



AI is the new electricity

It will transform every industry and create huge economic value

Andrew Ng



I believe that Artificial Intelligence represents the greatest opportunity in human history

I estimate the AI market potential will be 10 times greater than that of the mobile internet revolution

Kai Fu Lee



One consequence of this AI revolution ..  
will be “a Cambrian explosion of autonomous machines”

Jensen Huang



Artificial intelligence

Nanotechnology

and Biotechnology

are going to be **central themes** in the next wave of science  
and **wealth creation**

Michio Kaku



We're at the beginning of a golden age of AI

Recent advancements have already led to inventions that previously lived in the realm of science fiction

*— and we've only scratched the surface of what's possible*

Jeff Bezos



The business value created by AI will reach \$3.9T in 2022

**\$3,900,000,000,000**

Gartner



However..

there is one **big** challenge with AI in Financial Services...



# Explainable AI for regulatory compliance, fair customer outcomes and market stability in the Global Financial Services Sector

Janet Adams





## Who am I?



- AI enthusiast, recently completed MSc in AI at University of Essex
- Representing my academic research today - how to unlock AI benefit in banking

### Recent career:

- Head of Risk and Controls, Head of AI, TSB business bank
- Global Head of Conduct, HSBC commercial bank
- Head of strategic regulatory change, RBS regulatory affairs
- COO, Credit Risk, RBS Investment bank

Lots of risk frameworks !

AFME AI working group



## Research Strand 1: review of relevant publications / speeches / regulatory guidance on Ethics of AI

Issuing body	Title	Issuing body	Title
US Government / Senate	Algorithmic Accountability Act of 2019	Electronic Privacy Information Center, Washington DC (part of Whitehouse AI task force)	Universal Guidelines for Artificial Intelligence
DNB	General principles for the use of Artificial Intelligence in the financial sector	Bank of England	Managing Machines: the governance of artificial intelligence
Australian government	Artificial Intelligence: Australia's Ethics Framework Discussion Paper	UK courts	Legal case against algorithmic trading firm for misleading investors about the capabilities of the system
Information Commissioners Office	GDPR	SEC	Guidance Update: ROBO-ADVISERS
European Commission	ETHICS GUIDELINES FOR TRUSTWORTHY AI	Government of China	Beijing AI Principles
BaFin Federal Financial Supervisory Authority	Big data meets artificial intelligence – results of the consultation on BaFin's report	Japanese government	AI Policy Japan
House of Lords	AI in the UK, Ready, Willing and Able?	Indian government	National Institute for Transforming India. 2018. National strategy for artificial intelligence.
French Government	For a meaningful artificial intelligence: Towards a French and European strategy	MAS	Principles to Promote Fairness, Ethics, Accountability and Transparency (FEAT) in the Use of Artificial Intelligence and Data Analytics in Singapore's Financial Sector
OECD	Recommendation of the Council on Artificial Intelligence	Office of the Privacy Commissioner for Personal Data	Ethical Accountability Framework for AI
IEEE	Ethically Aligned Design (EAD1e), A Vision for Prioritizing Human Well-being with Autonomous and Intelligent Systems	AI Now	AI Now 2018 report
European Parliament	European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL))	FCA	The future of regulation: AI for consumer good



Accountability & Explainability driving positive AI outcomes

**Transparency**

- Disclosure to Clients
- Explainability of AI

**Human Autonomy**

- Human self-agency
- Ability to challenge and override AI
- Human empowerment and weaknesses

**Robustness**

- Proven reliability of results
- Algorithm performance e.g. accuracy, recall, precision
- Sustainability, Scalability

**Fairness**

- No bias or discrimination
- Accessibility of products and services
- Inclusiveness of AI
- Operationalise fairness where applicable

**Ethics and Conduct**

- Reflection of culture, values, diversity and ethical standards
- Consideration of societal impact

