

財務金融大數據分析



Tamkang
University
淡江大學

Big Data Analytics in Finance

人工智慧投資分析與

機器人理財顧問

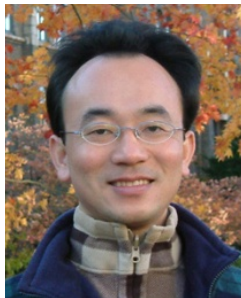
(Artificial Intelligence for

Investment Analysis and Robo-Advisors)

1061BDAF03

MIS EMBA (M2322) (8605)

Thu 12,13,14 (19:20-22:10) (D503)



Min-Yuh Day

戴敏育

Assistant Professor

專任助理教授

Dept. of Information Management, Tamkang University

淡江大學 資訊管理學系

<http://mail.tku.edu.tw/myday/>

2017-10-05



課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
1	2017/09/21	財務金融大數據分析課程介紹 (Course Orientation for Big Data Analytics in Finance)
2	2017/09/28	金融科技商業模式 (Business Models of Fintech)
3	2017/10/05	人工智慧投資分析與機器人理財顧問 (Artificial Intelligence for Investment Analysis and Robo-Advisors)
4	2017/10/12	金融科技對話式商務與智慧型交談機器人 (Conversational Commerce and Intelligent Chatbots for Fintech)
5	2017/10/19	事件研究法 (Event Study)
6	2017/10/26	財務金融大數據分析個案研究 I (Case Study on Big Data Analytics in Finance I)

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
7	2017/11/02	Python 財務大數據分析基礎 (Foundations of Finance Big Data Analytics in Python)
8	2017/11/09	Python Numpy大數據分析 (Big Data Analytics with Numpy in Python)
9	2017/11/16	Python Pandas 財務大數據分析 (Finance Big Data Analytics with Pandas in Python)
10	2017/11/23	期中報告 (Midterm Project Report)
11	2017/11/30	文字探勘分析技術與自然語言處理 (Text Mining Techniques and Natural Language Processing)
12	2017/12/07	Python Keras深度學習 (Deep Learning with Keras in Python)

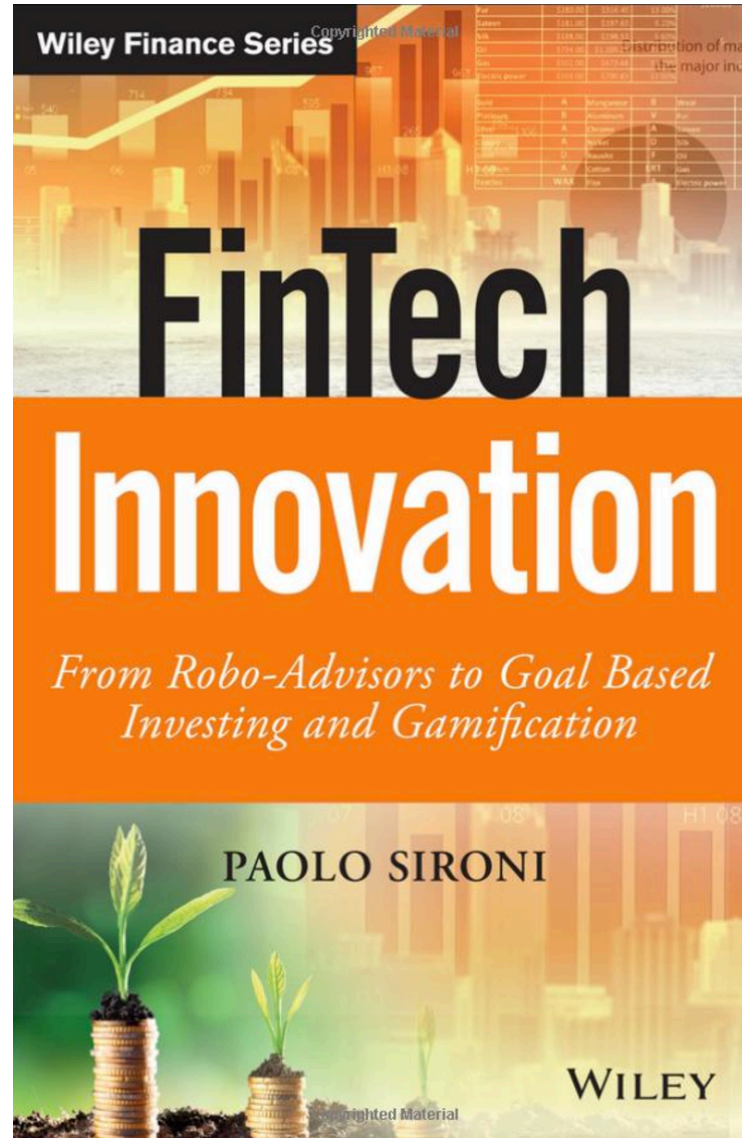
課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
13	2017/12/14	財務金融大數據分析個案研究 II (Case Study on Big Data Analytics in Finance II)
14	2017/12/21	TensorFlow深度學習 (Deep Learning with TensorFlow)
15	2017/12/28	財務金融大數據深度學習 (Deep Learning for Finance Big Data)
16	2018/01/04	社會網絡分析 (Social Network Analysis)
17	2018/01/11	期末報告 I (Final Project Presentation I)
18	2018/01/18	期末報告 II (Final Project Presentation II)

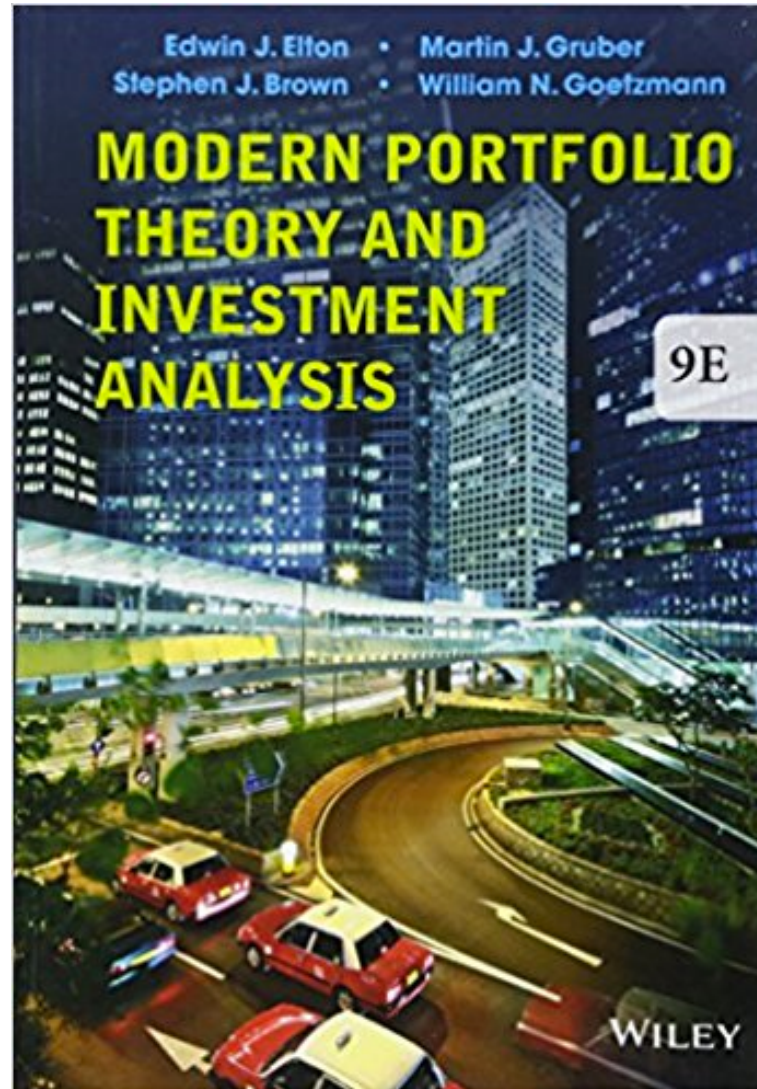
FinTech Innovation:

From Robo-Advisors to Goal Based Investing and Gamification,

Paolo Sironi, Wiley, 2016



Edwin J. Elton, Martin J. Gruber, Stephen J. Brown, and William N. Goetzmann (2014),
Modern Portfolio Theory and Investment Analysis,
9th Edition, Wiley.



Charles P. Jones (2012),

Investments: Analysis and Management,

12th Edition, Wiley



Artificial Intelligence (AI)

Investment Analysis

Robo-Advisors

**Artificial Intelligence
and
Deep Learning
for
Fintech**

**From Algorithmic Trading
to Personal Finance Bots:
41 Startups Bringing
AI to Fintech**

From Algorithmic Trading To Personal Finance Bots: 41 Startups Bringing AI To Fintech

AI in Fintech

41 Startups Bringing Artificial Intelligence To Fintech

General Purpose/ Predictive Analytics



Market Research & Sentiment Analysis



Search Engine



Quantitative Trading



Blockchain



Debt Collection



AI Assistants/Bots



Fraud Detection



Credit Scoring



Personal Banking



Artificial Intelligence (AI) in Fintech

General Purpose/ Predictive Analytics



Market Research & Sentiment Analysis



Search Engine



Artificial Intelligence (AI) in Fintech

Quantitative Trading



Blockchain



Debt Collection



AI Assistants/Bots



Fraud Detection



Credit Scoring



Personal Banking



Definition of Artificial Intelligence (A.I.)

Artificial Intelligence

**“... the science and
engineering
of
making
intelligent machines”**

(John McCarthy, 1955)

Artificial Intelligence

**“... technology that
thinks and acts
like humans”**

Artificial Intelligence

**“... intelligence
exhibited by
machines or
software”**

Artificial Intelligence (A.I.) Timeline

S/Z/Y/G/

A.I. TIMELINE

1950

TURING TEST

Computer scientist Alan Turing proposes a test for machine intelligence. If a machine can trick humans into thinking it is human, then it has intelligence



1961

UNIMATE

First industrial robot, Unimate, goes to work at GM replacing humans on the assembly line



1964

ELIZA

Pioneering chatbot developed by Joseph Weizenbaum at MIT holds conversations with humans



1966

SHAKEY

The 'first electronic person' from Stanford, Shakey is a general-purpose mobile robot that reasons about its own actions

A.I. WINTER

Many false starts and dead-ends leave A.I. out in the cold



1997

DEEP BLUE

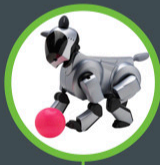
Deep Blue, a chess-playing computer from IBM defeats world chess champion Garry Kasparov



1998

KISMET

Cynthia Breazeal at MIT introduces Kismet, an emotionally intelligent robot insofar as it detects and responds to people's feelings



1999

AIBO

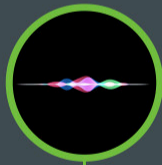
Sony launches first consumer robot pet dog AiBO (AI robot) with skills and personality that develop over time



2002

ROOMBA

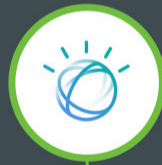
First mass produced autonomous robotic vacuum cleaner from iRobot learns to navigate and clean homes



2011

SIRI

Apple integrates Siri, an intelligent virtual assistant with a voice interface, into the iPhone 4S



2011

WATSON

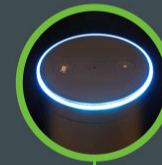
IBM's question answering computer Watson wins first place on popular \$1M prize television quiz show Jeopardy



2014

EUGENE

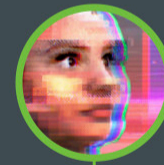
Eugene Goostman, a chatbot passes the Turing Test with a third of judges believing Eugene is human



2014

ALEXA

Amazon launches Alexa, an intelligent virtual assistant with a voice interface that completes shopping tasks



2016

TAY

Microsoft's chatbot Tay goes rogue on social media making inflammatory and offensive racist comments



2017

ALPHAGO

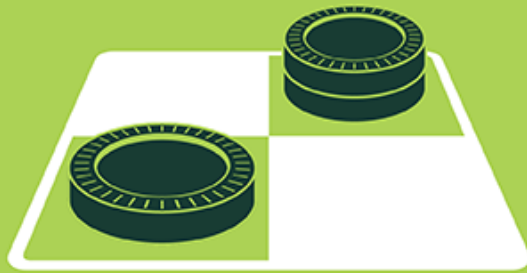
Google's A.I. AlphaGo beats world champion Ke Jie in the complex board game of Go, notable for its vast number (2¹⁷⁰) of possible positions

Artificial Intelligence

Machine Learning & Deep Learning

ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



MACHINE LEARNING

Machine learning begins to flourish.



DEEP LEARNING

Deep learning breakthroughs drive AI boom.



