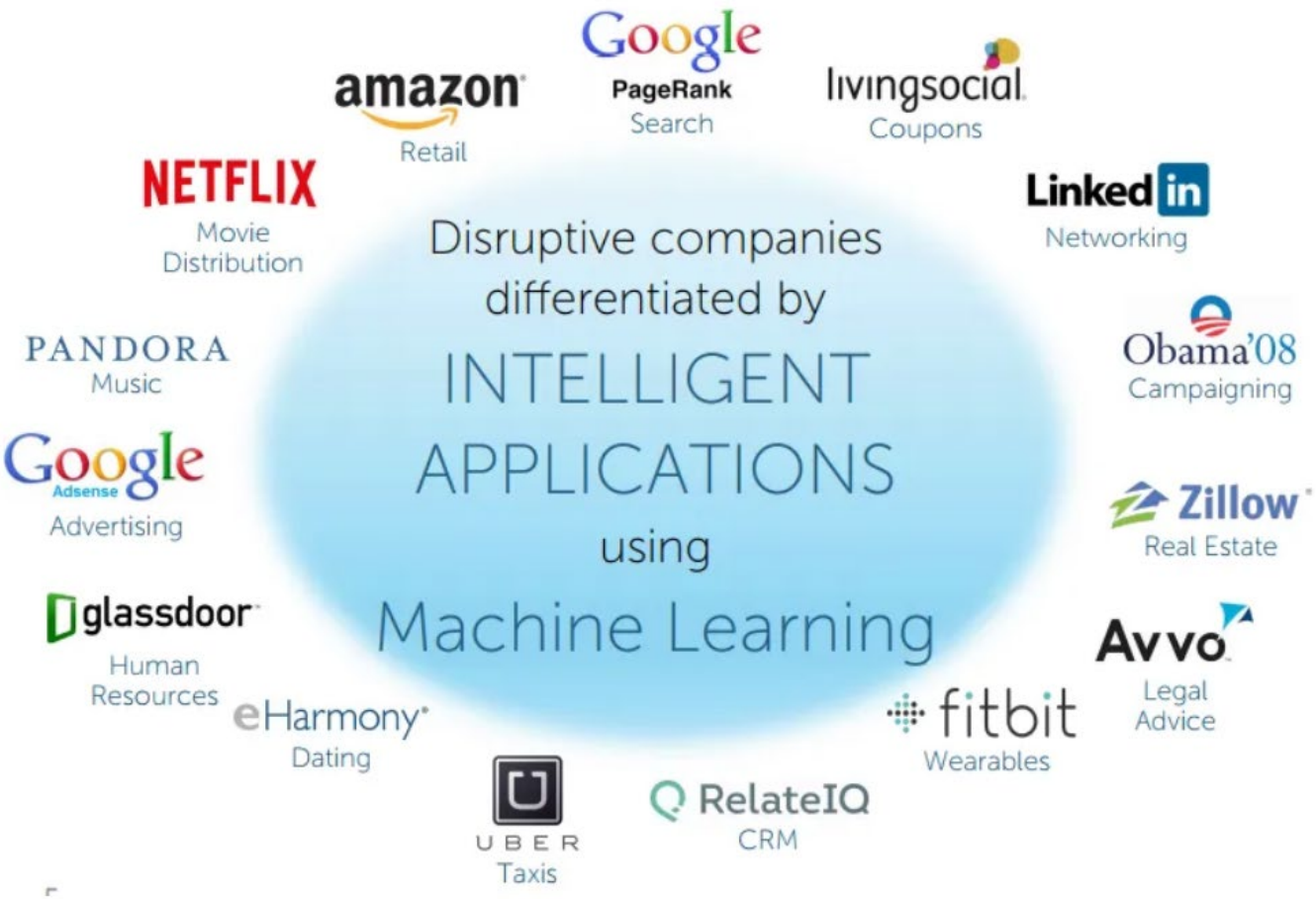
Introduction to NN/ML


Disruptive companies
differentiated by
INTELLIGENT
APPLICATIONS
using
Machine Learning
amazon
Retail
Google
PageRank
Search
livingsocial
Coupons
NETFLIX
Movie
Distribution
LinkedIn
Networking
PANDORA
Music
Obama'08
Campaigning
Google
Adsense
Advertising
Zillow
Real Estate
glassdoor
Human
Resources
Avvo
Legal
Advice
eHarmony
Dating
fitbit
Wearables
UBER
Taxis
RelateIQ
CRM

