

AI, Industrial Revolution, and India/Mysore

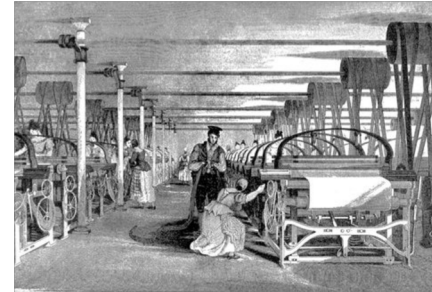
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Topics

- Three Industrial revolutions
 - Role of India/Mysore
- The Fourth Revolution: AI
 - What is it?
- Promise of AI
 - Drive economic growth
 - Enhance national security
 - Improve quality of life.

Grand Technological Revolutions

1. 1800: Steam engine



2. Electricity



3. 1970:
Electronics/Computers



4. 2018: Artificial Intelligence



Mysore in Steam Revolution



ES-506 1922
9 locomotives built by KS
Bangalore-Bangarpet (Kolar)

Mysore State Railway

1879: Bangalore-Mysore
1891: Mysore-Nanjangud

Mysore in Electric Revolution

Shivanasamudram

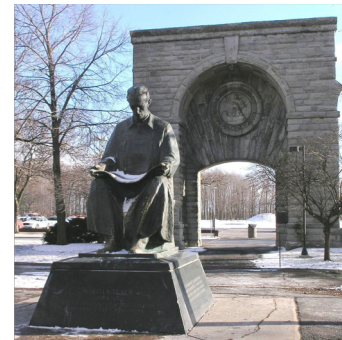


Commissioned in 1899
First transmission in 1902
to KGF (80 miles)

Niagara Falls

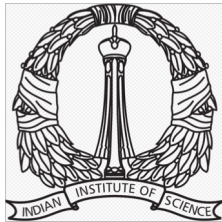
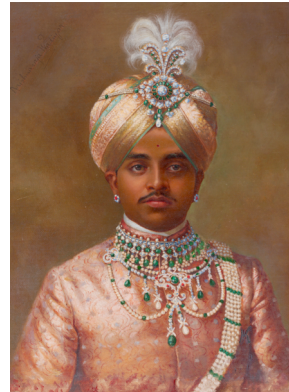


Commissioned in 1882 (DC power)
First AC transmission in 1896
to Buffalo (25 miles) by Westinghouse



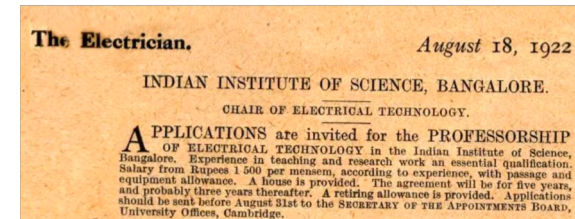
Mysore in Computer Revolution

Educational Institutions



Electronic industry

BEL, ITI, NAL, LRDE, HMT, BHEL,...



Software industry

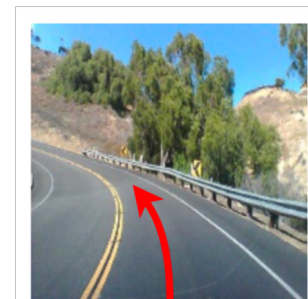
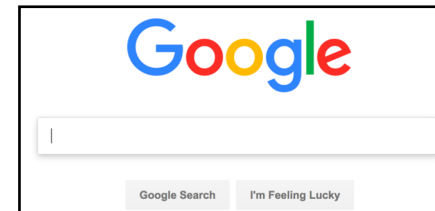
TI, Infosys, WIPRO,.....

The Fourth Revolution: Artificial Intelligence

- In comparison to Industrial Revolution
- AI Revolution is Larger
 - Steam engine took over physical labor
 - AI can perform both physical and intellectual labor
- Faster
 - Industrial revolution took centuries
 - Adopted simultaneously across the world

AI is ubiquitous, performs tasks requiring intelligence

- Reasoning
 - Games
- Planning
 - Action sequences
- Natural language
- Sensors
 - Vision, Speech



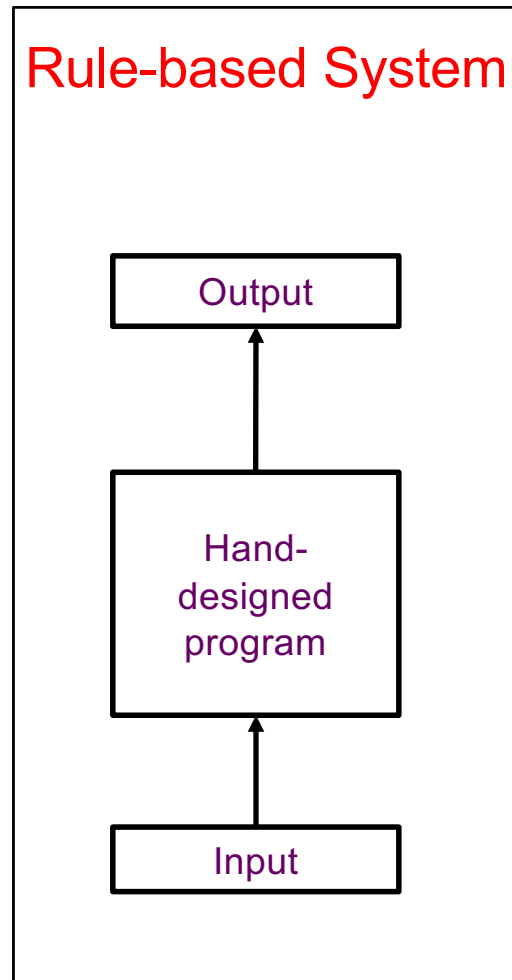
How is AI accomplished?

