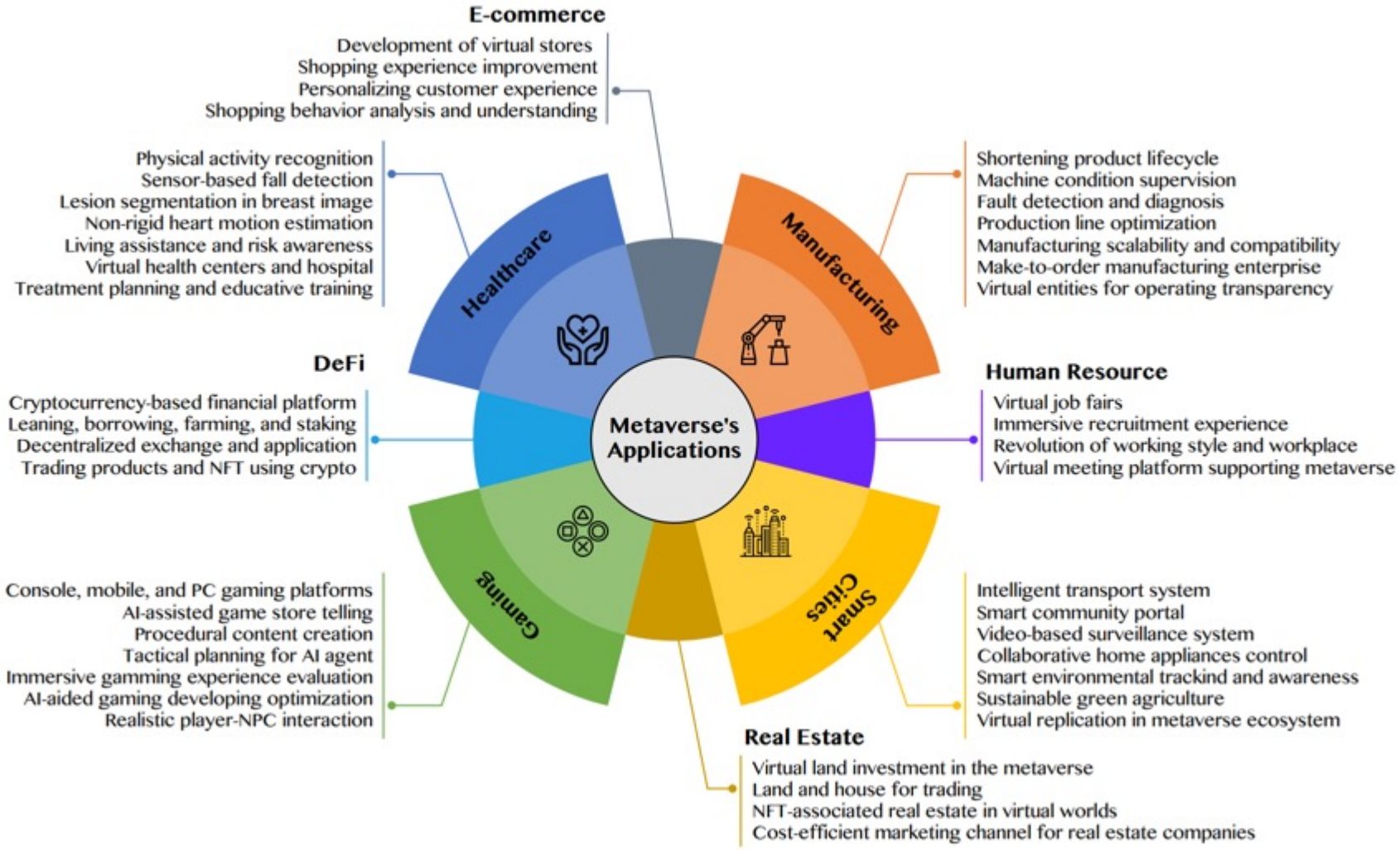
AI for the Metaverse

Technical Aspect	Ref	Task	AI Technique
NLP	[20]	Word and linguistic prediction for language modeling.	RNNs and LSTM networks with the attention mechanisms.
	[21]		Advanced memory network with residual connection.
	[24]		Deep networks with gated connection and bi-directional structure.
	[25]	Analyzing and understand the representation of words from characters	General deep networks with CNN and LSTM architectures.
	[27]	Identifying prefixes and suffixes and detecting misspelled words	DL framework with CNN, Bi-LSTM, and conditional random field.
	[29]	Sentiment prediction and question type classification.	Various CNNs and LSTM networks with simple structures and advanced-designed architectures.
	[31]	Generate short text in image captioning and long text in virtual question answer.	DL framework with single RNN/LSTM and mixture LSTM-CNN models.
	[32]	Semantic labeling, context retrieval, and language interpretation.	Unsupervised and reinforcement learning with common RNN/LSTM and CNN models.

Source: Huynh-The, Thien, Quoc-Viet Pham, Xuan-Qui Pham, Thanh Thi Nguyen, Zhu Han, and Dong-Seong Kim (2022). "Artificial Intelligence for the Metaverse: A Survey." arXiv preprint arXiv:2202.10336.

AI for the Metaverse in the Application Aspects

healthcare, manufacturing, smart cities, gaming
E-commerce, human resources, real estate, and DeFi



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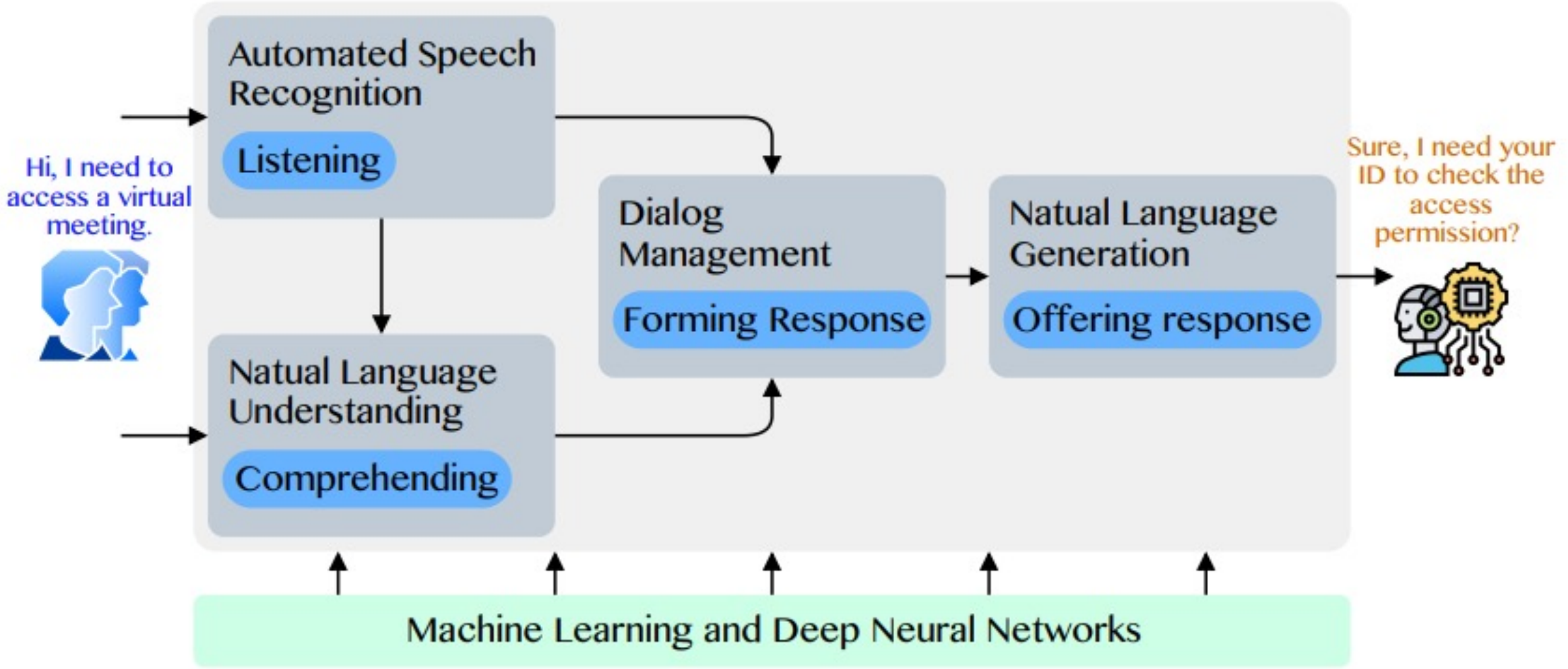
Conversational AI

to deliver contextual and personal experience to users



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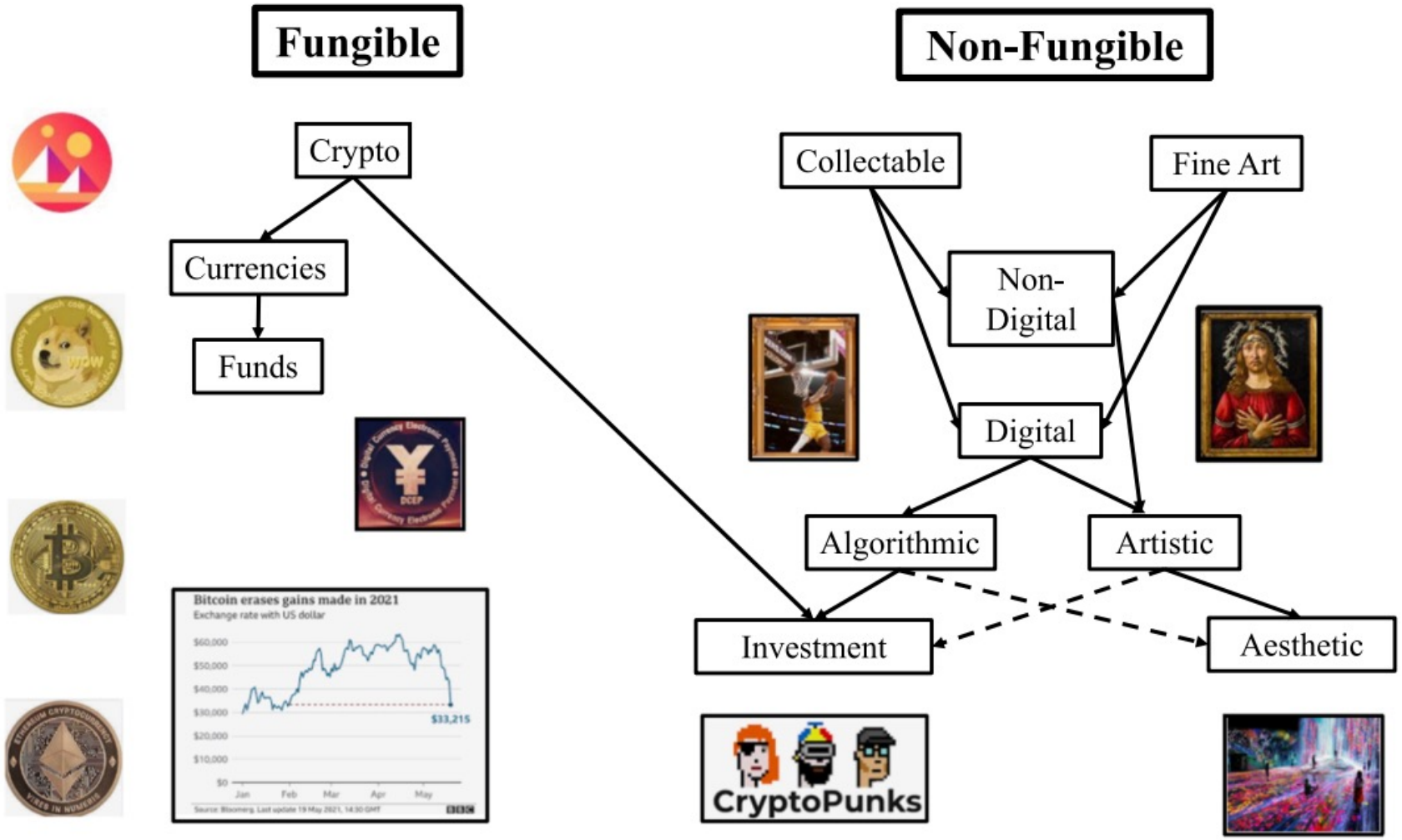
Blockchain-Registered: Crypto, Collectables, and Art.



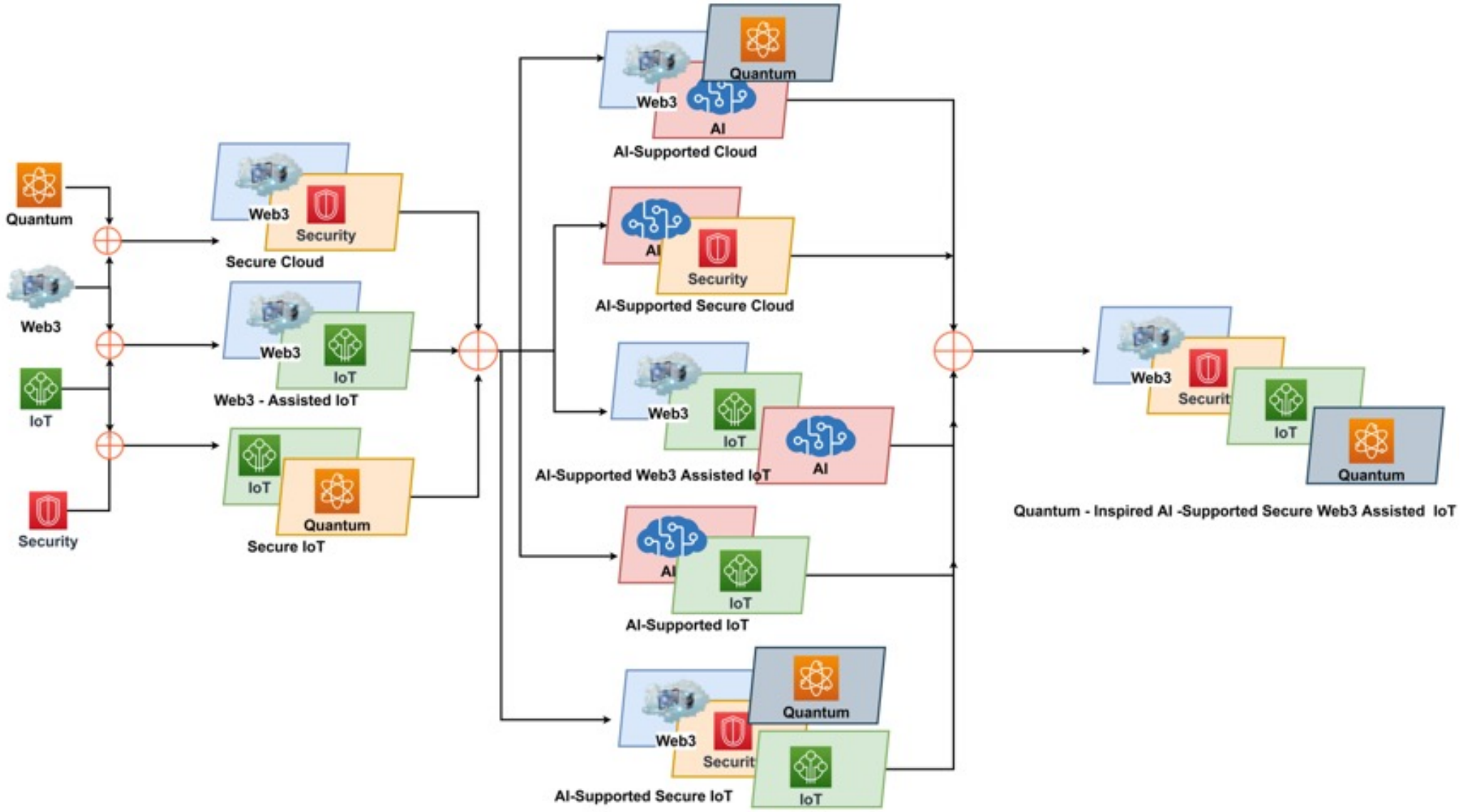
Source: Belk, Russell, Mariam Humayun, and Myriam Brouard. (2022)
"Money, possessions, and ownership in the Metaverse: NFTs, cryptocurrencies, Web3 and Wild Markets." Journal of Business Research 153: 198-205.

Full Versus Fractional [NFT] Property Ownership Rights for an Artwork

RIGHTS	Full Ownership	NFT (Fractional Ownership)
Use	Yes	Yes
Sell or dispose of	Yes	Yes
Manipulate or modify	Yes	No
Exclude Others	Yes	No
Copyright	No	No
Intellectual property	No	Possibly with some NFTs
Income from	Yes	Mostly no
Artist Resale (% for artist)	No	Possibly yes

Source: Belk, Russell, Mariam Humayun, and Myriam Brouard. (2022)
"Money, possessions, and ownership in the Metaverse: NFTs, cryptocurrencies, Web3 and Wild Markets." Journal of Business Research 153: 198-205.

Combination of Web3 with other Technologies



Source: Sheridan, Dan, James Harris, Frank Wear, Jerry Cowell Jr, Easton Wong, and Abbas Yazdinejad. (2022) "Web3 Challenges and Opportunities for the Market." arXiv preprint arXiv:2209.02446.

FinTech

Financial Technology
FinTech

"providing
financial services
by making use of
software and
modern technology"

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

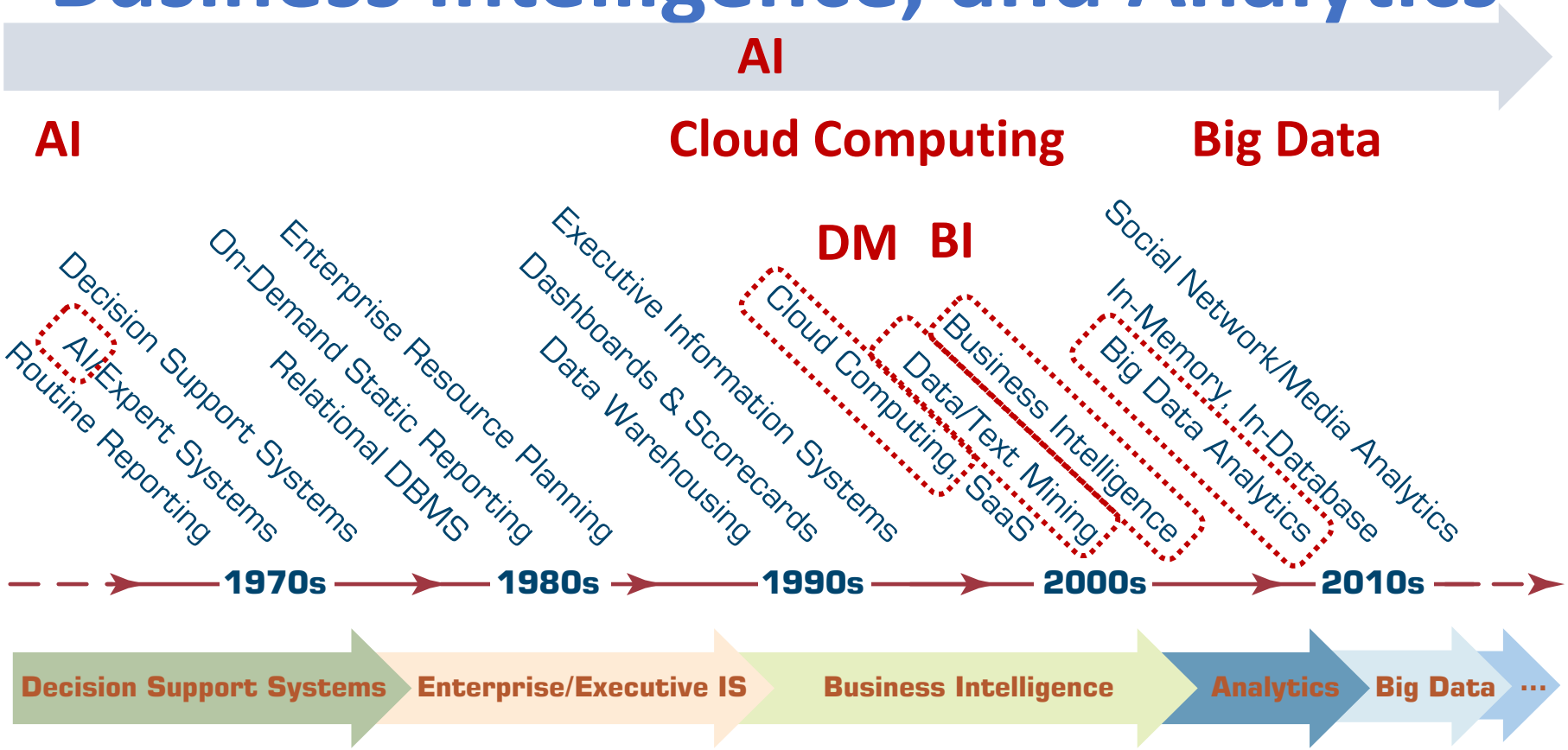
Financial Technology

Financial Services

Artificial Intelligence (AI)