What is machine learning

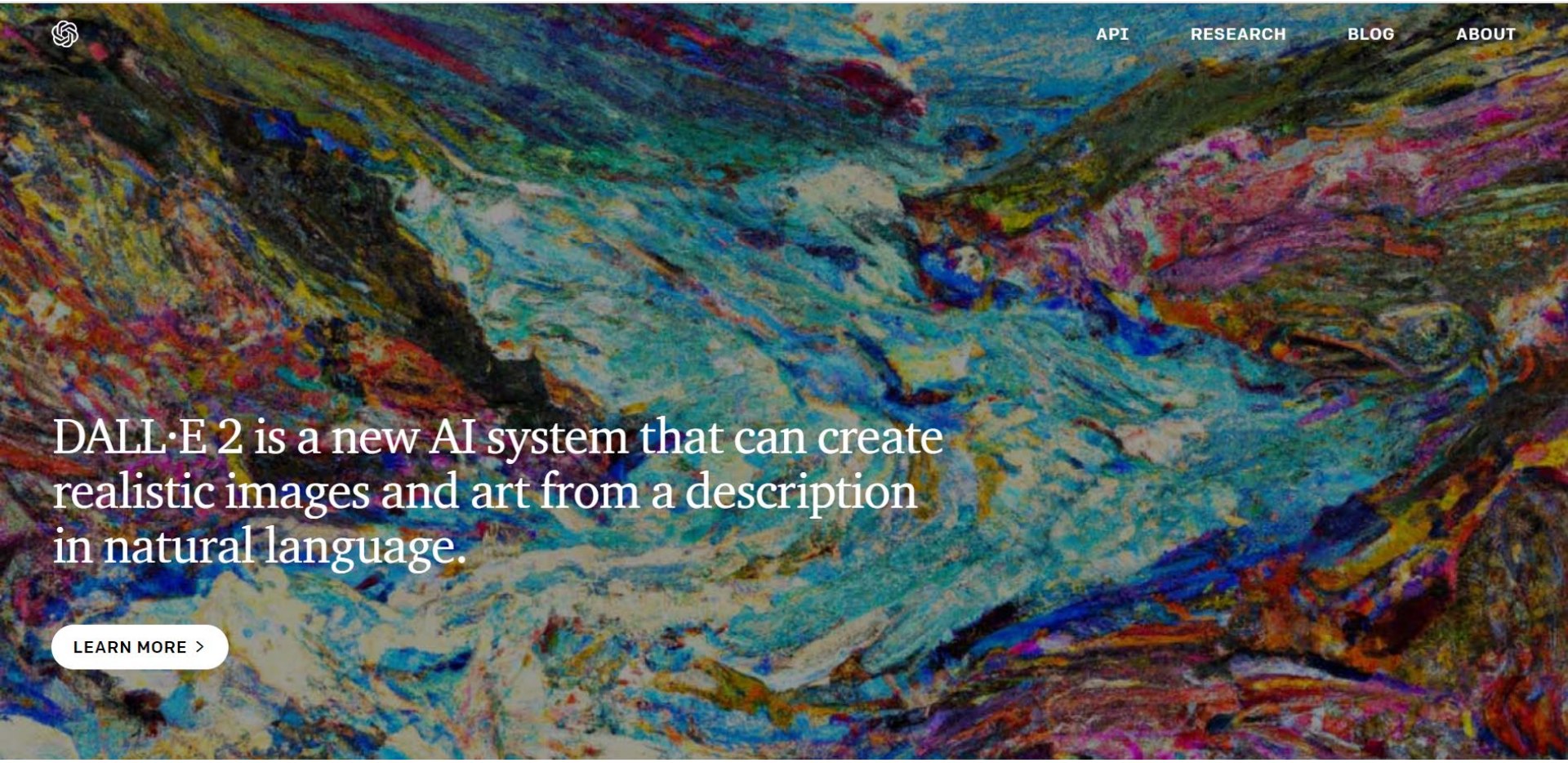
- Machine learning is programming computers to optimize a performance criterion using example data or past experience.

