Brief Intro to Machine Learning
CS539

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Most figures and images in this presentation were obtained from Google Images

Reminder: What is AI?

There are many definitions of Artificial Intelligence. Two of them are:

- "AI as an attempt to understand intelligent entities and to build them" (Russell and Norvig, 1995)
- "AI is the design and study of computer programs that behave intelligently" (Dean, Allen, and Aloimonos, 1995)

But what is an "intelligent entity" or what does it mean to "behave intelligently"?

- Intelligence is the degree of accomplishment exhibited by a system when performing a task" (Allen, AAAI97 invited lecture)

What is AI? (cont.)

<u>Core AI:</u>

* Knowledge Representation Techniques:

    Semantic Nets, Rules, Propositional Logic, 1st Order Logic,

        Probability, . . .

* Problem Solving Strategies:

    Blind Search, Heuristic Search, Optimal Search, Adversarial Search

    (Game Playing), Constraint Satisfaction, Logical Inference, Planning,

    Probabilistic Reasoning, . . .

<u>AI Areas:</u>

* Machine Learning   ←
* Machine Vision
* Natural Language Processing (NLP)

(Robotics combines these 3 areas)

What is Machine Learning?

Writing computer programs that learn from experience

More precisely (Mitchell, 1997)

- Given:
  - A class of tasks T (e.g., recognizing faces)
  - A performance measure P (e.g., accuracy)
  - Training experience E (e.g., dataset of faces with names)
- Write computer programs that can learn from experience E to improve their performance, as measured by P, on tasks in T

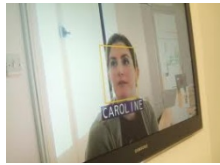# Supervised vs. Unsupervised Learning

(e.g., i ~~mart doorman"~~
to do automa ~~า)~~

Supervisor or Teacher

Training experience:

face   teacher says:

yes

no
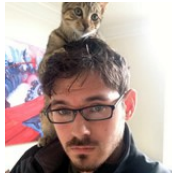
yes
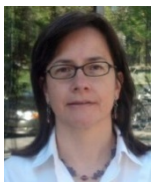
no

No supervisor

Training Experience:
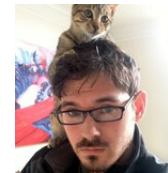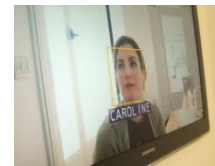
Reinforcement Learning

Task: Learning a policy: Learning what action to perform in a given situation
and what sequence of actions to perform to achieve a goal
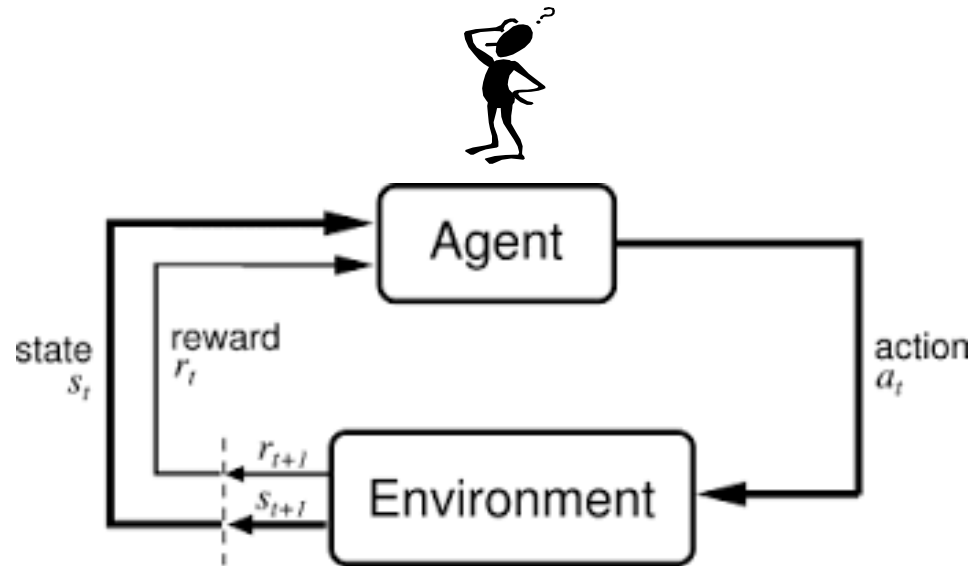
"Hands-off" Supervisor / Teacher / Environment

provides + and − rewards

How to provide "experience"?