- AI Paradox
- Hard problems for people are easy for AI
 - Narrow Intelligence
- Easy problems for people are hard for AI
 - General Intelligence

Everyday life needs knowledge

- Knowledge is intuitive and subjective
 - Key challenge of AI is how to get this informal knowledge into a computer
- Knowledge-based Approach
 - Hard-code knowledge in a formal language
 - Computer can reason about statements in these languages using inference rules

Knowledge-Based AI



Disadvantage: Unwieldy process

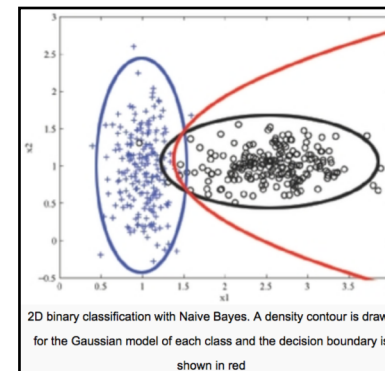
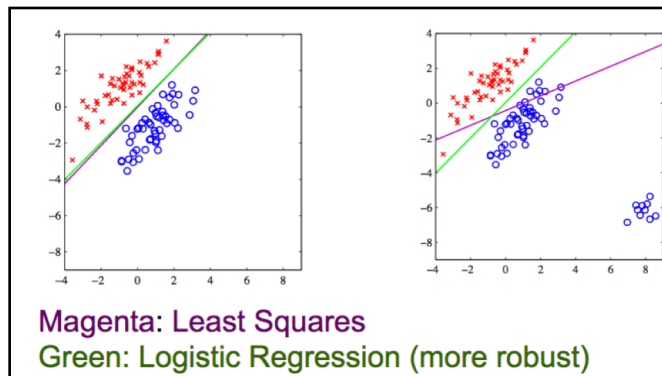
Time of human experts