Learning is used when:

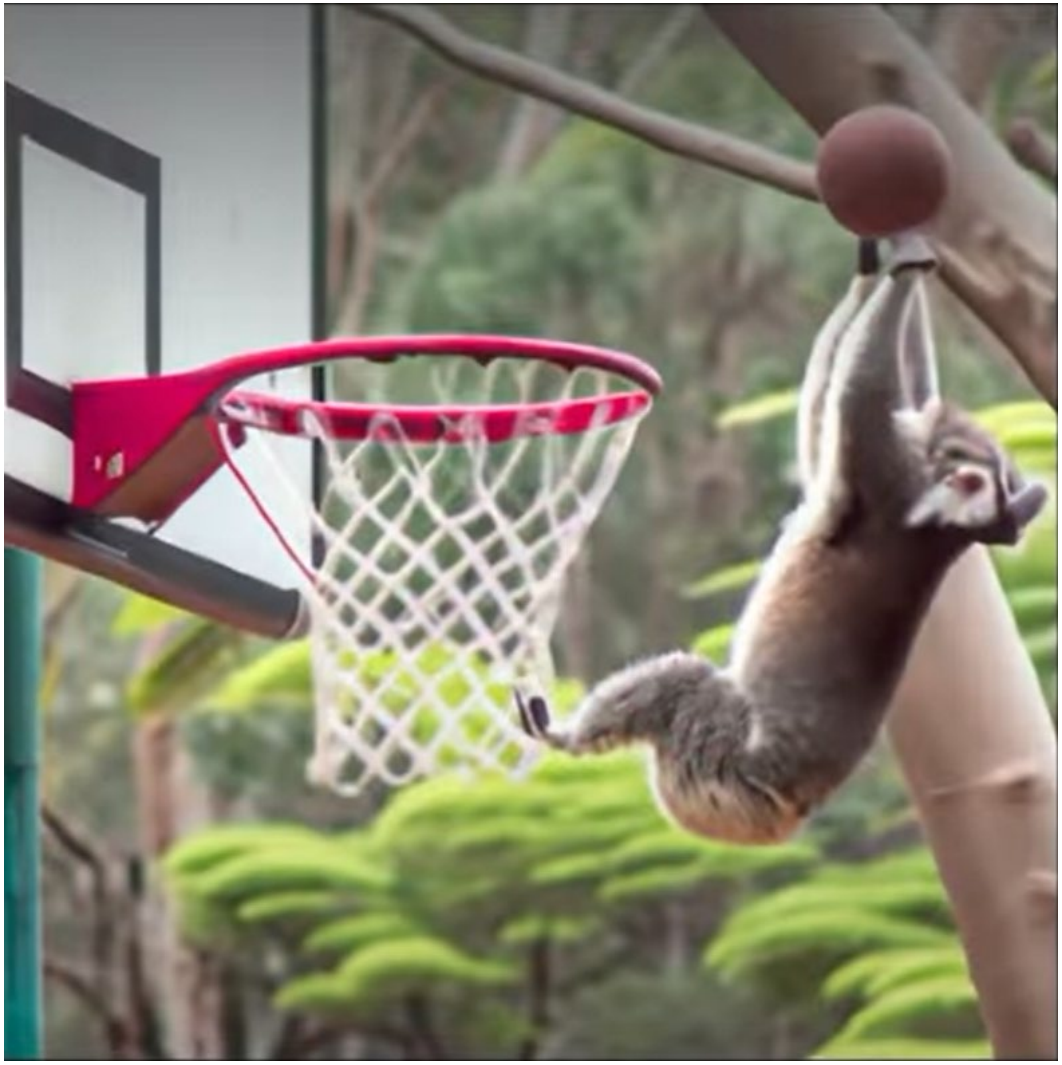
- Human expertise does not exist (navigating on Mars),
- Humans are unable to explain their expertise (speech recognition)
- Solution changes in time (routing on a computer network)
- Solution needs to be adapted to particular cases (user biometrics)

AI/Machine learning in daily life

- Virtual Personal Assistants
- Predictions while Commuting
- Videos Surveillance
- Social Media Services
- Email Spam and Malware Filtering
- Online Customer Support
- Search Engine Result Refining
- Matching ads with individual users
- Product Recommendations
- Online Fraud Detection


API
RESEARCH
BLOG
ABOUT
DALL·E 2 is a new AI system that can create realistic images and art from a description in natural language.
LEARN MORE >

a koala dunking a basketball



OpenAI Dall.e 2

Essence: build a model that is a good and useful approximation to the data

- Data is cheap and abundant (data warehouses, data marts); knowledge is expensive and scarce.