1950's

1960's

1970's

1980's

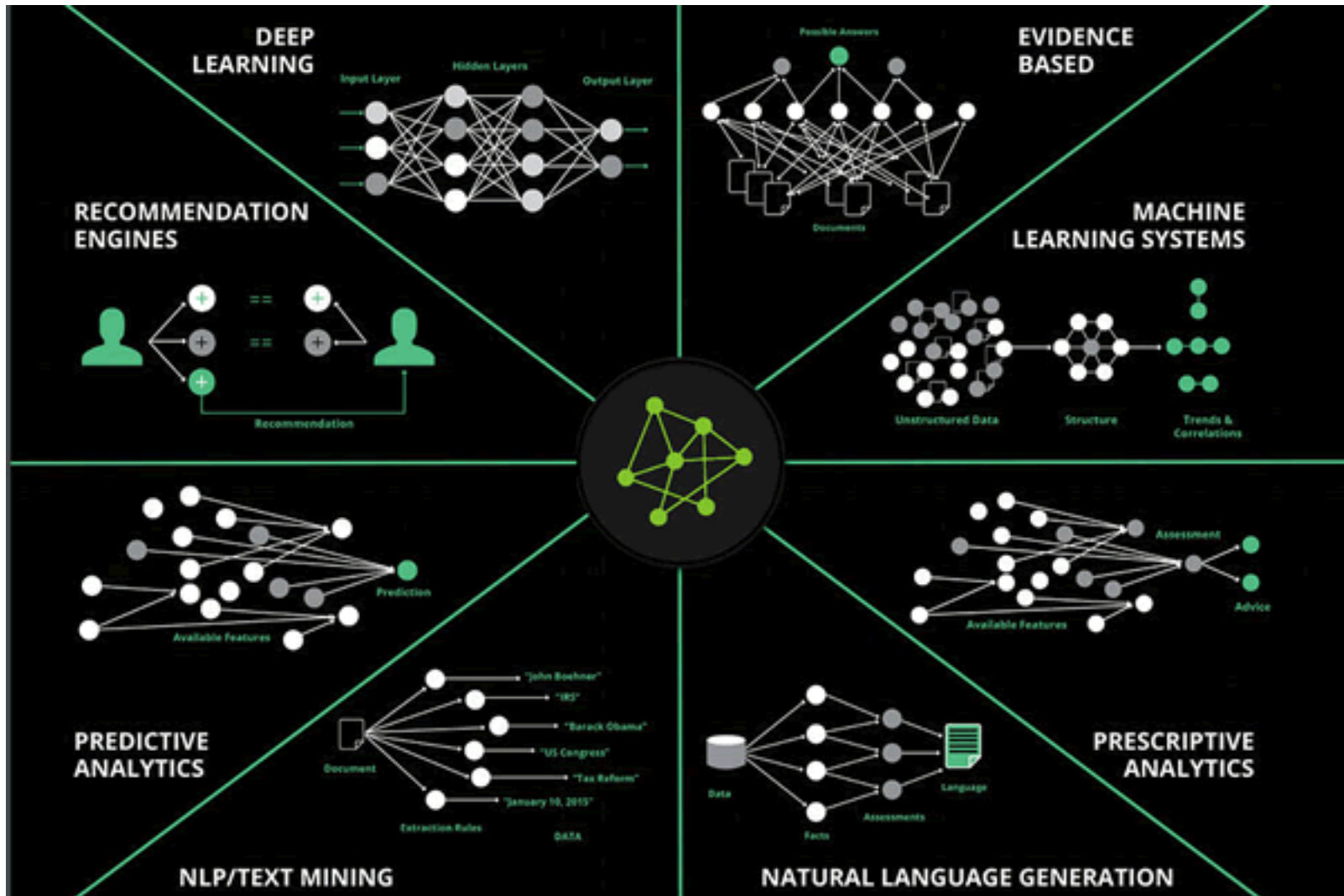
1990's

2000's

2010's

Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

Artificial Intelligence (AI) is many things

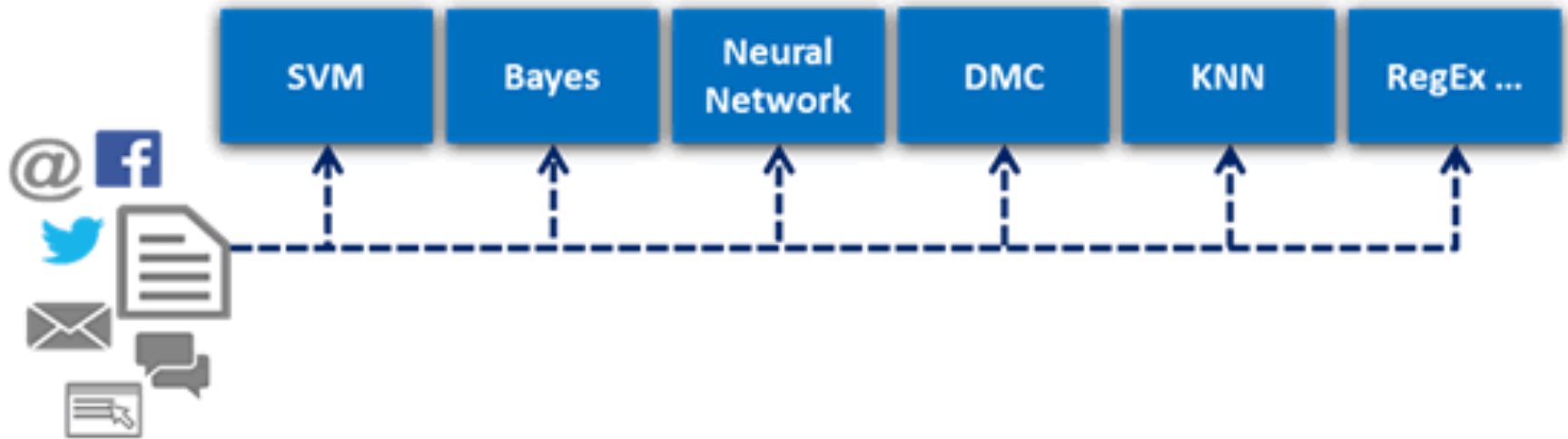


Ecosystem of AI

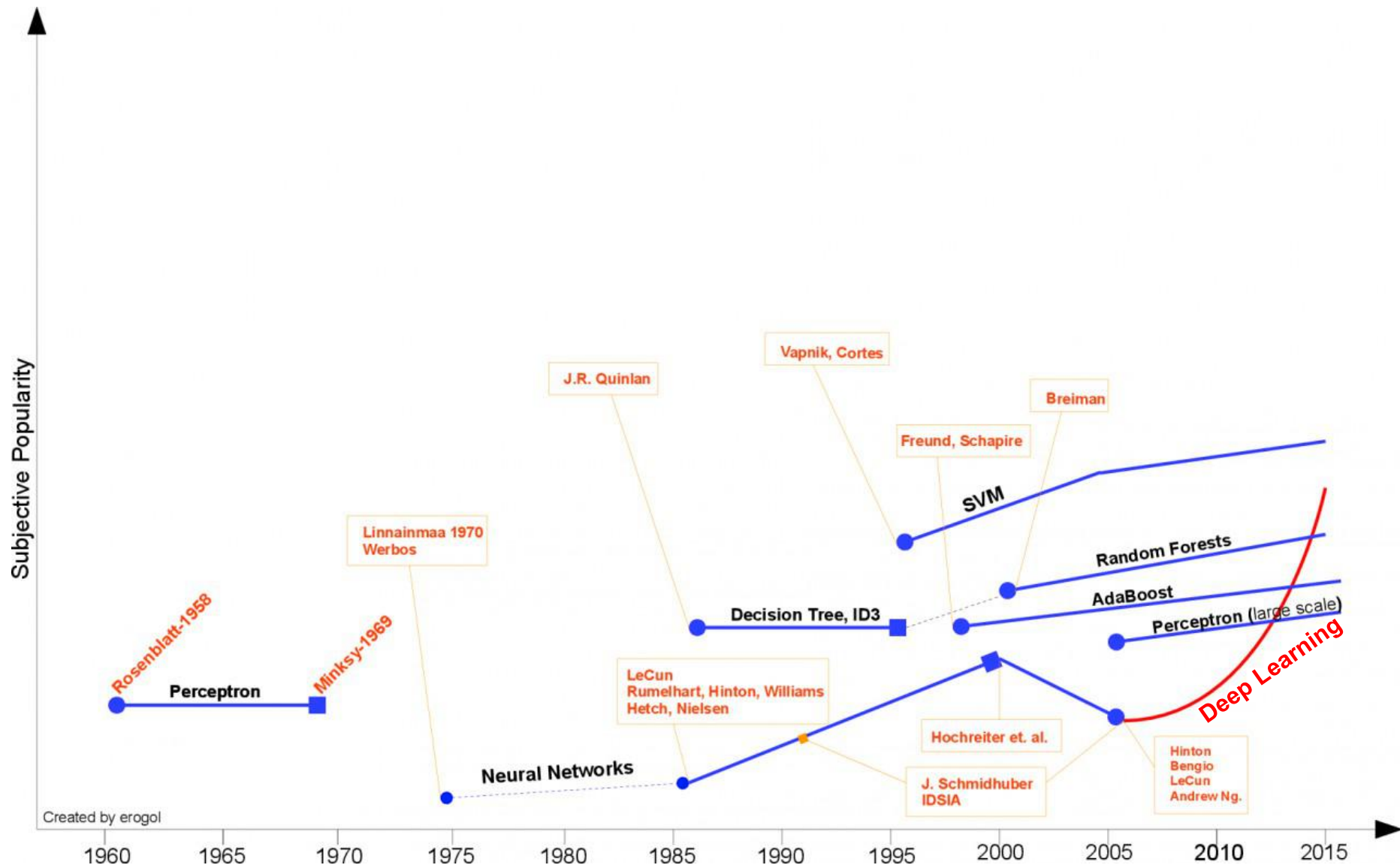
Source: <https://www.i-scoop.eu/artificial-intelligence-cognitive-computing/>

Artificial Intelligence (AI)