People struggle to formalize rules with enough complexity to describe the world

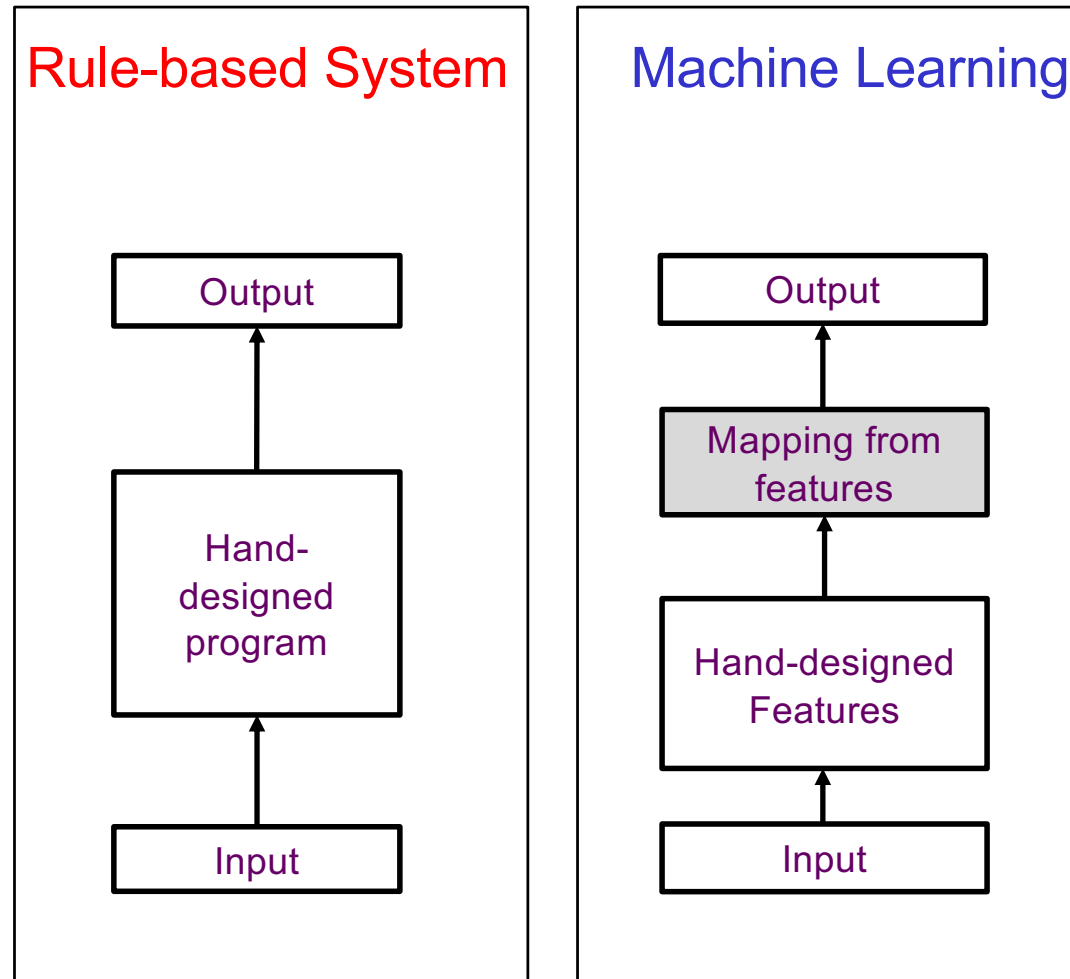
Machine Learning approach to AI

- Difficulties of hard-coded approach suggests:
 - Allow computers to learn from experience
- Determine how inputs are represented
- Map the features to outputs

Decide whether email is spam



Two paradigms in AI

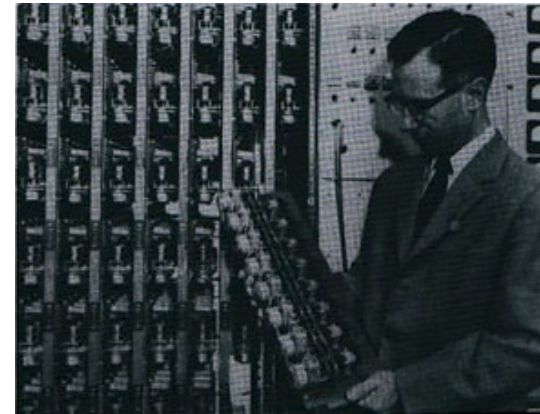
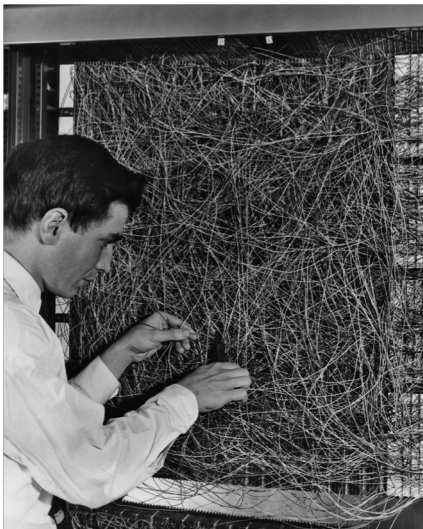
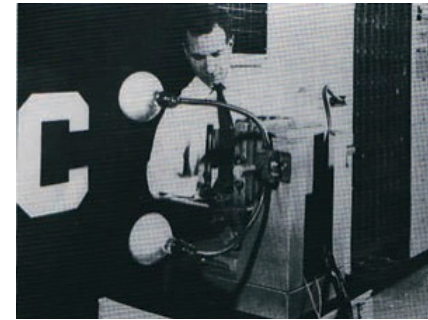
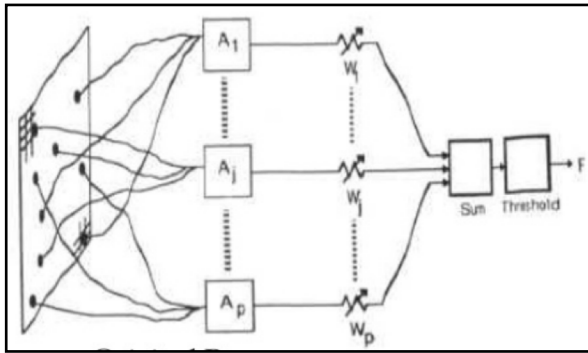


