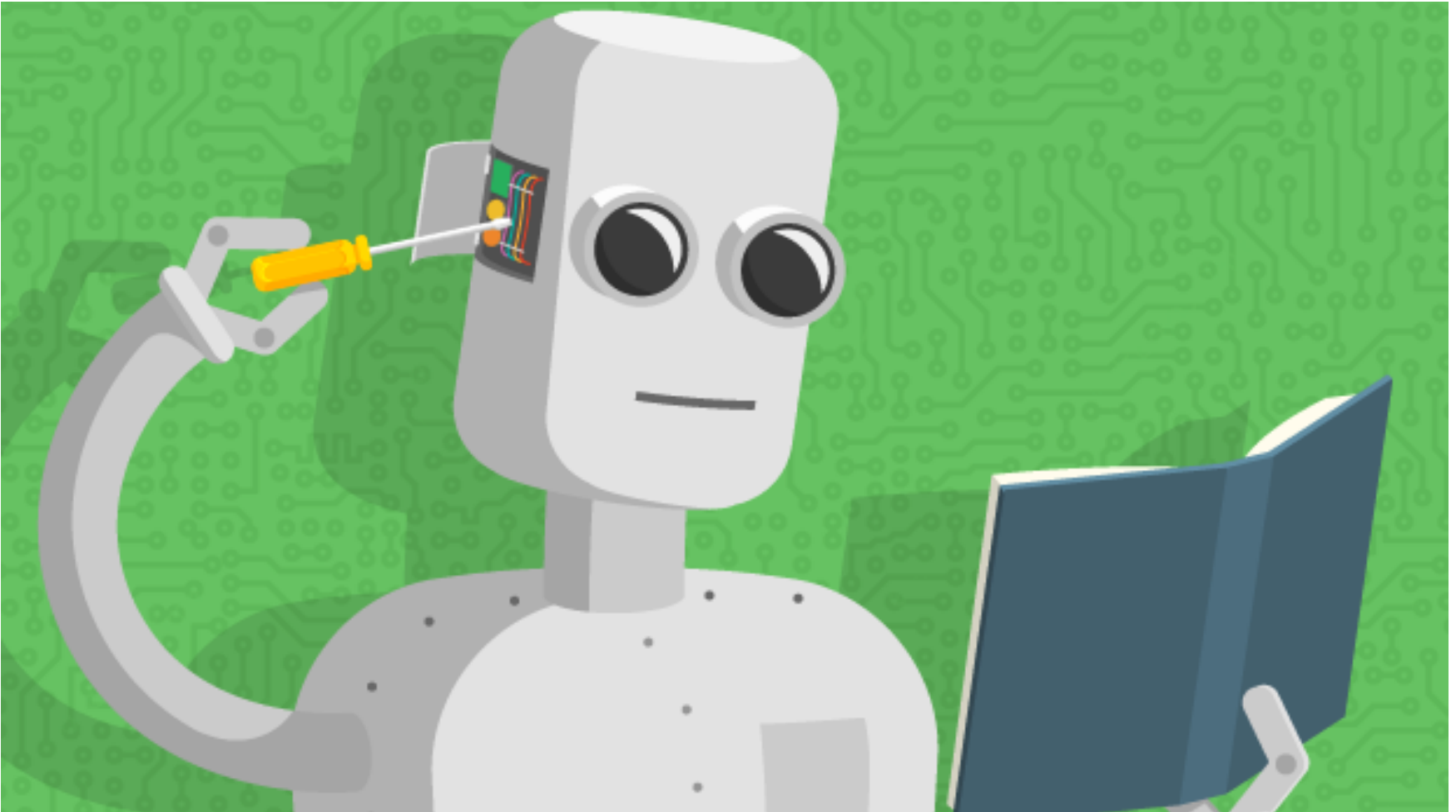


# Machine Learning overview

## Chapter 19



# What we will cover

- Some popular ML problems and algorithms
  - Take Machine Learning, Data Science, NLP, Computer Vision for more
  - Use online resources & experiment on your own
- We will focus on when/how to use techniques and only touch on how/why they work
- Basic ML methodology and evaluation
- Use various platform for examples & demos (e.g., [scikit-learn](#), [Weka](#), [TensorFlow](#), [PyTorch](#))
  - Great for exploration and learning