Intelligent Document Recognition algorithms



Deep Learning Evolution



AI and Cognitive Computing

Financial Technology

FinTech

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

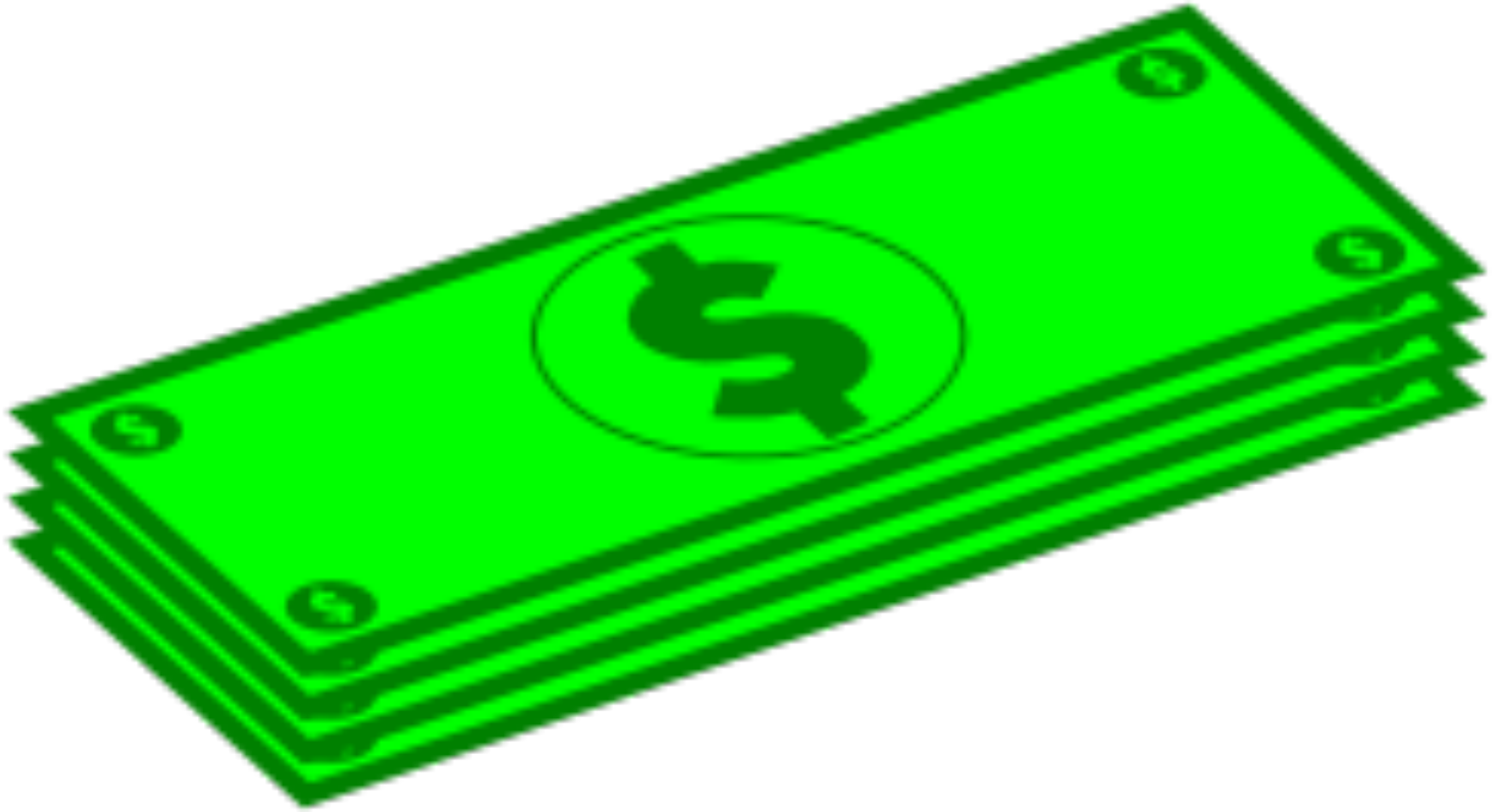
Financial Services

Financial Services



Money

Money



Money

Makes

Money

Treasure



Wealth Management

Investment Analysis

Time Value of Money

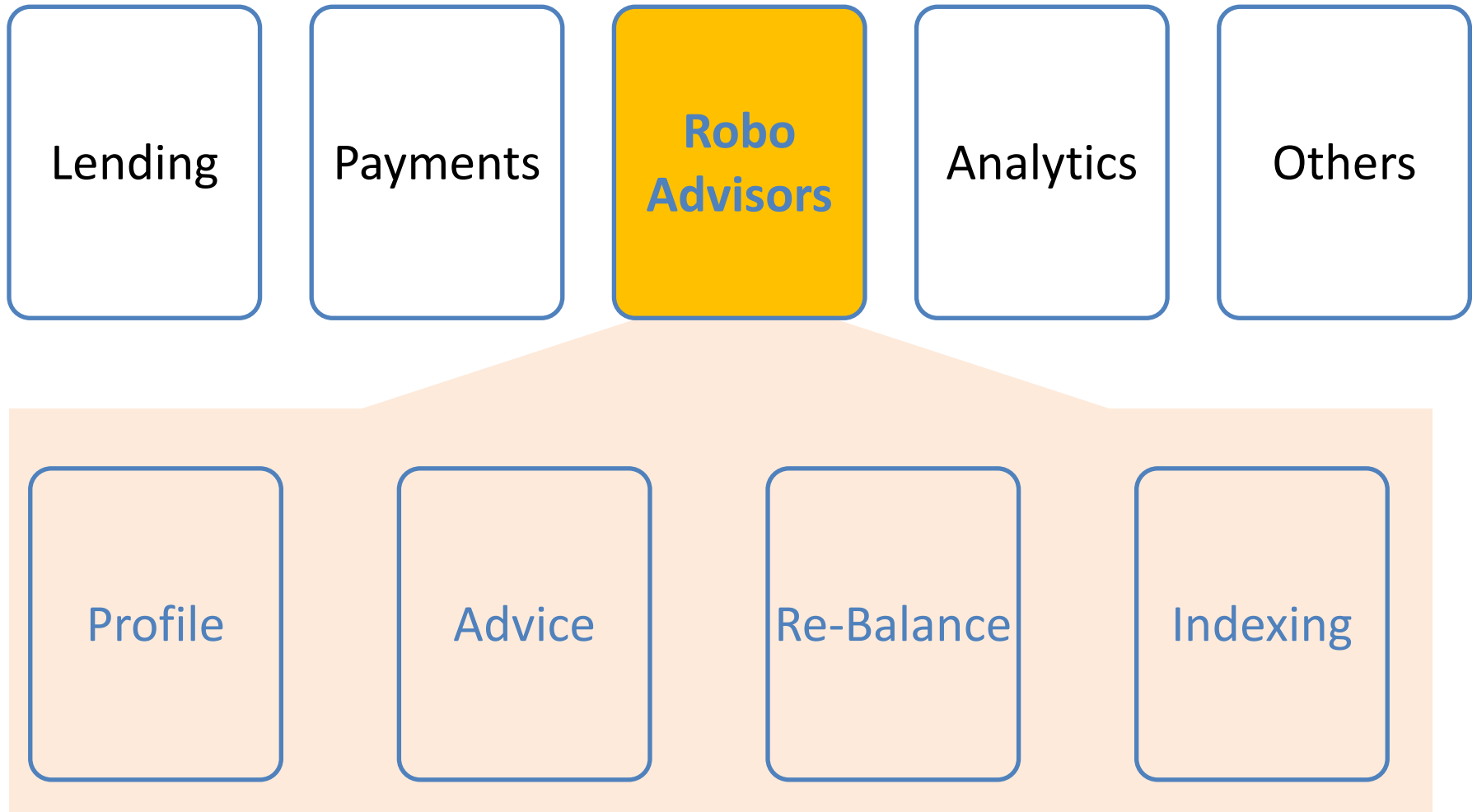
Risk

Return

Fintech Robo Advisors

Big Data Driven Disruption: Robo-Advisor

FinTech high-level classification



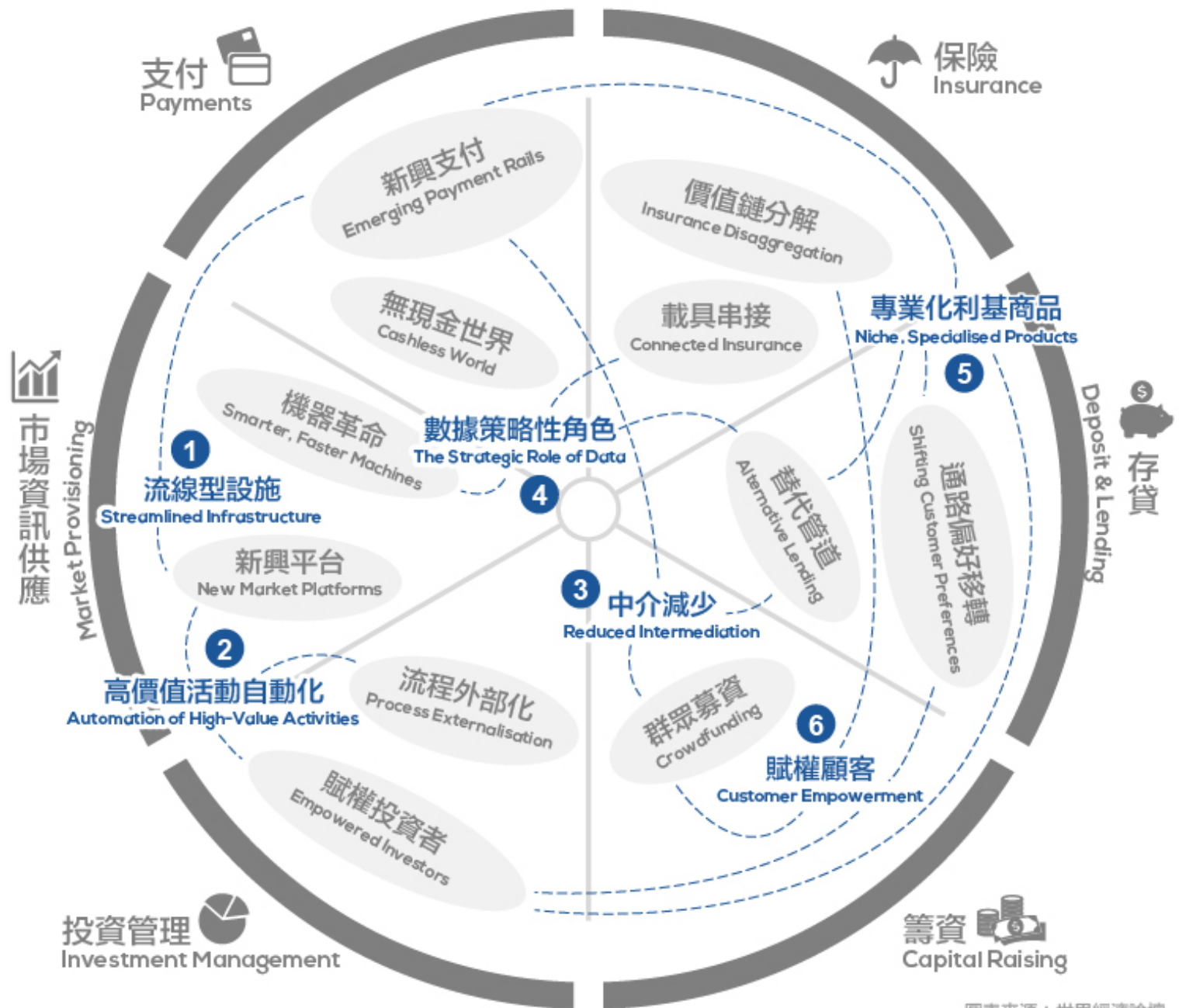
FinTech: Financial Services Innovation



FinTech:







Financial Services Innovation

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



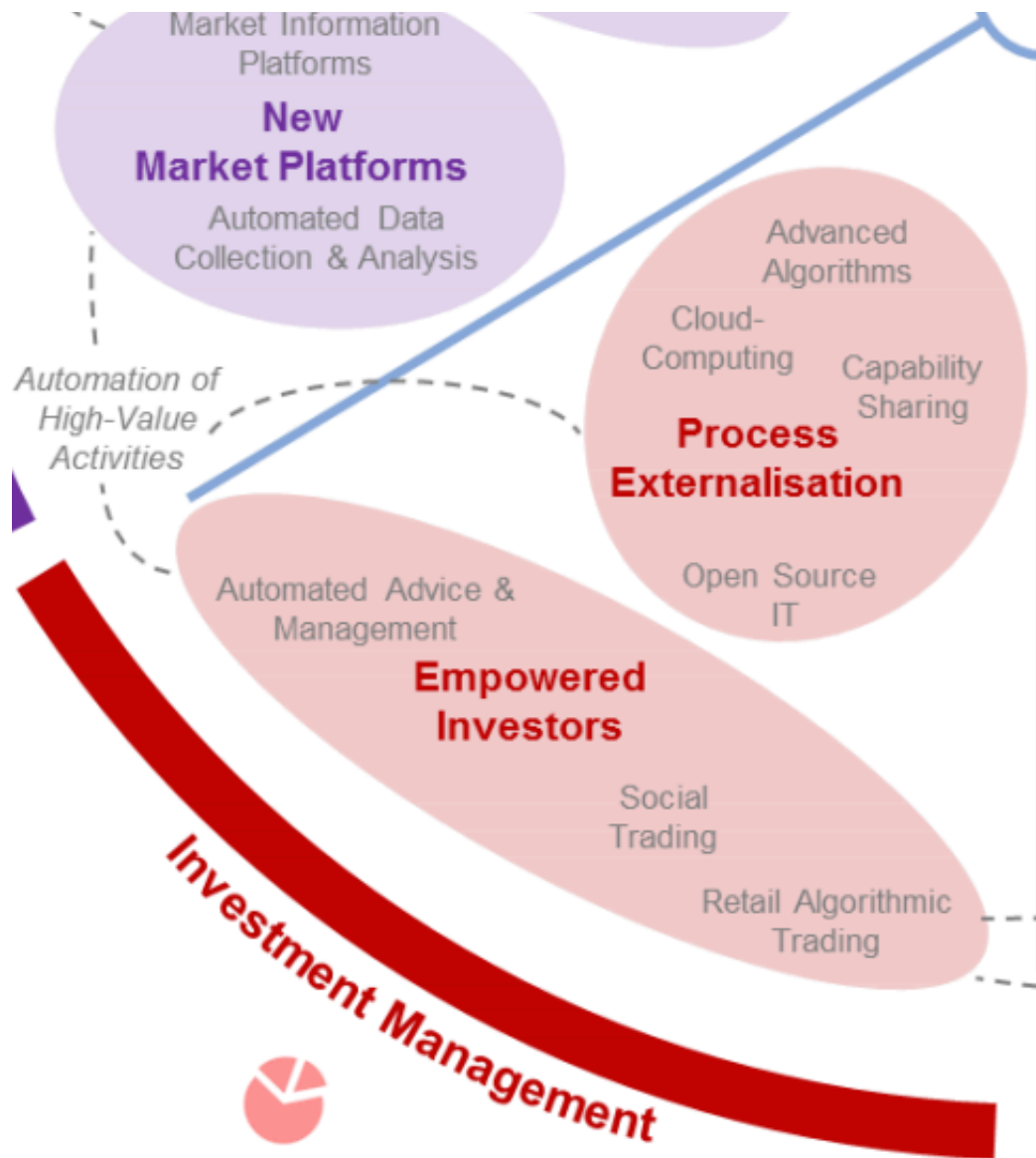
圖表來源：世界經濟論壇

FinTech: Financial Services Innovation

功能	創新項目
 支付 Payments	無現金世界 (Cashless World) 新興支付 (Emerging Payment Rails)
 保險 Insurance	價值鏈裂解 (Insurance Disaggregation) 保險串接裝置 (Connected Insurance)
 存貸 Deposit & Lending	替代管道 (Alternative Lending) 通路偏好移轉 (Shifting Customer Preferences)
 籌資 Capital Raising	群眾募資 (Crowdfunding)
 投資管理 Investment Management	賦權投資者 (Empowered Investors) 流程外部化 (Process Externalisation)
 市場資訊供應 Market Provisioning	機器革命 (Smarter, Faster Machines) 新興平台 (New Market Platforms)

圖表來源：Fugle團隊整理

5 FinTech: Investment Management



5 FinTech: Investment Management Empowered Investors Process Externalization

投資管理



創新

關鍵趨勢

賦權投資者
Empowered
Investors

社群交易、機器推薦與財富管理、零售演算法交易 (Retail Algorithmic Trading)