■ Shaded boxes indicate components that can learn from data

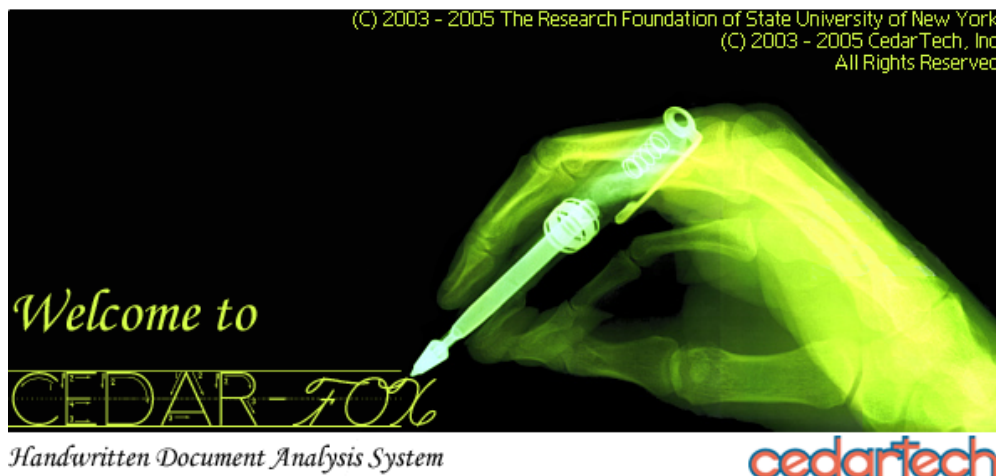
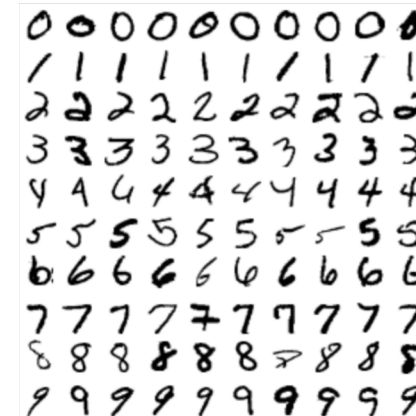
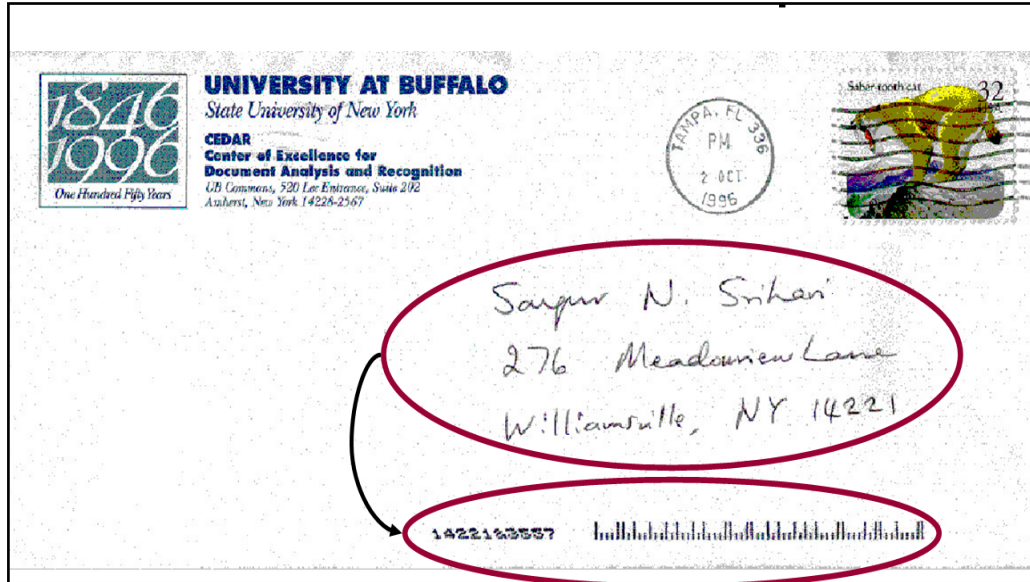
Neural Networks