# What is learning?

- Learning denotes changes in a system that ... enable a system to do the same task more efficiently the next time – [Herbert Simon](#)
- Learning is constructing or modifying representations of what is being experienced – [Ryszard Michalski](#)
- Learning is making useful changes in our minds – [Marvin Minsky](#)

# Why study learning?

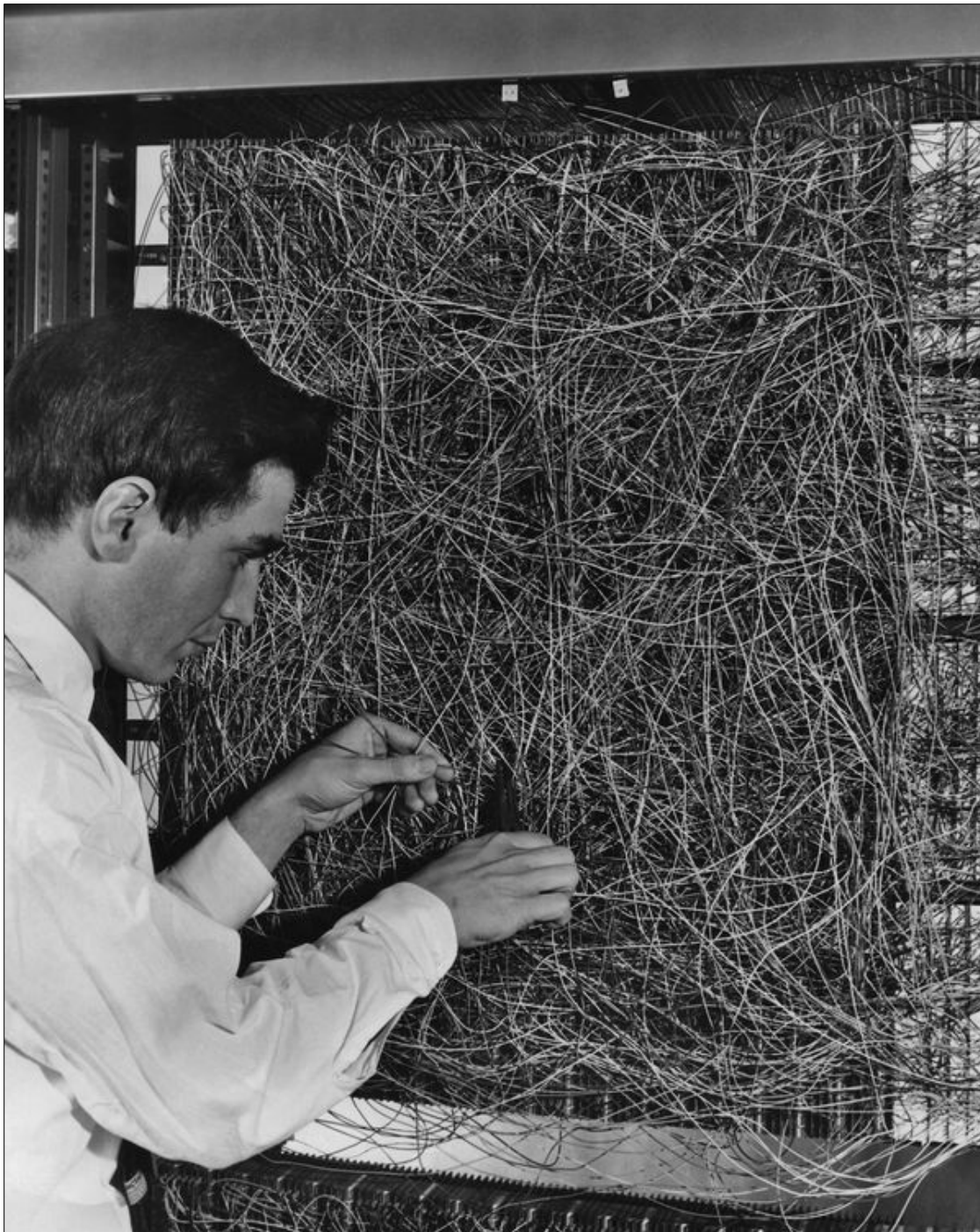
- **Discover** new things or structure previously unknown
  - Examples: data mining, scientific discovery
- Fill in skeletal or **incomplete specifications** in a domain
  - Large, complex systems can't be completely built by hand & require dynamic updating to incorporate new info.
  - Learning new characteristics expands the domain or expertise and lessens the “brittleness” of the system
- Acquire **models directly from data** rather than by manual programming
- Build agents that can **adapt** to users, other agents, and their environment
- Understand and improve efficiency of **human learning**