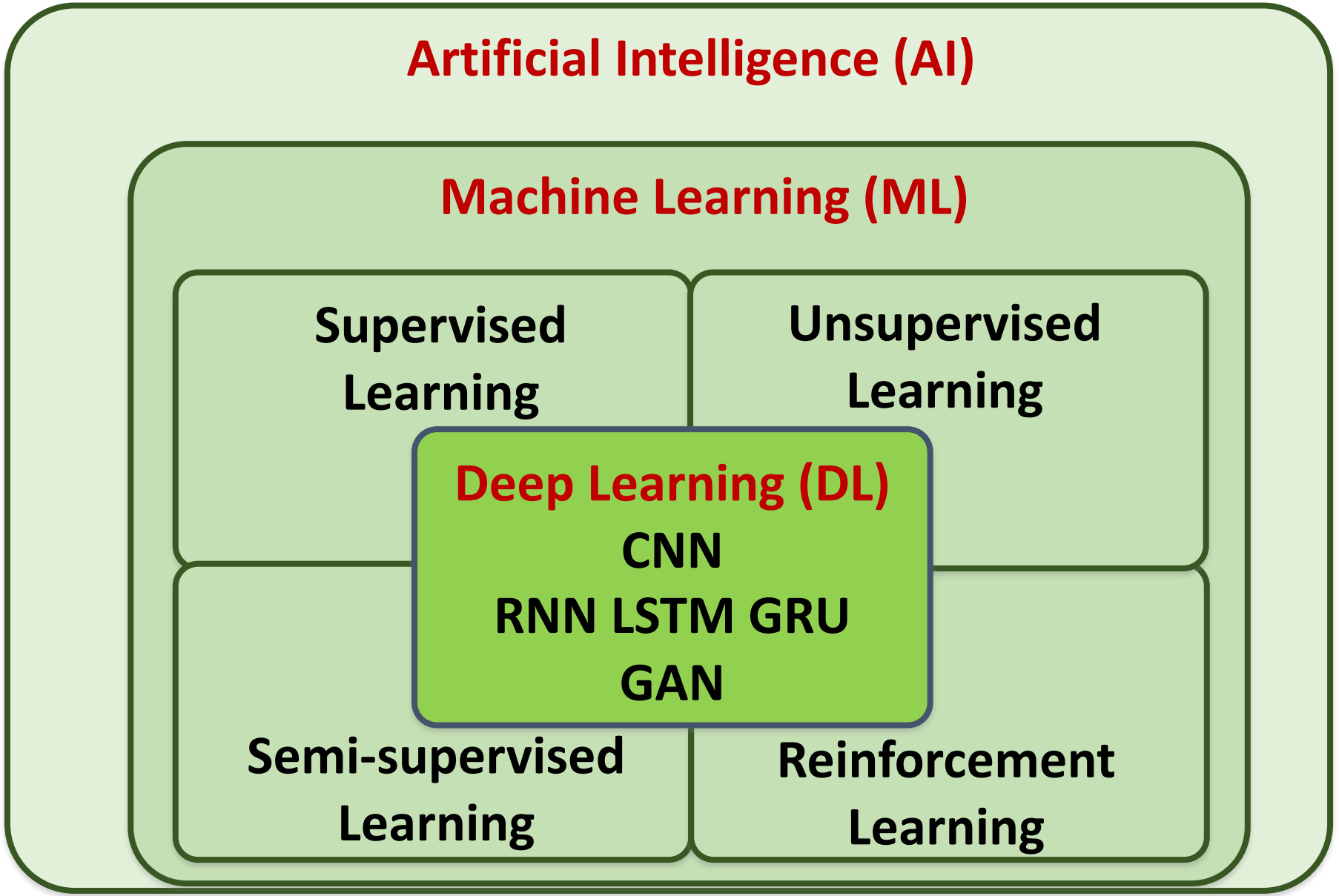
AI, Big Data, Cloud Computing

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

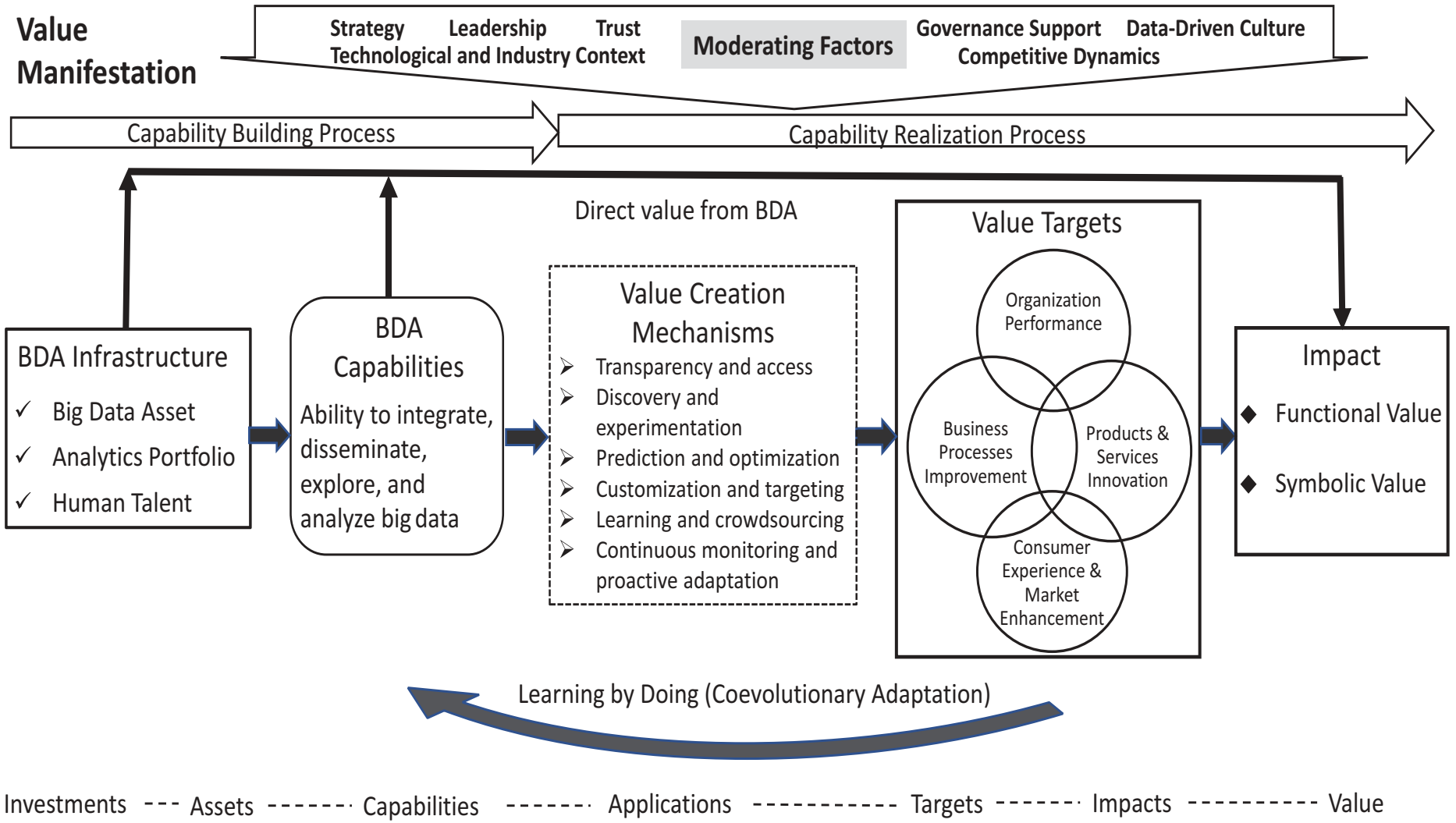
AI, ML, DL



Source: https://leonardoaraujosantos.gitbooks.io/artificial-inteligence/content/deep_learning.html

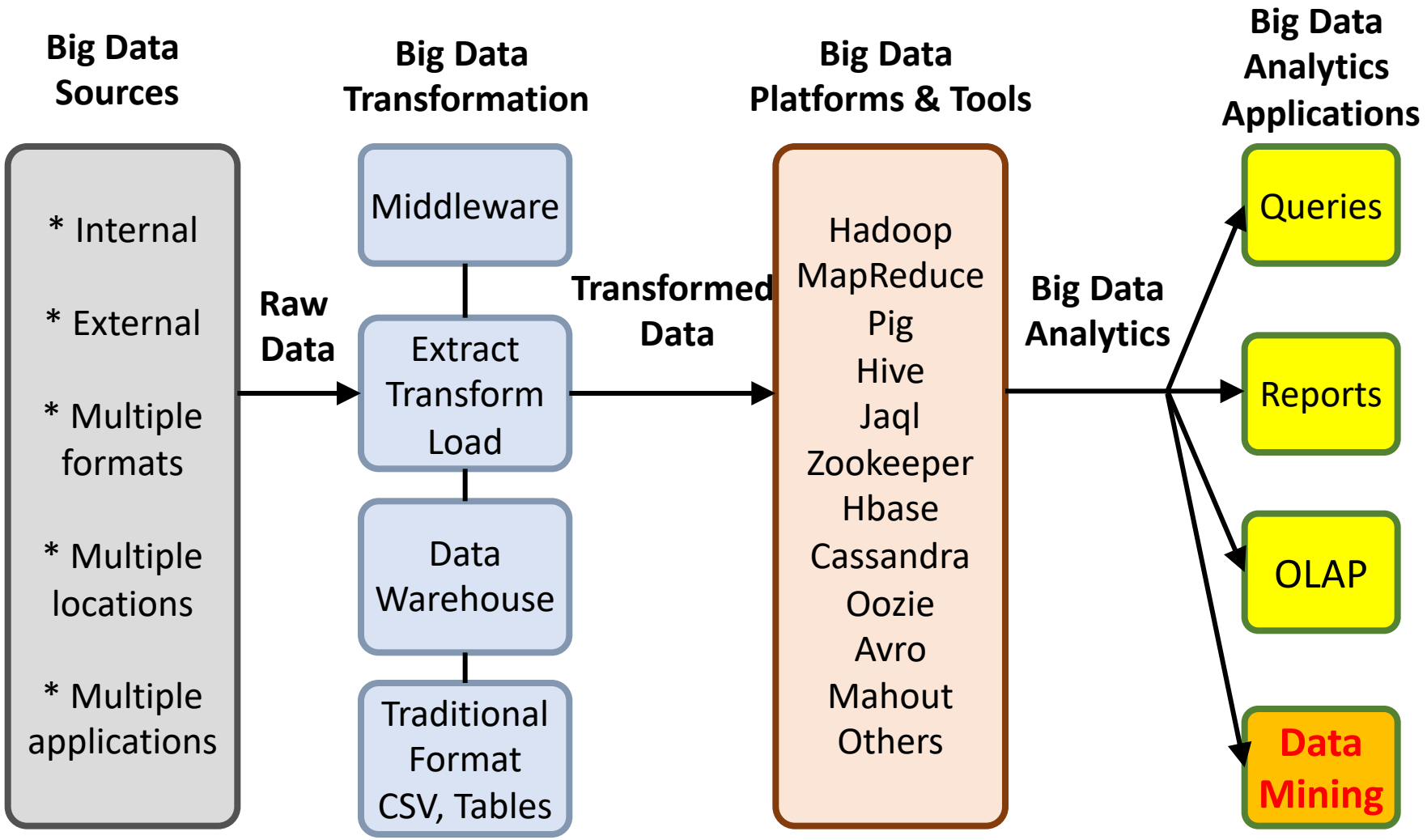
Value Creation by Big Data Analytics

(Grover et al., 2018)



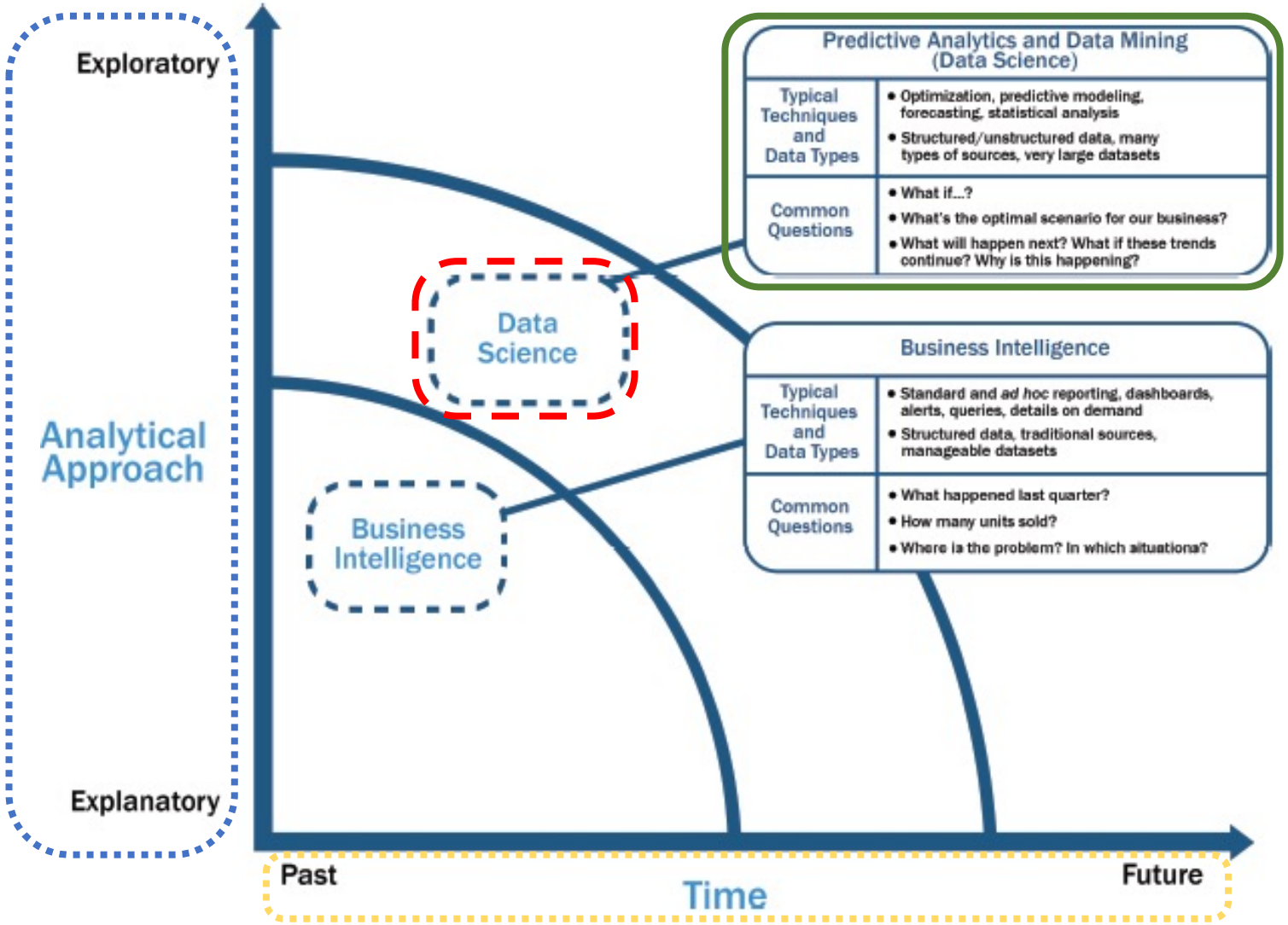
Source: Varun Grover, Roger HL Chiang, Ting-Peng Liang, and Dongsong Zhang (2018), "Creating Strategic Business Value from Big Data Analytics: A Research Framework", Journal of Management Information Systems, 35, no. 2, pp. 388-423.

Architecture of Big Data Analytics



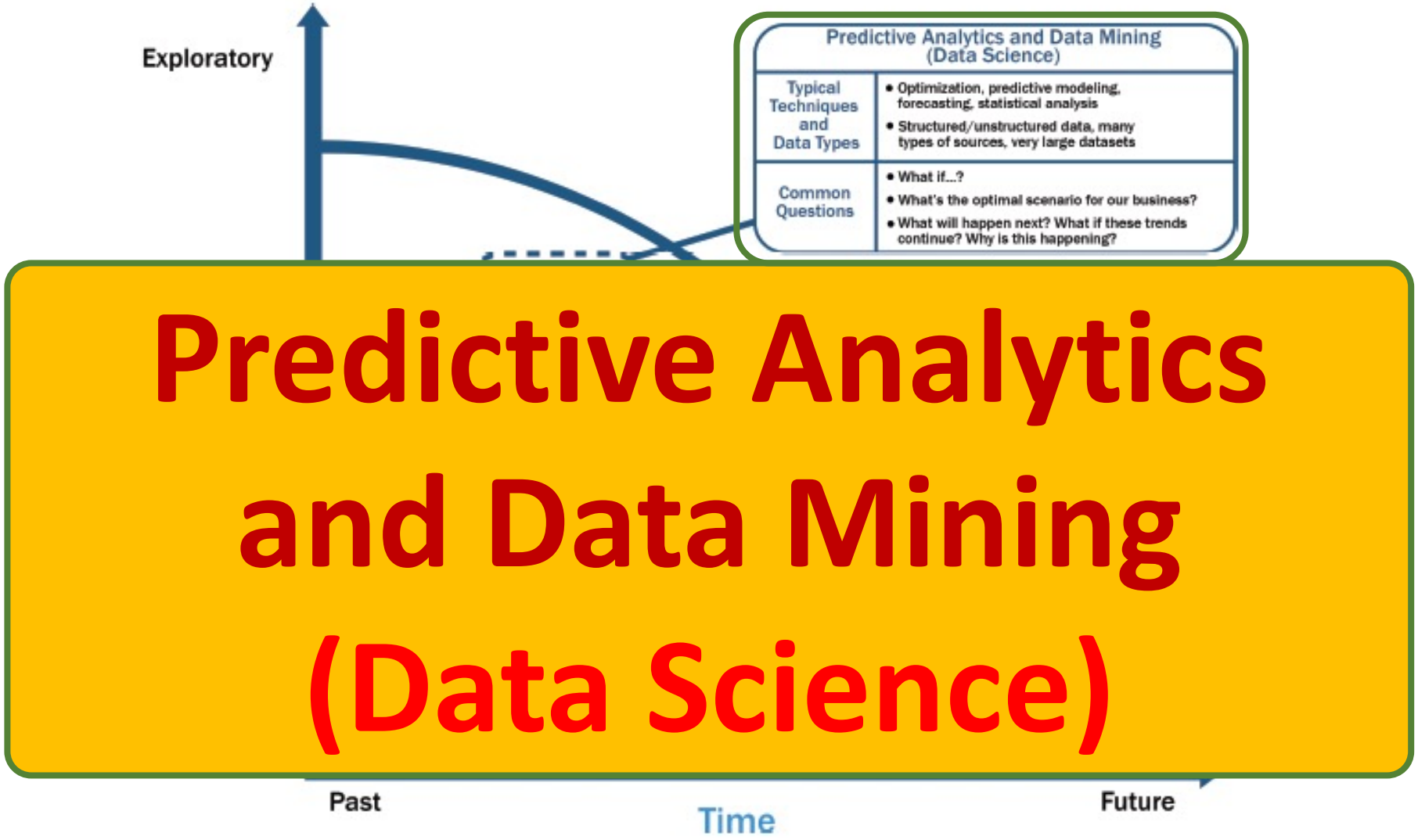
Source: Stephan Kudyba (2014), Big Data, Mining, and Analytics: Components of Strategic Decision Making, Auerbach Publications

Data Science and Business Intelligence



Source: EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley, 2015

Data Science and Business Intelligence



Source: EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley, 2015

Predictive Analytics and Data Mining (Data Science)

Structured/unstructured data, many types of sources, very large datasets

Optimization, predictive modeling, forecasting statistical analysis

What if…?
What's the optimal scenario for our business?
What will happen next?
What if these trends countinue?
Why is this happening?

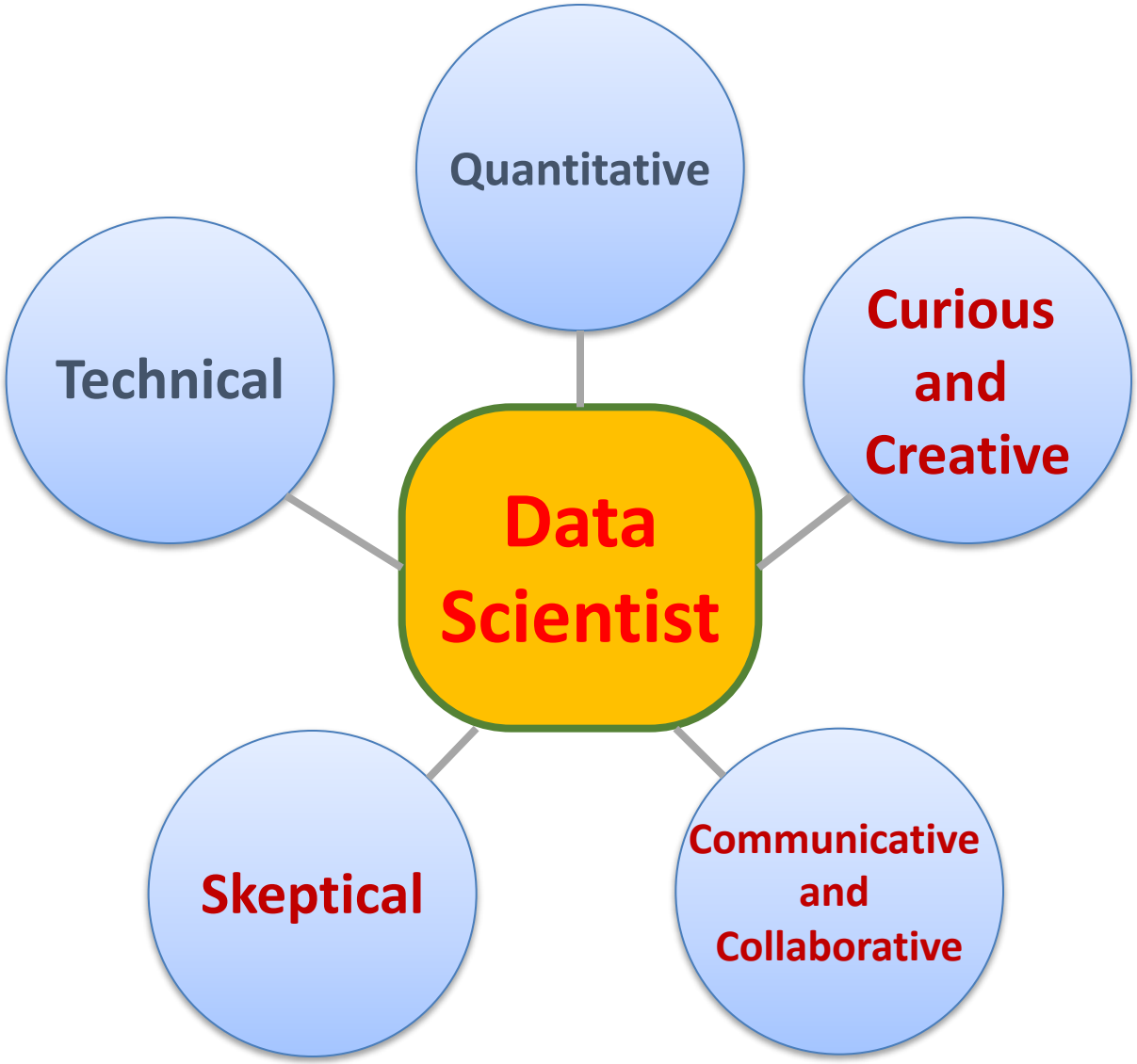
Source: EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley, 2015

Profile of a Data Scientist

- **Quantitative**
  - **mathematics or statistics**
- **Technical**
  - **software engineering, machine learning, and programming skills**
- **Skeptical mind-set and critical thinking**
- **Curious and creative**
- **Communicative and collaborative**