Perceptron

--a perceiving and recognizing automaton, 1957
CALSPAN, Buffalo



1983: Handwriting as *Fruit Fly* of AI



Designing right set of features

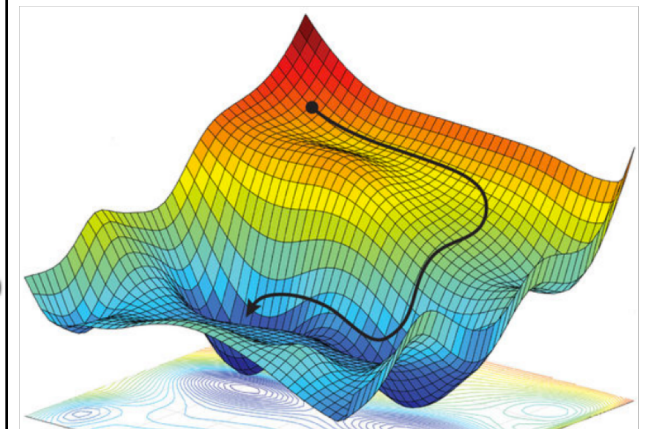
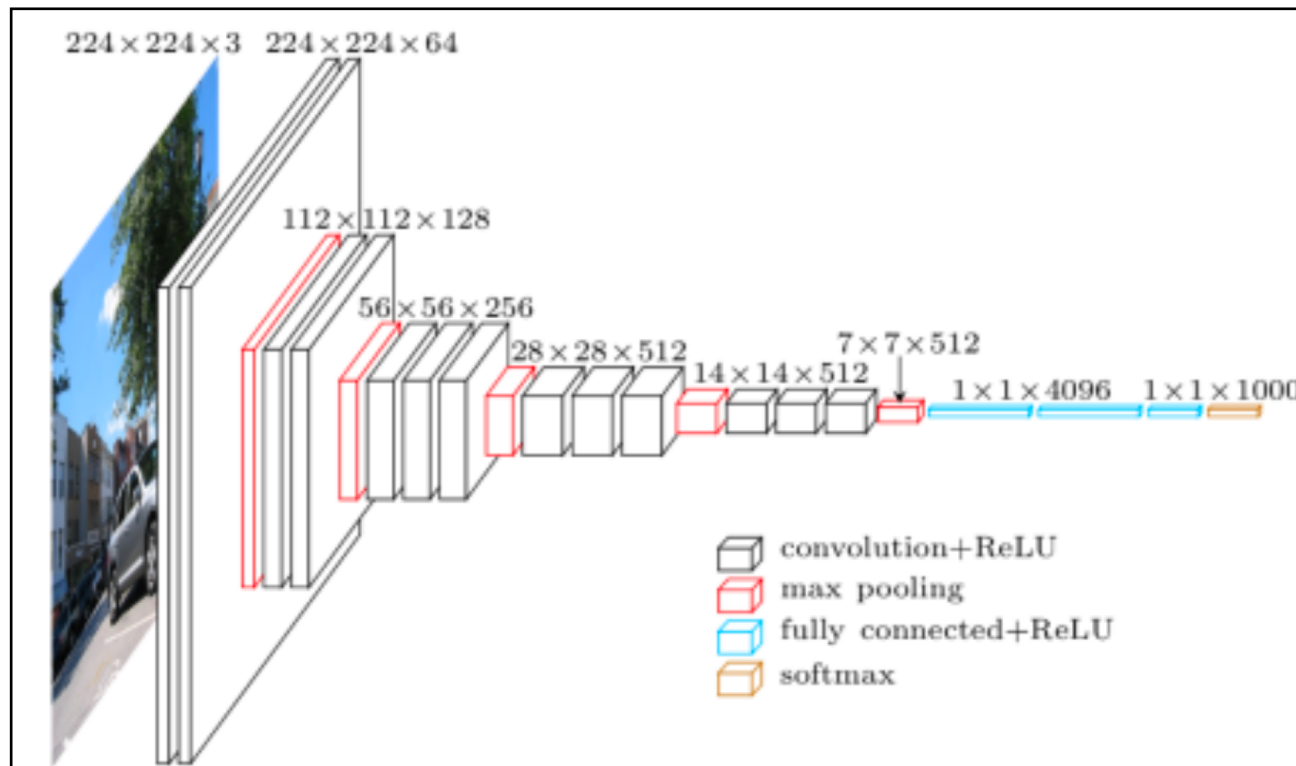
- Simple Machine Learning depends on *feature engineering*
 - For detecting a car **detecting wheels is not always a solution**
 - Shadows, glare, occlusion



Deep Learning

- Learn representations from data
- Understand the world as hierarchy of concepts
 - Concepts built on top of each other is deep-- layers
 - Weights learnt by gradient descent

$$\mathbf{x}^{t+1} = \mathbf{x}^t - \epsilon \nabla_{\mathbf{x}^t} f(\mathbf{x}^t)$$



Deep Learning



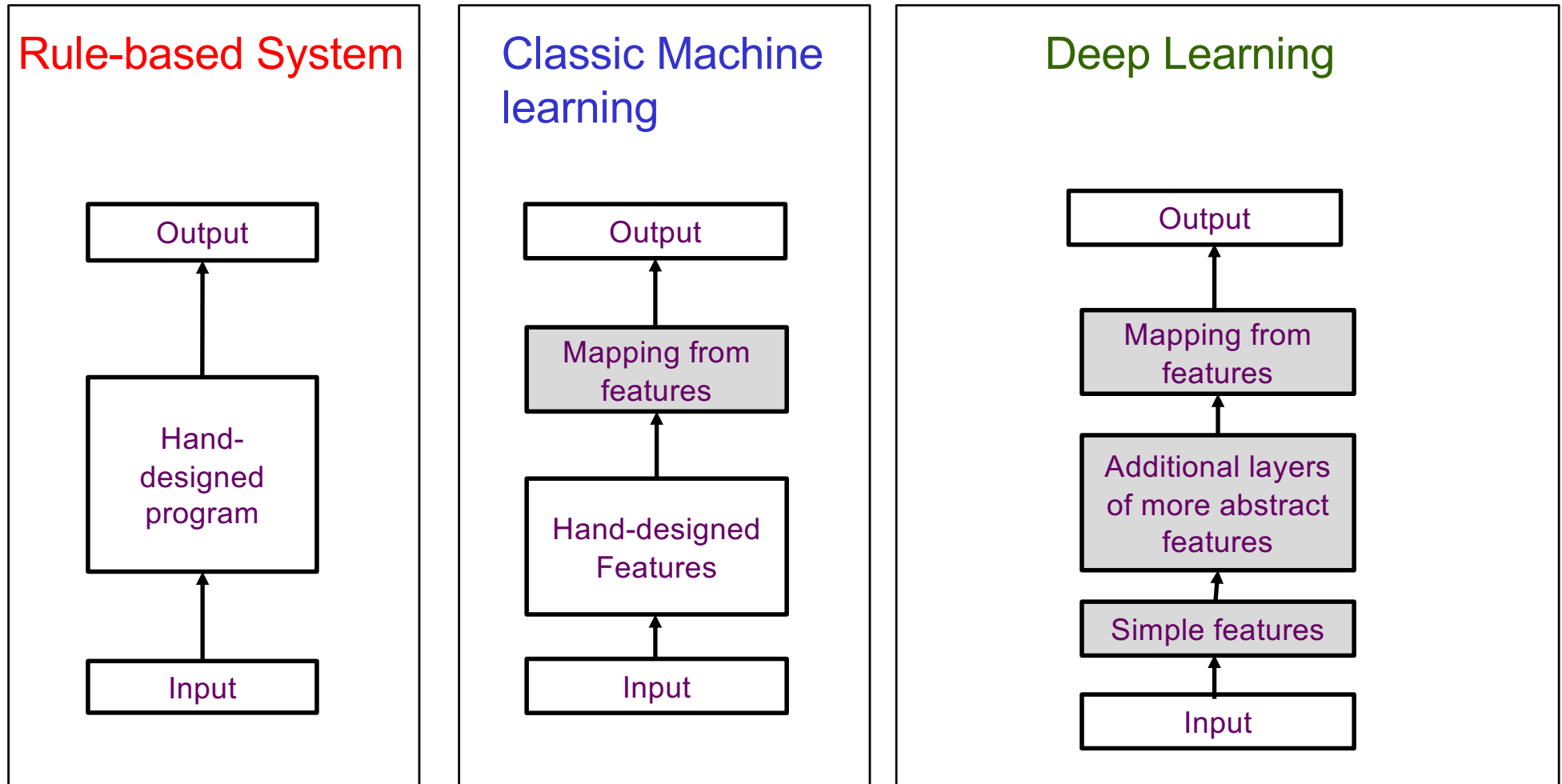
Yann Lecun: NYU/Facebook
Geoff Hinton: Toronto/Google
Yoshua Bengio: Montreal
Andrew Ng: Stanford/Baidu