- Learning general models from a data of particular examples

- Example in retail: Customer transactions to consumer behavior:

People who bought “Da Vinci Code” also bought “The Five People You Meet in Heaven” (www.amazon.com)

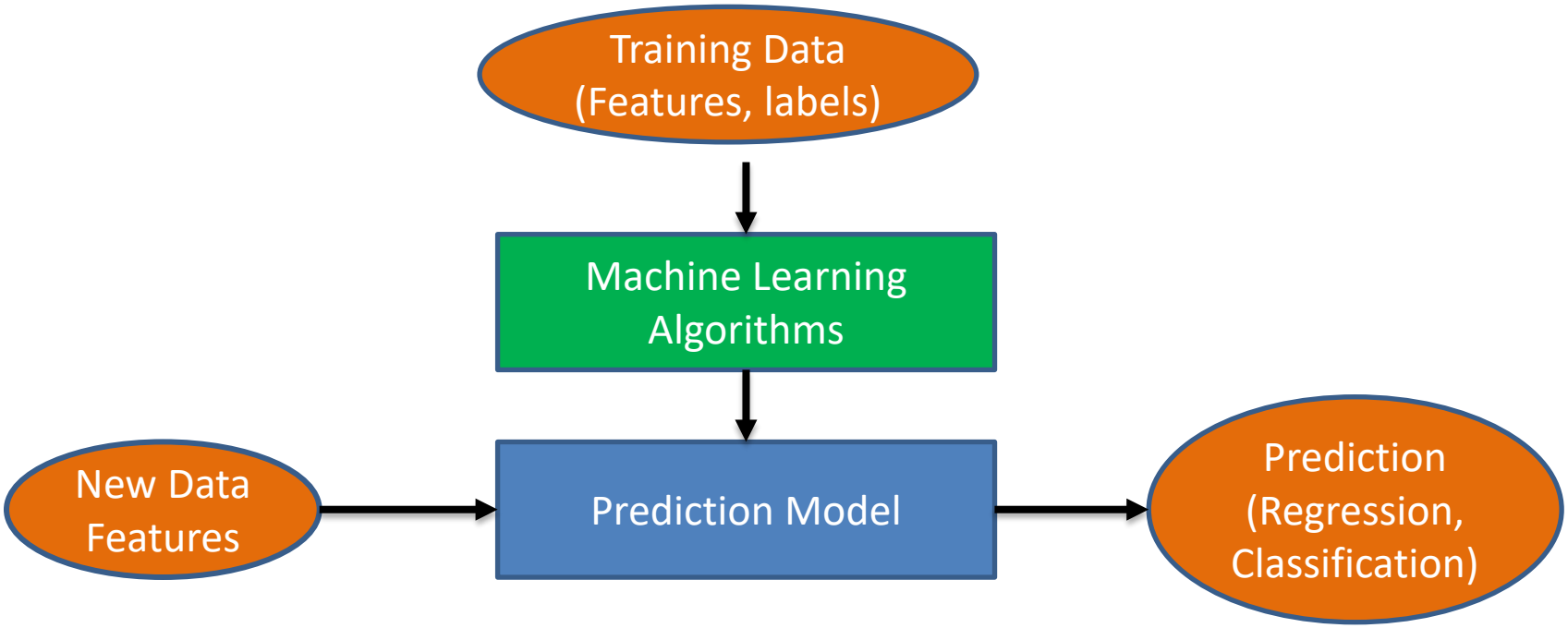
How to build a machine learning model

- Optimize a performance criterion using example data or past experience.
- Role of Statistics: Inference from a sample
- Role of Computer science: Efficient algorithms to Solve the optimization problem
- Representing and evaluating the model for inference

Major machine learning paradigms:

- Supervised Learning
  - Classification
  - Regression
- Unsupervised Learning
- Reinforcement Learning