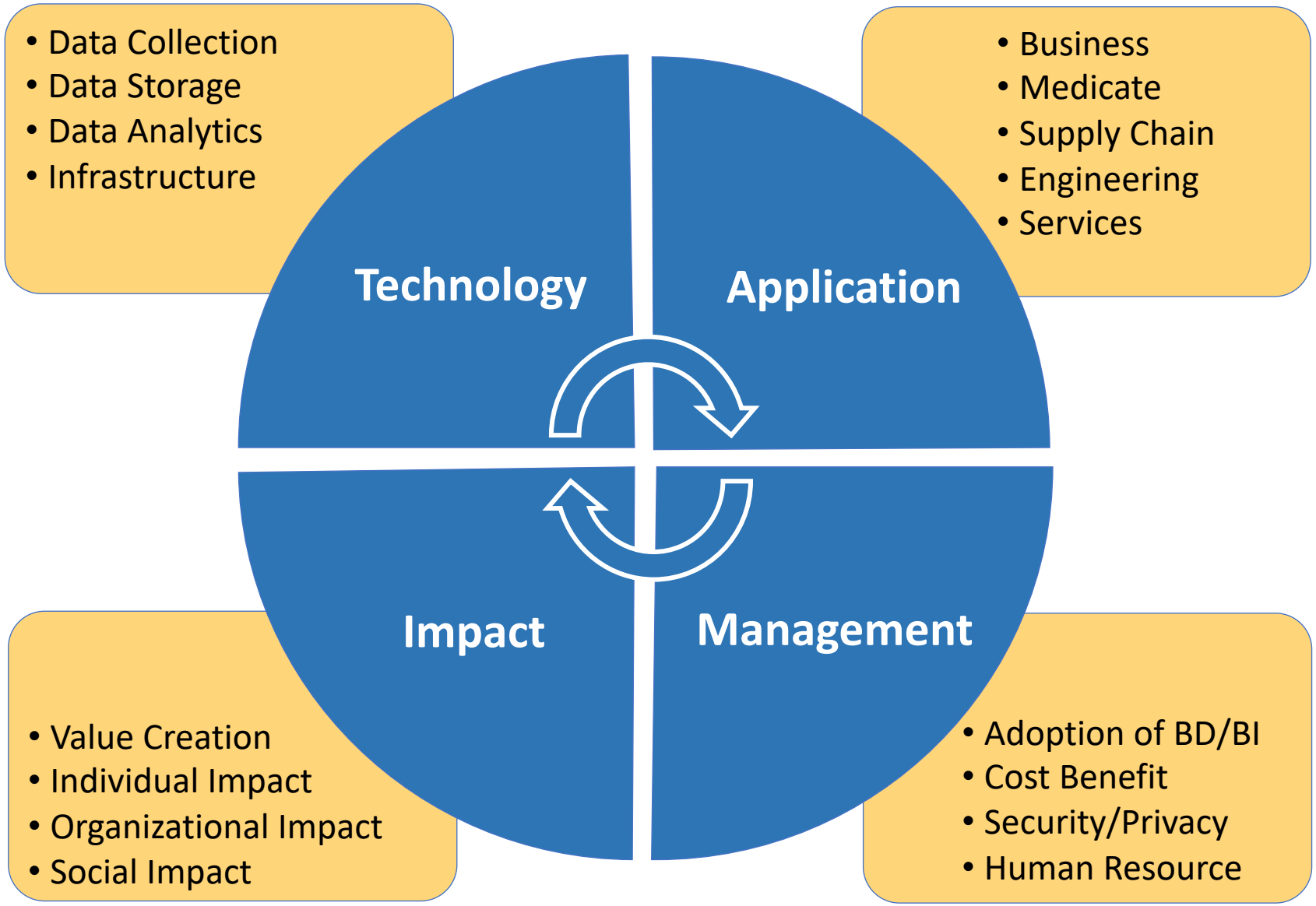
Source: EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley, 2015

Data Scientist Profile



Source: EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley, 2015

Framework for BD and BI Research



Source: Ting-Peng Liang and Yu-Hsi Liu (2018), "Research Landscape of Business Intelligence and Big Data analytics: A bibliometrics study", Expert Systems with Applications, Volume 111, 30, 2018, pp. 2-10

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 Services Innovation

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

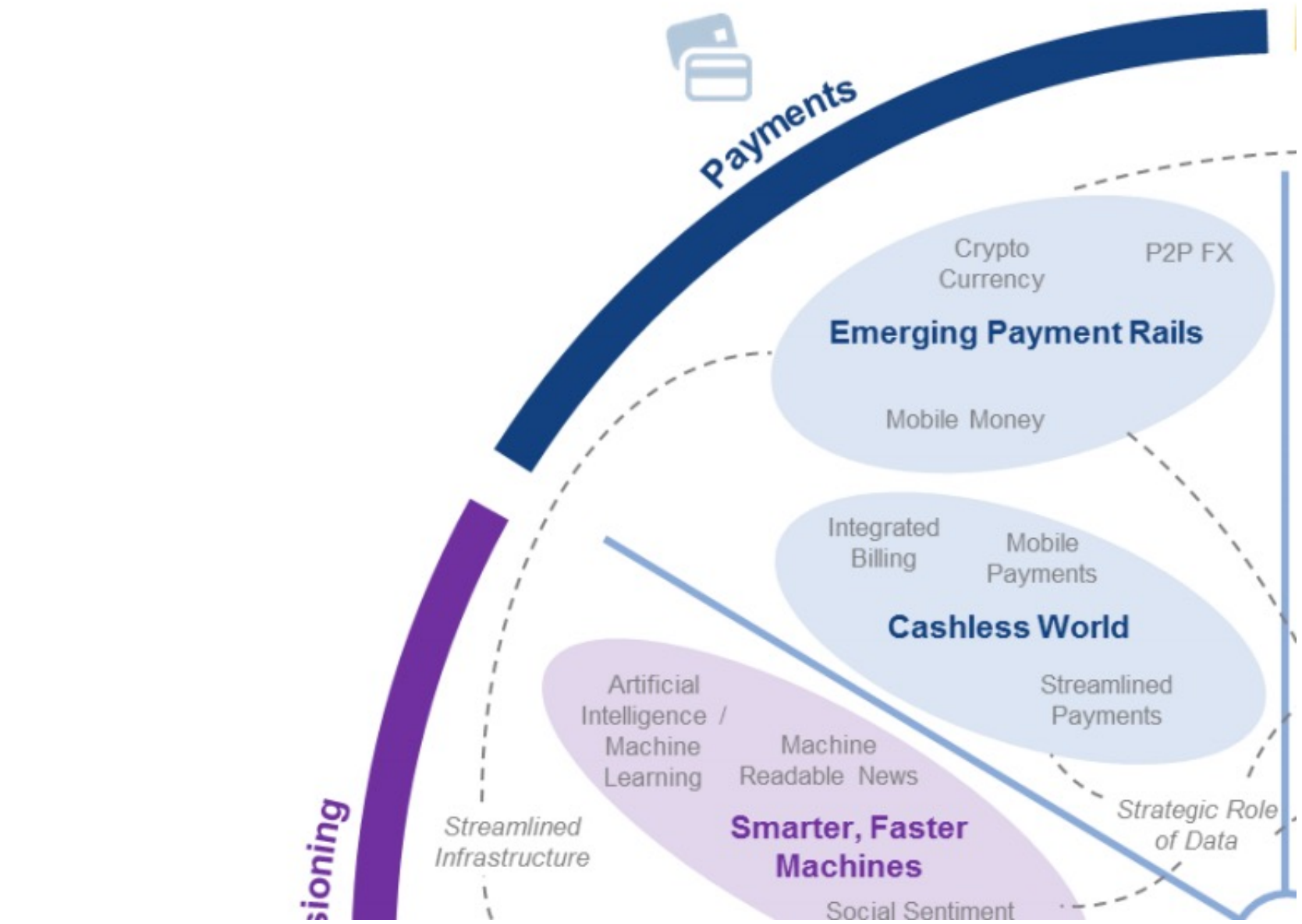
FinTech:

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

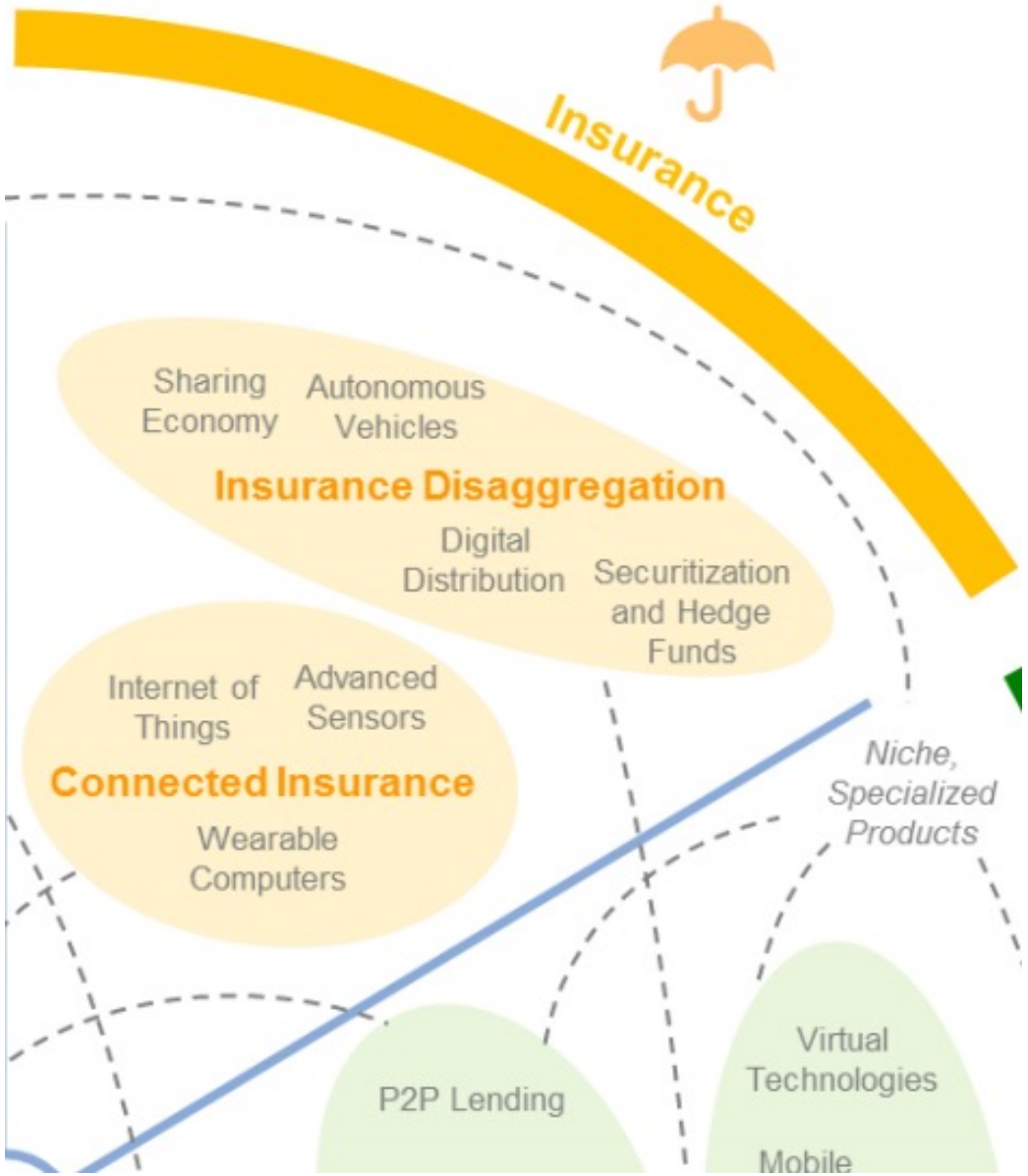
1 FinTech: Payment



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

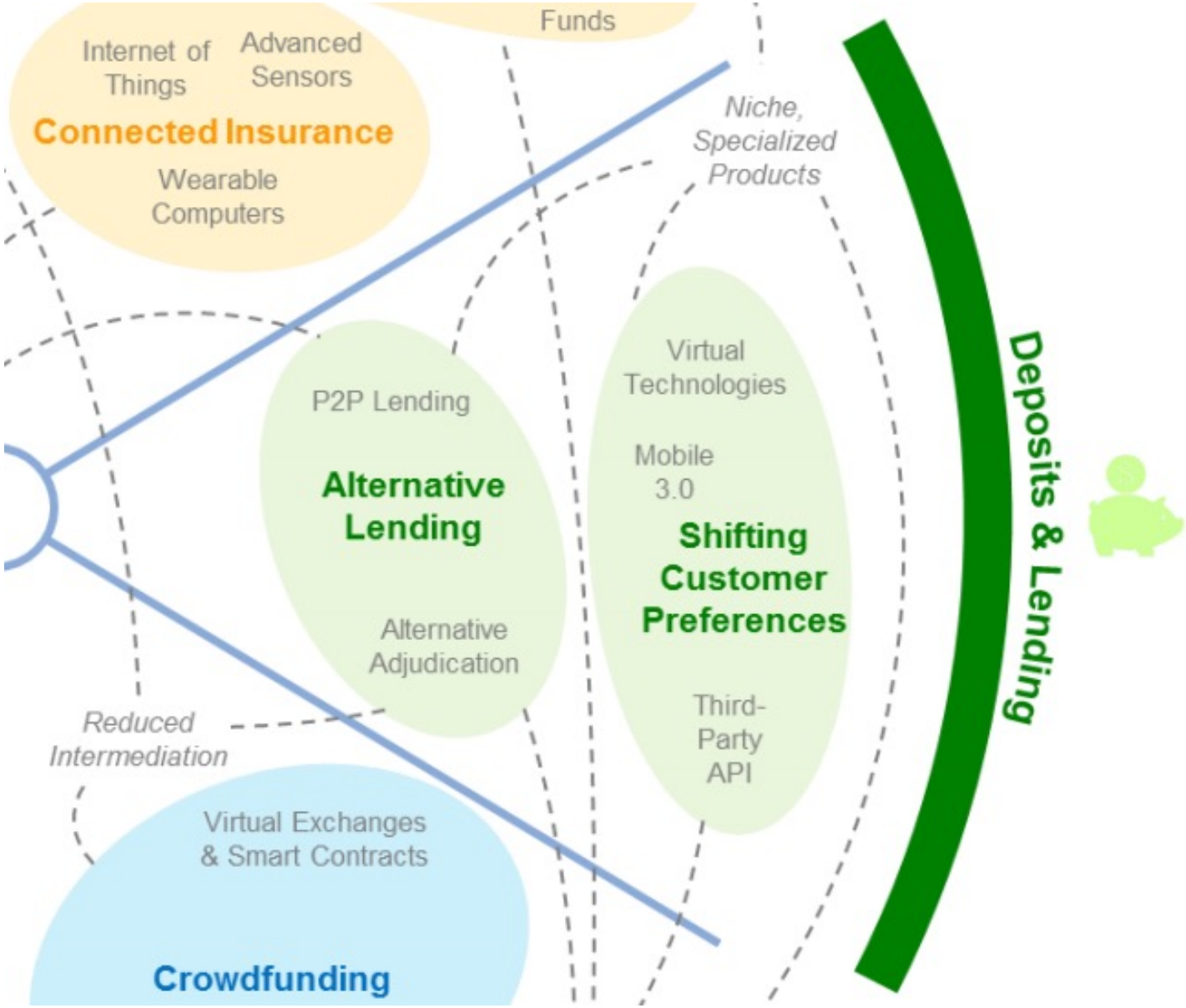
2

FinTech: Insurance



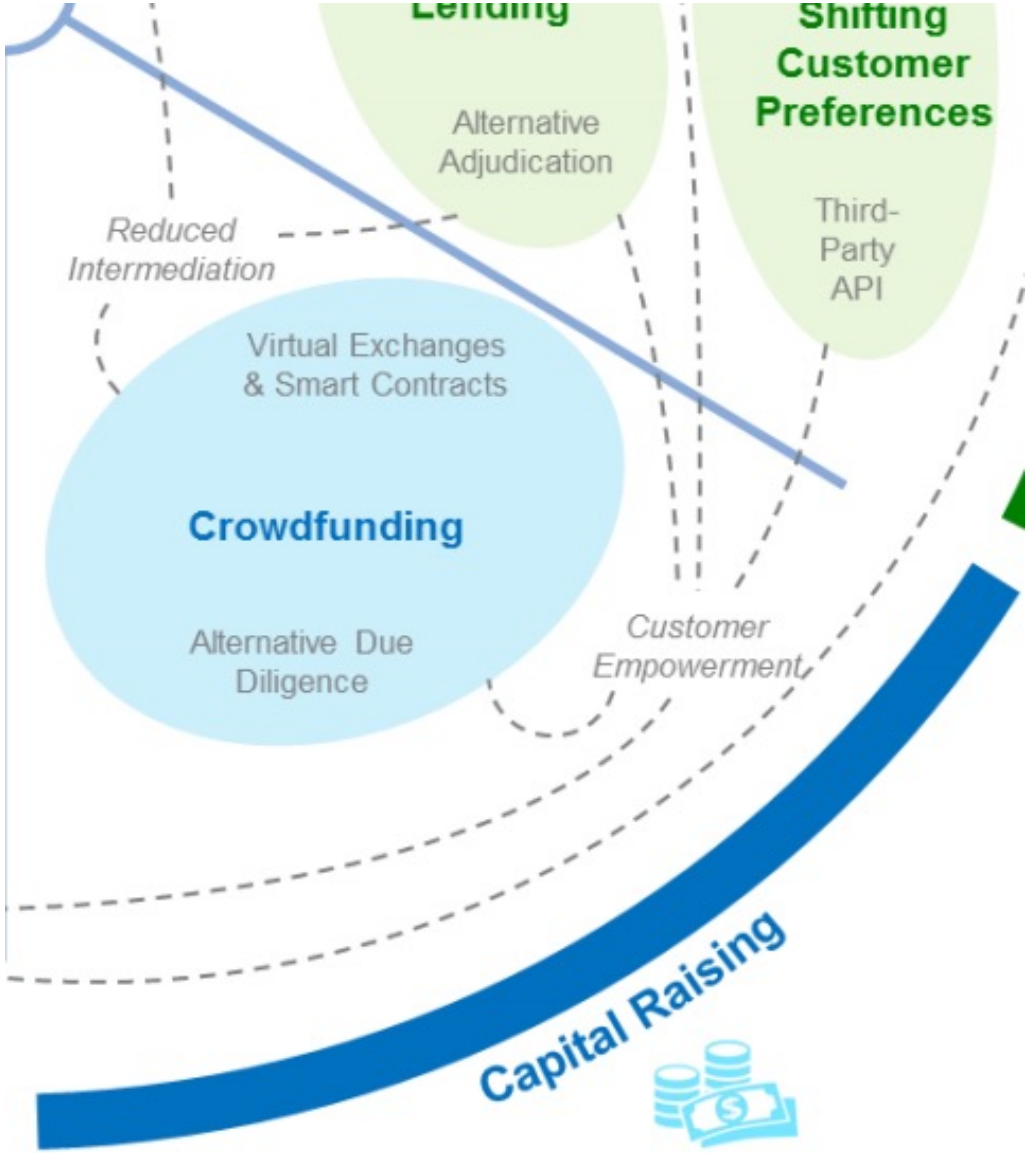
Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

3 FinTech: Deposits & Lending



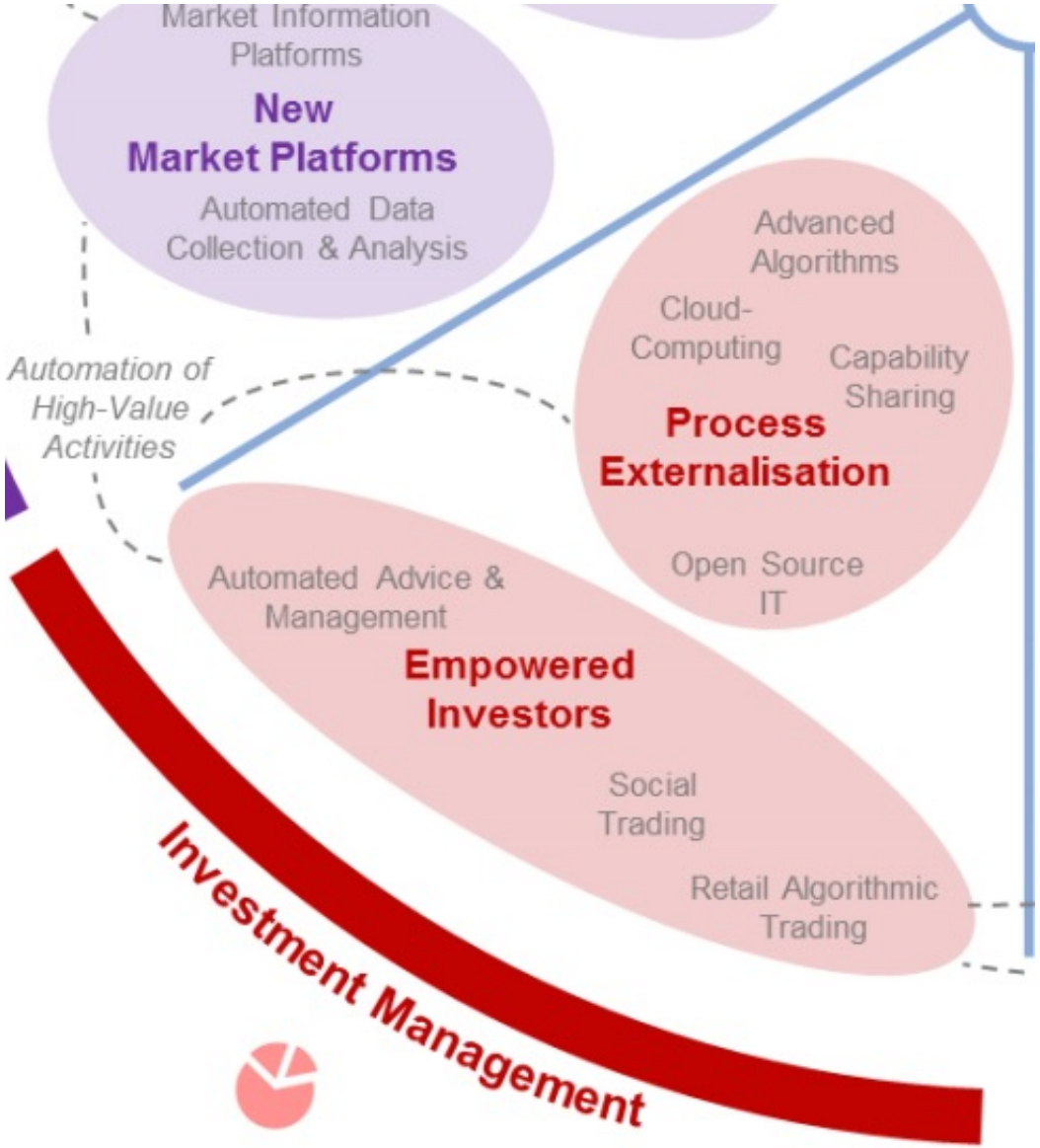
Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