Robin Li, UB-CS 1990



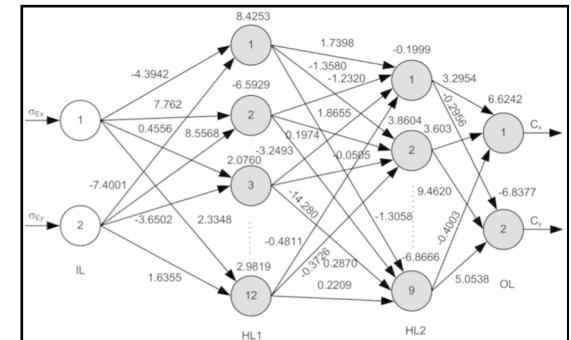
Three Paradigms of AI



■ Shaded boxes indicate components that can learn from data

Disruption in Software Development

- AI is said to be poised to disrupt the world
- A disruption in computer science as well
- Deep Learning: a fundamental shift
- Software 1.0 (Classical “stack”)
 - It is code we write
 - e.g., LAMP(Linux, Apache, MySQL, Python/Perl)
- Software 2.0 (Code written by Optimizer)
 - Code in a user unfriendly language
 - There are millions of weights
 - No human involved in coding



Benefits of Software 2.0

- Computationally homogeneous
 - Sandwich of two operations: matrix multiply, RELU
- Simple to bake into silicon
 - Small instruction set
- Constant run time
 - Every iteration of forward pass has same FLOPS
 - Constant memory use
- Highly portable: sequence of matrix multiplies is easier
- Very agile
 - C++ is hard to speed-up, instead remove half of channels
- Can meld into optimal whole
 - Software often has modules, can jointly optimize
- It is better than you

How Deep Learning disrupts CS

- Software Developer

- **Past:** Write and maintain layers of tangled code
- **Future:** Curate data & analyze results

- Mathematics

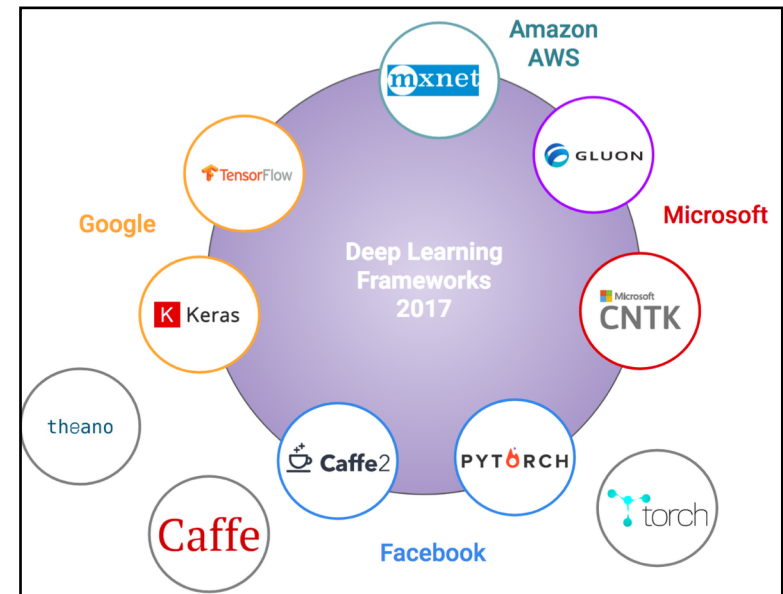
- **Past:** Logic, Discrete math
- **Future:** Probability, Calc, Linear Alg