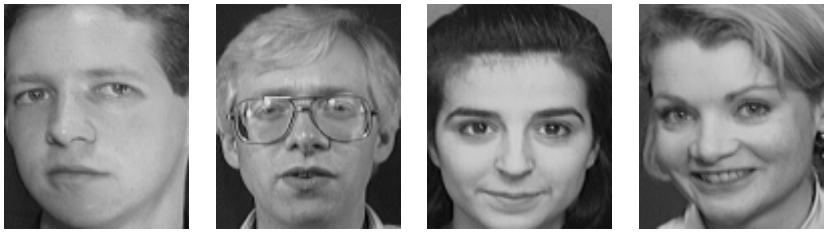
Supervised Learning – making predictions about future



Example of supervised learning – face recognition

Training examples of a person

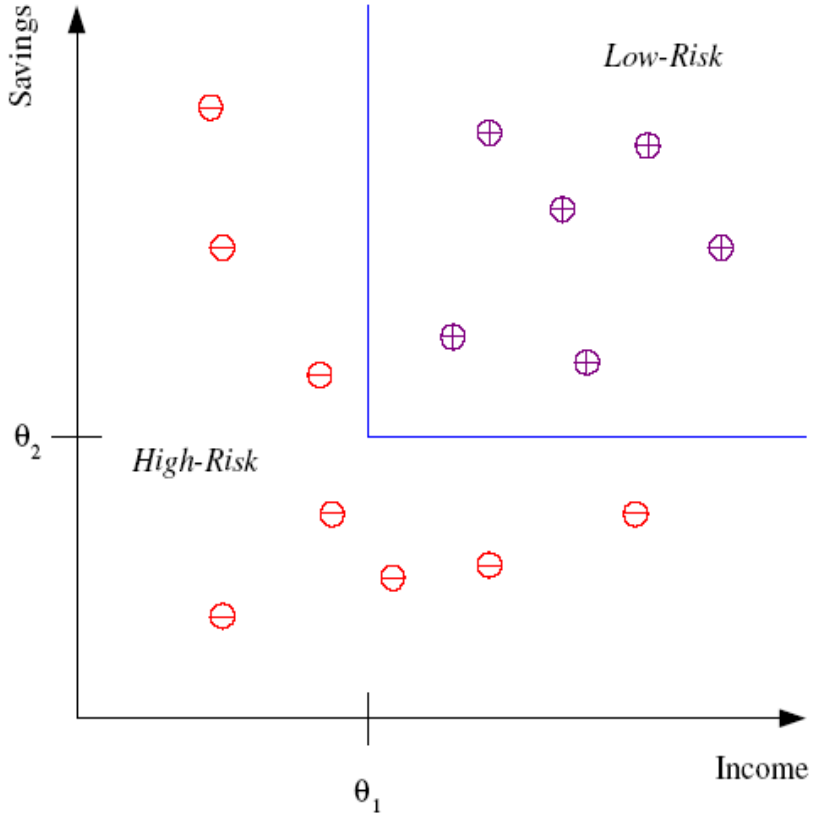
Test images



AT&T Laboratories, Cambridge UK
http://www.uk.research.att.com/facedatabase.html

Example of supervised learning – credit scoring

- Differentiating between low-risk and high-risk customers from their *income* and *savings*



Discriminant: IF *income* > θ_1 AND *savings* > θ_2
THEN low-risk ELSE high-risk

Example of supervised learning – prediction of used car price (a regression problem)