4 FinTech: Capital Raising



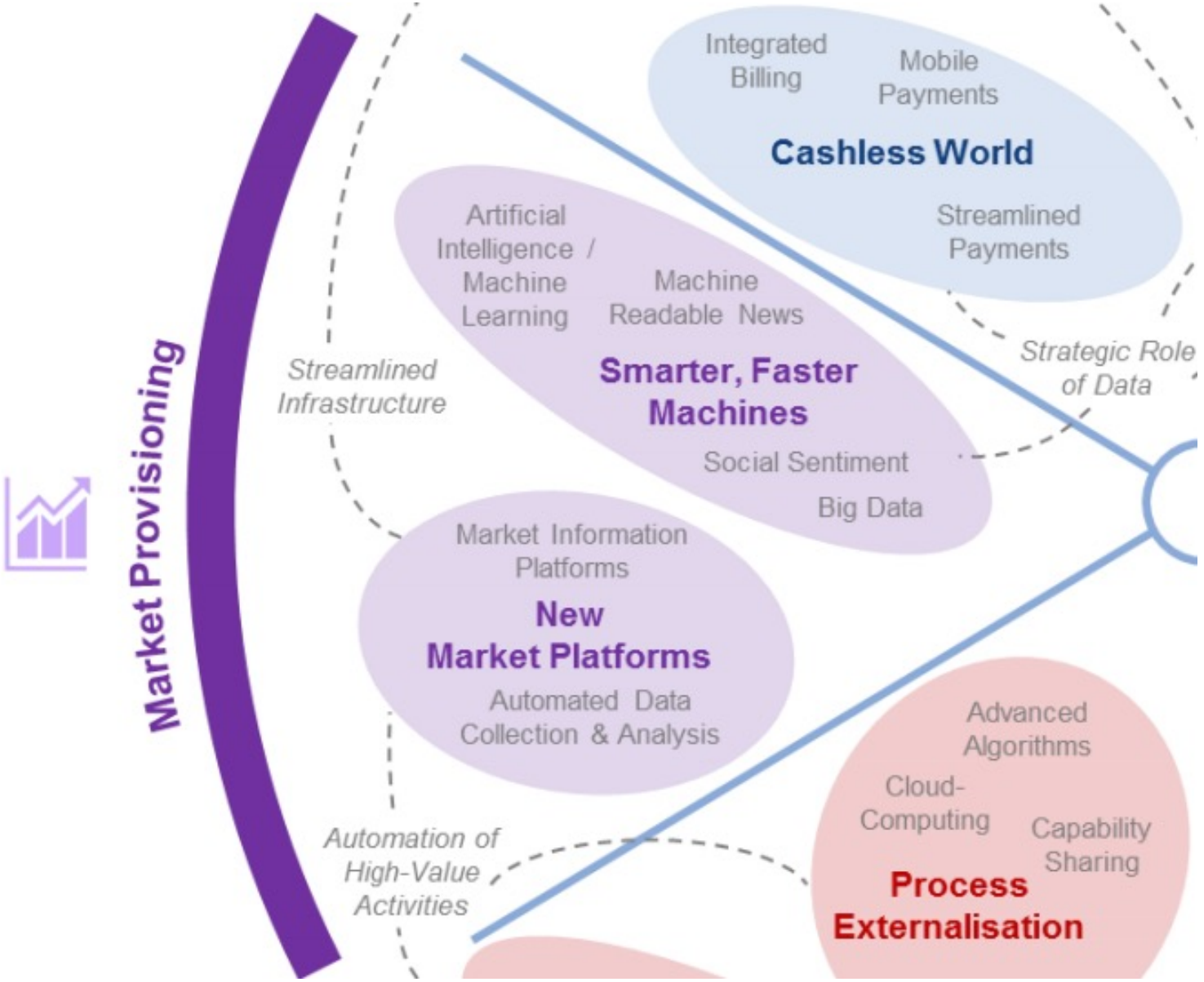
Source: http://www3.weforum.org/docs/WEF_The_future__of_financial_services.pdf

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

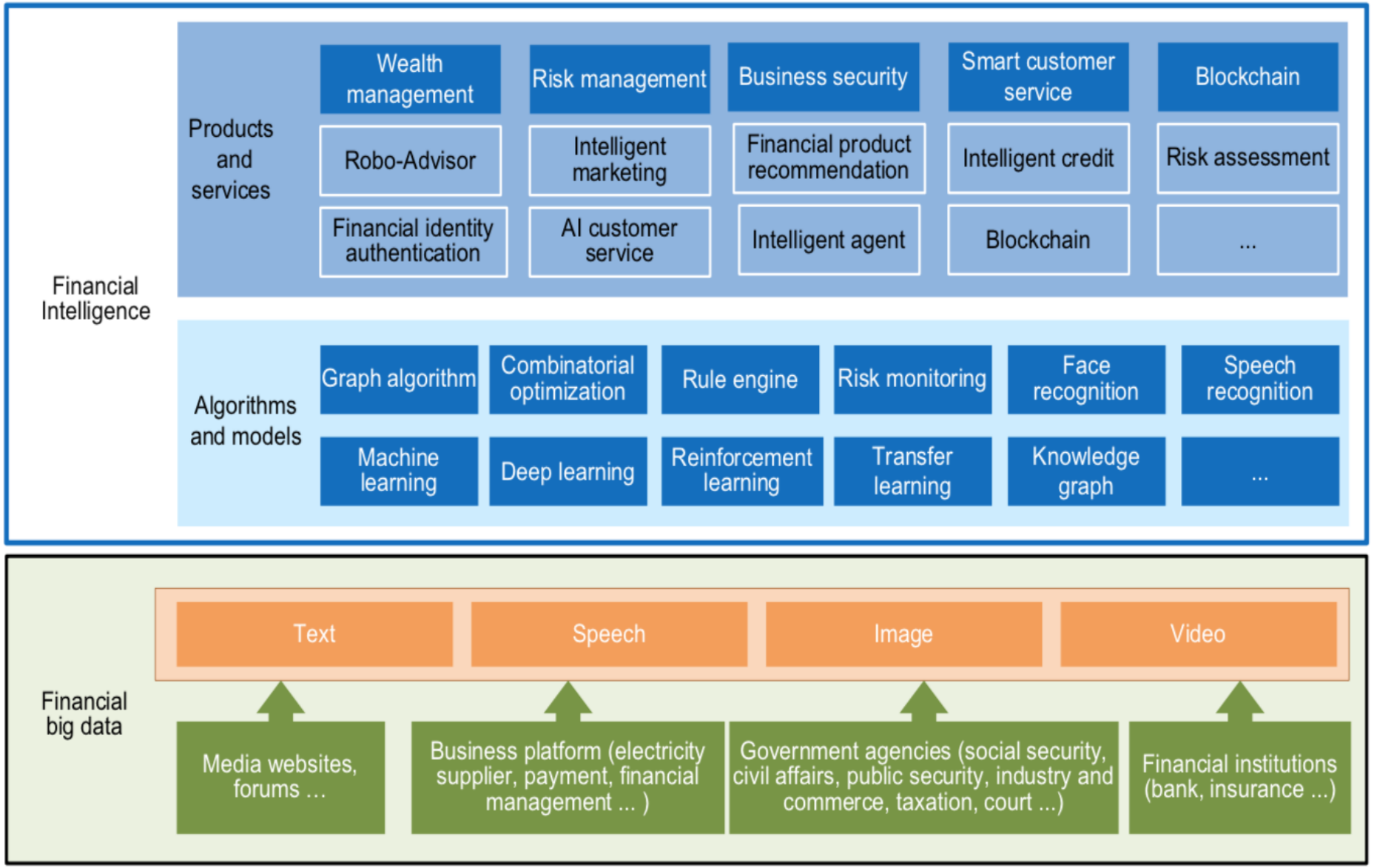
AI

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

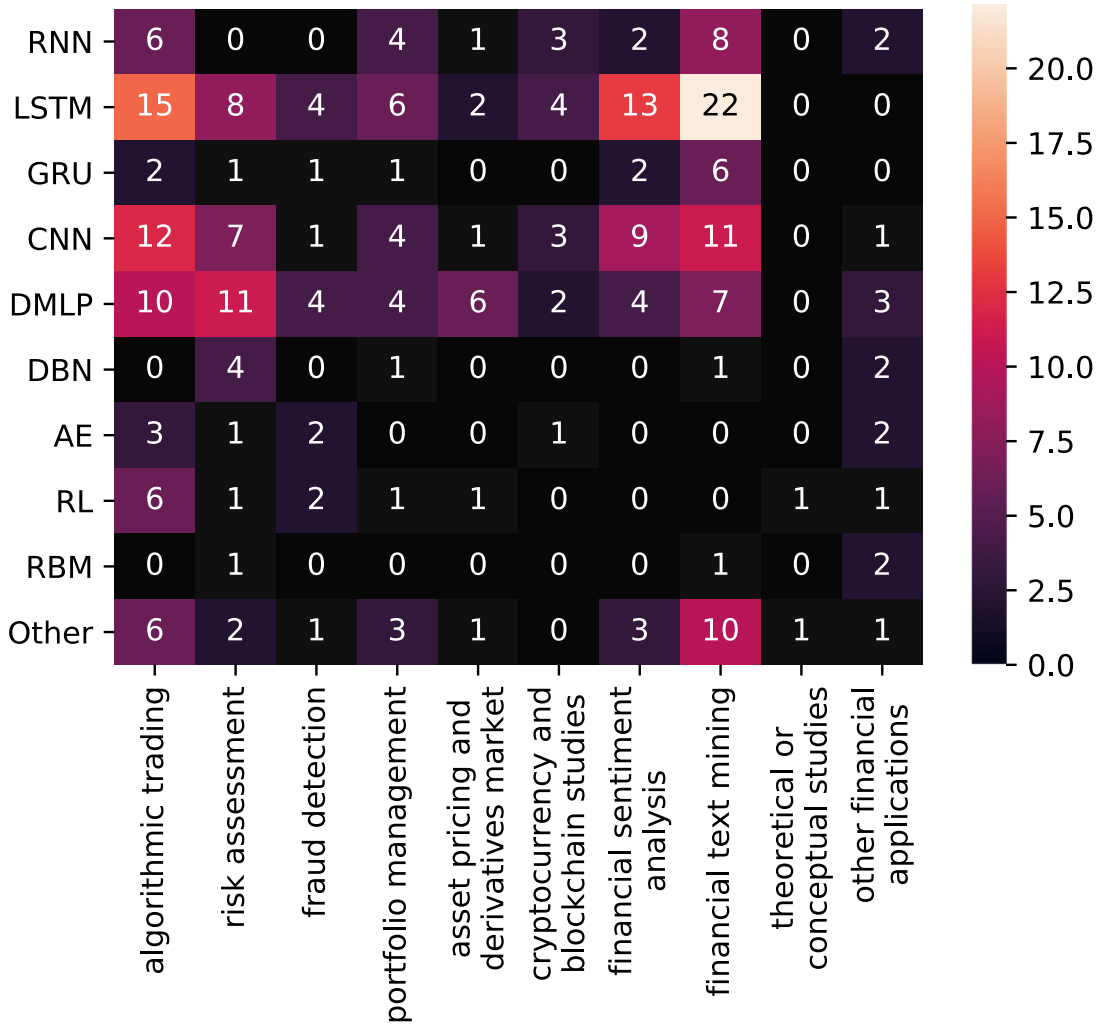
a new generation of AI
based on the
novel information environment of
major changes and
the development of
new goals.

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

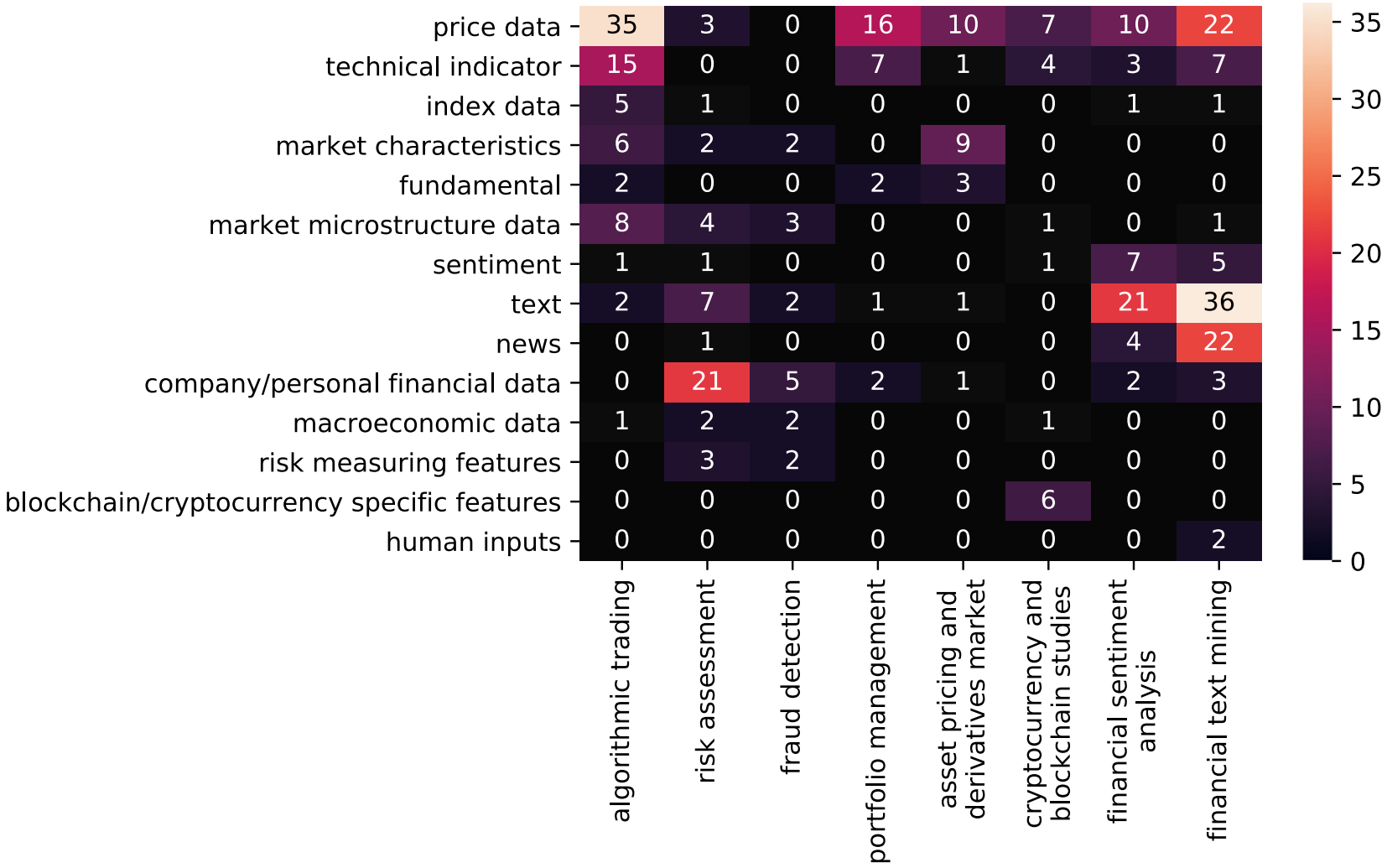
Source: Xiao-lin Zheng, Meng-ying Zhu, Qi-bing Li, Chao-chao Chen, and Yan-chao Tan (2019), "Finbrain: When finance meets AI 2.0." Frontiers of Information Technology & Electronic Engineering 20, no. 7, pp. 914-924

Deep learning for financial applications: Topic-Model Heatmap



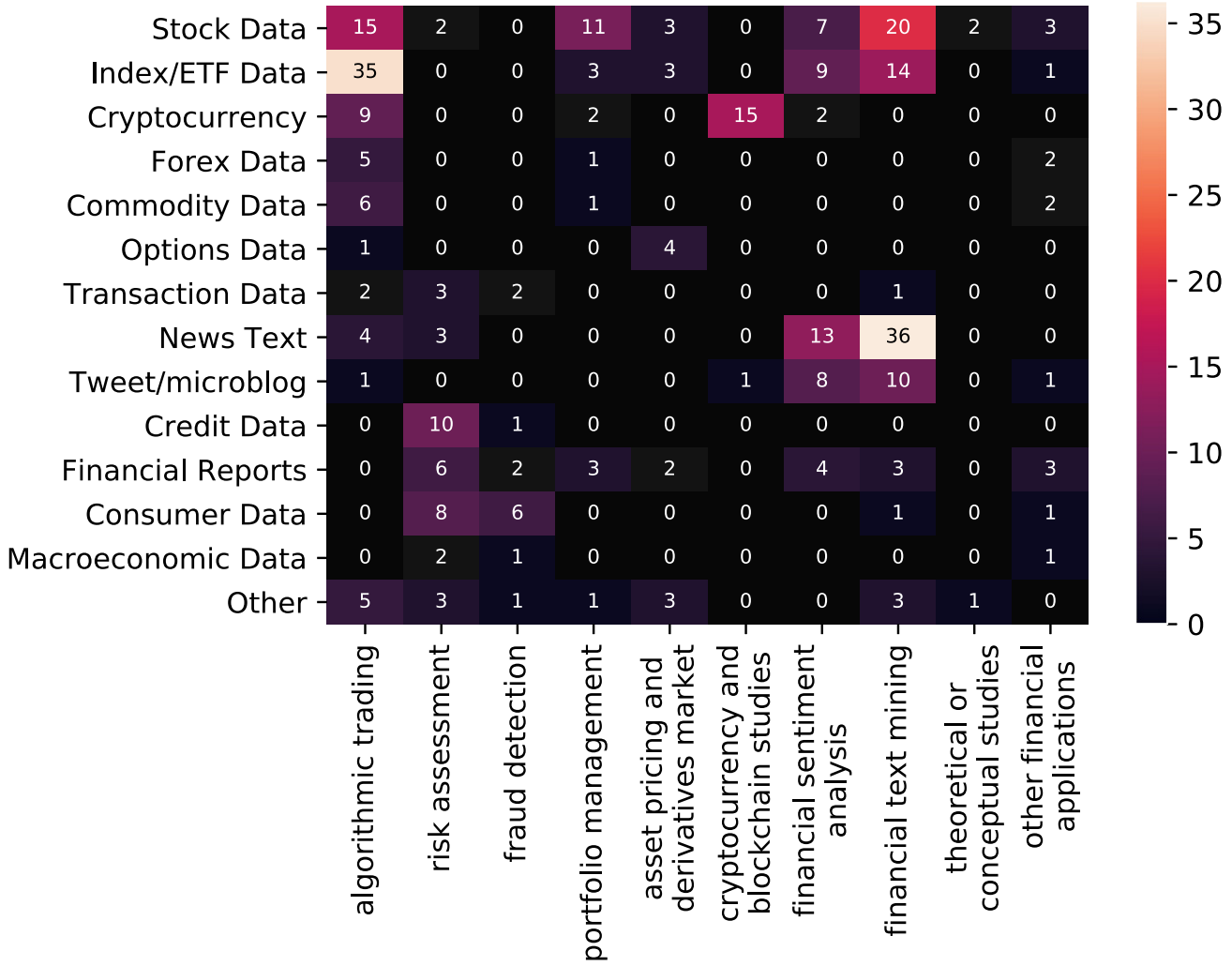
Source: Ahmet Murat Ozbayoglu, Mehmet Ugur Gudelek, and Omer Berat Sezer (2020). "Deep learning for financial applications: A survey." Applied Soft Computing (2020): 106384.

Deep learning for financial applications: Topic-Feature Heatmap



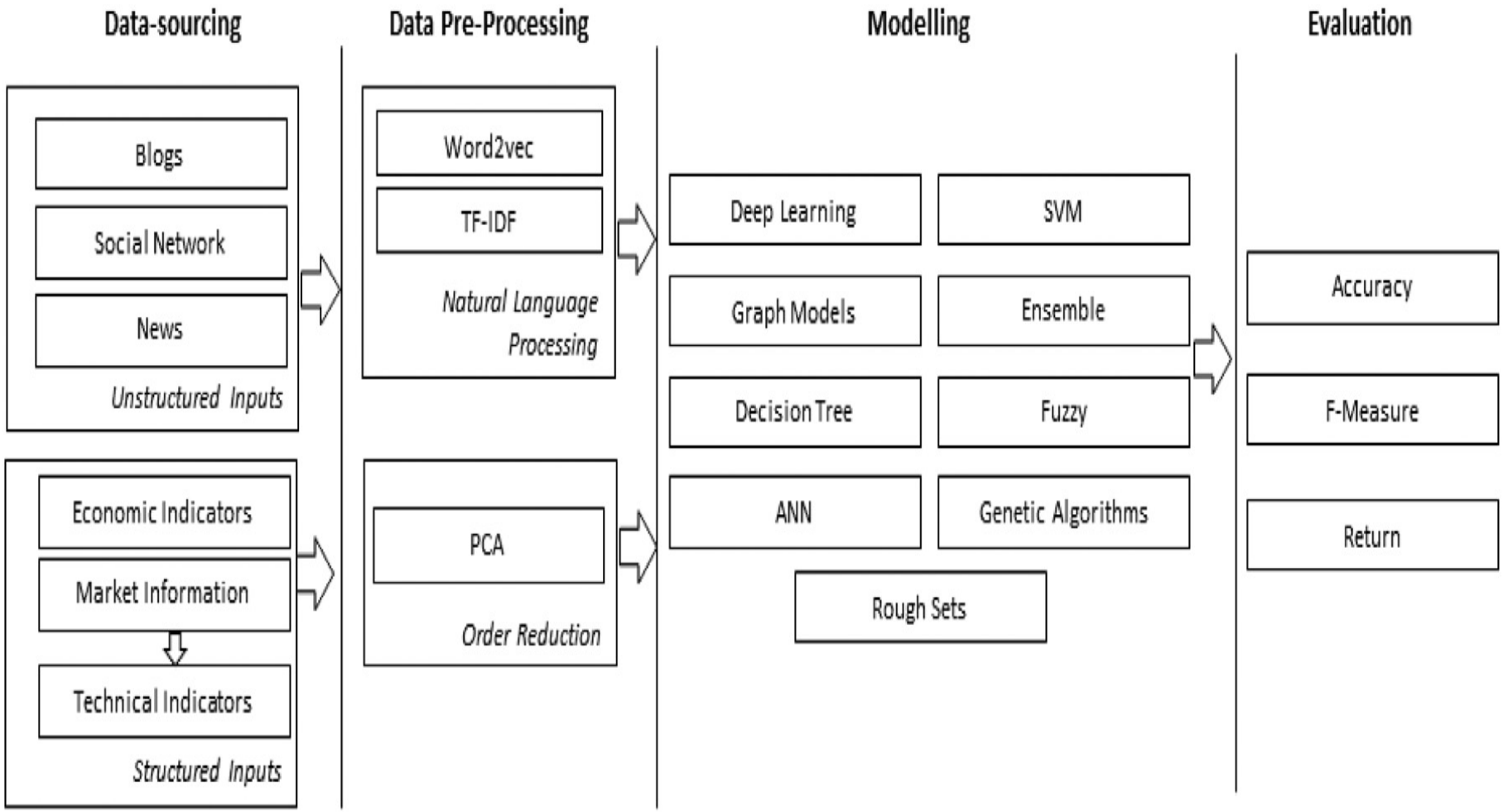
Source: Ahmet Murat Ozbayoglu, Mehmet Ugur Gudelek, and Omer Berat Sezer (2020). "Deep learning for financial applications: A survey." Applied Soft Computing (2020): 106384.