- Programming Environments

- **Past:** C++, Java
- **Future:** Tensorflow/Pytorch/Gluon/...
 - Most software jobs won't need programming

- Hardware

- **Past:** CPUs
- **Future:** GPUs



Future of AI: Utopian view

- Boring and Back-office jobs will be eliminated
- While human facing jobs will remain
 - CEOs, Nurses, Home caregivers
- Intellectually challenging tasks will be solved
 - Diagnose disease
 - Drive cars
 - Customer support

AI and Ethics

- Bias Anecdotes

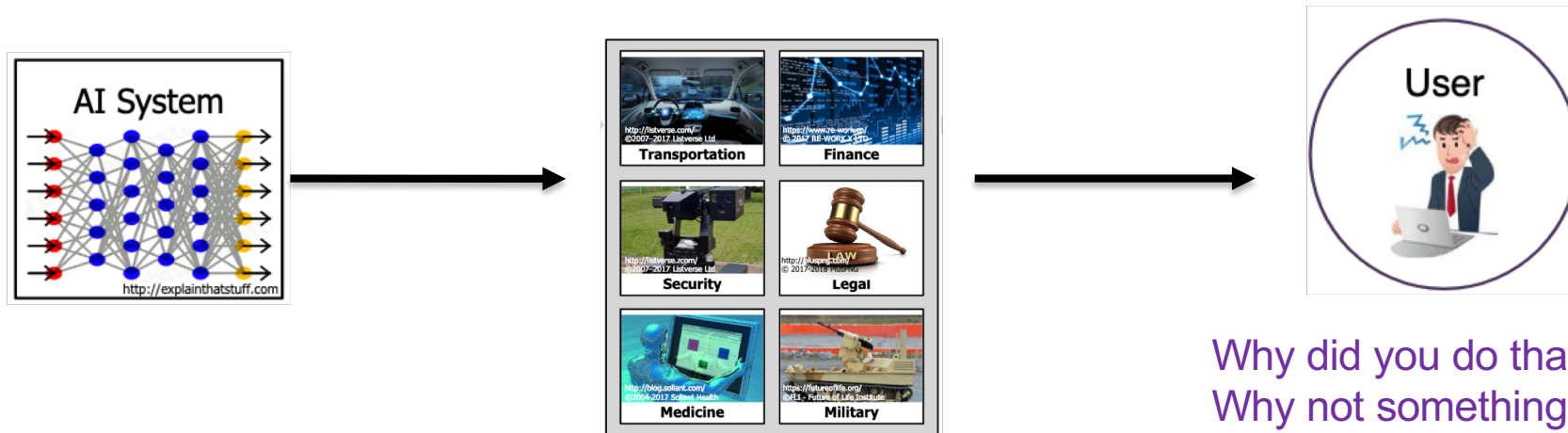
- Common dataset is 74% male and 84% white

- Google program identified African Americans as Gorillas
- Amazon's screening rejected applicants mentioning women's groups or colleges
- Facial recog. misidentified 35% dark-skinned women as men, while error rate for white men was 0.8%
- Creditworthiness of those who drove long distances

- Solutions

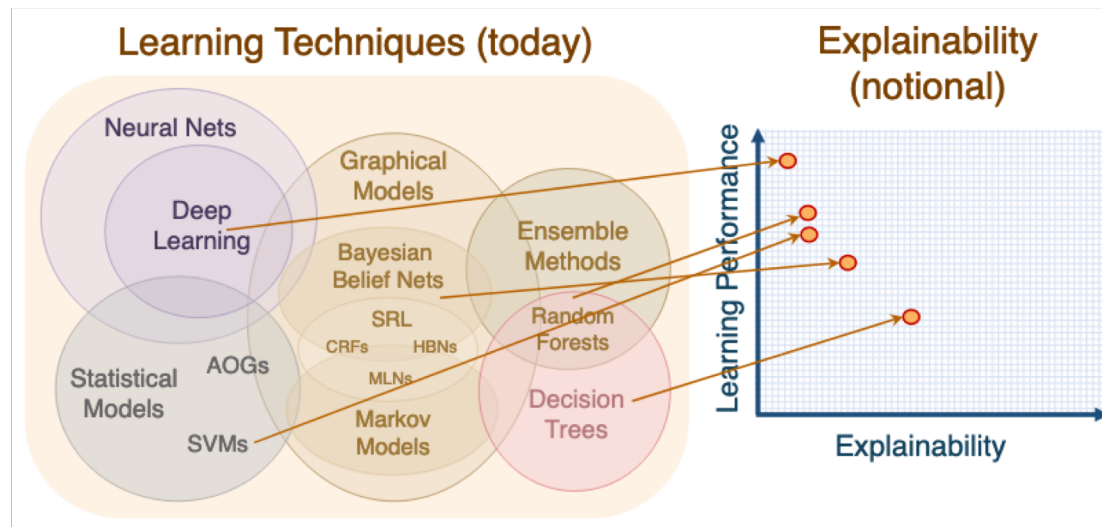
- Diverse group of developers
- Up-front logic (Software 1.0) to handle situations