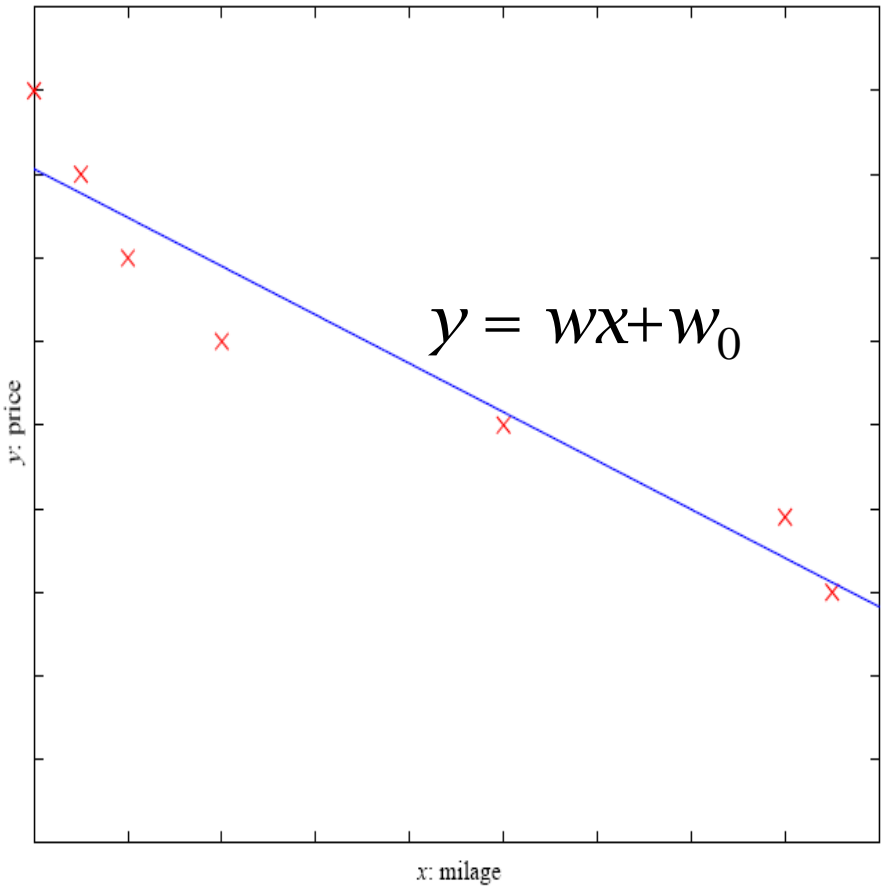
- x : car attributes

  y : price

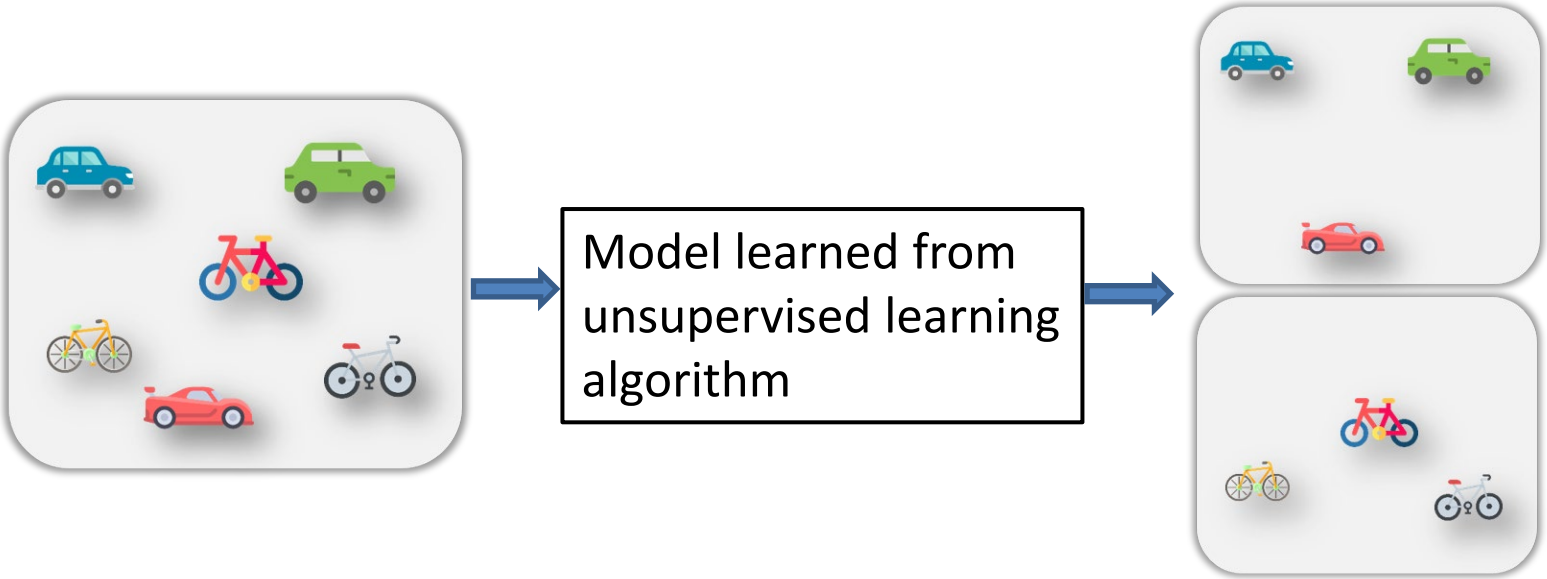
  $$y = g(x \mid \vartheta)$$

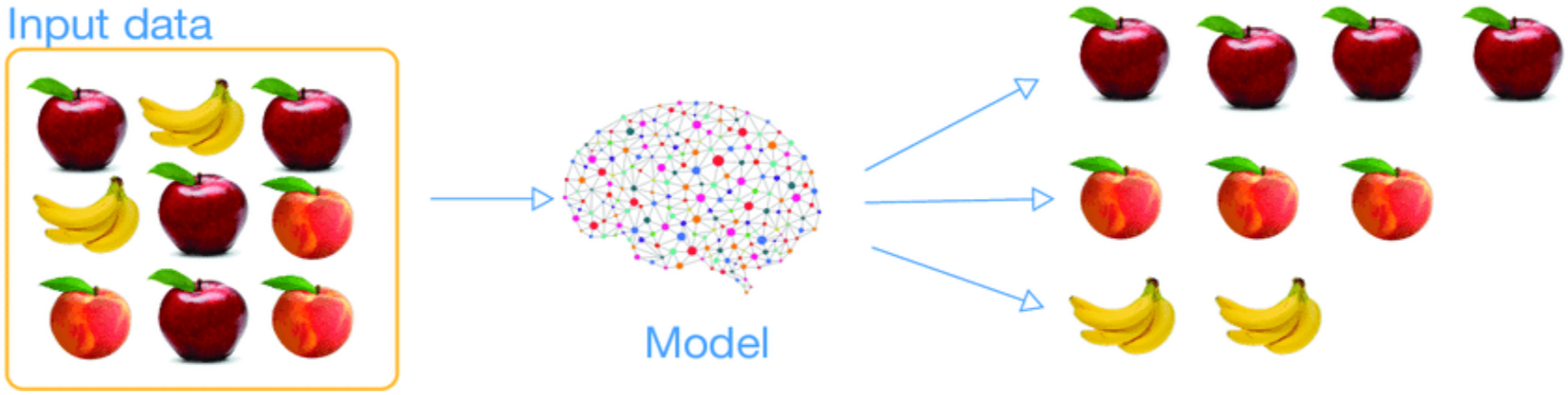
  g: ( ) model,

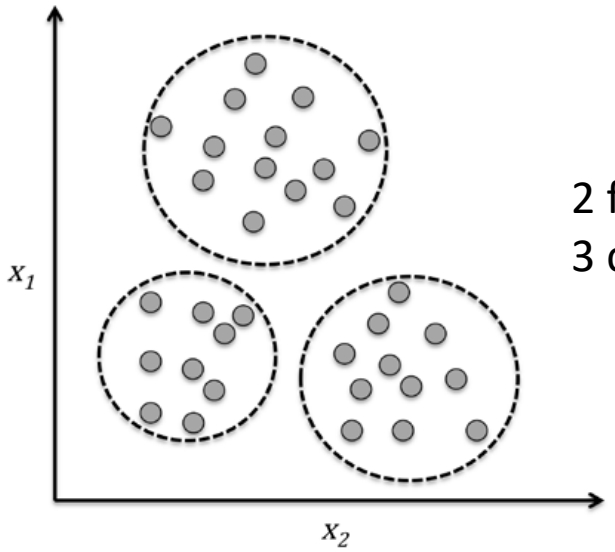
  ϑ: parameters



Unsupervised Learning – discovering hidden structure in data





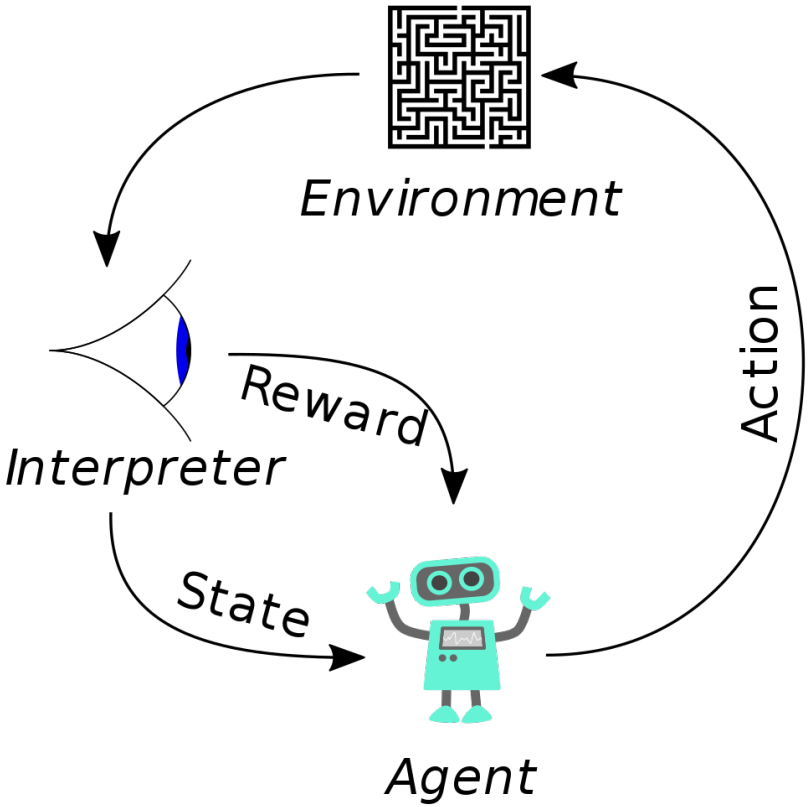


2 features
3 clusters

Unsupervised Learning

- No output or training data does not have labels
- Clustering: Grouping similar instances
- Other applications: Summarization, Association Analysis
- Example applications
  - Customer segmentation in CRM
  - Image compression: Color quantization
  - Bioinformatics: Learning motifs

Reinforcement Learning – sequential decision making and control



Reinforcement Learning

- Policy: what actions should an agent take in a particular state/situation
- Value estimation: how good is a state-action or credit assignment (what was responsible for the outcome)