# AI and Learning Today

- 50s&60s: neural network learning popular  
Marvin Minsky did neural networks for his dissertation
- Mid 60s: replaced by paradigm of manually encoding & using symbolic knowledge  
Cf. [Perceptrons](#), Minsky & Papert book showed limitations of perceptron model of neural networks
- 90s: more data & processing power drove interest in statistical machine learning techniques & data mining
- Now: machine learning techniques & big data play biggest driver in almost all successful AI systems  
... and neural networks are the current favorite approach

seeAlso: [Timeline of machine learning](#)

# Neural Networks 1960

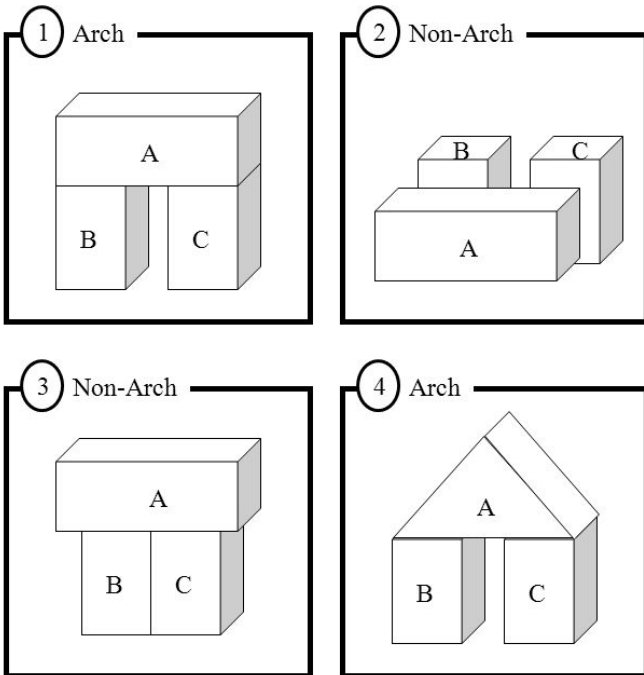


A man adjusting the random wiring network between the light sensors and association unit of scientist Frank Rosenblatt's [Perceptron](#), or MARK 1 computer, at the Cornell Aeronautical Laboratory, Buffalo, New York, circa 1960. The machine is designed to use a type of artificial neural network, known as a perceptron.