Explainable AI

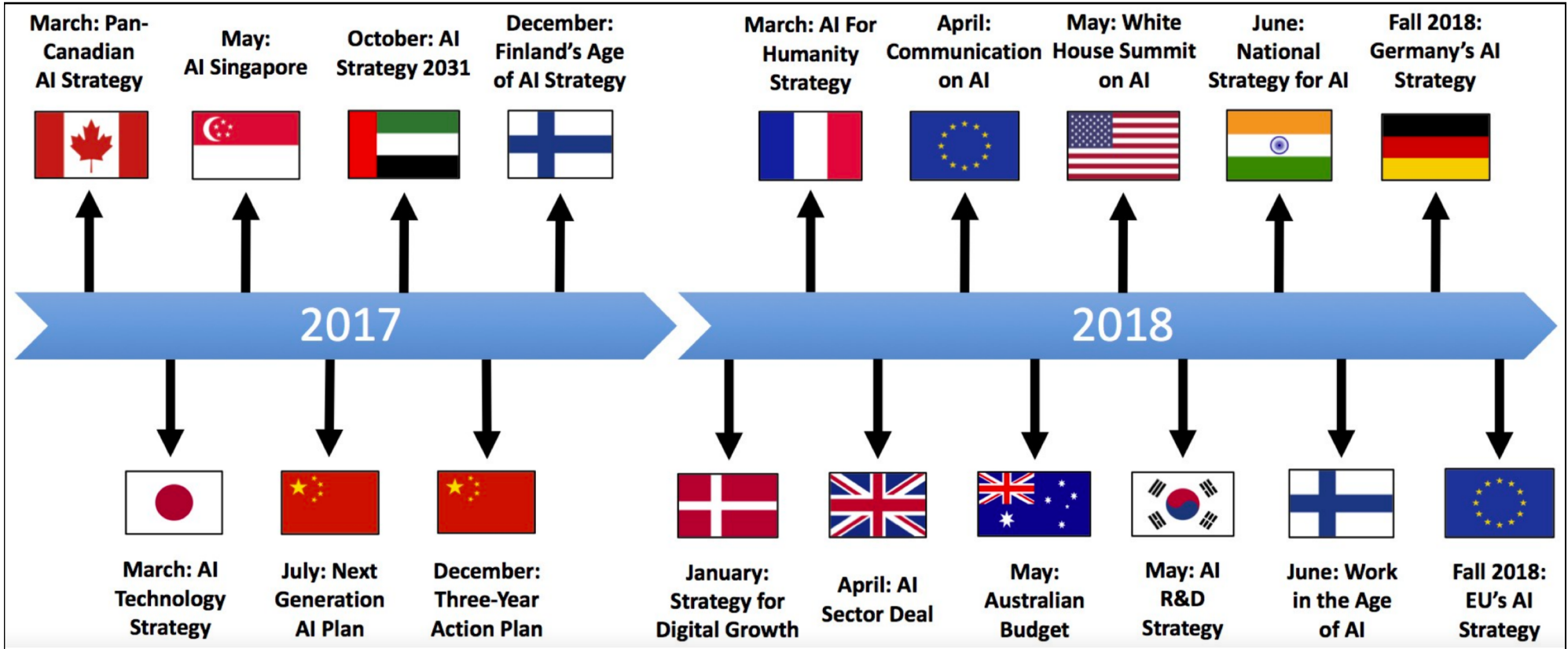


Anecdote: Medical AI
 Decisions can be worse with AI
 e.g., Patient discharge to a nursing home

Why did you do that?
 Why not something else?
 When do you succeed?
 When do you fail?
 When can I trust you?
 How do I correct an error?



National AI Initiatives



“Artificial Intelligence is poised to disrupt the world”

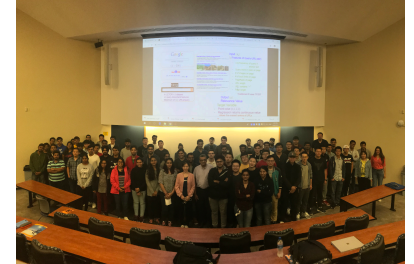
NITI Aayog

US Executive Order on AI

- Issued Feb 11, 2019
 1. Investing in AI R&D
 2. Unleashing data for AI
 3. Setting government standards
 4. Building AI workforce (education)
 5. International engagement/protection

AI and Education

- Grad AI courses
 - Introduction to ML: 350 students
 - Deep Learning: 60 students
 - PGMs: 90 students
- Undergrad AI courses
 - Enabled by programming libraries
 - Tensorflow, Pytorch, Gluon
- AI in high school
 - AI as a tool for learning



Conclusion

- AI is the fourth industrial revolution
- India/Mysore has had a role in past revolutions
- AI is poised to disrupt the world
 - AI is already disrupting Computer Science
- AI will eliminate boring, repetitive jobs and create new types of jobs
- There are opportunities and challenges