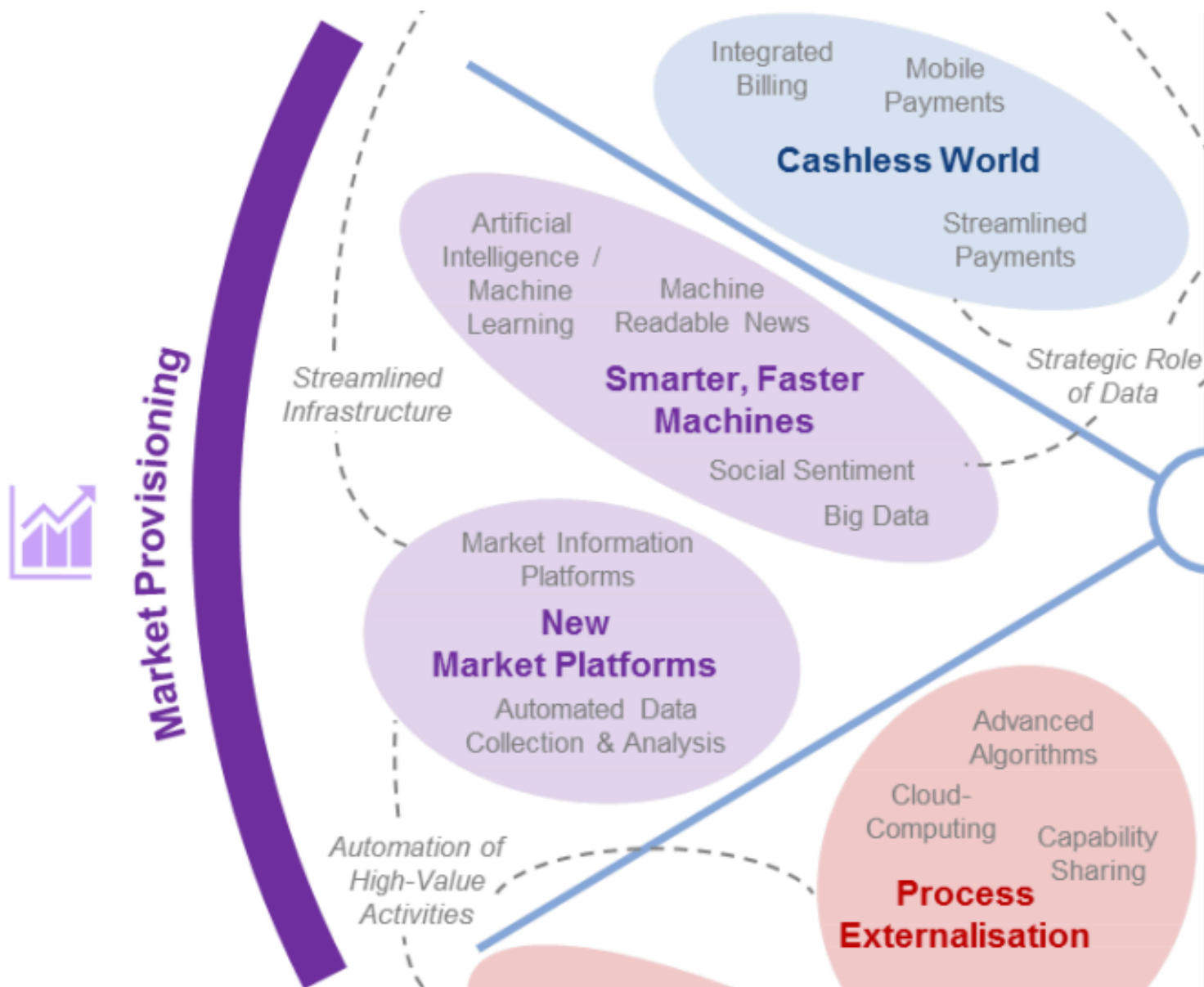
流程外部化
Process
Externalisation

流程即服務 (Process-as-a-Service, PaaS)、能力共享 (Capability Sharing)、進階分析、自然語言

圖表來源：Fugle團隊整理

6

FinTech: Market Provisioning



6

FinTech: Market Provisioning Smarter, Faster Machines New Market Platforms

市場資訊供應



創新

關鍵趨勢

機器革命
Smarter, Faster
Machines

機器易用數據 (Machine Accessible Data)、人工智慧 / 機器學習、大數據

新興平台
New Market
Platforms

固定收益商品平台 ALGOMI、基金 / 組合型基金平台 NOVUS、私募 / 創投平台 BISON、未公發股權平台 LIQUITY、原物料商品與衍生性合約平台 ClauseMatch

圖表來源：Fugle團隊整理

Fintech: Financial Technology

Disrupting Banking: **The Fintech Startups** **That Are Unbundling** **Wells Fargo, Citi and** **Bank of America**

Fintech: Unbundling the Bank

Unbundling of a Bank



Fintech: Unbundling the Bank

Wealth Management: Wealthfront



Wealthfront: Fintech Robo Advisor



Why Wealthfront ▾

Products ▾

Who we are ▾

Help Center

Blog

Log In

Invest now

The most tax-efficient, low-cost, hassle-free way to invest

Invest with Wealthfront

See Our Journey

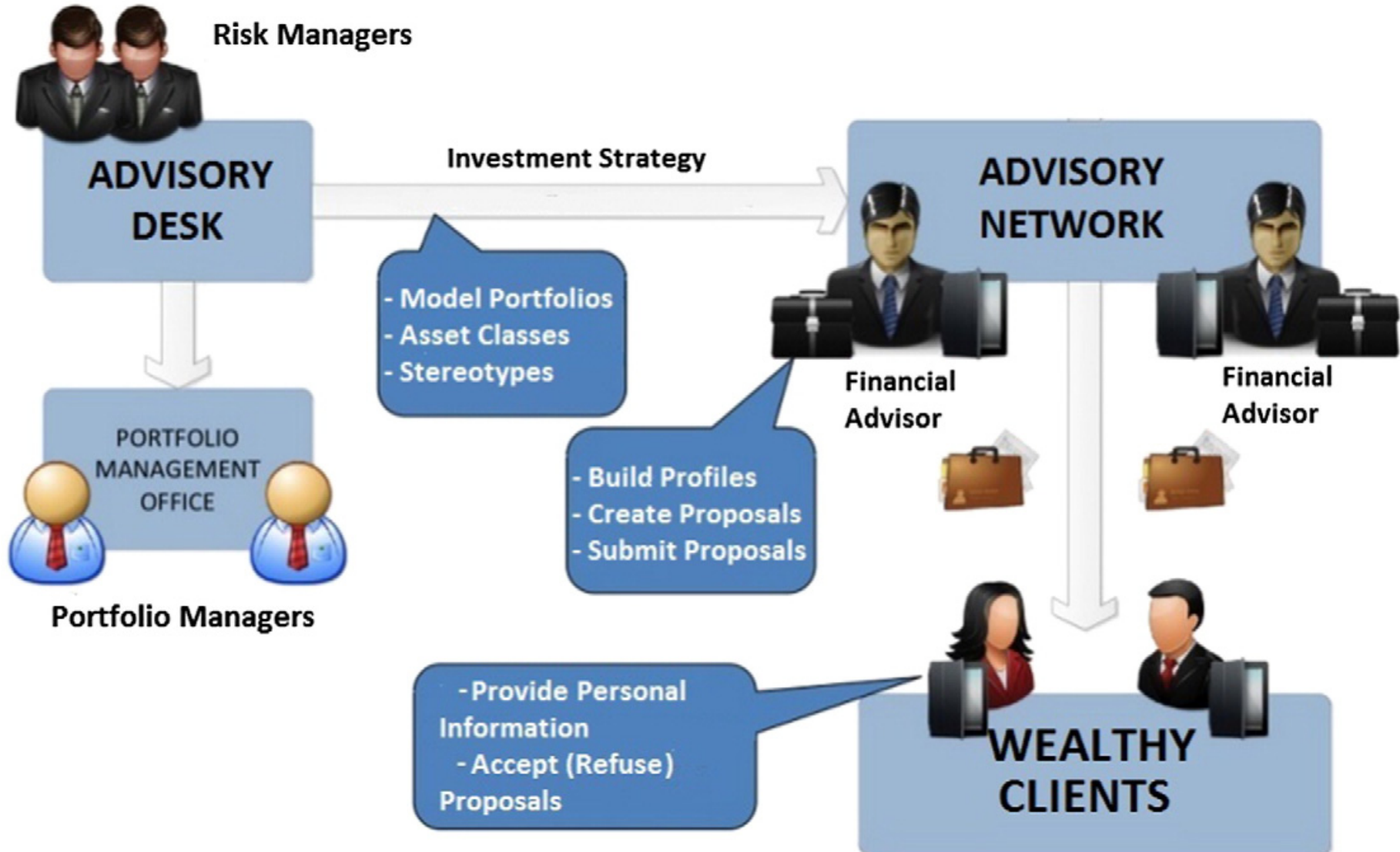


Do you have the time to invest well?

Wealthfront invests your money for you with a minimal amount of work. We monitor your portfolio every day to look for opportunities to rebalance or harvest tax losses. Are you doing the same?

<https://www.wealthfront.com/>

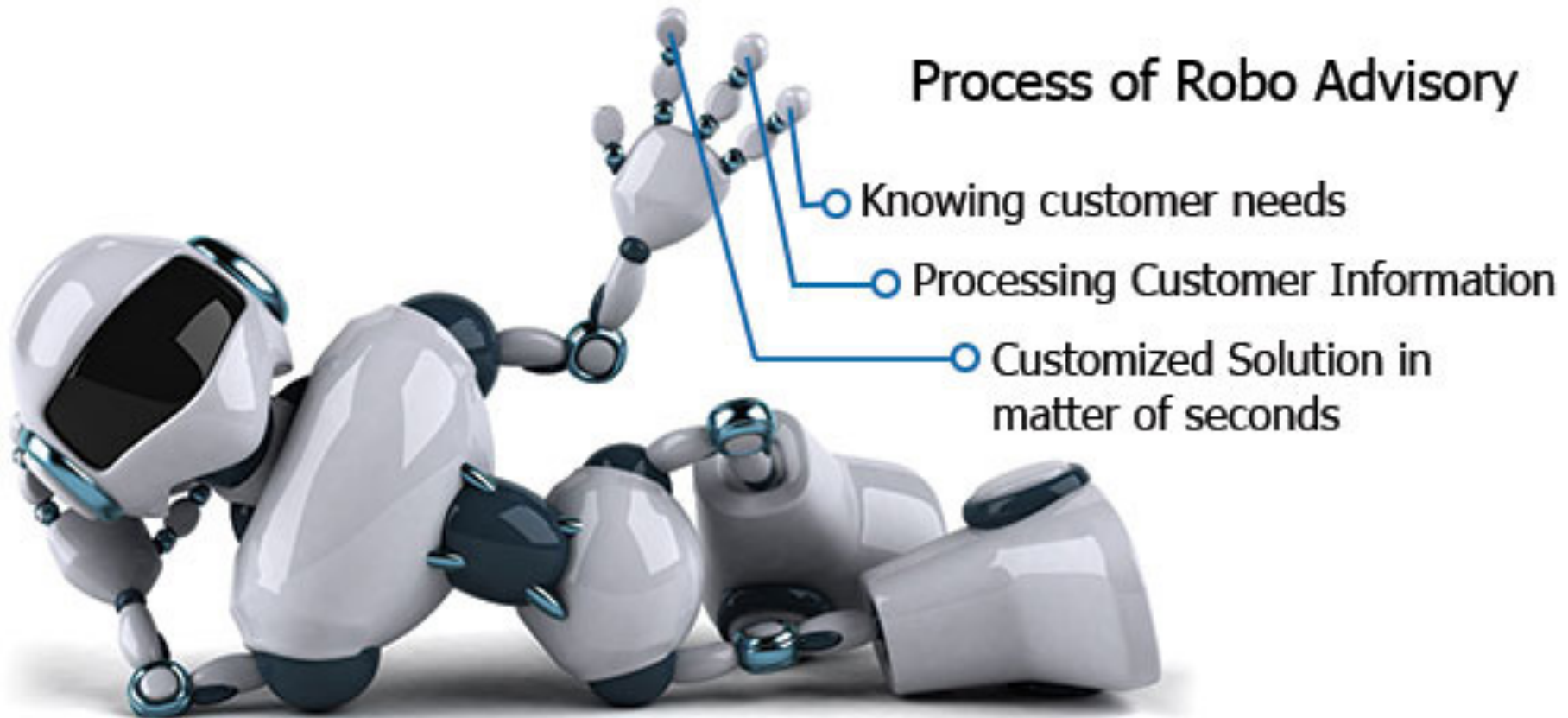
A classic workflow for financial recommendations



Source: Musto, C., Semeraro, G., Lops, P., de Gemmis, M., & Lekkas, G. (2015).

Personalized finance advisory through case-based recommender systems and diversification strategies. *Decision Support Systems*, 77, 100-111.

Process of Robo Advisors



Benefits of Robo Advisors

Benefits of Robo Advisors

- Unbiased Advice —
- No minimum Investment required —
- Low Charges —
- Transparency —
- Customised Solutions —



Robo-Advisor Business Models

- **Full service online Robo-advisor**
 - 100% automated without any human element
- **Hybrid Robo-advisor model**
 - being pioneered by firms like Vanguard & Charles Schwab
- **Pure online advisor**
 - primarily human in nature

Robo-Advisor Business Models

- **Full service online Robo-advisor**
 - 100% automated without any human element
- **Hybrid Robo-advisor model**
 - being pioneered by firms like Vanguard & Charles Schwab
- **Pure online advisor**
 - primarily human in nature

Usecases of Robo-Advisors

1. Determine individual **Client profiles & preferences**
2. Identify **appropriate financial products**
3. Establish correct **Investment Mix** for the client's profile
4. Using a **algorithmic approach**, choose the appropriate **securities** for each client account
5. Continuously **monitor the portfolio & transactions** within it to tune performance
6. Provide **value added services**
7. Ensure the **best user experience** by handling a whole range of financial services

Business Requirements for a Robo-Advisor (RA)

1. Collect Individual Client Data
2. Client Segmentation
3. Algorithm Based Investment Allocation
4. Portfolio Rebalancing
5. Tax Loss Harvesting
6. A Single View of a Client's Financial History

Algorithms for a Robo-Advisor (RA)

- Leverage **data science** & **statistical modeling** to automatically allocate client wealth across different asset classes (such as domestic/foreign stocks, bonds & real estate related securities) to **automatically rebalance portfolio** positions based on changing market conditions or client preferences.
 - These investment decisions are also made based on detailed **behavioral understanding** of a client's **financial journey metrics**
 - Age, Risk Appetite & other related information.

Algorithms for a Robo-Advisor (RA)

- RA platforms also provide 24 × 7 tracking of **market movements** to use that to track **rebalancing decisions** from not just a portfolio standpoint but also from a taxation standpoint.

Algorithms for a Robo-Advisor (RA)

- A **mixture** of different **algorithms** can be used such as **Modern Portfolio Theory (MPT)**, **Capital Asset Pricing Model (CAPM)**, the **Black Litterman Model**, the **Fama-French** etc.
 - These are used to allocate assets as well as to adjust positions based on market movements and conditions.