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.

Decentralized Finance (DeFi)

Block Chain FinTech

Decentralized Finance (DeFi)

- A global, open alternative to the current financial system.
- Products that let you borrow, save, invest, trade, and more.
- Based on open-source technology that anyone can program with.

Source: https://ethereum.org/en/defi/

Traditional Finance
Centralized Finance (CeFi)

- Some people aren't granted access to set up a bank account or use financial services.
- Lack of access to financial services can prevent people from being employable.
- Financial services can block you from getting paid.
- A hidden charge of financial services is your personal data.
- Governments and centralized institutions can close down markets at will.
- Trading hours often limited to business hours of specific time zone.
- Money transfers can take days due to internal human processes.
- There's a premium to financial services because intermediary institutions need their cut.

Source: https://ethereum.org/en/defi/

DeFi vs. CeFi

Decentralized Finance (DeFi)	Traditional Finance (Centralized Finance; CeFi)
You hold your money.	Your money is held by companies.
You control where your money goes and how it's spent.	You have to trust companies not to mismanage your money, like lend to risky borrowers.
Transfers of funds happen in minutes.	Payments can take days due to manual processes.
Transaction activity is pseudonymous.	Financial activity is tightly coupled with your identity.
DeFi is open to anyone.	You must apply to use financial services.
The markets are always open.	Markets close because employees need breaks.
It's built on transparency – anyone can look at a product's data and inspect how the system works.	Financial institutions are closed books: you can't ask to see their loan history, a record of their managed assets, and so on.

Source: https://ethereum.org/en/defi/

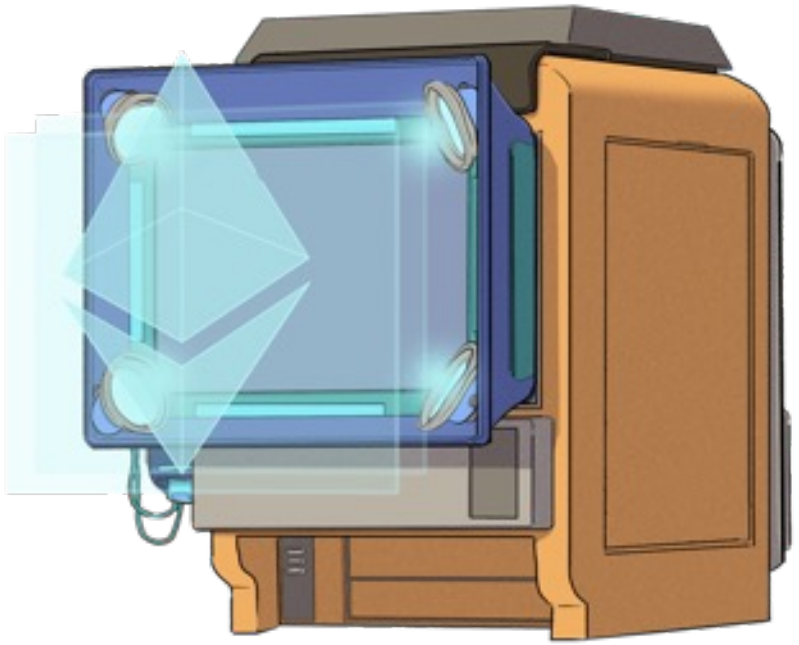
(DeFi)
Decentralized Applications (Dapps)

- **Ethereum-powered tools and services**
- **Dapps are a growing movement of applications that use Ethereum to disrupt business models or invent new ones**

Source: https://ethereum.org/en/defi/

The Internet of Assets

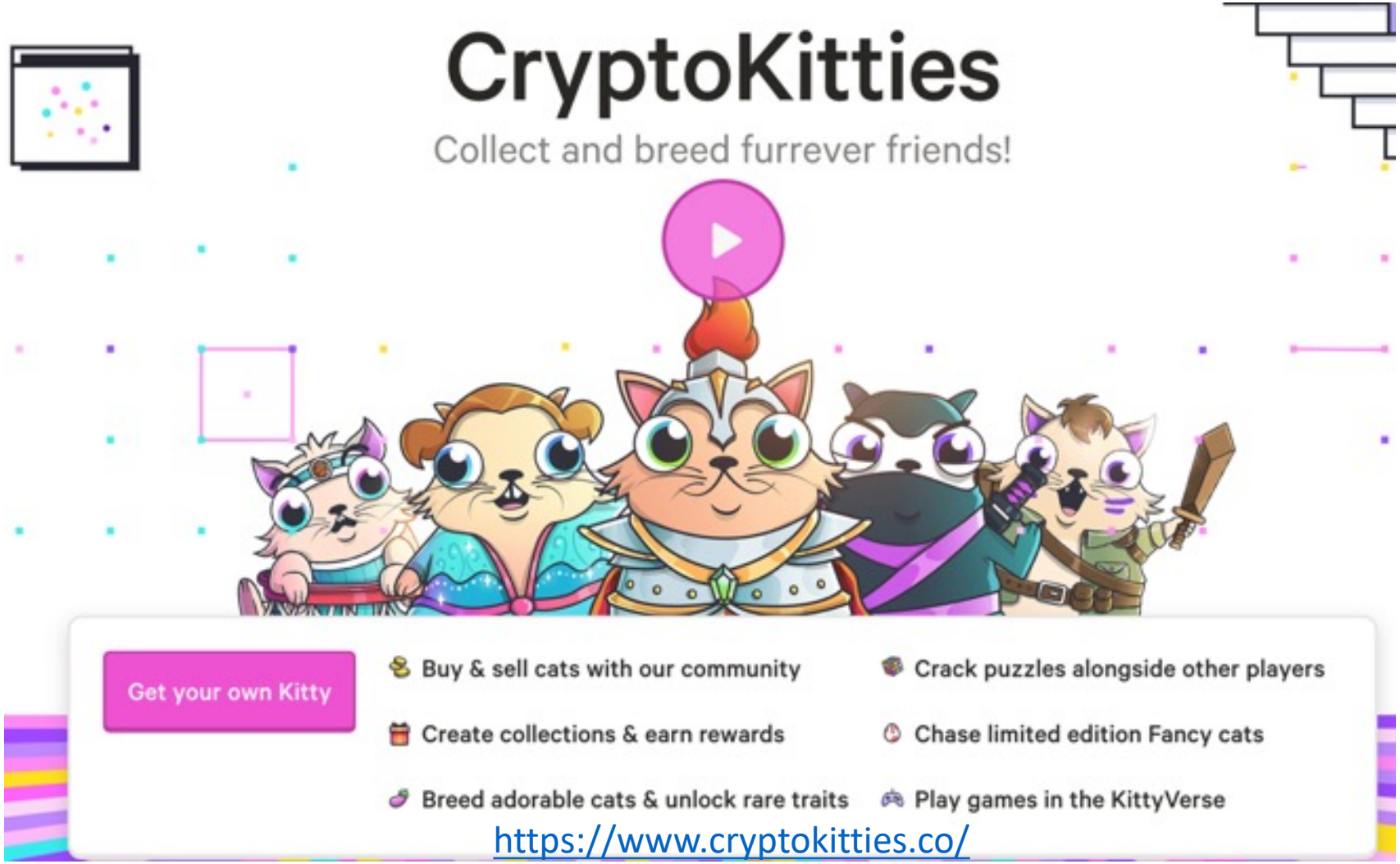
- **Ethereum** isn't just for **digital money**.
- Anything you can own can be **represented**, **traded** and **put to use** as **non-fungible tokens (NFTs)**.



Source: https://ethereum.org/en/defi/

Non-Fungible Tokens (NFT)

CryptoKitties



https://www.cryptokitties.co/

Source: Matt Fortnow and QuHarrison Terry (2021), The NFT Handbook - How to Create, Sell and Buy Non-Fungible Tokens, Wiley

Top 10 Cryptocurrency Prices by Market Cap

The global cryptocurrency market cap today is $949 Billion (2022/09/19)

#	Coin		Price	1h	24h	7d	24h Volume	Mkt Cap	Last 7 Days
☆ 1	Bitcoin BTC	Buy	$18,661.01	1.1%	-6.4%	-14.0%	$36,957,734,563	$357,450,768,001	
☆ 2	Ethereum ETH	Buy	$1,313.63	1.3%	-8.5%	-25.4%	$18,988,880,341	$158,564,862,486	
☆ 3	Tether USDT		$0.997150	-0.2%	-0.5%	-0.0%	$46,657,045,064	$68,000,277,868	
☆ 4	USD Coin USDC		$0.996395	-0.2%	-0.5%	-0.1%	$5,228,754,733	$50,102,628,549	
☆ 5	BNB BNB		$260.50	0.6%	-5.9%	-11.6%	$689,626,161	$42,564,018,996	
☆ 6	Binance USD BUSD		$1.00	0.1%	0.4%	0.2%	$9,983,425,894	$20,819,973,178	
☆ 7	XRP XRP		$0.353198	1.3%	-7.0%	-0.4%	$2,380,959,267	$17,549,730,741	
☆ 8	Cardano ADA		$0.442609	1.4%	-7.6%	-13.0%	$713,335,000	$14,972,334,641	
☆ 9	Solana SOL	Buy	$31.30	1.2%	-6.1%	-10.3%	$859,963,985	$11,095,015,943	
☆ 10	Dogecoin DOGE		$0.056770	0.6%	-6.7%	-10.7%	$320,451,732	$7,535,360,925	

Source: https://www.coingecko.com/en

Top Stablecoins
(Tether USDT, USD Coin USDC, Dai)

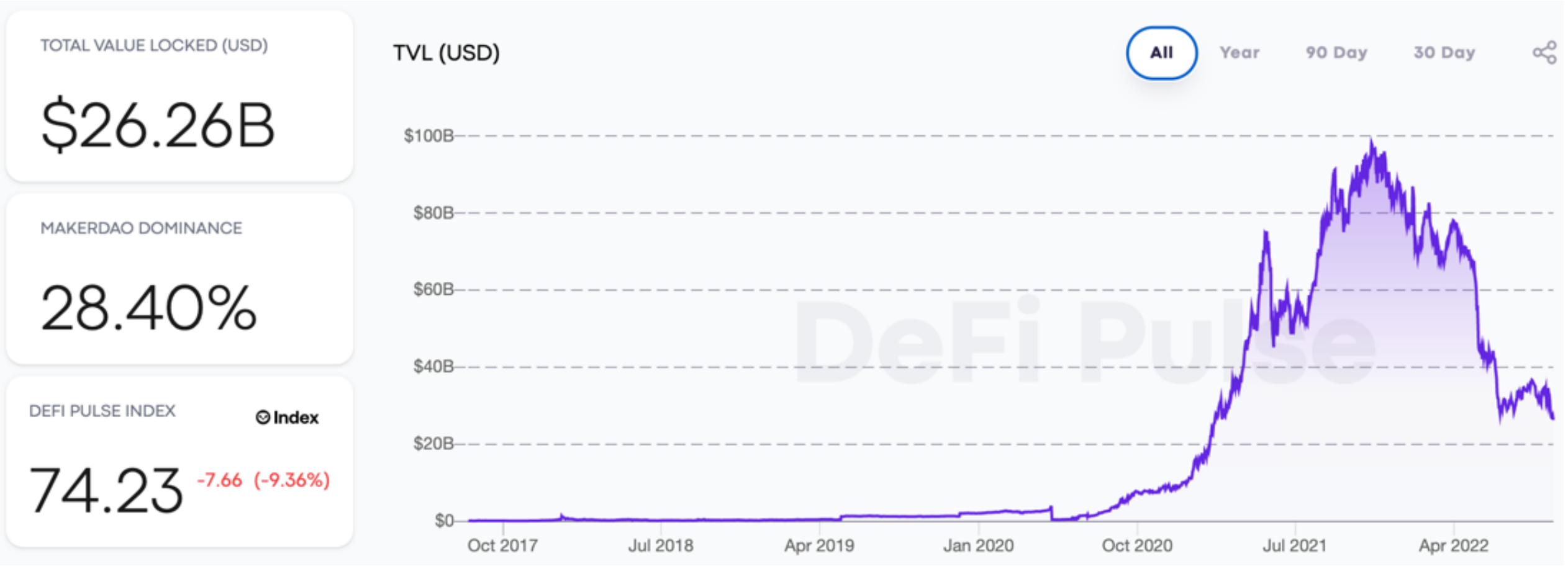
Digital money for everyday use
Stablecoins are
Ethereum tokens designed to
stay at a fixed value,
even when
the price of ETH changes.

CURRENCY	MARKET CAPITALIZATION	COLLATERAL TYPE
Tether	$67,921,899,068	Fiat
USD Coin	$50,081,277,279	Fiat
Binance USD	$20,811,100,732	Fiat
Dai	$6,411,784,420	Crypto
Frax	$1,358,584,284	Algorithmic
TrueUSD	$1,074,503,081	Fiat
Pax Dollar	$963,944,923	Fiat

Source: https://ethereum.org/en/stablecoins/

DeFi Total Value Locked (USD)

(DeFi Pulse)



Source: https://defipulse.com/

Top 10 DeFi Applications (DApps)

(DeFi Pulse)

Lending

DEXes (Decentralized Exchanges)

Derivatives

Assets

Payments

#	NAME	CHAIN	SECTOR	TVL (USD)
1	MakerDAO	Ethereum	Lending	$7.25B
2	Curve	Ethereum	DEXes	$4.22B
3	Aave	Ethereum	Lending	$3.98B
4	Uniswap	Ethereum	DEXes	$3.60B
5	Compound	Ethereum	Lending	$2.10B
6	InstaDApp	Ethereum	Lending	$1.19B
7	Liquity	Ethereum	Lending	$643.3M
8	Balancer	Ethereum	DEXes	$488.8M
9	dYdX	Ethereum	Derivatives	$471.3M
10	SushiSwap	Ethereum	DEXes	$305.1M

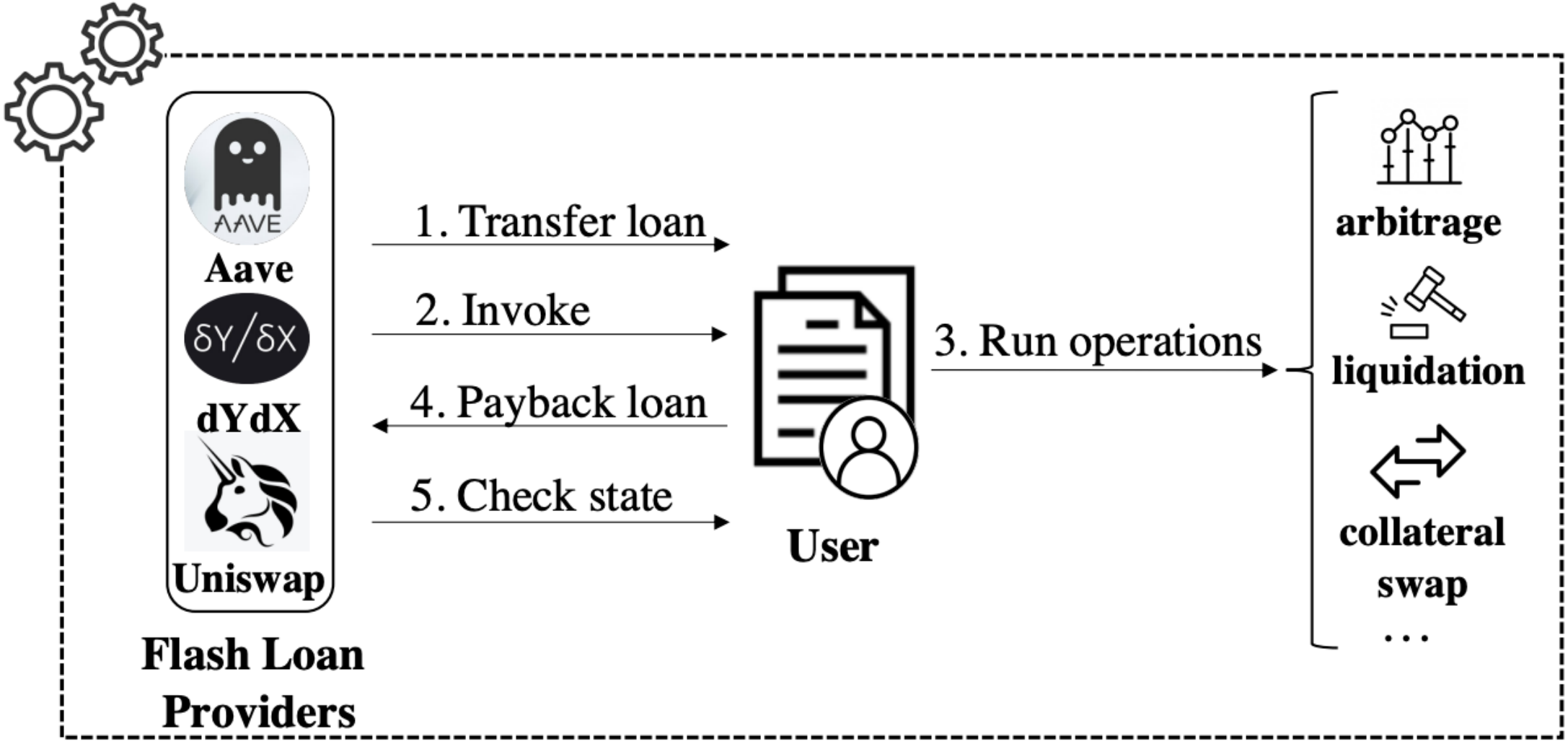
Source: https://defipulse.com/

Financial Stability Challenges

Crypto Ecosystem	• **Operational, cyber, and governance risks** • **Integrity (market and AML/CFT)** (Anti–Money Laundering / Combating the Financing of Terrorism) • **Data availability / reliability** • **Challenges from cross-boarder activites**
Stablecoins	• **How stable are stablecoins?** • **Domestic and global regulatory and supervisory approaches**
Macro-Financial	• **Cryptoization, capital flows, and restrictions** • **Monetary policy transmission** • **Bank disintermediation**

Source: Parma Bains, Mohamed Diaby, Dimitris Drakopoulos, Julia Faltermeier, Federico Grinberg, Evan Papageorgiou, Dmitri Petrov, Patrick Schneider, and Nobu Sugimoto (2021), The Crypto Ecosystem and Financial Stability Challenges, International Monetary Fund, October 2021

Decentralized Finance Applications (DApps): Flash Loan Transaction



Source: Wang, Dabao, Siwei Wu, Ziling Lin, Lei Wu, Xingliang Yuan, Yajin Zhou, Haoyu Wang, and Kui Ren (2021). "Towards A First Step to Understand Flash Loan and Its Applications in DeFi Ecosystem." In *Proceedings of the Ninth International Workshop on Security in Blockchain and Cloud Computing*, pp. 23-28. 2021.

The Economics of Money, Banking and Financial Markets

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Economics of Money, Banking and Financial Markets

1. Money, Banking, and Financial System
2. Financial Markets
3. Financial Institutions
4. Central Banking and the Conduct of Monetary Policy
5. International Finance and Monetary Policy
6. Monetary Theory
7. Financial Services Industry

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

INTRODUCTION

1. Why Study Money, Banking, and Financial Markets?
2. An Overview of the Financial System
3. What Is Money?

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

FINANCIAL MARKETS

4. Understanding Interest Rates

5. The Behavior of Interest Rates

6. The Risk and Term Structure of Interest Rates

7. The Stock Market, the Theory of Rational Expectations, and the Efficient Market Hypothesis

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

FINANCIAL INSTITUTIONS

8. An Economic Analysis of Financial Structure
9. Banking and the Management of Financial Institutions
10. Economic Analysis of Financial Regulation
11. Banking Industry: Structure and Competition
12. Financial Crises

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

CENTRAL BANKING AND THE CONDUCT OF MONETARY POLICY

13. Central Banks and the Federal Reserve System

14. The Money Supply Process

15. The Tools of Monetary Policy

16. The Conduct of Monetary Policy: Strategy and Tactics

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

MONETARY THEORY

19. Quantity Theory, Inflation, and the Demand for Money

20. The IS Curve

21. The Monetary Policy and Aggregate Demand Curves

22. Aggregate Demand and Supply Analysis

23. Monetary Policy Theory

24. The Role of Expectations in Monetary Policy

25. Transmission Mechanisms of Monetary Policy

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Financial Services Industry

26. Financial Crises in Emerging Market Economies

27. The ISLM Model

28. Nonbank Finance

29. Financial Derivatives

30. Conflicts of Interest in the Financial Services Industry

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Why Study Money, Banking, and Financial Markets?

Why Study Money, Banking, and Financial Markets?