# AI Learning in the 1970s

*Winston's ARCH learning experiments ...*

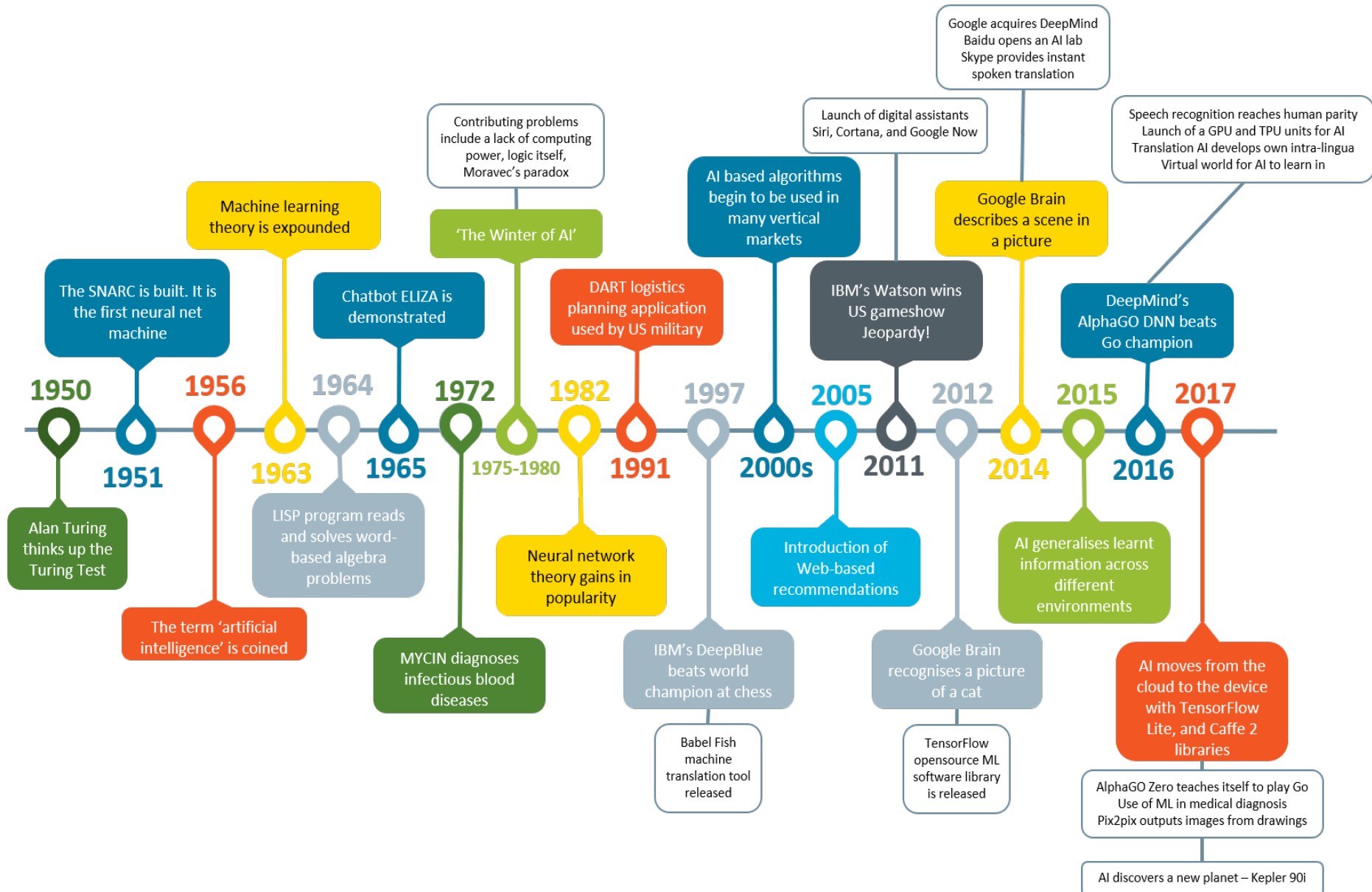
Marvin Minsky



First we need to understand how to program machines to be intelligent in some way, then we can take on the task of getting the to learn how to do it.



# AI timelines show Machine Learning beginning to dominate in the early 2000s





# Neural Networks 2018

Google's AIY Vision Kit (\$89.99 at Target) is an intelligent camera that can recognize objects, detect faces and emotions. Download and use a variety of image recognition neural networks to customize the Vision Kit for your own creation. Included in the box: Raspberry Pi Zero WH, Pi Camera V2, Micro SD Card, Micro USB Cable, Push Button.