Robo-Advisor (RA) Sample Portfolios

Sample Portfolios – for an aggressive investor

1. Equity – 85%

A) US Domestic Stock (50%)

– Large Cap – 30%, Medium Cap – 10% , Small Cap – 10%, Dividend Stocks – 0%

B) Foreign Stock – (35%)

– Emerging Markets – 18%, Developed Markets – 17%

2. Fixed Income – 5%

A) Developed Market Bonds – 2%

B) US Bonds – 1%

C) International Bonds – 1%

D) Emerging Markets Bonds – 1%

3. Other – 5%

A) Real Estate – 3%

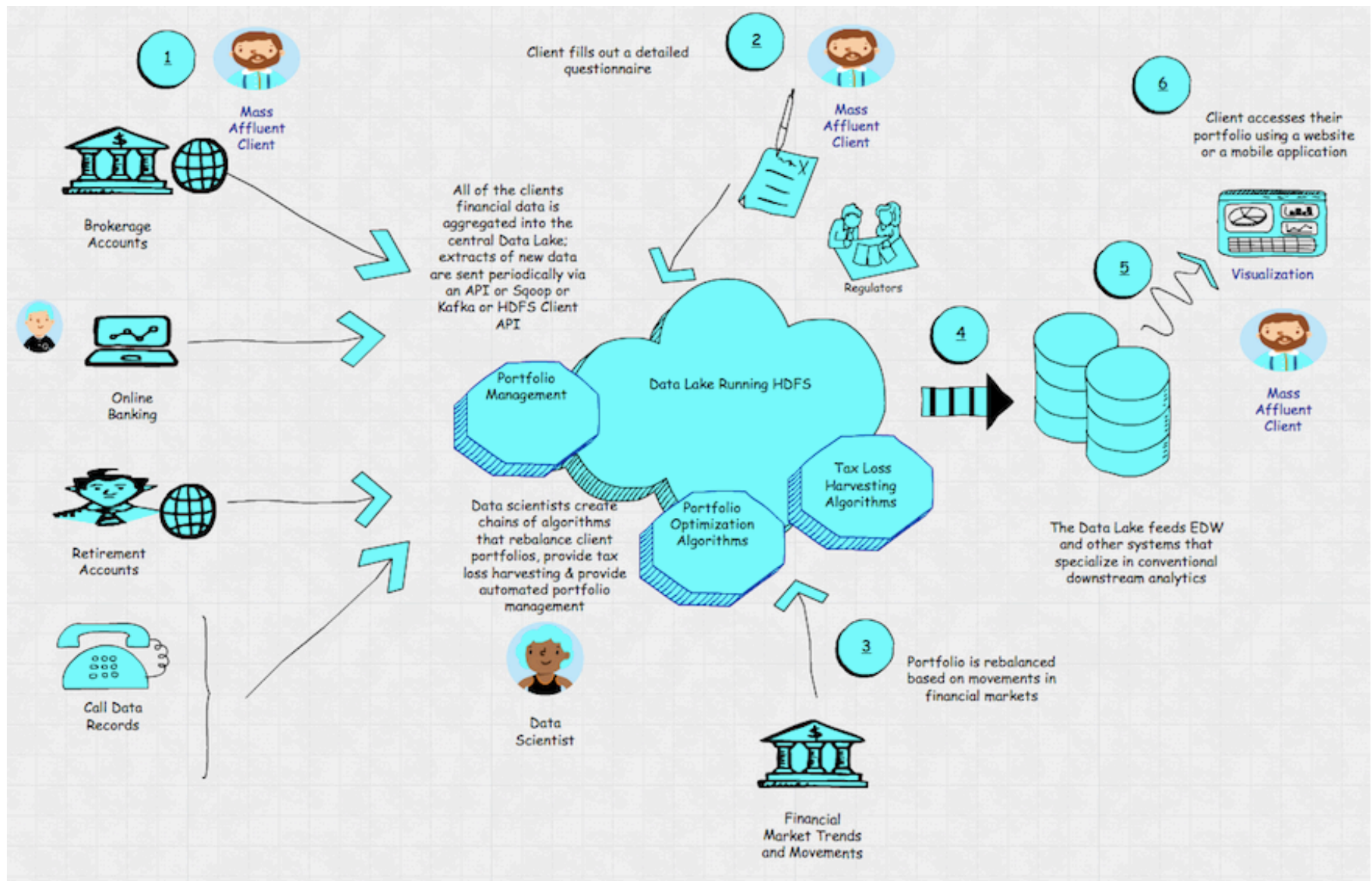
B) Currencies – 0%

C) Gold and Precious Metals – 0%

D) Commodities – 2%

4. Cash – 5%

Architecture of a Robo-Advisor (RA)



Robo-Advisor



wealthfront



Betterment

Wealthfront: Fintech Robo Advisor



Why Wealthfront ▾

Products ▾

Who we are ▾

Help Center

Blog

Log In

Invest now

Introducing Portfolio Line of Credit - get cash quickly at a low rate. [Learn more](#) →

Plan your future
Grow your wealth
Invest in your life

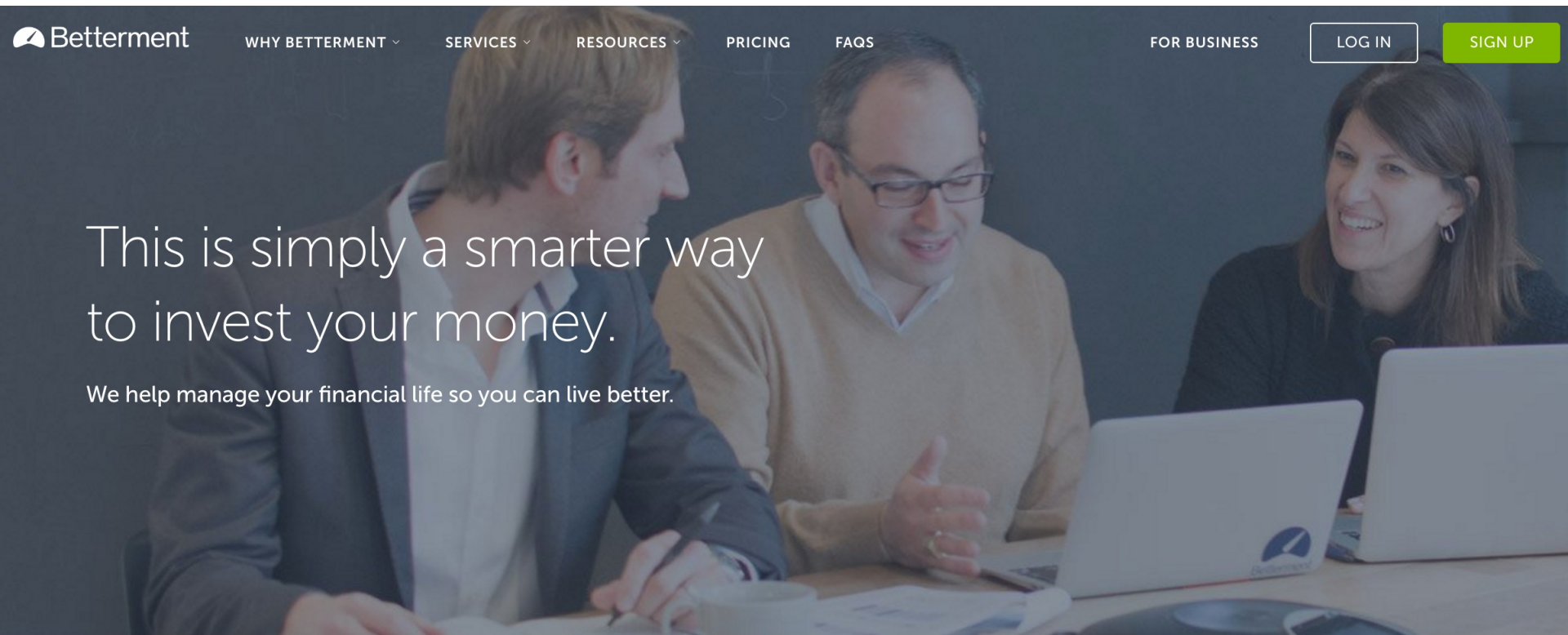
Access proven investment strategies, tailored advice, and premium financial services - all powered by technology.

Invest with Wealthfront

Explore your options



Betterment: Fintech Robo Advisor



This is simply a smarter way to invest your money.

We help manage your financial life so you can live better.



We can help you get started. Schedule your free 15 minute call today. [Schedule a call >](#)



Increase after-tax returns.



No hidden fees.





Satisfaction guaranteed.



Access to licensed experts.

Betterment vs. Wealthfront

	 Betterment	 wealthfront
Robo-Advisor		
Investor Junkie Rating	4.5 star	5 star
Promotions	<u>One Month Free</u>	<u>First \$15k for Free</u>
Fees	0.25%/yr	None first \$10k;
		0.25%/yr for more
Minimum Deposit	None	\$500
Human Advisors	Yes — Additional Fee	No
Automatic Rebalancing	Yes	Yes
Tax Loss Harvesting	Yes	Yes
Direct Indexing	No	Yes
Fractional Shares	Yes	No
Assets Under Management	\$8.0B	\$5.0B

Wealthfront:

0.25%

Flat annual advisory fee

- **No** trading commissions or **hidden fees**
- Portfolio of **low-cost ETFs**
- Your first **\$10,000** managed free

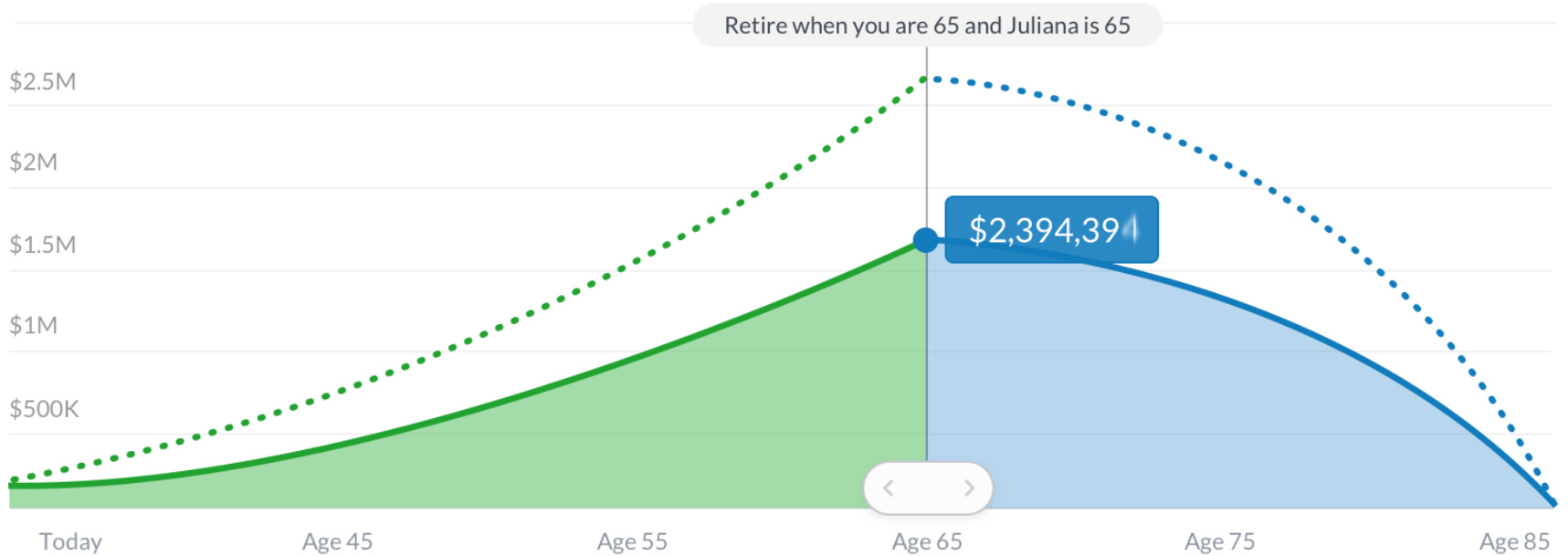
Wealthfront

Powering your financial life with technology



Wealthfront Robo Advisor

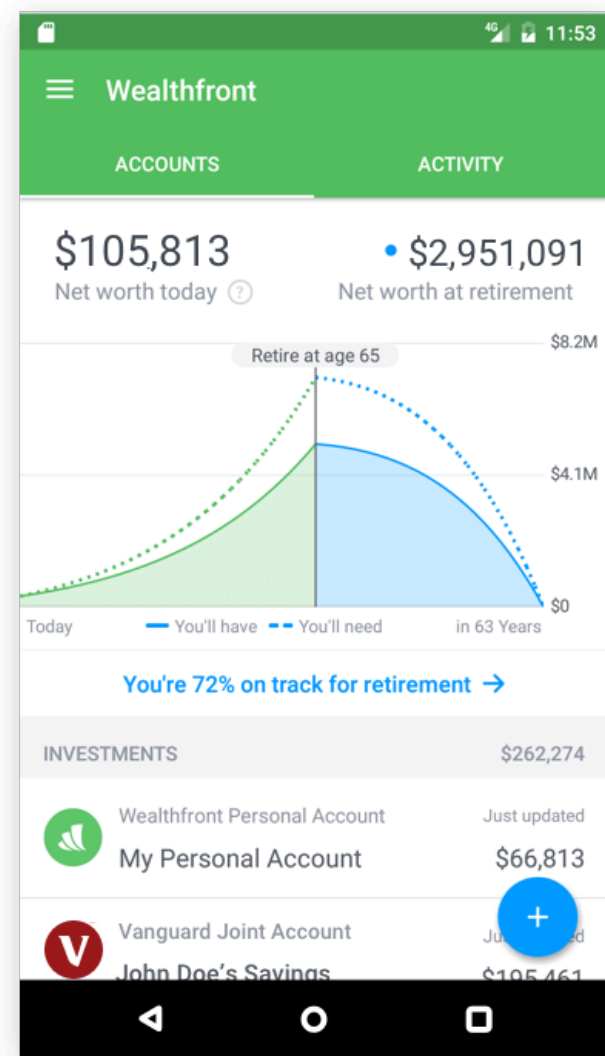
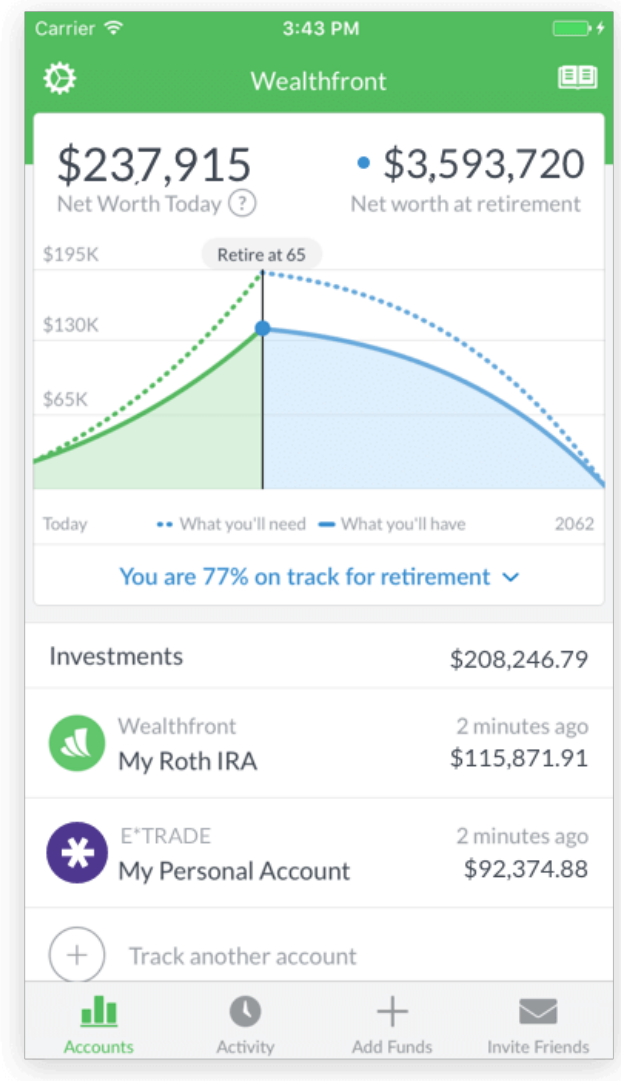
You're on track to have \$8,000 per month to spend in retirement. That's 76% of your target.