- To examine how financial markets such as bond, stock and foreign exchange markets work
- To examine how financial institutions such as banks and insurance companies work
- To examine the role of money in the economy

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Financial Markets

- **Markets in which funds are transferred from people who have an excess of available funds to people who have a shortage of funds**
  - **Bond market**
  - **Stock market**
  - **Foreign exchange market**

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Financial Institutions

- **Financial Intermediaries: institutions that borrow funds from people who have saved and make loans to other people:**
  - **Banks: accept deposits and make loans**
  - **Other Financial Institutions: insurance companies, finance companies, pension funds, mutual funds and investment banks**
- **Financial Innovation: the advent of the information age and e-finance**

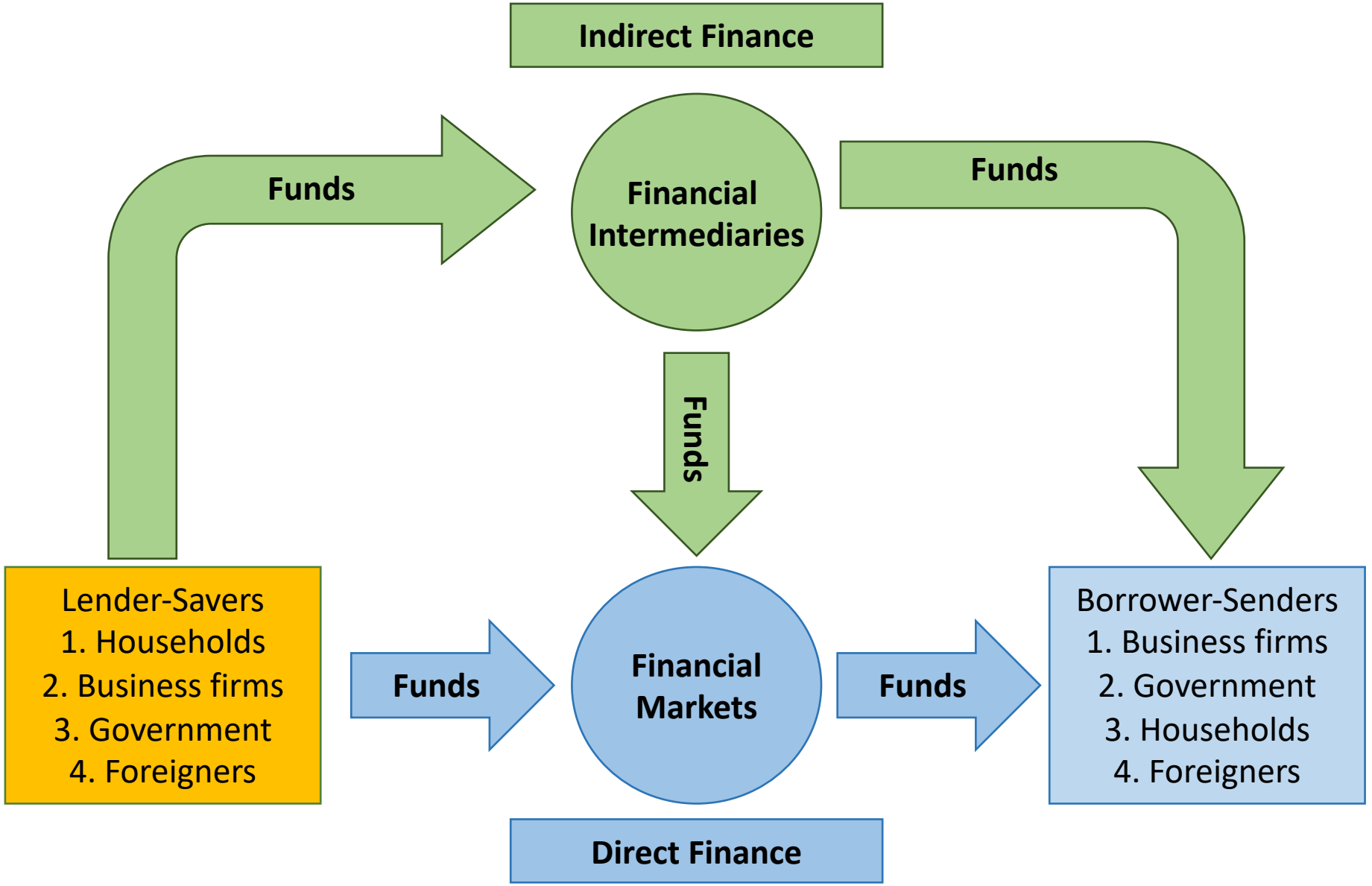
Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Money and Business Cycles

- **Money plays an important role in generating business cycles**
- **Recessions (unemployment) and expansions affect all of us**
- **Monetary Theory ties changes in the money supply to changes in aggregate economic activity and the price level**

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Overview of the Financial System



Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

What is Money?

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Money

Source: http://www.wpclipart.com/money/bills/bills_2/stack_of_bills_2.png.html

Bills

Source: http://www.wpclipart.com/money/bills/bills_2/stack_of_bills_2.png.html

Meaning of Money

- **Money (=money supply) any vehicle used as a means of exchange to pay for goods, services or debts.**
- **In today's society, any asset that can quickly be transferred into cash is considered money.**
- **The more liquid an asset is, the closer it is to money.**
- **In economics, money does not mean wealth nor does it mean income.**

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Functions of Money

- **Medium of Exchange**
- **Unit of Account**
- **Store of Value**

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Medium of Exchange

- By eliminating barter, this function of money increases efficiency in a society.
- As human societies started to engage in exchange money had to be invented.
- Any technological change that reduces transaction costs increases the wealth of the society.
- Any technological change that allows people to specialize also increases wealth.

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Unit of Account

- We use money to measure the value of goods and services.
- Suppose we had 4 goods and no money. How do we measure the price of each good?
  - A in terms of B
  - B in terms of C
  - C in terms of D
  - A in terms of C
  - A in terms of D
  - B in terms of D

N!/2(N-2)!

- Money allows to quote prices in terms of currency only.

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Store of Value

- All assets are stored value.
- Money, although without any return, is still desirable to hold because it allows purchases immediately.
- Other assets take time (transaction costs) to use as a payment for purchases.
- The more liquid an asset is, the less transaction cost it carries.
- Inflation erodes the value of money.

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Evolution of the Payments System

- **Commodity Money:**
  - **valuable, easily standardized and divisible commodities (e.g. precious metals, cigarettes).**
- **Fiat Money:**
  - **paper money decreed by governments as legal tender.**

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Electronic Money

- **Debit Cards**
  - **Instant transfer from your checking account to merchant's checking account.**
- **Stored Value Card**
  - **Gift cards.**
- **Electronic Cash**
  - **Account set up on a person's PC from her bank whereby she can buy products over the Internet.**
- **Electronic Checks**
  - **Checks written on PC and sent through the Internet.**

Benefits of Paper Checks

- **Cheaper than telecommunications network.**
- **Provide receipts.**
- **Allow float.**
- **May be more secure; avoid hacker problems.**
- **Do not leave a wealth of information trail.**

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Measuring Money

- **M1:**
  - **Currency, demand deposits, travelers checks.**
- **M2:**
  - **M1, saving deposits, small time deposits, retail MMMF.**
- **M3:**
  - **M2, large time deposits, repos, Eurodollar deposits, institutional MMMF.**
- **MZM:**
  - **M2, institutional MMMF minus small time deposits.**
- **Growth rates of these aggregates do not always go hand in hand, making monetary policy difficult since signals are conflicting.**

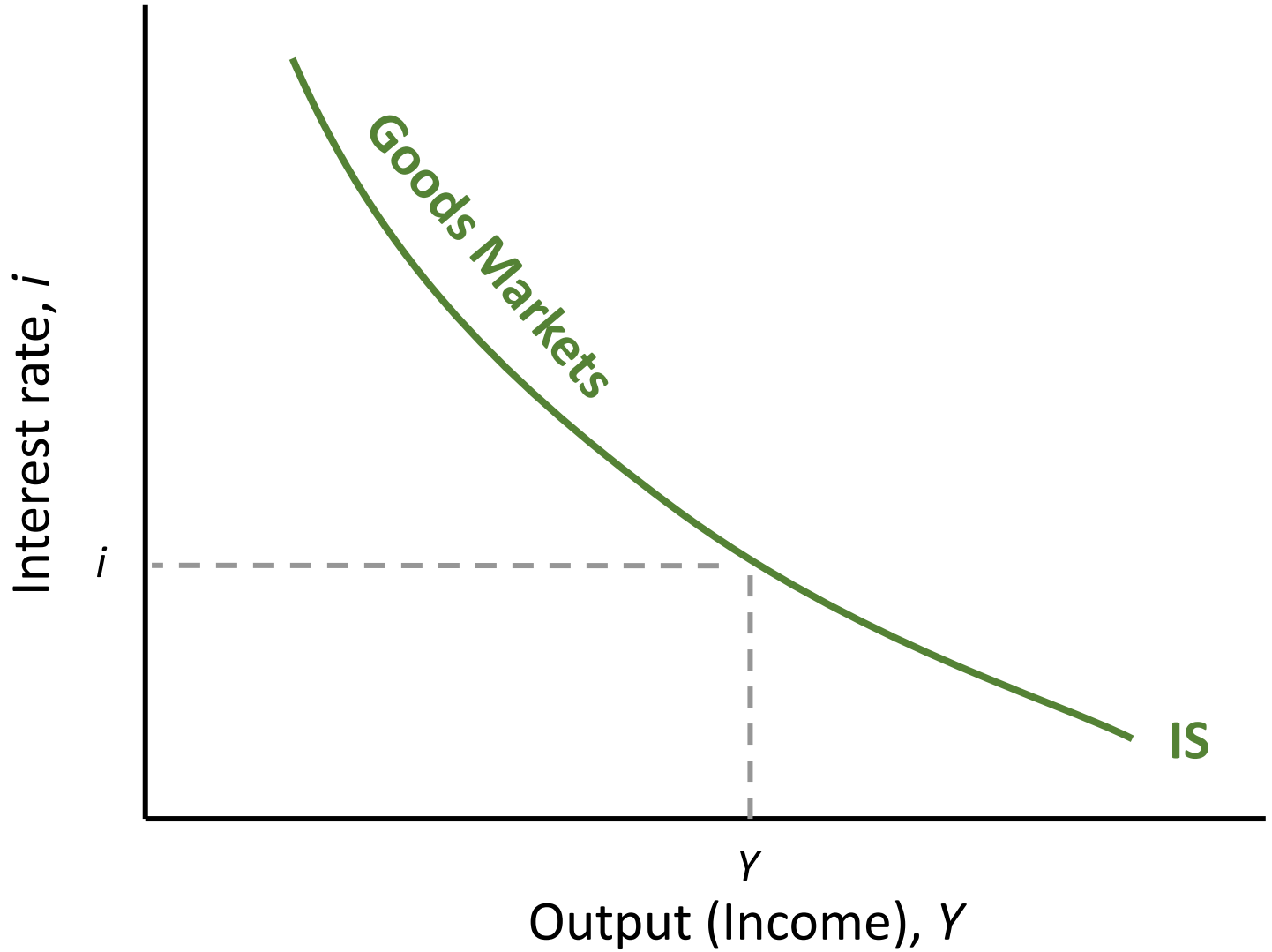
Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

The IS Curve

The IS (Investment/Saving) Curve

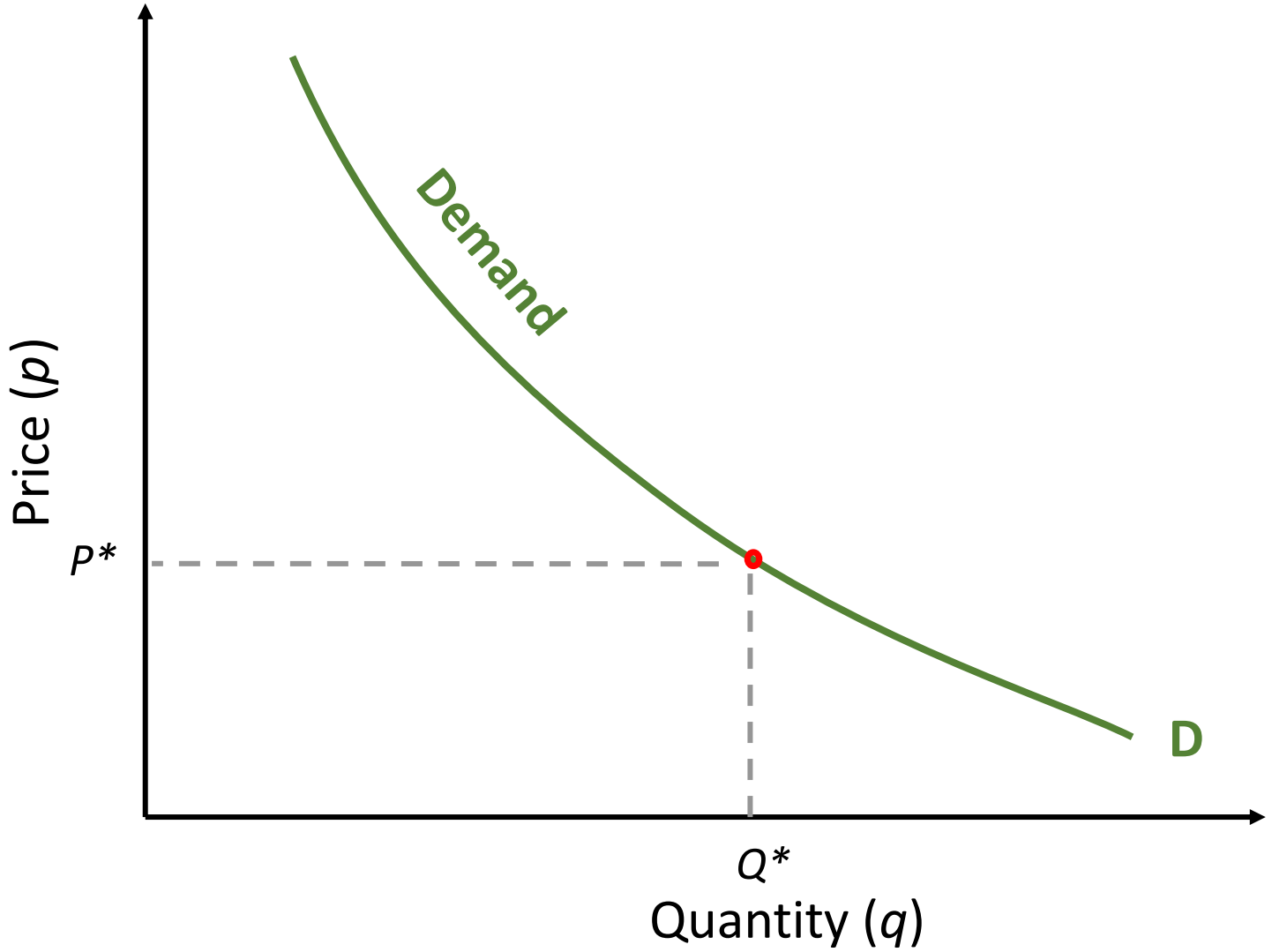
Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

The IS (Investment/Saving) Curve



Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Demand



Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

The ISLM Model

Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

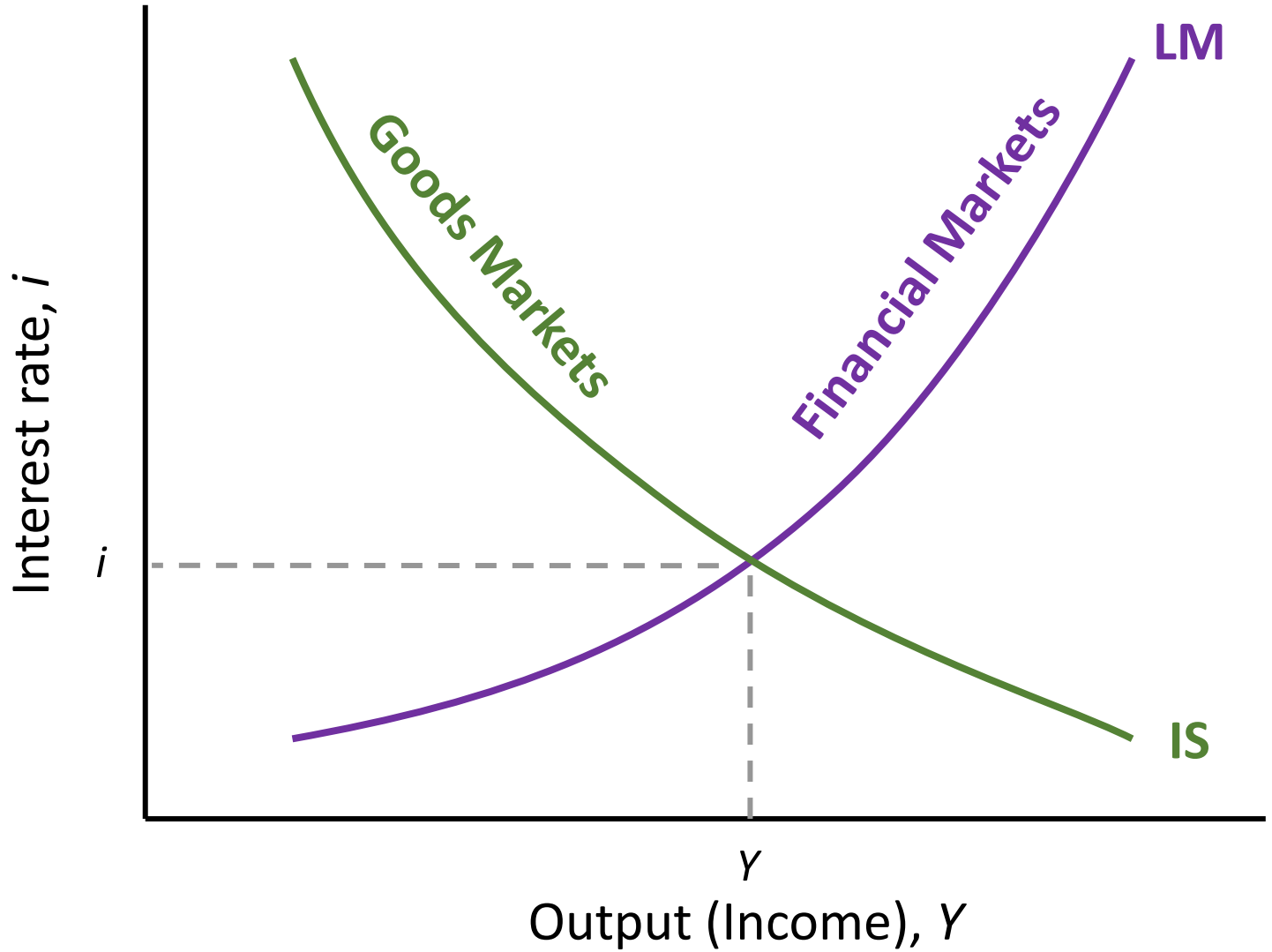
Goods and Financial Markets:

The ISLM Model

(Investment Saving – Liquidity Preference Money Supply) model

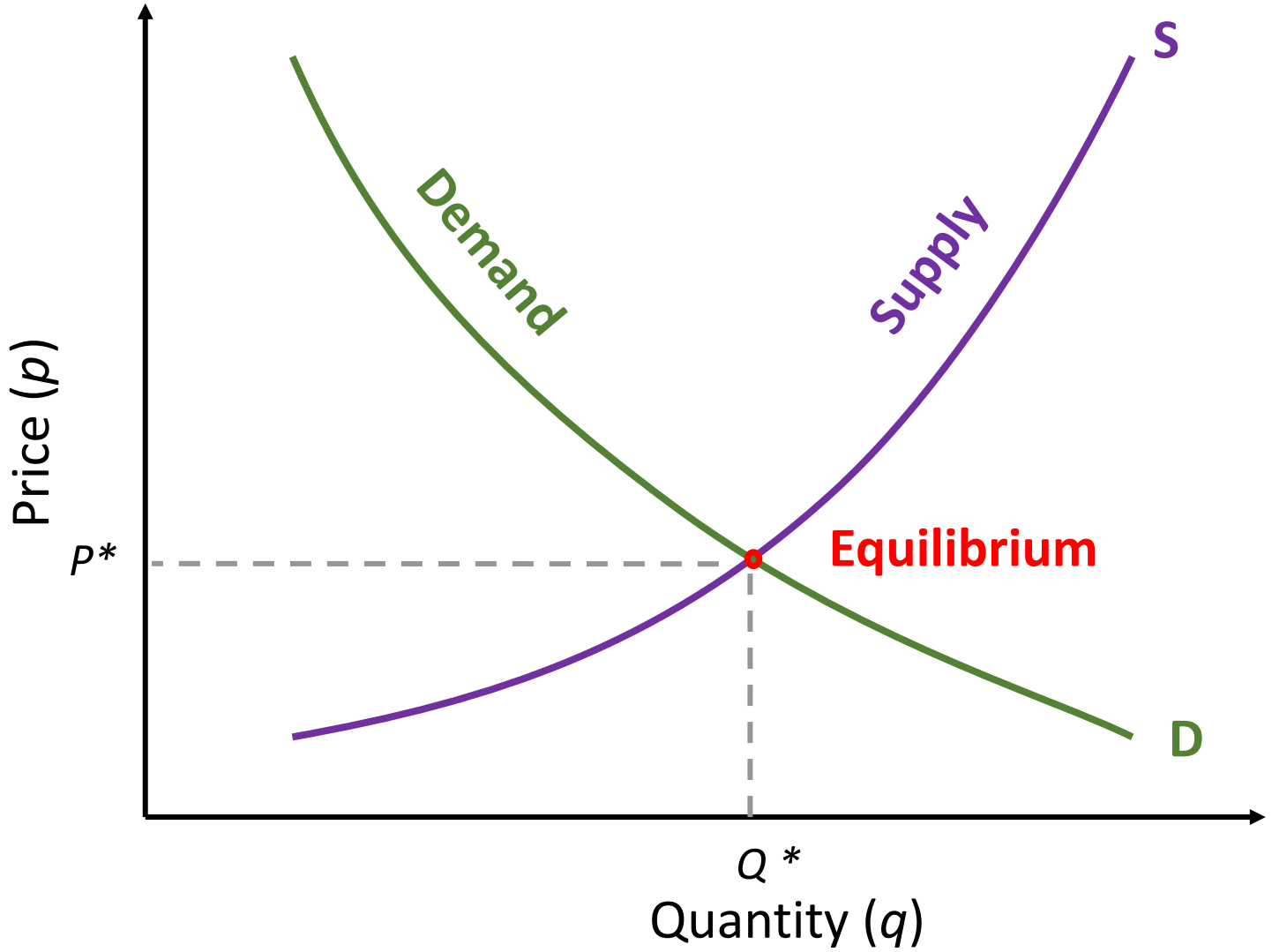
Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

The ISLM Model (Investment Saving – Liquidity Preference Money Supply) model



Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Supply and Demand



Source: Frederic S. Mishkin (2015), The Economics of Money, Banking and Financial Markets, 11th Edition, Pearson