- No supervised output but delayed reward
- Applications:
  - Game playing
  - Robotics
  - Real-time control of complex dynamic systems
  - Multiple agents (partial observability, ...)

Data Resources

- Kaggle.com
- Registry of Open Data on AWS: https://registry.opendata.aws/ (from Cancer Genome, Covid-19, Japanese dictionaries, NASA Landat satellite dataset of earth, sea surface temperature, and many more …)
- Wikipedia List of datasets for machine-learning research: https://en.wikipedia.org/wiki/List_of_datasets_for_machine-learning_research (from image, text, sound, to biological data…)
- Microsoft Azure Open Datasets: https://azure.microsoft.com/en-us/services/open-datasets/#overview
- Google public data: https://www.google.com/publicdata/directory
- ILSVRC (ImageNet large scale visual recognition challenge)
- UCI Repository: http://www.ics.uci.edu/~mlearn/MLRepository.html
- UCI KDD Archive: http://kdd.ics.uci.edu/summary.data.application.html
- Statlib: http://lib.stat.cmu.edu/
- Delve: http://www.cs.utoronto.ca/~delve/
- TIMIT (ASR) and MNIST (image classification)

Open Resources

- GitHub
- TensorFlow
- PyTorch
- Scikit-learn
- Keras
- OpenAI Gym
- DeepMind Control Suite
- MuJoCo, ROS
- …

Publication Venues

- Journal of Machine Learning Research www.jmlr.org
- Machine Learning
- IEEE Transactions on Neural Networks & Learning Systems
- IEEE Transactions on Pattern Analysis and Machine Intelligence
- Annals of Statistics
- Journal of the American Statistical Association
- arXiv
- ...

Conferences

- International Conference on Machine Learning (ICML)
- European Conference on Machine Learning (ECML)
- Neural Information Processing Systems (NIPS)
- International Joint Conference on Neural Networks (IJCNN)
- International Joint Conference on Artificial Intelligence (IJCAI)
- AAAI Conference on Artificial Intelligence (AAAI)
- IEEE International Control on Robotics and Automation (ICRA)
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- …