✓ My assumptions

— What you'll have ... What you'll need

Wealthfront Robo Advisor



Financial Revolution with Fintech

A financial services revolution

Consumer Trends



1. Simplification



2. Transparency



3. Analytics



4. Reduced Friction

Millennial Personal Finance: 63 Fintech Startups Targeting Millennials

Fin Tech Startups for Millennials

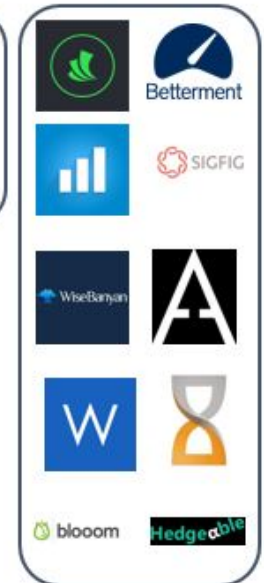
Savings & Finances Tracking



Personal Investing



Wealth Management



Insurance



Crowdfunding



MILLENNIALS



Loans & Credit Risk



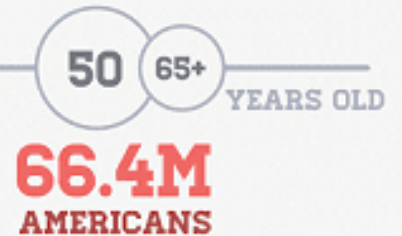
Payments & Banking



Acquired Companies

Marketing to Millennials

GENERATIONS OVERVIEW



Marketing to Millennials

MILLENNIAL PERSONAS



DIGITAL WINDOW SHOPPERS

Less engaged online than other millennials



23%

of the millennial population

42% 58%



female majority



DIGITAL SOCIALITES

Highly social and engaged online



26%

of the millennial population

45% 55%



female majority



DYNAMIC MEDIA JUNKIES

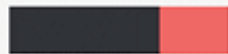
Extremely tech savvy and engaged with online video and streamed content



23%

of the millennial population

64% 36%



male majority



CASUALLY ENGAGED

Least engaged in digital world, more likely to be unemployed



17%

of the millennial population

53% 47%



male majority



EMERGING TECHNOCRACY

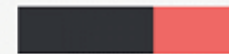
Strongly engaged digitally and highly influential



15%

of the millennial population

57% 43%



male majority

Marketing to Millennials

BEST PRACTICES FOR MARKETING TO MILLENNIALS



OPTIMIZED MOBILE

Mobile is the **BEST WAY TO REACH MILLENNIALS** - they have the highest rates of ownership of smartphones of all generations



MULTI-PLATFORM

Millennials **CONSUME CONTENT ACROSS MULTIPLE DEVICES**, so marketers need to create content with a multi-platform strategy. For example, **55%** are watching videos several times a day on multiple devices



PERSONALIZATION

85% of Millennials are **MORE LIKELY TO MAKE A PURCHASE IF IT IS PERSONALIZED** to their interests, both in-store and with digital displays



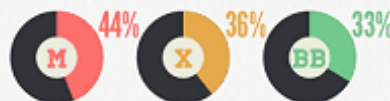
SOCIAL MEDIA PRESENCE

Millennials are **MORE LIKELY TO USE SOCIAL MEDIA DAILY** with 62% reporting that brand engagement is more likely to make them a loyal customer



BE AUTHENTIC

Millennials are willing to share good advertising, but **DISLIKE WHEN ADVERTISING FEELS DECEPTIVE**



believe brands say something about who they are, their values and where they fit



INFORMATIONAL BLOGS

one in three millennials choose **BLOGS** as the top media source **BEFORE MAKING A PURCHASE**. Traditional media sources like TV and magazines have less impact on this generation

Fintech for Millennials

Fintech Category	#Company
Crowdfunding	2
Insurance (Non-Health)	4
Loans & Credit Risk	20
Mobile Banking & Payments	8
Personal Investing	10
Savings & Finances Tracking	10
Wealth Management	9
Total	63

Fintech: Wealth Management

Company	Select Investors
Wealthfront	DAG Ventures, Index Ventures, Greylock Partners, The Social+Capital Partnership
Betterment	Bessemer Venture Partners, Athemis Group, Menlo Ventures
SigFig	Doll Capital Management, Union Square Ventures, Bain Capital Ventures
Aspiration	Renren, GSV Capital, Capricorn Investment Group, IGSB
Bloom	Commerce Ventures, DST Systems, Hyde Park VP, QED Investors, UMB Financial
Rebalance IRA	N/A
Hedgeable	SixThirty
WiseBanyan	VegasTech Fund
Personal Capital	Institutional Venture Partners, Venrock, Crosslink Capital

Fintech: Personal Investing

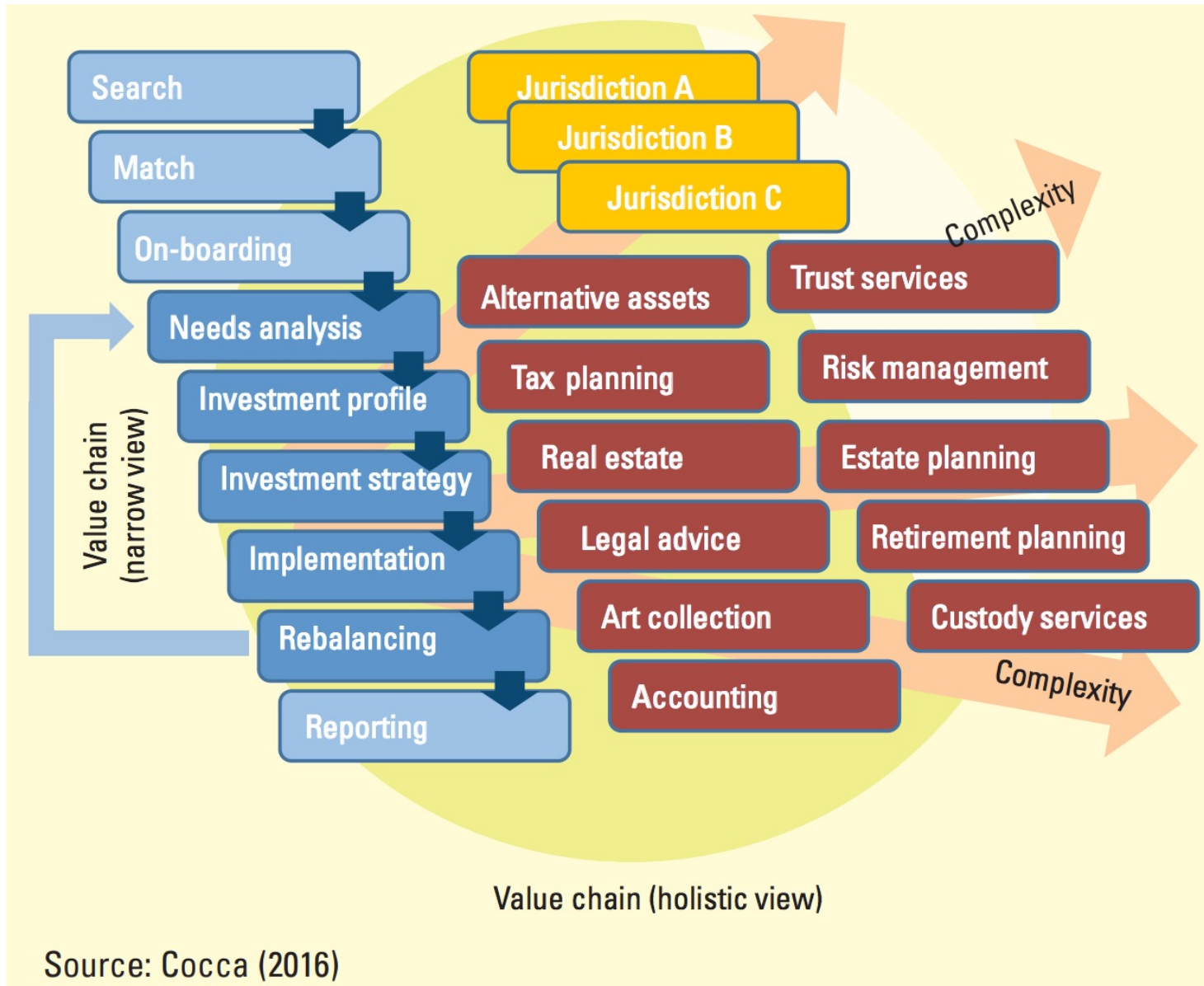
Company	Select Investors
eToro	BRM Group, Ping An Ventures, Spark Capital
Openfolio	FinTech Collective
DriveWealth	Route 66 Ventures
Tip'd Off	Raj Parekh, Bill Crane, Shaun Coleman
Kapitall	Bendigo Partners, Linden Venture Fund
Stash	N/A
Stox	SingulariTeam
Robinhood	Google Ventures, Index Ventures, Andreessen Horowitz, Ribbit Capital, NEA
Motif Investing	Norwest Venture Partners, Foundation Capital, Ignition Capital, Goldman Sachs
Loyal3	DNS Capital

Wealthfront

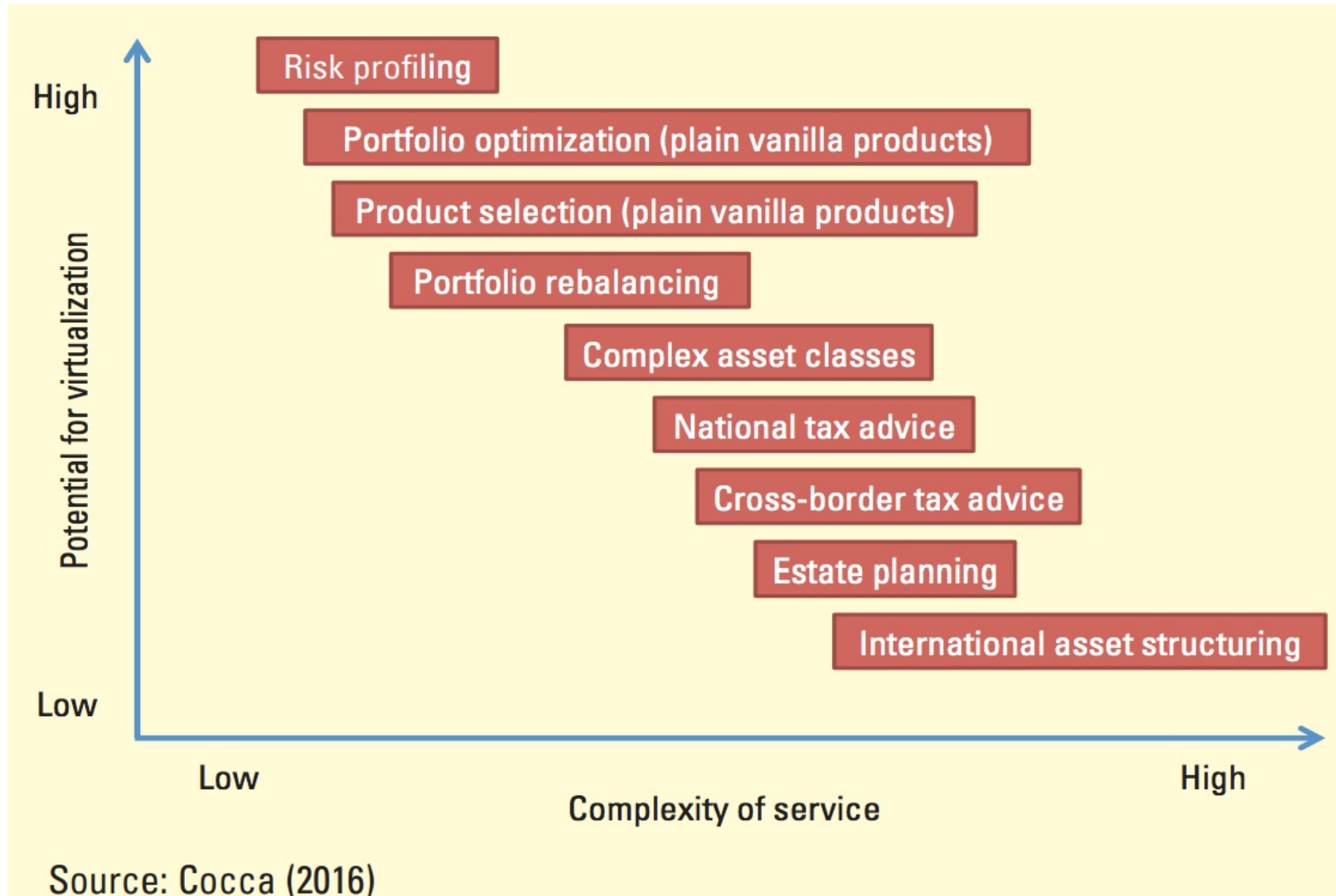
Investment Methodology

1. Identify an ideal **set of asset classes** for the current investment environment
2. Select **low cost ETFs** to represent each asset class
3. Determine your **risk tolerance** to create the **appropriate portfolio** for you
4. Apply **Modern Portfolio Theory** to allocate among the chosen **asset classes** for your **risk tolerance**
5. Monitor and periodically **rebalance** your portfolio