Currently \$59.00 on [Amazon](#)

Google Vision Kit AIY : Target

https://www.target...

Categories Deals Search Sign in

You're shopping (open until 10pm): Glen Burnie North

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### Google Vision Kit AIY

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**WARNING: choking hazard - small parts. Not for children under 3 yrs.**

#### About this item

Details Shipping & Returns Q&A (4) What's GiftN

#### Highlights

- A do-it-yourself project for STEM education, ideal for teens
- Build your own smart camera and learn about image recognition
- Detect faces and their emotions, like joy and sadness
- Instantly recognize 1,000 common objects using the camera
- Raspberry Pi ZWH, Raspberry Pi Camera v2 and SD card included
- No internet connection required

Google AIY Projects brings do-it-yourself artificial intelligence to students and makers. The AIY Vision Kit from Google is an intelligent camera that can recognize objects, detect faces, and emotions. Download and use a variety of image recognition neural networks to customize the Vision Kit for your own creation.

What is included in the box: Raspberry Pi Zero WH, Pi Camera V2, Micro SD Card, Micro USB Cable, Push Button

# Machine Learning Successes

- Games: chess, go, poker
- Text sentiment analysis
- Email spam detection
- Recommender systems (e.g., Netflix, Amazon)
- Machine translation
- Speech understanding
- SIRI, Alexa, Google Assistant, ...
- Autonomous vehicles
- Individual face recognition
- Understanding digital images
- Credit card fraud detection
- Showing annoying ads

# Major Machine learning paradigms (1)

- **Rote:** 1-1 mapping from inputs to stored representation, learning by memorization, association-based storage & retrieval
- **Induction:** Use specific examples to reach general conclusions
- **Clustering:** Unsupervised discovery of natural groups in data

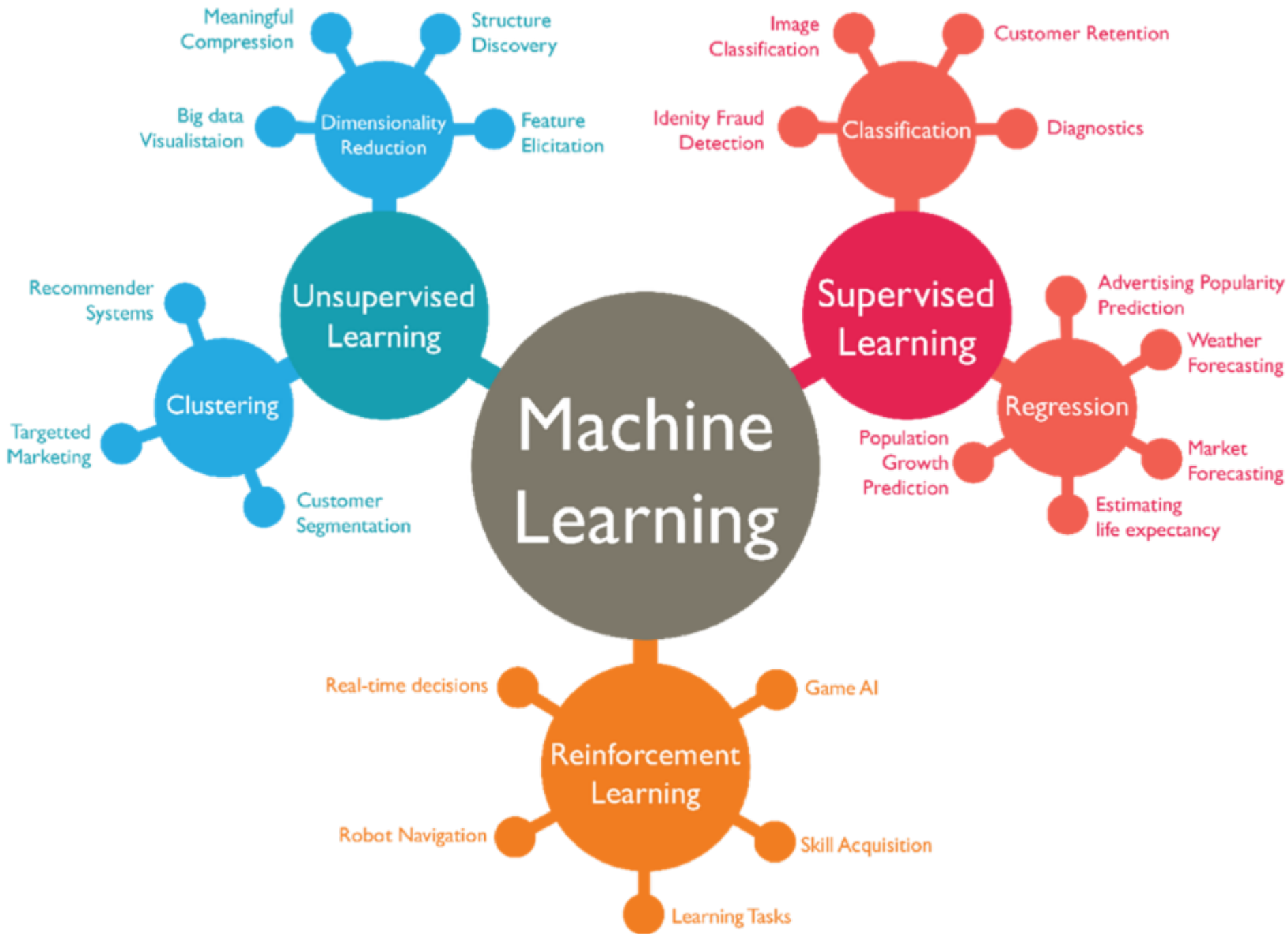
# Major Machine learning paradigms (2)