**Governance**

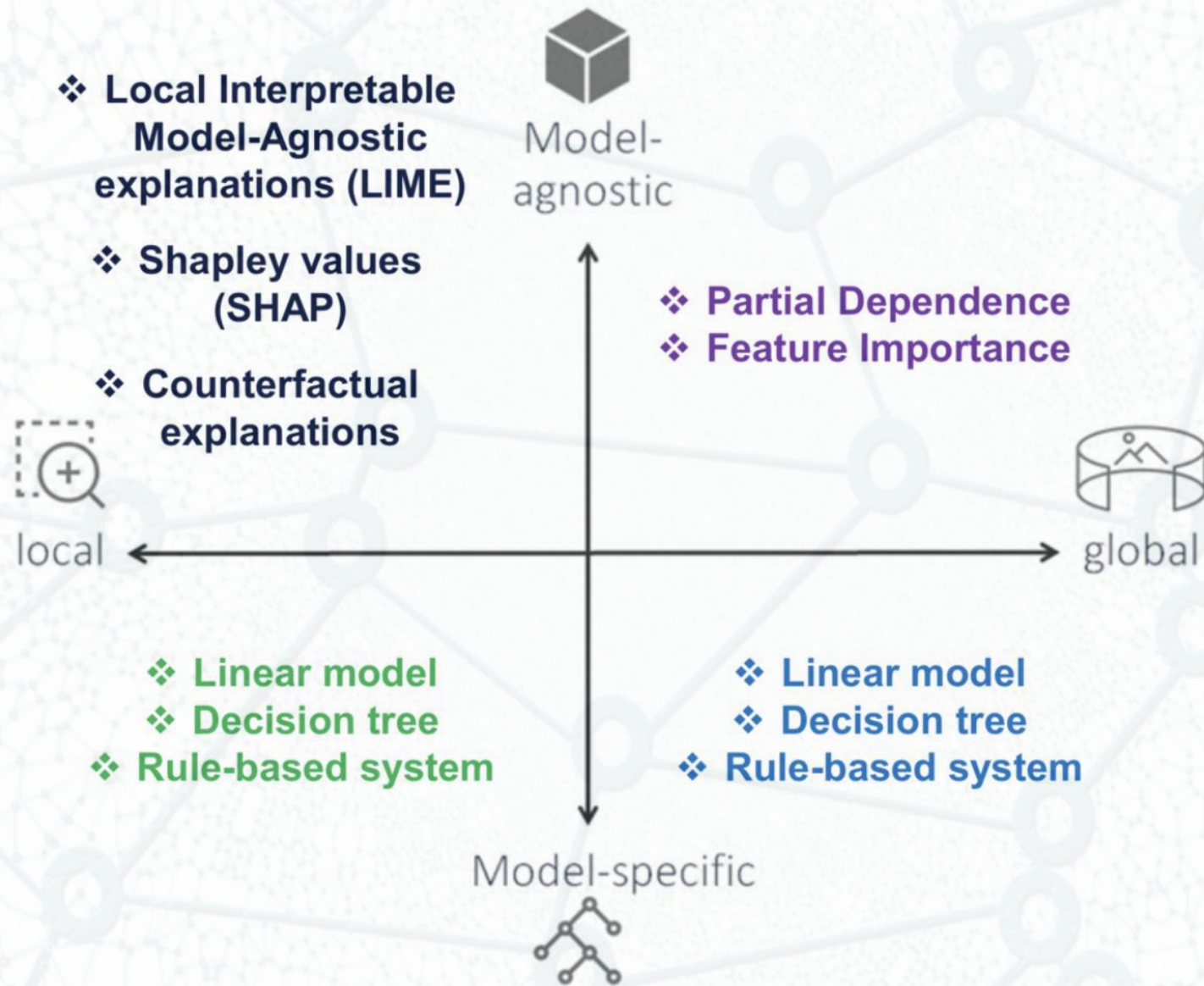
- Auditable risk assessment and cost / benefit analysis taking into consideration key principles of AI design
- Monitoring and testing of AI outcomes and data input against key risks and principles
- Appropriate oversight of AI systems and clear accountability of senior management with sufficient understanding of AI

**Compliance with existing laws, regulations and procedures**

Including Data Privacy, Record Keeping, Use of Data, Data Collection and Consent, Cyber Security, Business Continuity, Conduct, Prudential and Product regulations



## Research Strand 2: Methods of explainability



# Developing a definition of 'sufficient explainability' for FS; assessment of top 50 use cases in banking for explainability