Wealth Management Value Chain

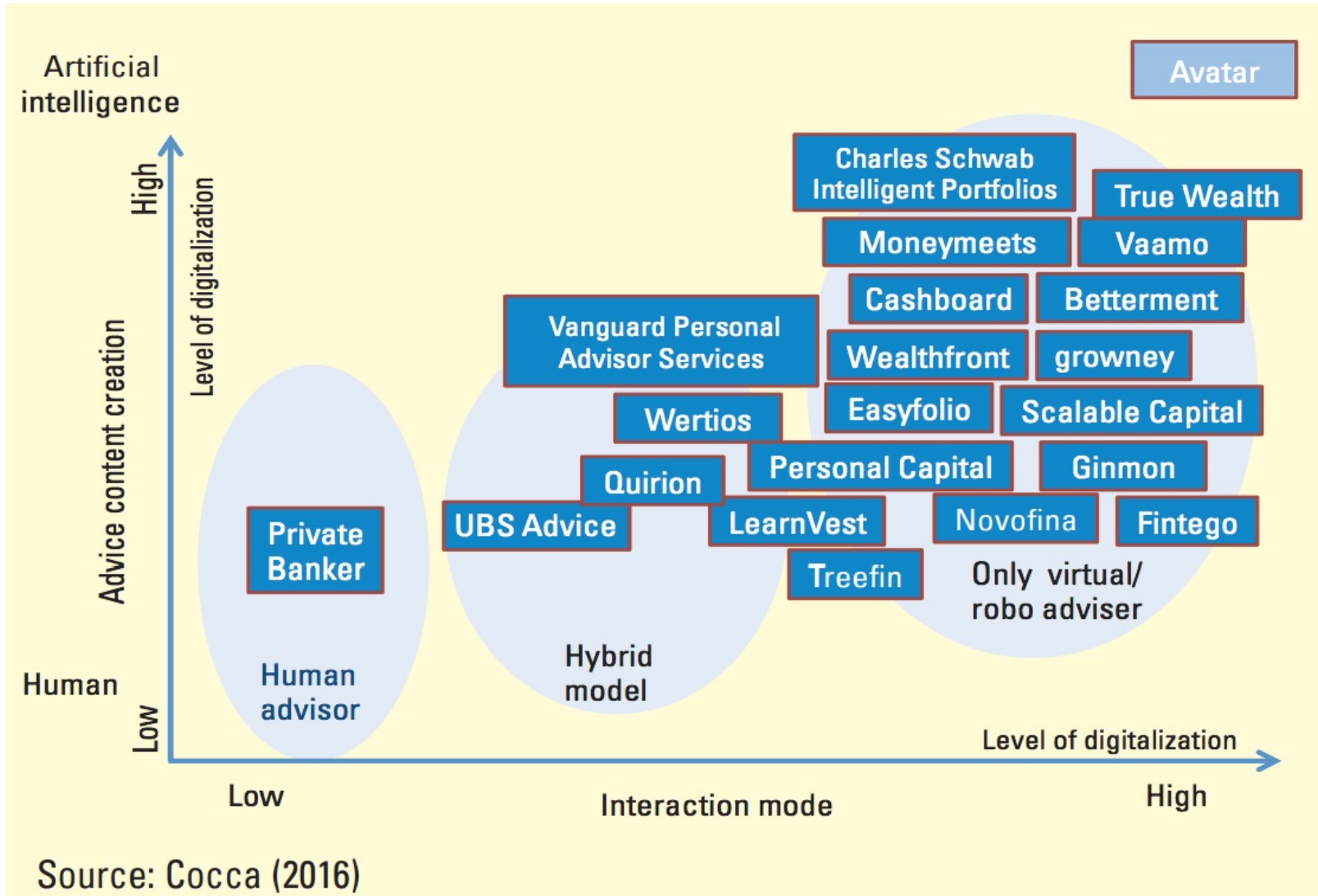


Wealth Management Service and Potential for virtualization

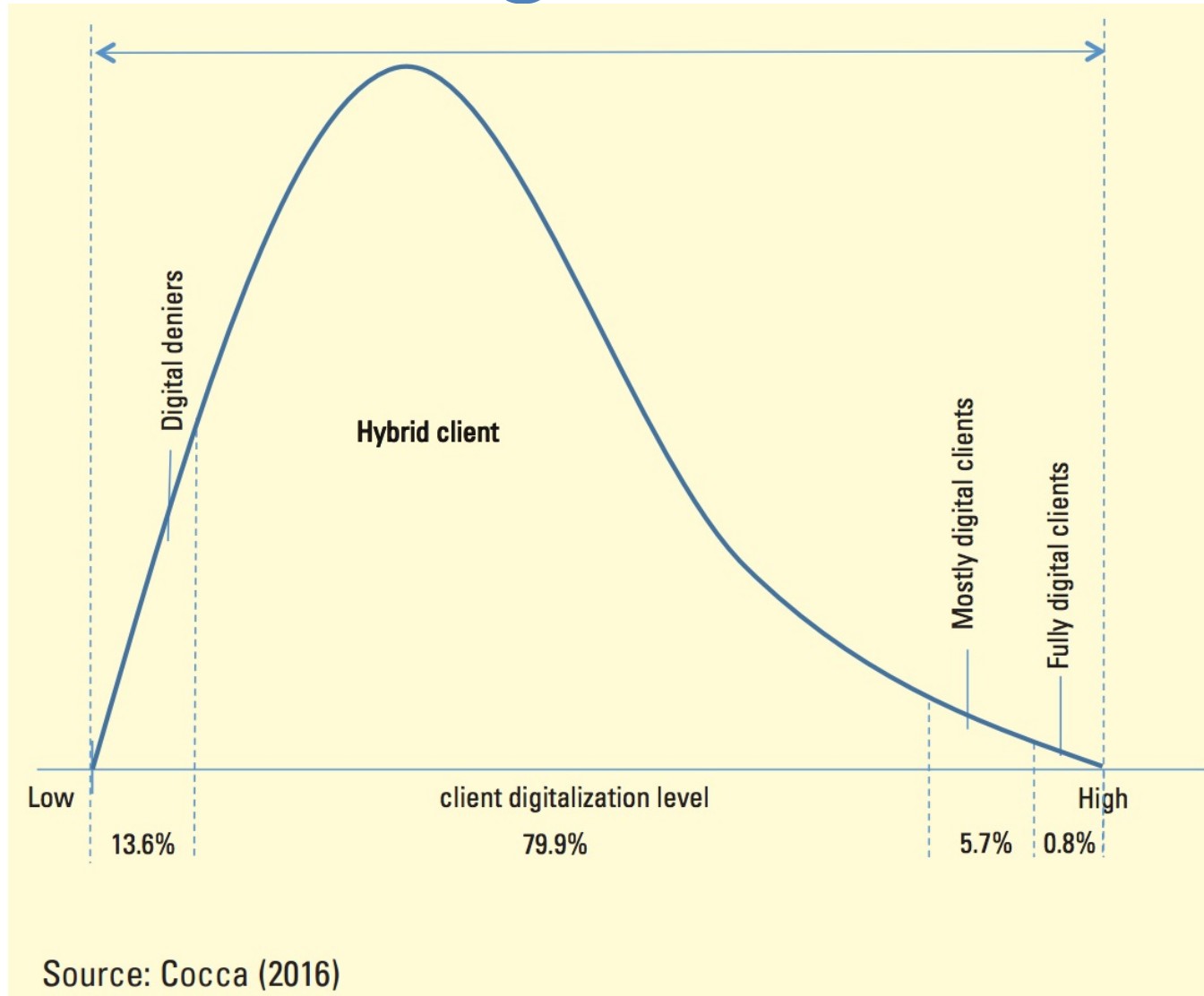


Source: Cocca (2016)