- **Analogy:** Find correspondence between different representations
- **Discovery:** Unsupervised, specific goal not given
- **Genetic algorithms:** *Evolutionary* search techniques, based on *survival of the fittest*
- **Reinforcement:** Feedback (positive or negative reward) given at the end of a sequence of steps
- **Deep learning:** *artificial neural networks* with *representation learning* for ML tasks

# Types of learning problems



- **Supervised:** learn from training examples
  - Regression:
  - Classification: Decision Trees, SVM
- **Unsupervised:** learn w/o training examples
  - Clustering
  - Dimensionality reduction
  - Word embeddings
- **Reinforcement learning:** improve performance using feedback from actions taken
- Lots more we won't cover
  - Hidden Markov models, Learning to rank, Semi-supervised learning, Active learning, ...



# Machine Learning Problems

*Supervised Learning*

*Unsupervised Learning*

*Discrete*

classification or  
categorization

clustering

*Continuous*

regression

dimensionality  
reduction

	<i>Supervised Learning</i>	<i>Unsupervised Learning</i>
<i>Discrete</i>	classification or categorization	clustering
<i>Continuous</i>	regression	dimensionality reduction



# Supervised learning

- Given **training examples** of inputs & corresponding outputs, produce “correct” outputs for new inputs
- Two important scenarios:
  - **Classification:** outputs typically labels (goodRisk, badRisk); learn decision boundary to separate classes
  - **Regression:** aka *curve fitting* or *function approximation*; Learn a *continuous* input-output mapping from examples, e.g., for a zip code, predict house sale price given its square footage

# Unsupervised Learning

Given only *unlabeled* data as input, learn some sort of structure, e.g.:

- **Clustering**: group Facebook friends based on similarity of post texts and friends
- **Embeddings**: Find sets of words whose meanings are related (e.g., doctor, hospital)
- **Topic modeling**: Induce  $N$  topics and words most common in documents about each

# Machine Learning



- ML's significance in AI has gone up and down over the last 75 years
  - Today it's **very** important for AI and data science
- Driving ML are three trends:
  - Cheaper and more powerful computing systems
  - Open-source ML tools (e.g., scikit-learn, TensorFlow)
  - Availability of large amounts of data
- Understanding ML concepts and tools allow many to use them with success