Domain	Use Case	Suitability of Explainability technique					
		Model Specific	Model Agnostic	Global	Local		
Sales /Product / Front Office (Retail & WM)	Enhanced sales and prospecting (pattern recognition)	●	●	●	●		
	Enhanced sales and prospecting (personality behavioural profiling)	●	●	●	●		
	Improved accuracy of credit decisions	●	●	●	●		
	Improved accuracy of pricing decisions	●	●	●	●		
	Client network analysis	●	●	●	●		
	Intelligent agents for sales (Chatbots)	●	○	○	○		
	Product administration and analysis	●	●	●	●		
	Product personalization	●	●	●	●		
	Service personalization	●	●	●	●		
	Customer forecasting (cashflow/safe to spend)	●	●	●	●		
Sales /Product / Front Office (Wholesale)	Invoice finance with intelligent accounting systems integration	●	○	●	●		
	Roboadvisors (Intelligent and automated investment advice)	●	○	●	○		
	Customer sentiment analysis	●	●	●	○		
	Algorithmic trading	●	●	●	●		
	Algorithmic portfolio management	●	●	●	●		
	Dynamic hedging	●	●	●	●		
	Customer pricing (automated offering of prices based on book and market)	●	●	●	●		
	Research and economic trend analysis	●	●	●	○		
	Automate approvals to trade (model and instrument permissions)	●	○	○	○		
	Market surveillance	●	●	●	●		
Risk and Compliance	Best execution	●	●	●	●		
	Customer growth analysis and forecasting	●	●	●	●		
	Machine learning for fraud detection	●	●	●	●		
	Machine learning for Cyber-security	●	●	●	●		
	Machine learning for transaction monitoring/AML/network analysis	●	●	●	●		
	Regulatory changes updates & horizon scanning	●	●	●	○		
	Automated compliance monitoring (eg phone calls for distress)	●	●	●	●		
	Trader / individual surveillance and compliance monitoring	●	●	○	●		
	KYC/ KYB automation including authentication/biometrics/NLP	●	●	●	●		
	Intelligent agents for servicing (Chatbots) / call centre automation	●	●	●	●		
Operations	Reduction of Process cycle times through Intelligent Automation	●	●	●	●		
	Straight Through Processing (STP) account opening	●	○	●	●		
	Robotic Complaint handling and AI complaints analysis & triage	●	○	○	○		
	Automated procurement process	●	●	○	○		
	Supply chain analysis	●	●	○	○		
	Finance	Collateral and capital optimisation	●	●	●	●	
		Automated accounting / Month end processes	●	●	●	●	
		Financial planning and forecasting	●	●	●	○	
		Profit and Loss Attribution	●	●	●	○	
		Cash reconciliation	●	○	○	○	
Independent price verification / valuation processes		●	○	○	○		
Payments		Automated open banking cash management	●	●	●	●	
		Prediction As A Service to merchants	●	●	●	●	
		Legal	Legal requirements changes and horizon scanning	●	●	○	○
			Legal documents review and generation	●	●	●	●
	Regulatory return data mining and analysis		●	●	●	○	
	HR		Workforce optimisation	●	○	●	○
			Hiring automation / CV screening / personality profiling etc	●	○	●	○
			Skillset and training needs analysis	●	○	●	○
			Staff sentiment analysis	●	●	●	○









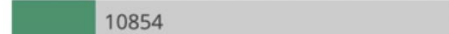


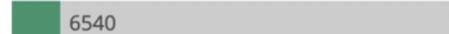


Domain	Suitability of Explainability technique			
	Model Specific	Model Agnostic	Global	Local
Sales /Product / Front Office (Retail & WM)	●	●	●	●
Sales /Product / Front Office (Wholesale)	●	●	●	●
Risk and Compliance	●	●	●	●
Operations	●	●	●	●
Finance	●	●	●	●
Payments	●	●	●	●
Legal	●	●	●	●
HR	●	●	●	●