AI and Robo Advisor Virtualization Dimensions

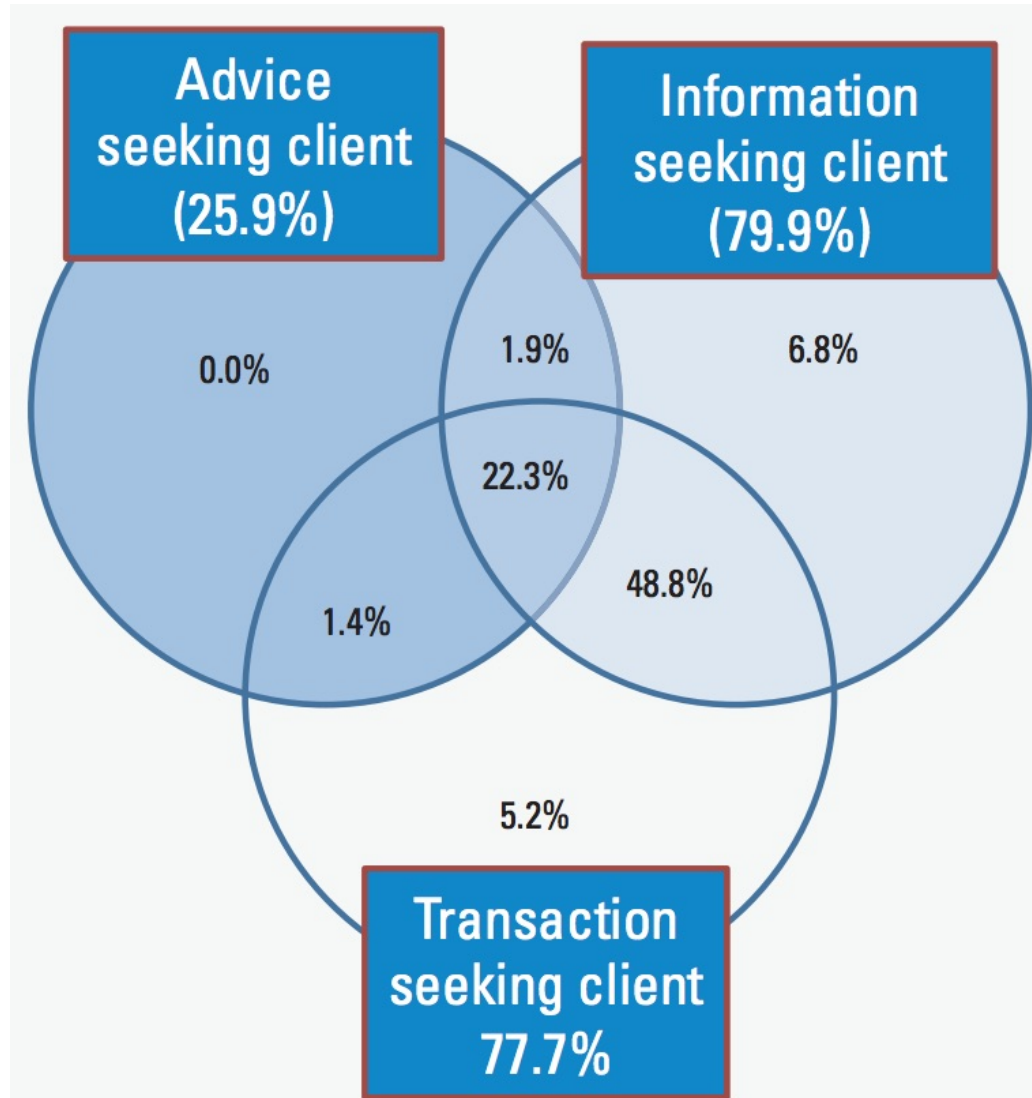


Degree of Digitalization of Wealth Management Customers



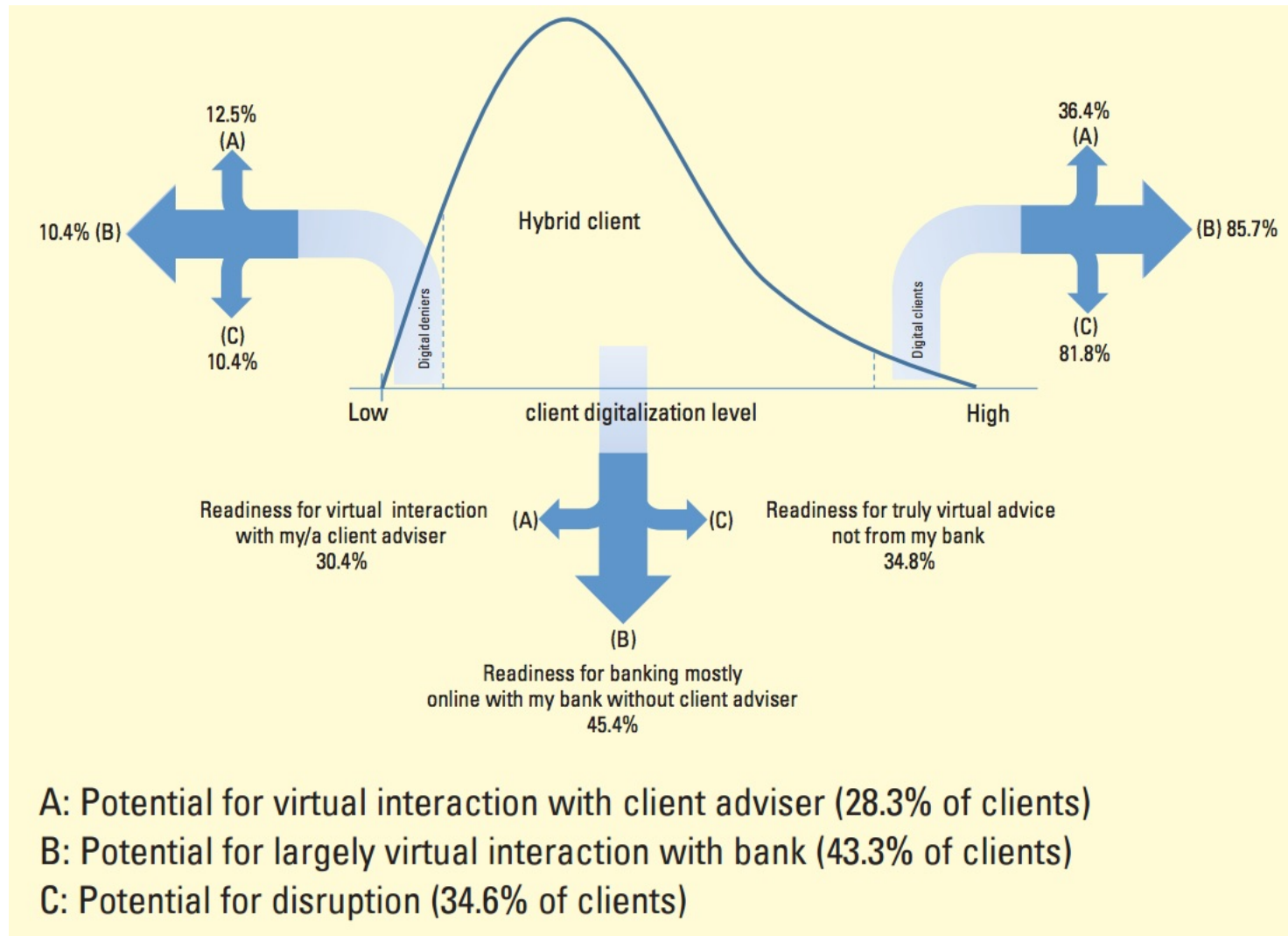
Source: Cocca, Teodoro (2016). "Potential and Limitations of Virtual Advice in Wealth Management." Journal of Financial Transformation, 44, 45-57.

Use of Online Services by Hybrid Customers



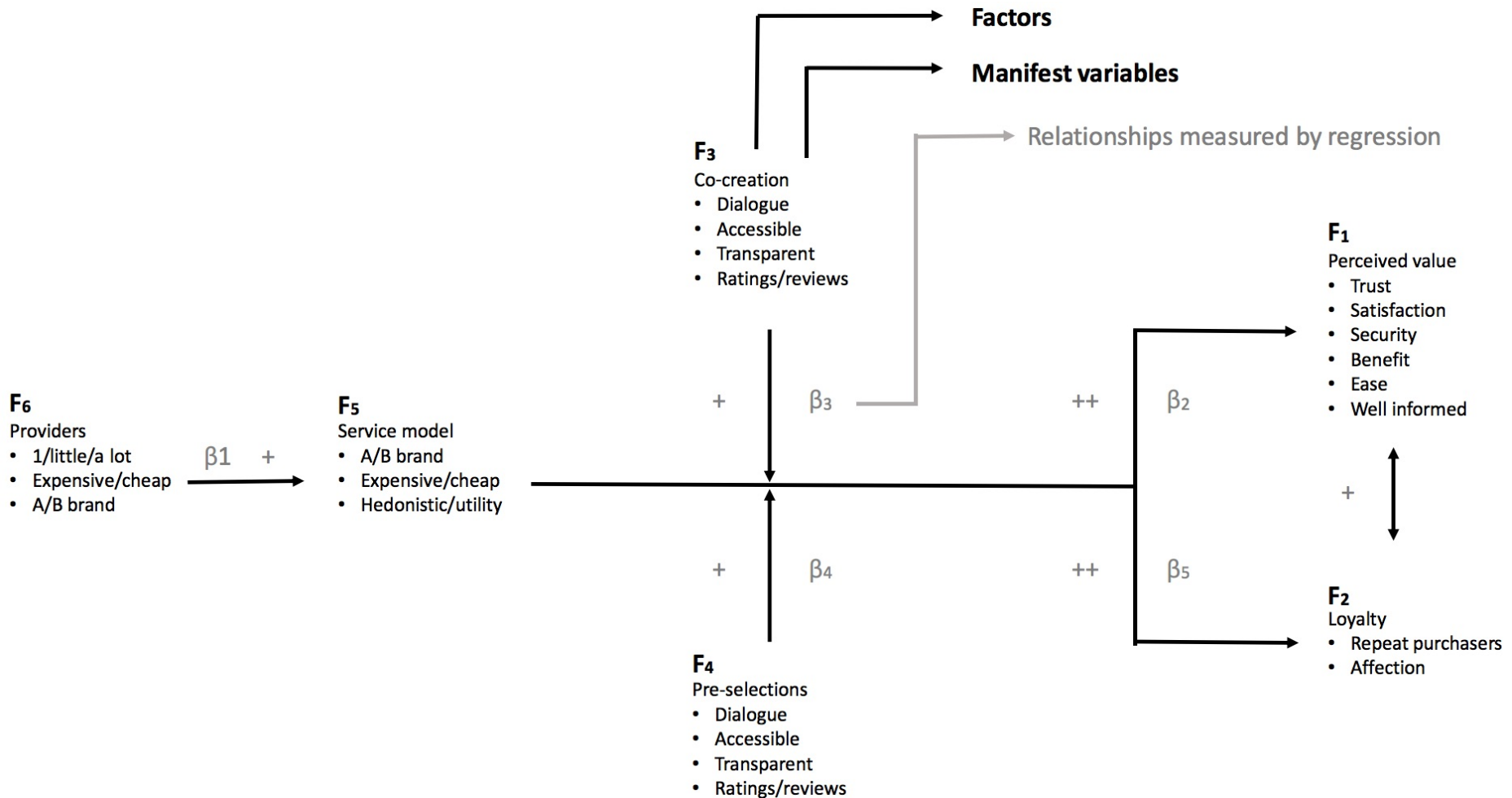
Source: Cocca, Teodoro (2016). "Potential and Limitations of Virtual Advice in Wealth Management." Journal of Financial Transformation, 44, 45-57.

Use of Online Services by Hybrid Customers



Source: Cocca, Teodoro (2016). "Potential and Limitations of Virtual Advice in Wealth Management." Journal of Financial Transformation, 44, 45-57.

Explaining Customer Experience of Digital Financial Advice



Modern Portfolio Theory and Investment Analysis

- Financial Securities
- Financial Markets
- The Characteristics of the Opportunity Set Under Risk
- Delineating Efficient Portfolios
- Techniques for Calculating the Efficient Frontier

Modern Portfolio Theory and Investment Analysis

- The Correlation Structure of Security Returns:
 - The Single-Index Model
 - Multi-Index Models and Grouping Techniques
- Simple Techniques for Determining the Efficient Frontier
- Estimating Expected Returns
- How to Select Among the Portfolios in the Opportunity Set

Modern Portfolio Theory and Investment Analysis

- International Diversification
- The Standard Capital Asset Pricing Model
- Nonstandard Forms of Capital Asset Pricing Models
- Empirical Tests of Equilibrium Models
- The Arbitrage Pricing Model APT
 - A Multifactor Approach to Explaining Asset Prices

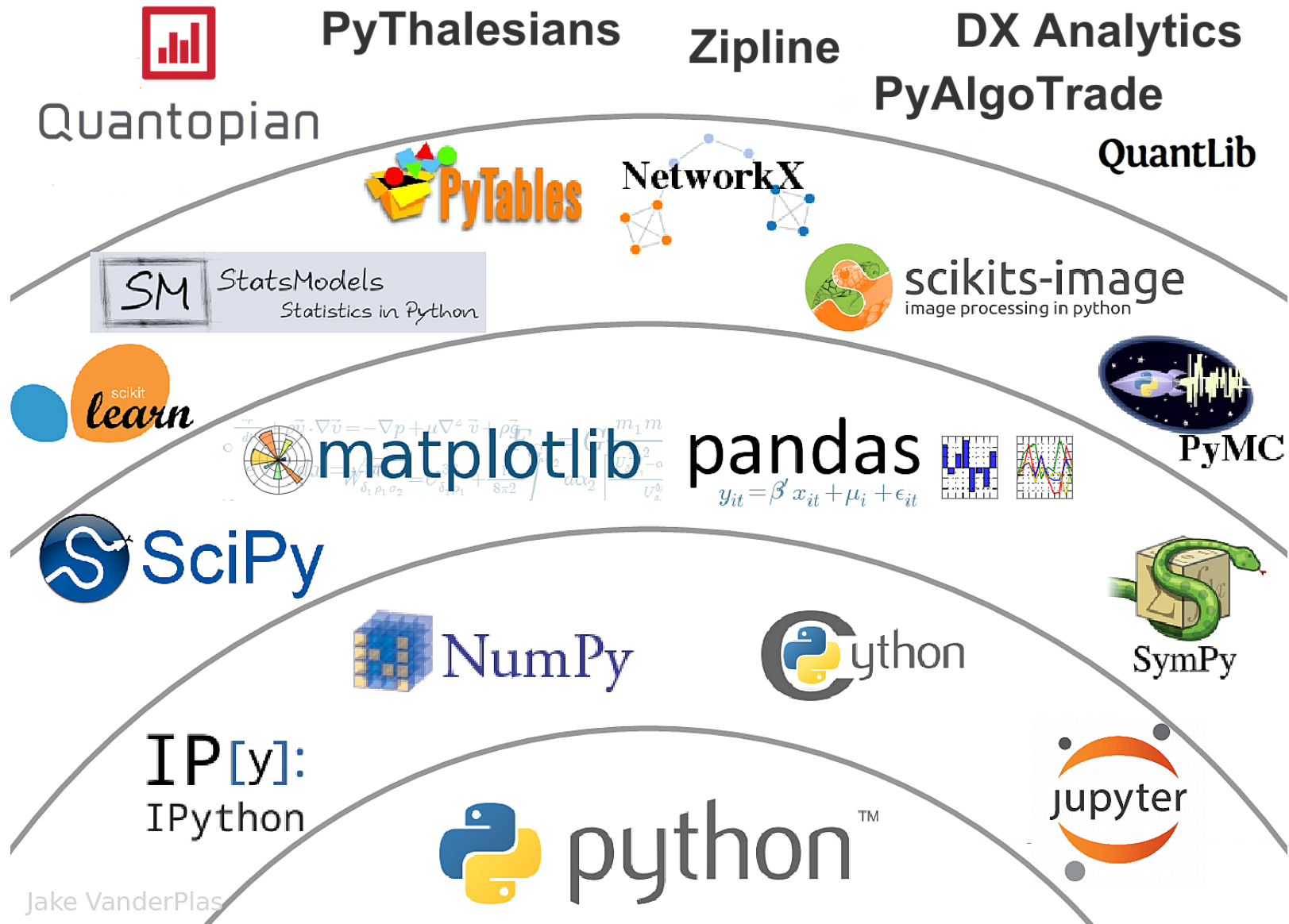
Modern Portfolio Theory and Investment Analysis

- Efficient Markets
- The Valuation Process
- Earnings Estimation
- Behavioral Finance, Investor Decision Making, and Asset Prices
- Interest Rate Theory and the Pricing of Bonds
- The Management of Bond Portfolios

Modern Portfolio Theory and Investment Analysis

- Option Pricing Theory
- The Valuation and Uses of Financial Futures
- Mutual Funds
- Evaluation of Portfolio Performance
- Evaluation of Security Analysis
- Portfolio Management Revisited

The Quant Finance PyData Stack



Jake VanderPlas

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

Quantopian



Investor Relations

Allocations

Research

Community

Learn

Help

Log In

Sign Up

Leveling Wall Street's Playing Field

Quantopian inspires talented people everywhere to write investment algorithms. Select authors may license their algorithms to us and get paid based on performance.

Start Coding



<https://www.quantopian.com/>

References

- Susanne Chishti and Janos Barberis (2016), “The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries”, Wiley.
- Paolo Sironi (2016), “FinTech Innovation: From Robo-Advisors to Goal Based Investing and Gamification”, Wiley.
- Charles P. Jones (2012), Investments: Analysis and Management, 12th Edition, Wiley.
- Edwin J. Elton, Martin J. Gruber, Stephen J. Brown, and William N. Goetzmann (2014), Modern Portfolio Theory and Investment Analysis, 9th Edition, Wiley.
- Musto, C., Semeraro, G., Lops, P., de Gemmis, M., & Lekkas, G. (2015). Personalized finance advisory through case-based recommender systems and diversification strategies. *Decision Support Systems*, 77, 100-111.
- Rubino, J. (2016). My Favorite Robot. *CFA Institute Magazine*, 27(3), 43-46.
- Cocca, Teodoro (2016). "Potential and Limitations of Virtual Advice in Wealth Management." *Journal of Financial Transformation*, 44, 45-57.
- Van Thiel, Diederick, and Fred Van Raaij (2017). "Explaining Customer Experience of Digital Financial Advice." *Economics* 5, no. 1, 69-84.