Using Data: experience is recorded in data

- (e.g., medical records)

Learning from data is also called data mining

Not using data: Direct experience

- (e.g., robot motion)

(c) Leo Blanchette

What do you want to learn from your data?
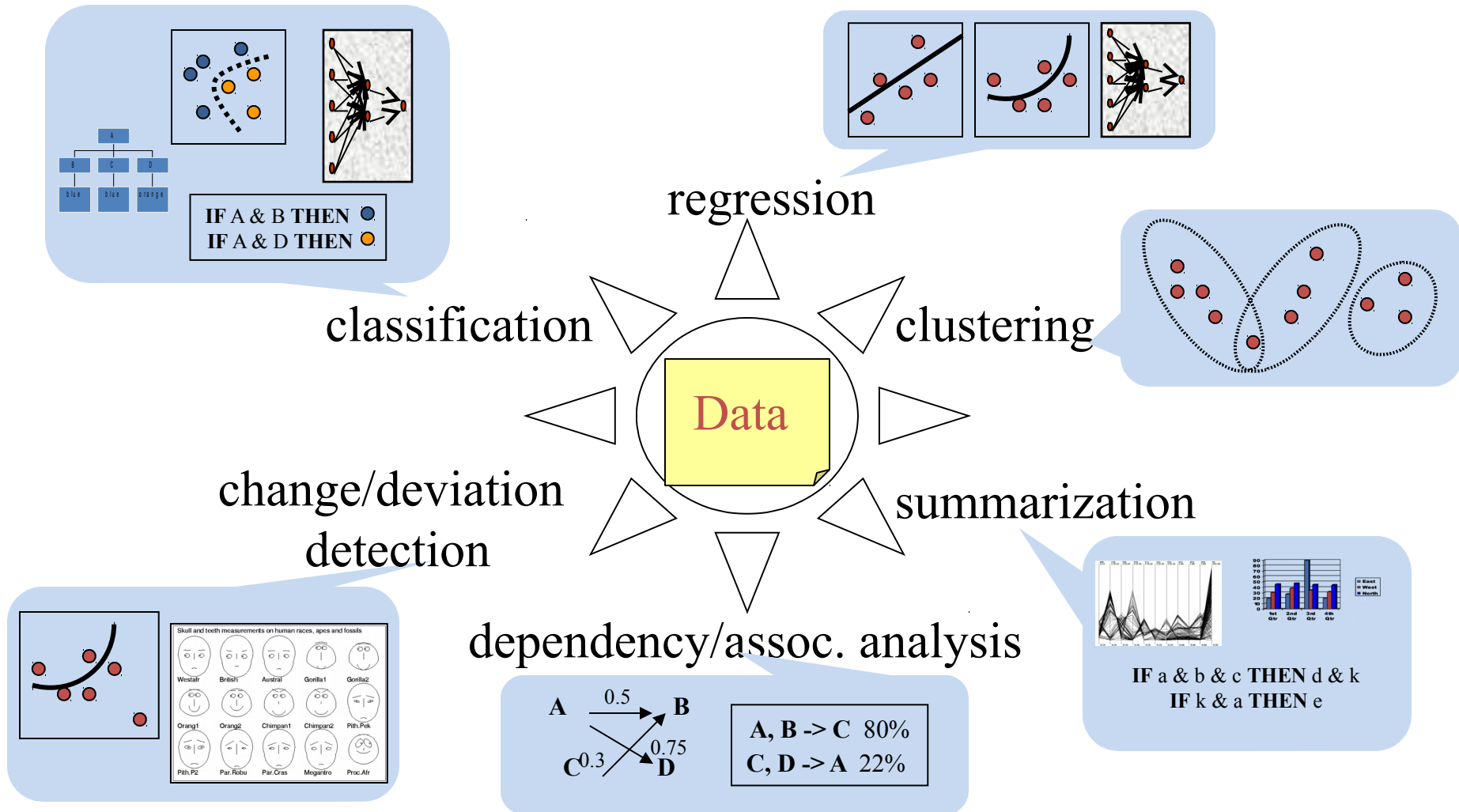
Topics that we'll cover in this course
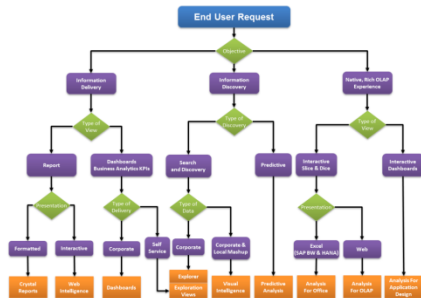
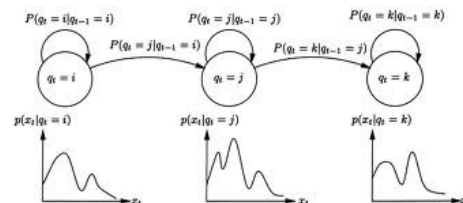**Supervised: Classification & Regression**