Financial Services

Technology Innovation

Innovation

Source: https://www.merriam-webster.com/dictionary/innovation

Innovation:

a new idea, method, or device

Source: https://www.merriam-webster.com/dictionary/innovation

Innovation: something new

Source: https://www.merriam-webster.com/dictionary/innovation

Novelty :

something new or unusual

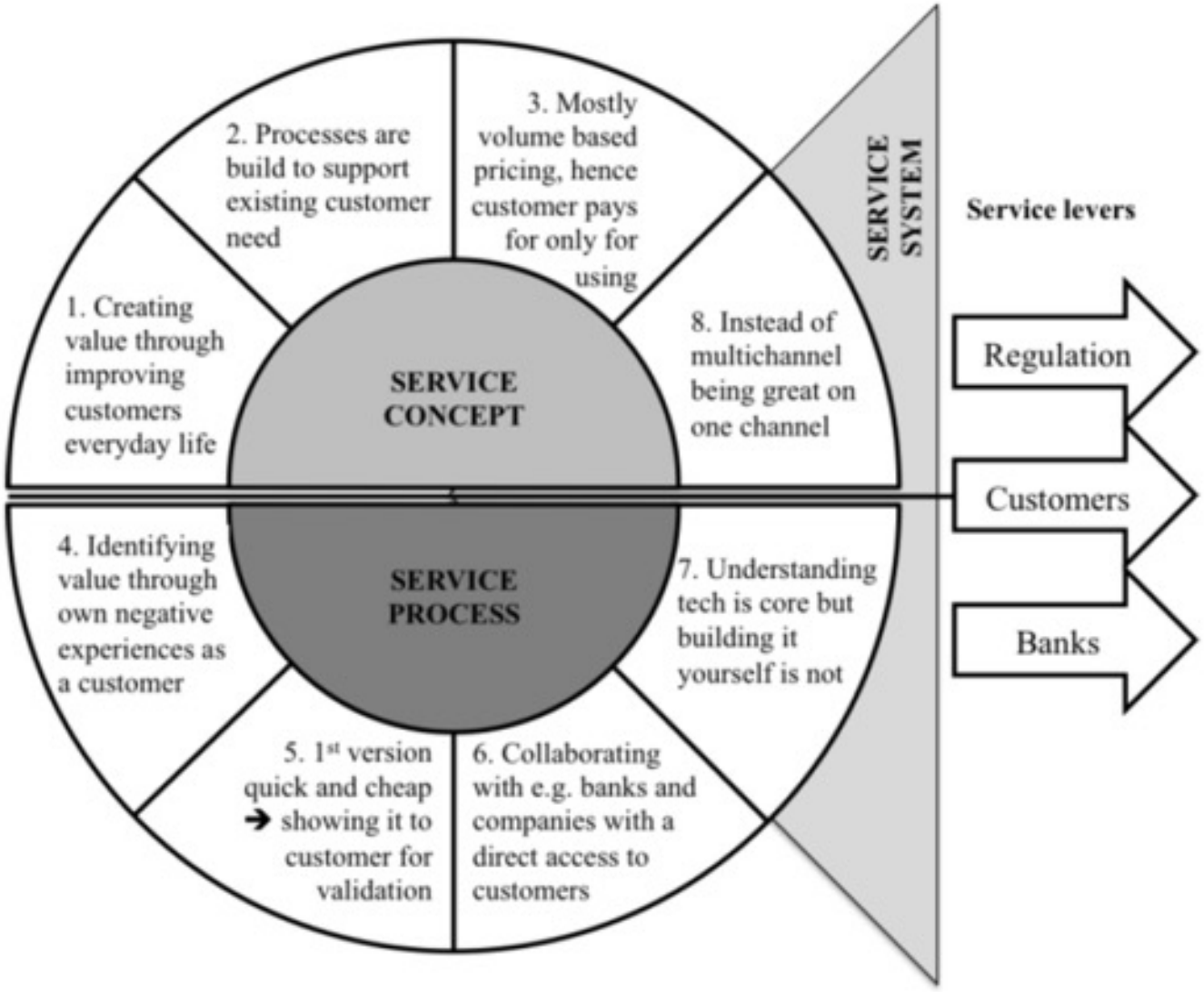
the novelty of a self-driving car

Source: https://www.merriam-webster.com/dictionary/novelty

Creativity is not a new Idea.

Creativity is an old belief you leave behind

FinTechs as Service Innovators: Analysing Components of Innovation



Source: Riikkinen, Mikko, Kaisa Still, Saila Saraniemi, and Katri Kallio. "FinTechs as service innovators: analysing components of innovation." In *ISPIM Innovation Symposium*, The International Society for Professional Innovation Management (ISPIM), 2016.

Innovation

“a process of searching and recombining existing knowledge elements”

Source: Savino, Tommaso, Antonio Messeni Petruzzelli, and Vito Albino. "Search and recombination process to innovate: A review of the empirical evidence and a research agenda." International Journal of Management Reviews (2017).

Search and recombination process to innovate:
A review of the empirical evidence and a research agenda

Source: Savino, Tommaso, Antonio Messeni Petruzzelli, and Vito Albino. "Search and recombination process to innovate: A review of the empirical evidence and a research agenda." International Journal of Management Reviews (2017).

Innovation Research in Economics, Sociology and Technology Management

Source: Gopalakrishnan, Shanti, and Fariborz Damanpour.
"A review of innovation research in economics, sociology and technology management." *Omega* 25, no. 1 (1997): 15-28.

Innovation Research in Economics, Sociology and Technology Management

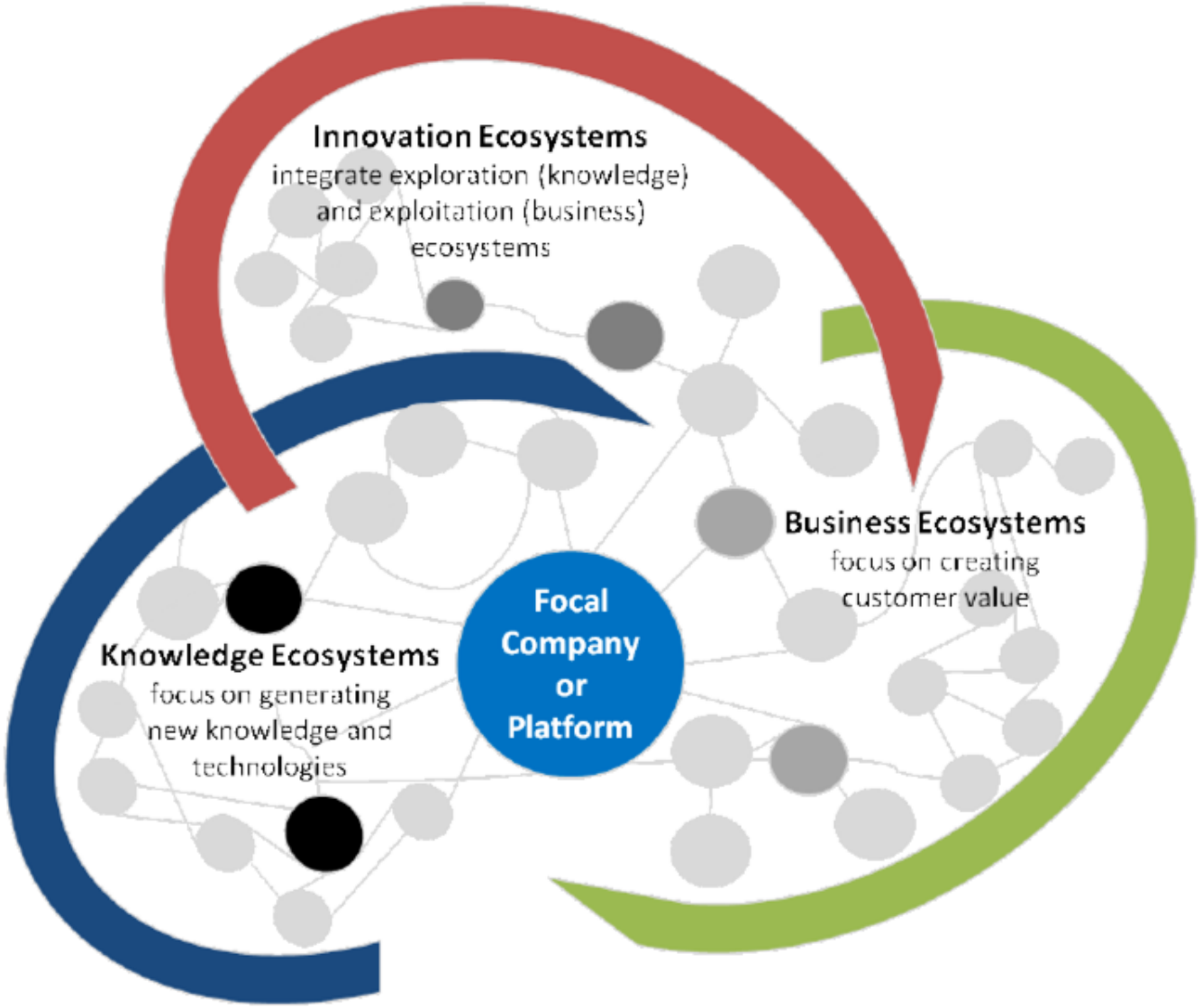
	Stage of process	Level of study	Type of innovation
Economists	Generation Idea generation Project definition	Industry	Product and process Only technical Only radical
Technologists			
Contextual technologists	Generation Commercialization and marketing Diffusion	Innovation (in the industry context)	Product and process Only technical Radical and incremental
Organizational technologists	Generation Idea generation Problem solving adoption Adoption Initiation	Organizational Sub-system	Product and process Only technical Radical and incremental
Sociologists			
Variance sociologists	Adoption Initiation Implementation	Organization	Product and process Technical and administrative Radical and incremental
Process sociologists	Adoption Initiation Implementation	Innovation (at the organizational level)	Product and process Technical and administrative Radical and incremental

Source: Gopalakrishnan, Shanti, and Fariborz Damanpour.
"A review of innovation research in economics, sociology and technology management." *Omega* 25, no. 1 (1997): 15-28.

Business, Innovation, and Knowledge Ecosystems

Source: Valkokari, Katri. "Business, innovation, and knowledge ecosystems: how they differ and how to survive and thrive within them." *Technology Innovation Management Review* 5, no. 8 (2015).

Business, Innovation, and Knowledge Ecosystems



Source: Valkokari, Katri. "Business, innovation, and knowledge ecosystems: how they differ and how to survive and thrive within them." *Technology Innovation Management Review* 5, no. 8 (2015).

Innovation Ecosystems Characteristics

	Business Ecosystems	Innovation Ecosystems	Knowledge Ecosystems
Baseline of Ecosystem	Resource exploitation for customer value	**Co-creation of innovation**	Knowledge exploration
Relationships and Connectivity	Global business relationships both competitive and co-operative	Geographically clustered actors, different levels of collaboration and openness	Decentralized and disturbed knowledge nodes, synergies through knowledge exchange
Actors and Roles	Suppliers, customers, and focal companies as a core, other actors more loosely involved	**Innovation policymakers, local intermediators, innovation brokers, and funding organizations**	Research institutes, innovators, and technology entrepreneurs serve as knowledge nodes
Logic of Action	A main actor that operates as a platform sharing resources, assets, and benefits or aggregates other actors together in the networked business operations	Geographically proximate actors interacting around hubs facilitated by intermediating actors	A large number of actors that are grouped around knowledge exchange or a central non-proprietary resource for the benefit of all actors

Source: Valkokari, Katri. "Business, innovation, and knowledge ecosystems: how they differ and how to survive and thrive within them." *Technology Innovation Management Review* 5, no. 8 (2015).

Diffusion of Innovation Theory (DOI)

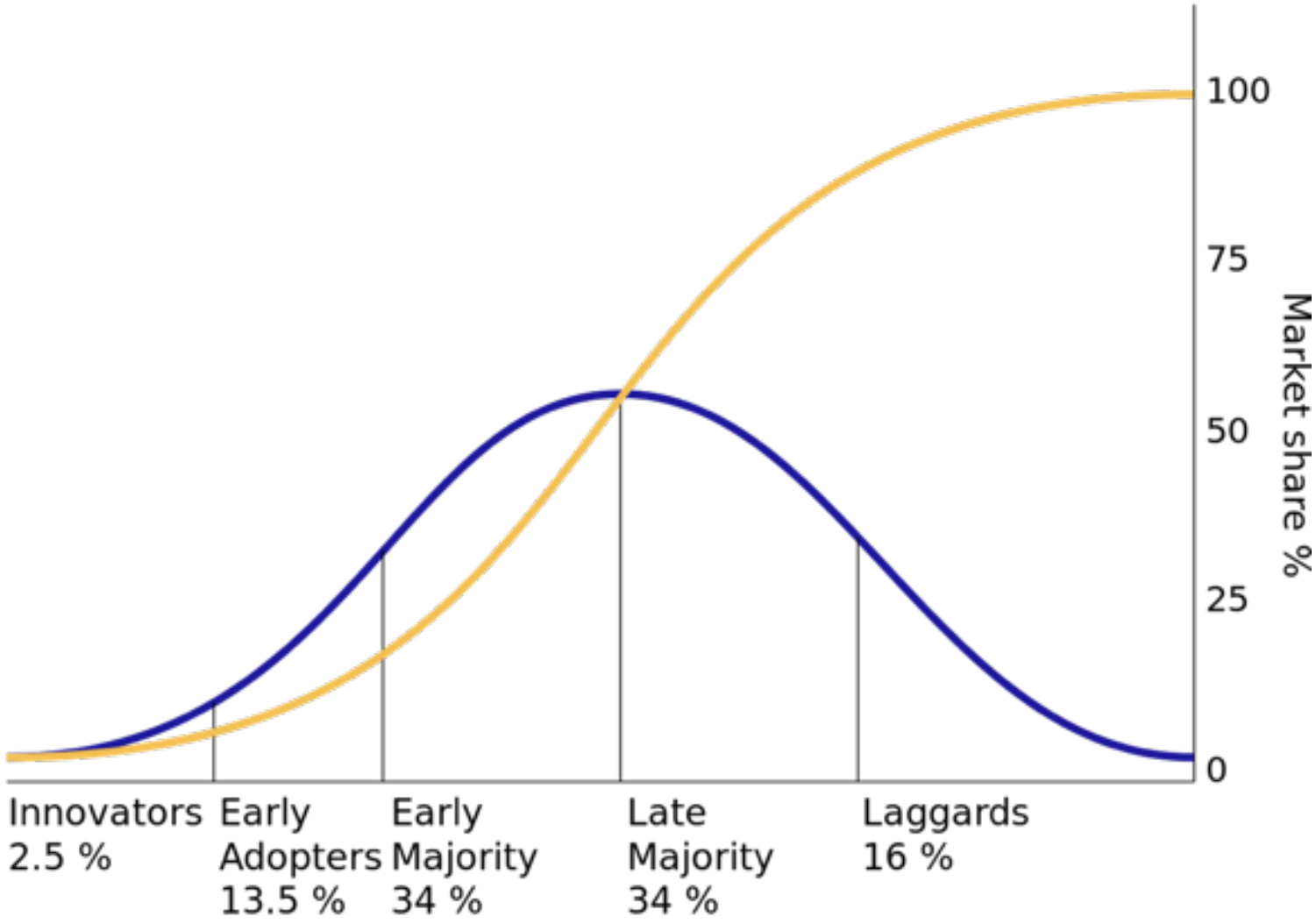
Source: Everett M. Rogers (2003), “Diffusion of Innovations”, Free Press, 5th Edition

Innovation
(Diffusion of Innovation)

1. Relative advantage
2. Compatibility
3. Complexity
4. Trialability
5. Observability

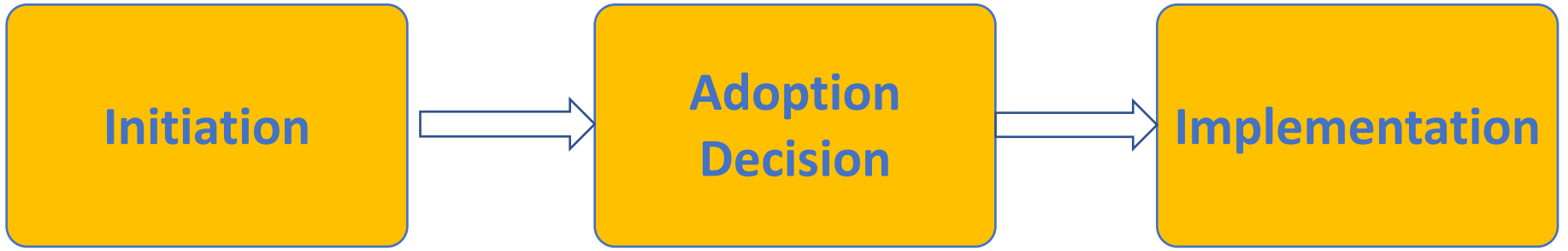
Source: Everett M. Rogers (2003), “Diffusion of Innovations”, Free Press, 5th Edition

Diffusion of Innovation



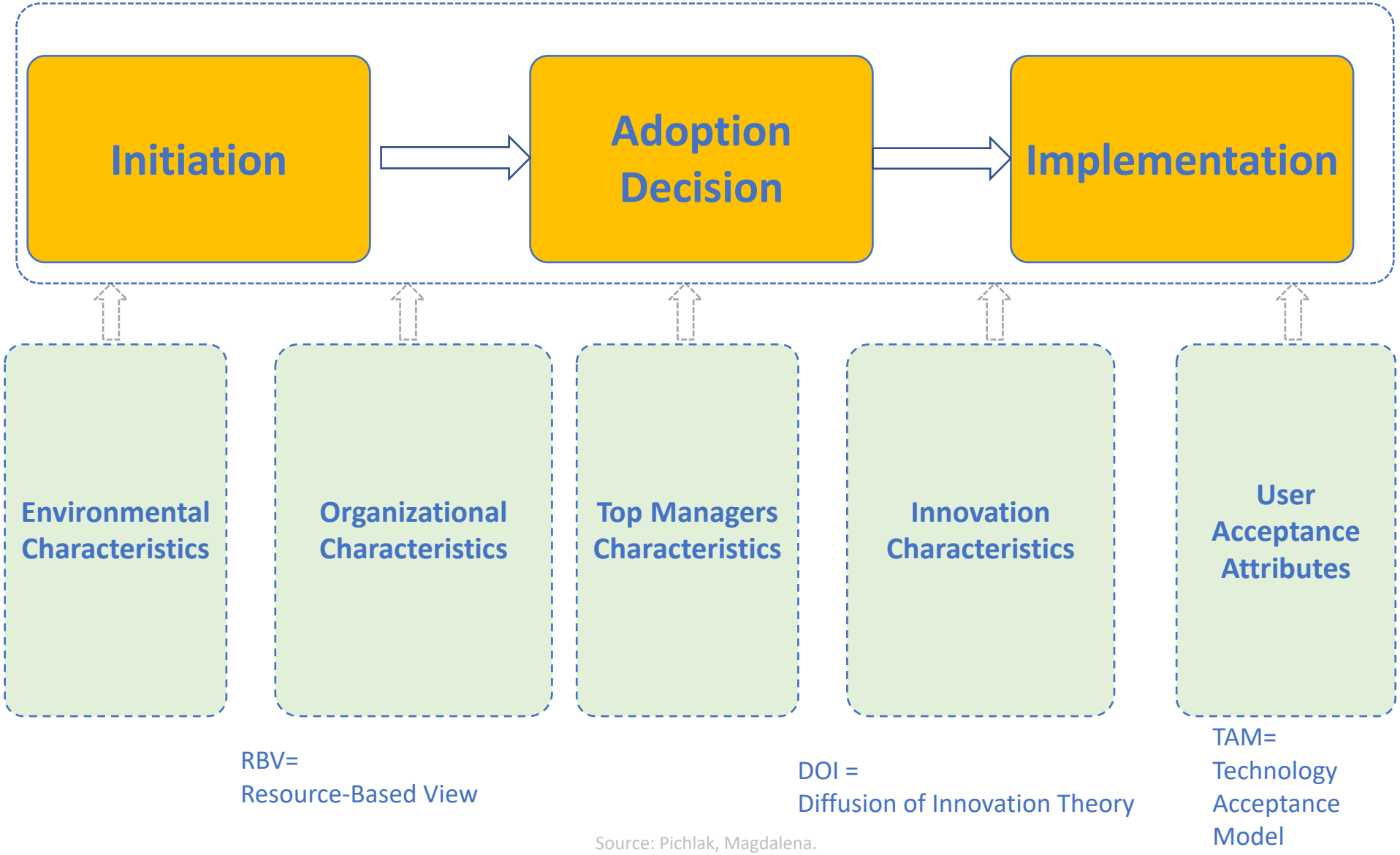
Source: https://en.wikipedia.org/wiki/Diffusion_of_innovations

Innovation Adoption Process



Source: Pichlak, Magdalena.
"The innovation adoption process: A multidimensional approach." Journal of Management and Organization 22, no. 4 (2016): 476.