## Research Strand 3: 9 banking uses cases explored using three algorithmic models

Sector	Use case	No. features	No. Instances	Target Class	Goal
Retail	Propensity To Buy (PTB)	21 features: 11 categorical, 9 continuous, and 1 mixed	41188	The target feature is 'Buy product?' There are 2 target classes: Bought - 11% Not bought - 89%	The classification goal is to predict if the client will subscribe (yes/no) a term deposit (variable y).
	Churn Modelling	11 features: 6 categorical, 5 continuous	100000	The target feature is 'Exited' There are 2 target classes: Exited - 20% Stayed - 80%	Given a Bank customer, can we build a classifier which can determine whether they will leave or not?
	Loan Default	21 features: 18 categorical, 3 continuous	5000	The target feature is 'Default Next Month?' There are 2 target classes: Default- 30% Pay - 70%	Classification task to identify whether a customer will default or not
	Credit card default	24 features: 10 categorical, 14 continuous	30000	Target feature is 'Default Next Month' There are two target classes: Pay - 78% Default - 22%	To predict whether a customer will default on a credit card
Wholesale	FX price change NZD:USD	35 features: 1 categorical, 34 continuous	1001	The target feature is 'RESPONSE' There are 2 target classes: Down- 49.95% Up- 50.05%	To predict whether the cost of buying a USD with a NZD will go up or down the following day
	FX price change USD:CHF	35 features: 1 categorical, 34 continuous	1001	The target feature is 'RESPONSE' There are 2 target classes: Down- 47% Up- 53%	To predict whether the cost of buying a CHF with a USD will go up or down the following day
	Gold:USD price change	35 features: 1 categorical, 34 continuous	1069	The target feature is 'RESPONSE' There are 2 target classes: Down- 49% Up- 51%	To predict whether the cost of buying a Gold with a USD will go up or down the following day
	Bitcoin:USD price change	35 features: 1 categorical, 34 continuous	472	The target feature is 'RESPONSE' There are 2 target classes: Down- 48% Up- 52%	To predict whether the cost of buying a Bitcoin with a USD will go up or down the following day
	Nikkei Index price prediction	35 features: 1 categorical, 34 continuous	1071	The target feature is 'RESPONSE' There are 2 target classes: Down- 48% Up- 52%	To predict whether the price of the Nikkei index will go up or down the following day

# Example Fuzzy Logic explainable global rules - PTB

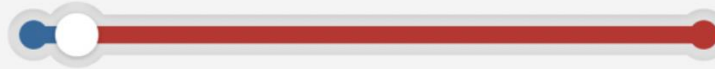
Fuzzy Logic Rules				Training	Matching Instances
Rule Id	Antecedents	Statistics	Result		
0	Duration of call is high	Dominance ^ ★★★★★ 1 Frequency  12304 Winning  6632	Bought		
53	Cons.conf.idx is high Nr.employed is medium	Dominance ^ ★★★★★ 2 Frequency  8734 Winning  6463	Bought		
81	Duration of call is low Days since last contact is No previous contact	Dominance ^ ★★★☆☆ 3 Frequency  12061 Winning  5943	Not bought		
367	Duration of call is low	Dominance ^ ★★★☆☆ 4 Frequency  12289 Winning  45	Not bought		
413	Duration of call is low Previous outcome is nonexistent	Dominance ^ ★★★☆☆ 5 Frequency  10854 Winning  0	Not bought		
12	Duration of call is medium Days since last contact is No previous contact	Dominance ^ ★★★☆☆ 6 Frequency  19699 Winning  6540	Not bought		

Example  
Fuzzy Logic  
explainable  
local rules -  
CCD

# Default

1.19%

Pay



98.81%

Default

Drivers

Rules

The top 10 drivers contributing to the classification are:



The drivers contributing to **Default** are:

Status Sept is 2 months arrears

Status Aug is 2 months arrears

Status Jul is 2 months arrears

Status Jun is 2 months arrears

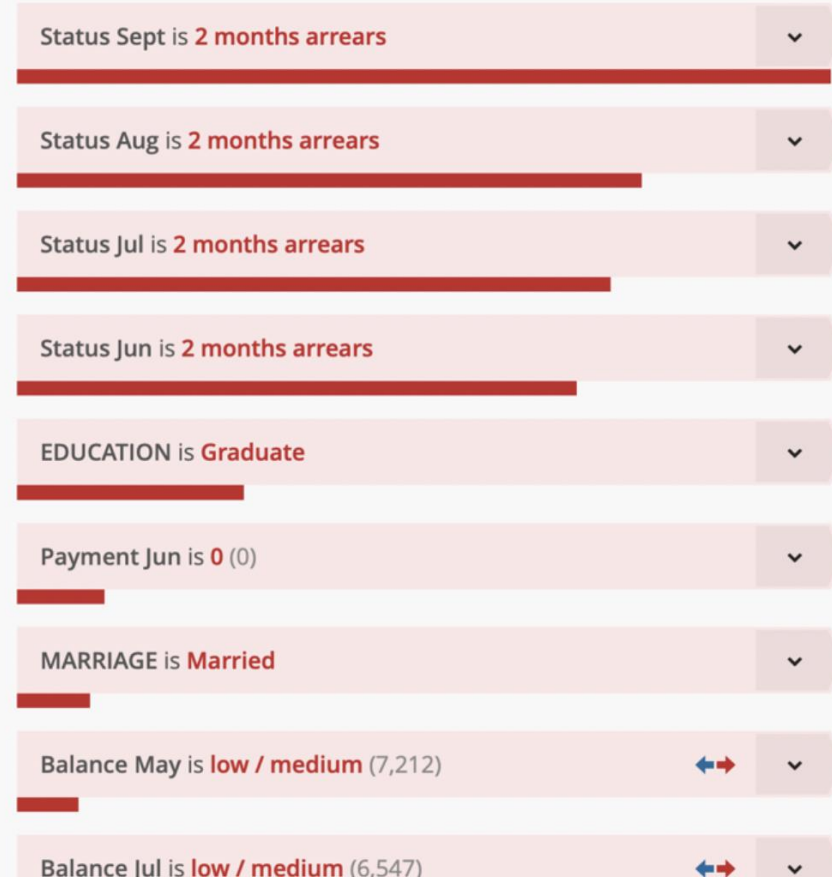
EDUCATION is Graduate

Payment Jun is 0 (0)

MARRIAGE is Married


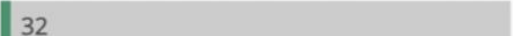







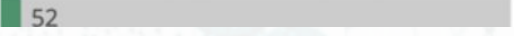
Balance May is low / medium (7,212)

Balance Jul is low / medium (6,547)





# Example FX global rules

0	<p><b>RETURNS5</b> is <i>medium</i></p> <p><b>EMA200</b> is <i>medium</i></p> <p><b>BB_LOWER50</b> is <i>medium</i></p>	<p><u>Dominance</u> ^ ★ ★ ★ ★ ★ 1</p> <p>Frequency  315</p> <p>Winning  32</p>	Up
1	<p><b>RETURNS5</b> is <i>medium</i></p> <p><b>BB_UPPER50</b> is <i>medium</i></p>	<p><u>Dominance</u> ^ ★ ★ ★ ★ ★ 2</p> <p>Frequency  352</p> <p>Winning  62</p>	Up
2	<p><b>RETURNS5</b> is <i>high</i></p>	<p><u>Dominance</u> ^ ★ ★ ★ ★ ★ 3</p> <p>Frequency  298</p> <p>Winning  163</p>	Down
3	<p><b>RETURNS5</b> is <i>medium</i></p> <p><b>SMA50</b> is <i>medium</i></p> <p><b>BB_LOWER100</b> is <i>medium</i></p>	<p><u>Dominance</u> ^ ★ ★ ★ ★ ☆ 4</p> <p>Frequency  284</p> <p>Winning  8</p>	Up
103	<p><b>EMA100</b> is <i>high</i></p> <p><b>BB_UPPER10</b> is <i>high</i></p> <p><b>BB_UPPER20</b> is <i>high</i></p>	<p><u>Dominance</u> ^ ★ ★ ★ ★ ☆ 5</p> <p>Frequency  226</p> <p>Winning  52</p>	Down

# Conclusions

- Type 2 Fuzzy Logic has the capability to deliver strong performance in recall, precision and accuracy, and outperforms Neural Networks and Logistic regression for explainability, supporting compliance, governance, risk assessment, oversight, monitoring and controls, disclosure, autonomy, human empowerment, sustainability, scalability, conduct, culture and societal impact
- Firms should consider building AI capability from the outset with model-specific explainable methods
- Deep Neural Networks and other complex algorithmic approaches which are not explainable by design have a place; however where opaque models are deployed, stringent and robust compliance, monitoring and auditability measures must be in place, along with expertise
- It is recommended that firms with ambitions to deploy AI at scale develop and rollout a global AI Accountability and Explainability Framework
- A risk based approach to explainability is proposed; a reasonable starting benchmark should be that every customer matters and any significant customer impacting decision being driven or informed by AI methods should be clearly explainable by design
- Additionally, issues of diversity in the workplace, particularly in data and technology focussed areas, must be addressed as a priority

The background of the slide is a light blue and white network diagram. It consists of numerous small circular nodes connected by thin lines, forming a complex web. Some nodes are highlighted with larger, semi-transparent blue circles. The overall aesthetic is clean and technical, suggesting a focus on technology or data science.

Thank you:

Professor Hani Hagraas at University of Essex

Logical Glue/Temenos

Adriano Soares Koshiyama at UCL

Eva Lueckemeier at HSBC Thailand