- Decision Trees
- Linear Discrimination
- Multilayer Percept. / Neural Nets
- Deep Learning
- Graphical Models
  - Naïve Bayes & Bayesian Networks
- Kernel methods
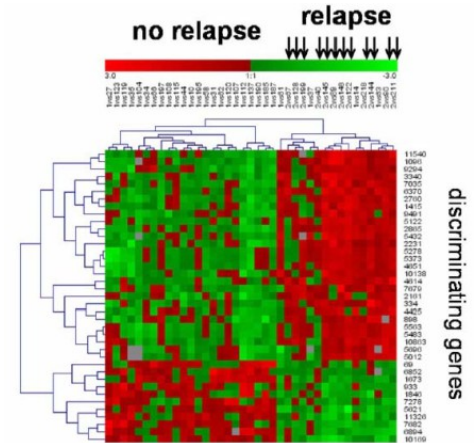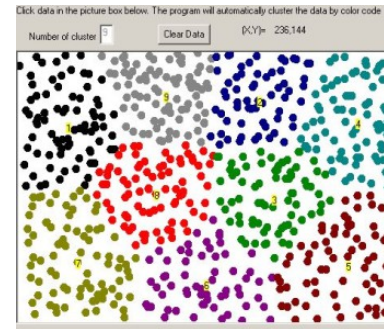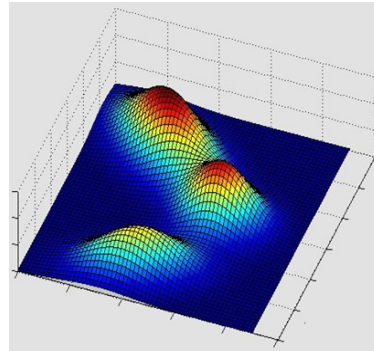 - Support Vector Machines
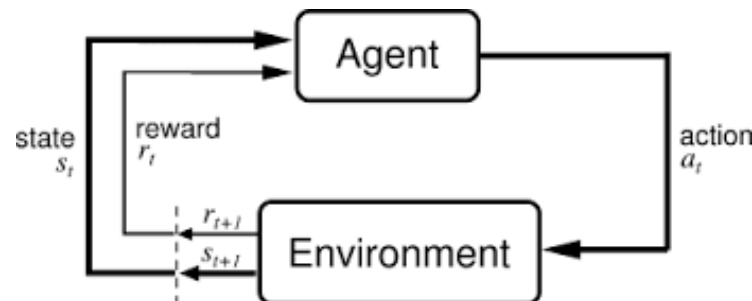- Hidden Markov Models