Innovation Adoption Process



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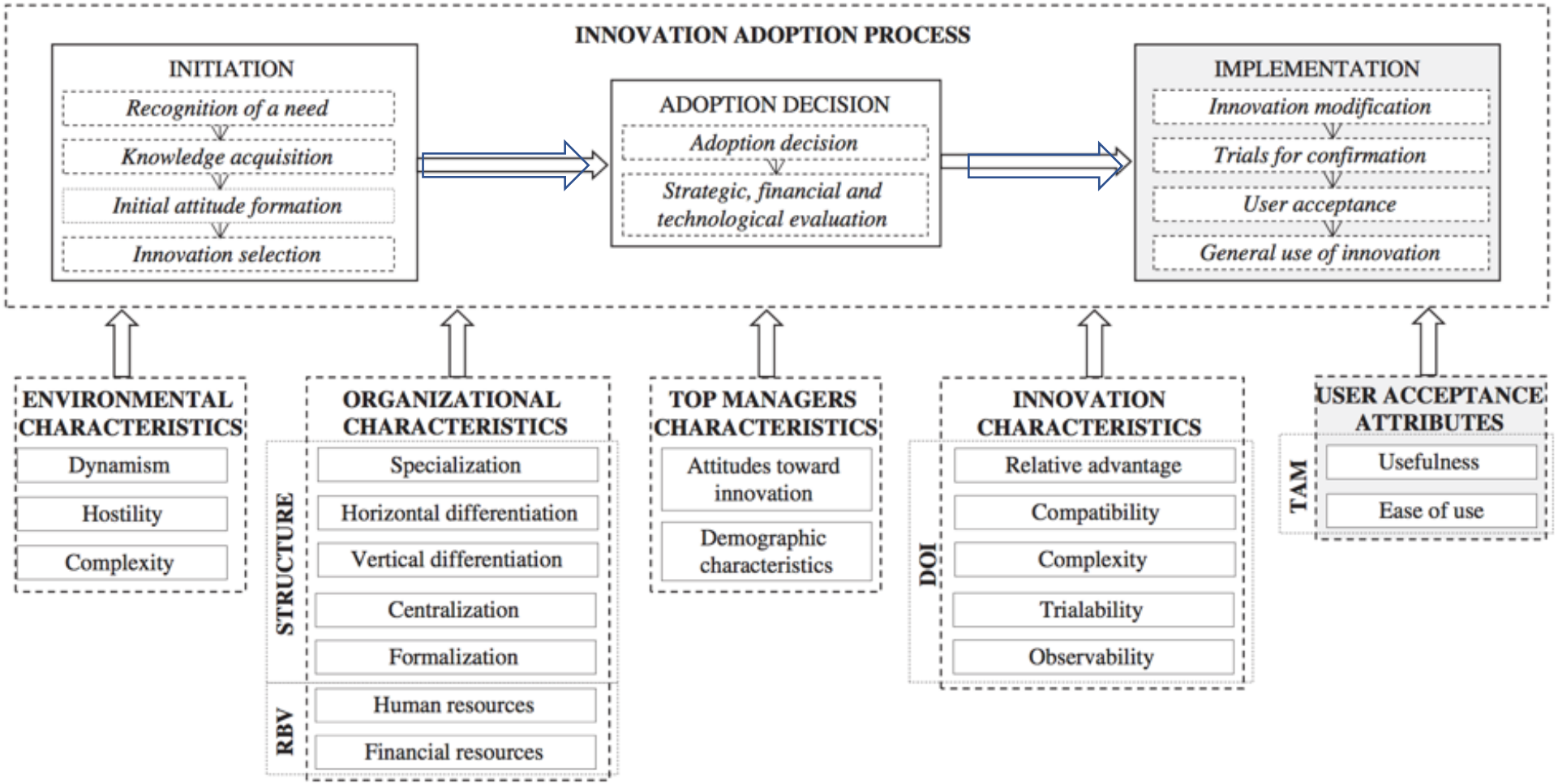
Innovation Adoption Process



RBV=
Resource-Based View

DOI =
Diffusion of Innovation Theory

TAM=
Technology Acceptance Model

Source: Pichlak, Magdalena.
"The innovation adoption process: A multidimensional approach." Journal of Management and Organization 22, no. 4 (2016): 476.

Innovation Adoption Process

Factors		Initiation					Adoption decision					Implementation				
		Mean	Me	Q3	Q1	QD	Mean	Me	Q3	Q1	QD	Mean	Me	Q3	Q1	QD
Environmental characteristics	Dynamism	3.4	3	4	2.75	0.625	3.6	4	4	3	0.5	4	4	5	4	0.5
	Hostility	3.3	3	4.25	3	0.625	3.9	4	4.25	3.75	0.25	3.7	4	4.5	3.5	0.5
	Complexity	4.5	5	5	4	0.5	3.2	3	4	2.75	0.625	3.3	3	4.25	3	0.625
Organizational characteristics	Specialization	3.8	4	4.25	3.75	0.25	2.9	3	4	2	1	2	2	3.25	2	0.625
	Horizontal differentiation	2.8	3	3.75	2.75	0.5	2.7	3	3.5	2	0.75	2	2	3.5	2	0.75
	Vertical differentiation	2.1	2	3.25	2	0.625	3.3	3	4	2.5	0.75	3.1	3	4	2.75	0.625
	Centralization	2	2	3.25	2	0.625	3.8	4	4.25	3.75	0.25	3.9	4	4.25	3.75	0.25
	Formalization	2.1	2	3	1.75	0.625	3	3	4.25	3	0.625	3.3	3	4	3	0.5
	Human resources	4.9	5	5	4.5	0.25	4	4	5	4	0.5	4.1	4	5	4	0.5
	Financial resources	3.2	3	4	2.5	0.75	4.1	4	4.25	3.75	0.25	4.8	5	5	4	0.5
Top managers characteristics	Top managers attitude towards innovation	4.1	4	4.5	4	0.25	3.9	4	4.25	3.75	0.25	4	4	4.5	3.5	0.5
	Top managers demographic characteristics	2.3	2	3.25	1.75	0.75	2	2.5	3	1	1	2.2	2	3	1.5	0.75
Innovation characteristics	Relative advantage	3	3	4	2.75	0.625	4.4	4.5	5	4	0.5	3.1	3	4	2.75	0.625
	Compatibility	2.8	3	3.5	2	0.75	3.9	4	4.25	3.75	0.25	3.9	4	4.25	3.75	0.25
	Complexity	3.6	4	4.25	3.75	0.25	3.8	4	4	3.75	0.125	3.9	4	4.25	3.75	0.25
	Trialability	3.2	3	4	2.75	0.625	3.1	3	4	2.5	0.75	4.1	4	5	4	0.5
	Observability	3.4	3.5	4.25	3	0.625	3.1	3.5	4	2	1	3.3	3	4.25	3	0.625
User acceptance attributes	Usefulness											3.2	3	4	2	1
	Ease of use											4	4	5	4	0.5

Note.
Me = median; Q = quartile; QD = quartile deviation.

Source: Pichlak, Magdalena.
"The innovation adoption process: A multidimensional approach." Journal of Management and Organization 22, no. 4 (2016): 476.

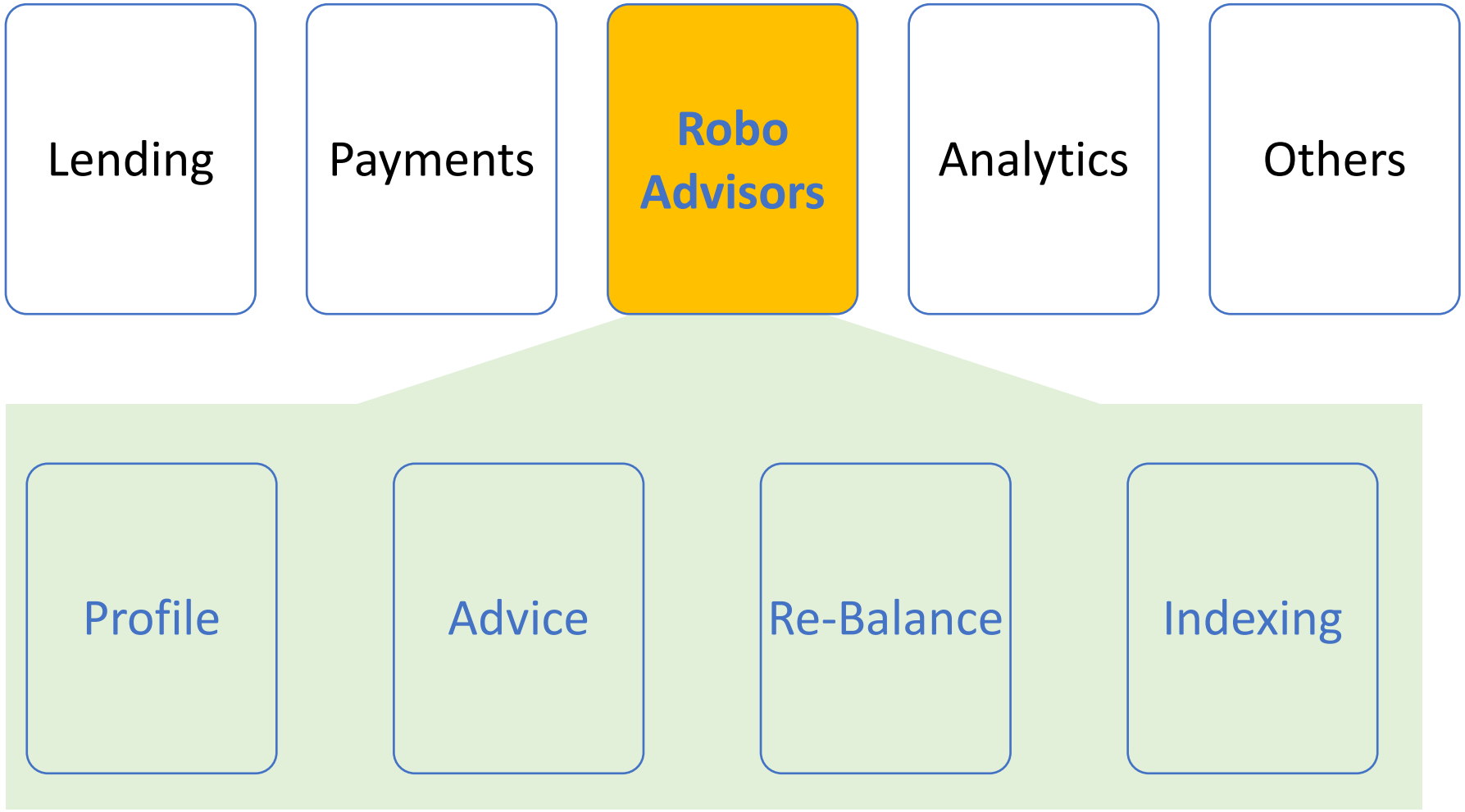
Innovation Adoption Process

Initiation			*Adoption decision*			*Implementation*		
Factors	*Round 1*	*Round 2*	*Factors*	*Round 1*	*Round 2*	*Factors*	*Round 1*	*Round 2*
Complexity in the environment	4.5	4.2	Dynamism in the environment	3.6	3.4	Dynamism in the environment	4.0	3.8
Specialization	3.8	3.4	Hostility in the environment	3.9	4.0	Hostility in the environment	3.7	3.4
Horizontal differentiation	2.8	3.1	Centralization	3.8	3.8	Centralization	3.9	3.8
Human resources	4.9	5.0	Human resources	4.0	4.2	Formalization	3.3	3.2
Top managers attitude towards innovation	4.1	4.3	Financial resources	4.1	4.4	Human resources	4.1	4.4
Innovation complexity	3.6	3.3	Top managers attitude towards innovation	3.9	4.0	Financial resources	4.8	5.0
			Relative advantage	4.4	4.1	Top managers attitude towards innovation	4.0	4.4
			Innovation compatibility	3.9	3.6	Innovation compatibility	3.9	3.8
			Innovation complexity	3.8	3.8	Innovation complexity	3.9	3.9
						Innovation trialability	4.1	3.9
						Ease of use	4.0	4.2

Source: Pichlak, Magdalena.
"The innovation adoption process: A multidimensional approach." Journal of Management and Organization 22, no. 4 (2016): 476.

FinTech Innovation

FinTech high-level classification



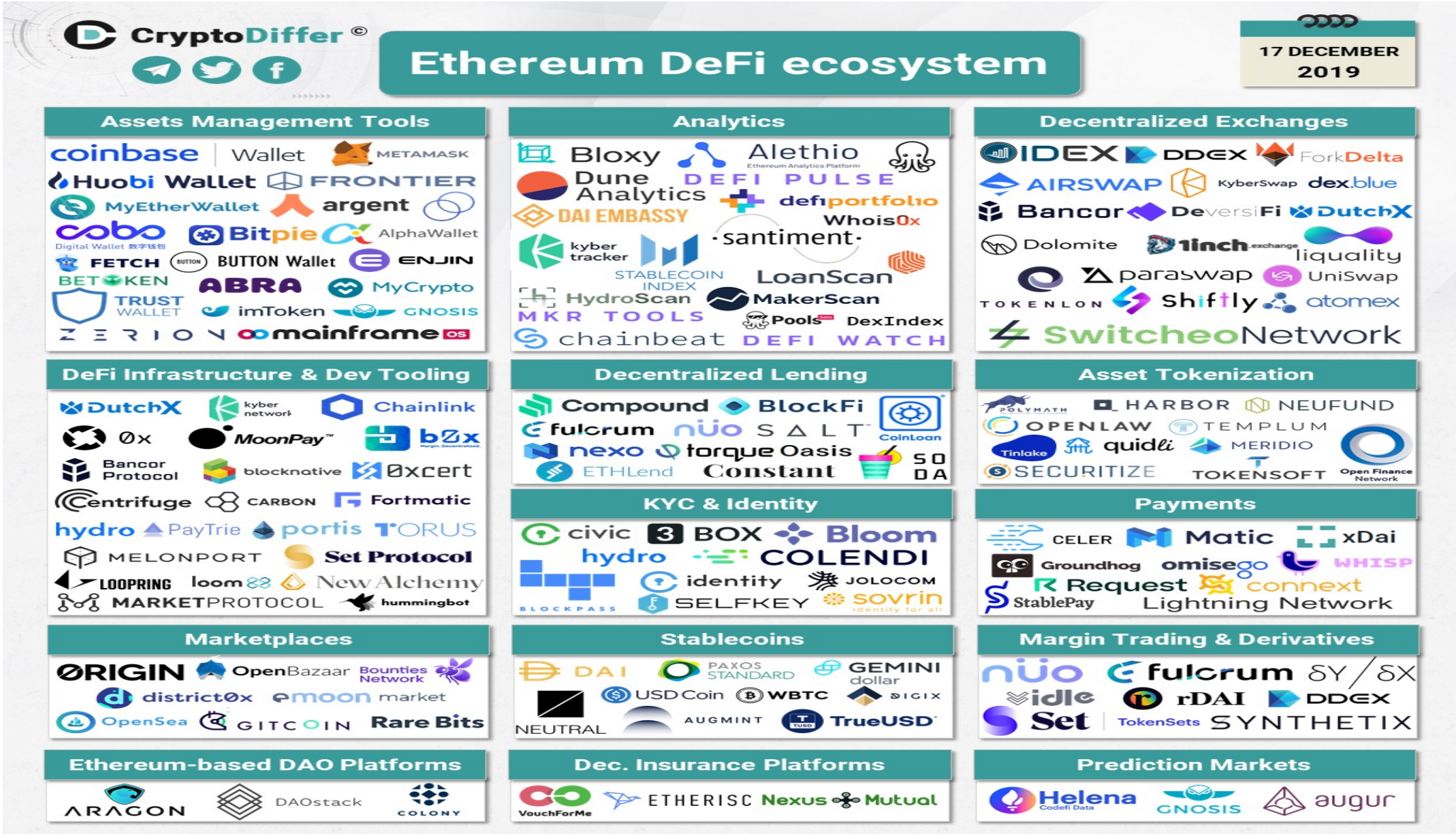
Source: Paolo Sironi (2016), "FinTech Innovation: From Robo-Advisors to Goal Based Investing and Gamification", Wiley.

Financial Technology (Fintech) Categories

1. Banking Infrastructure
2. Business Lending
3. Consumer and Commercial Banking
4. Consumer Lending
5. Consumer Payments
6. Crowdfunding
7. Equity Financing
8. Financial Research and Data
9. Financial Transaction Security
10. Institutional Investing
11. International Money Transfer
12. Payments Backend and Infrastructure
13. Personal Finance
14. Point of Sale Payments
15. Retail Investing
16. Small and Medium Business Tools

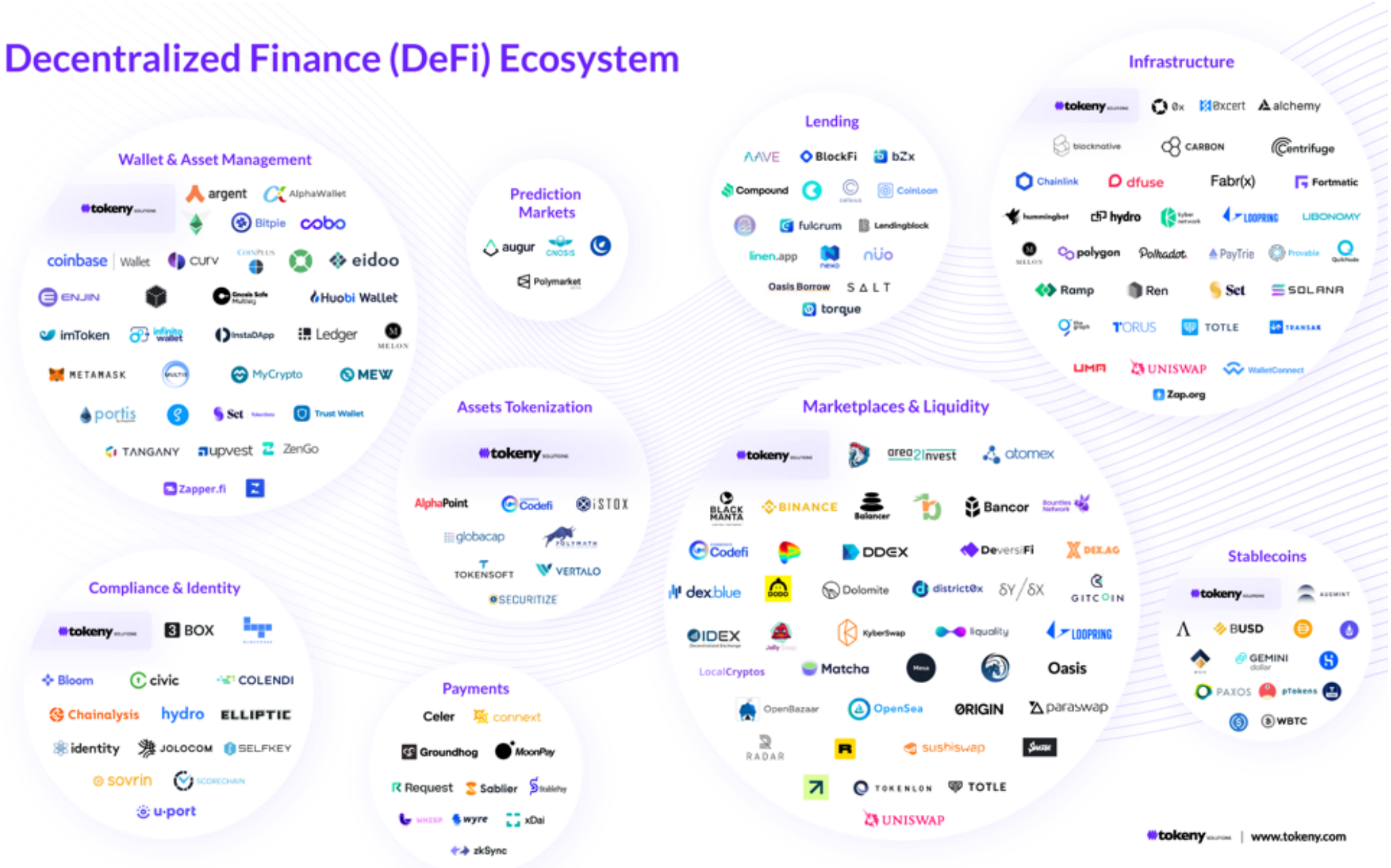
Source: http://www.venturescanner.com/financial-technology

Ethereum DeFi Ecosystem



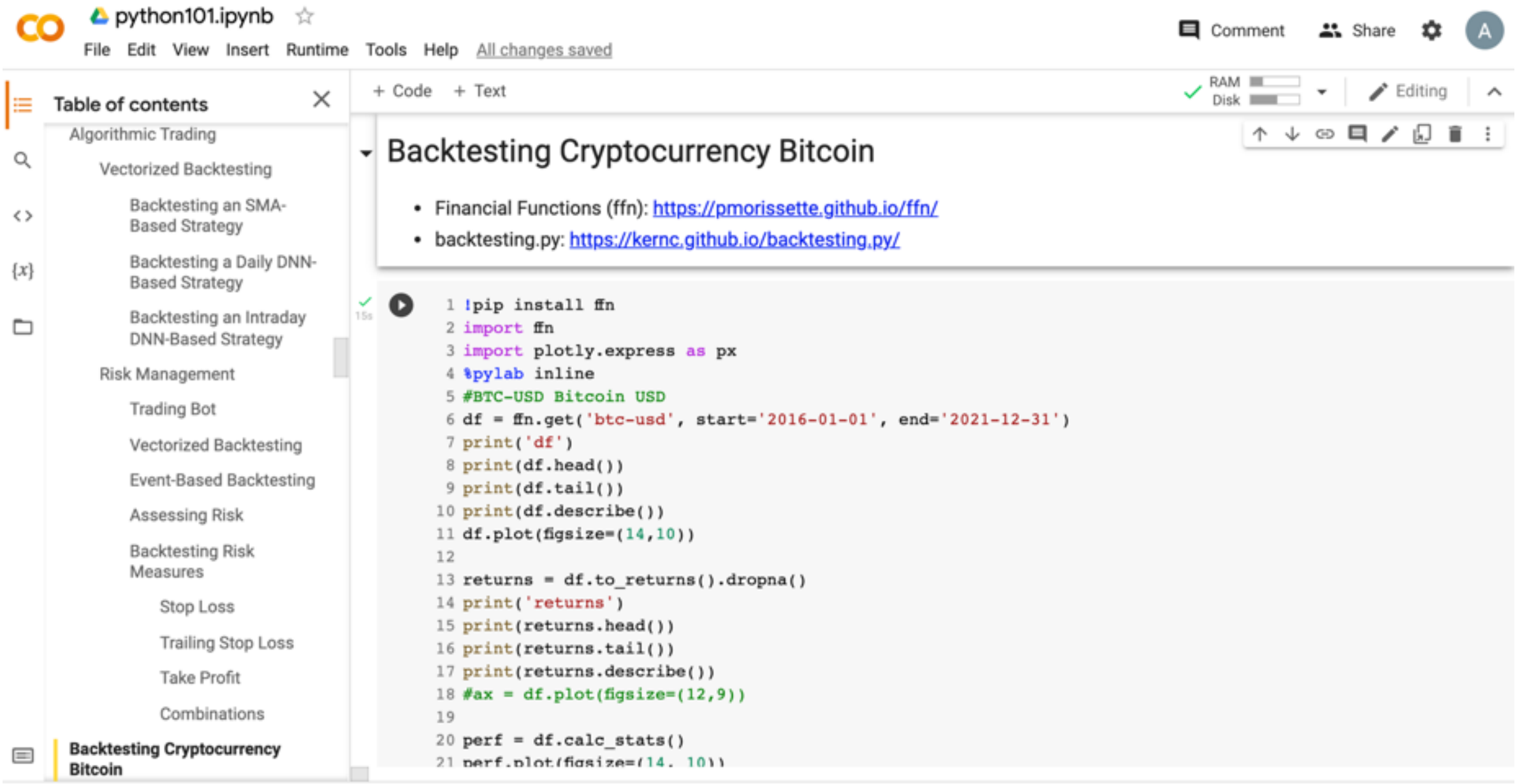
Source: https://cryptodiffer.com/news/ethereum-defi-ecosystem/

Decentralized Finance (DeFi) Ecosystem



Source: https://tokeny.com/defi-ecosystem/

Python in Google Colab (Python101)



https://tinyurl.com/aintpupython101

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