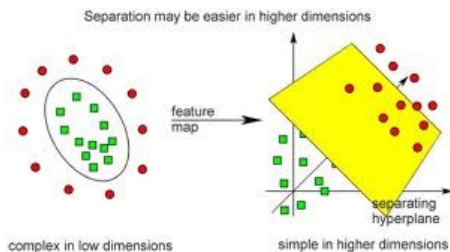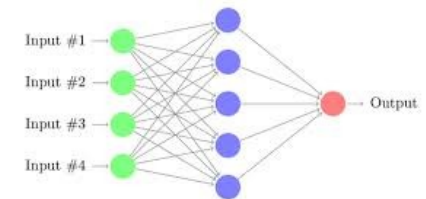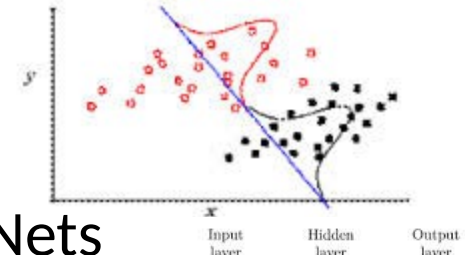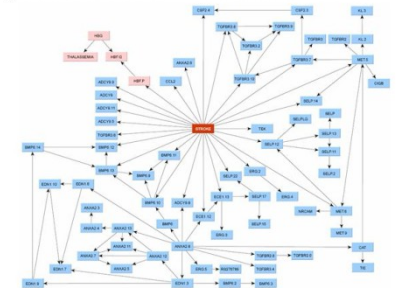
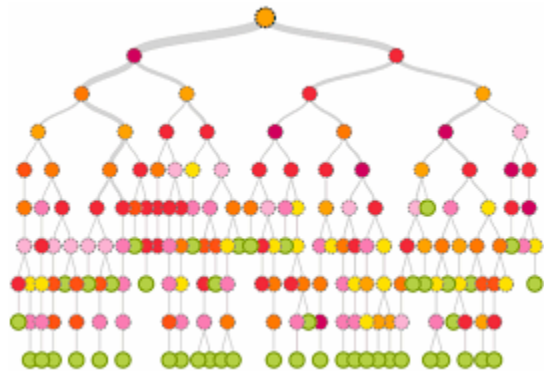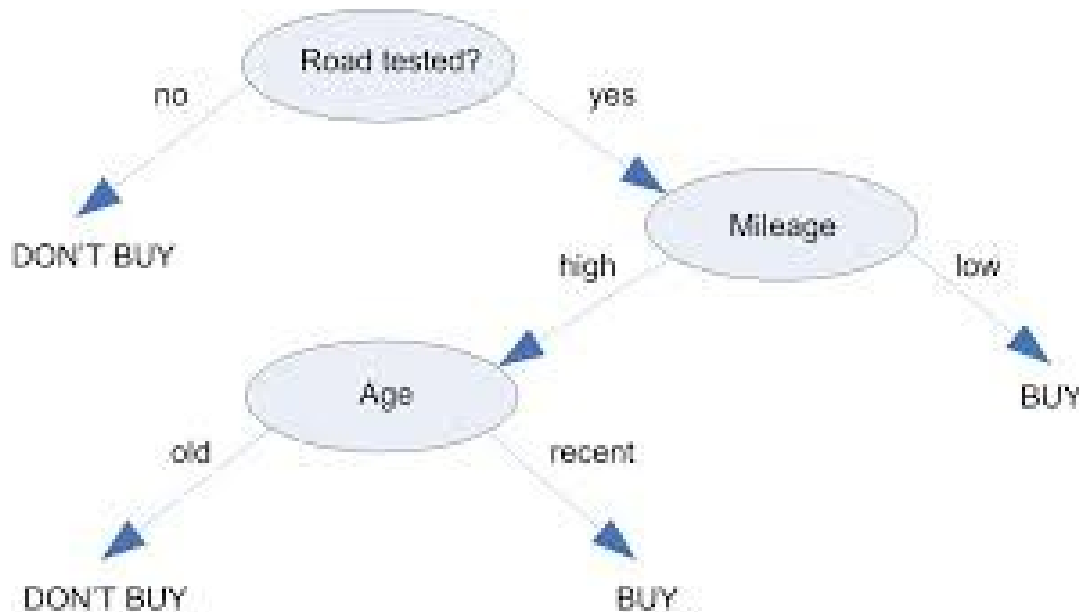# Topics that we'll cover in this course

- **Unsupervised Learning**
  - Clustering:
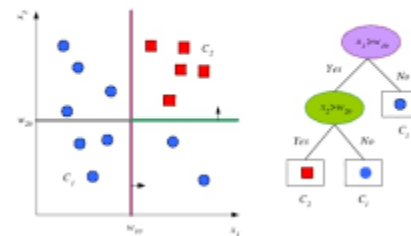   - Expectation Maximization (EM)
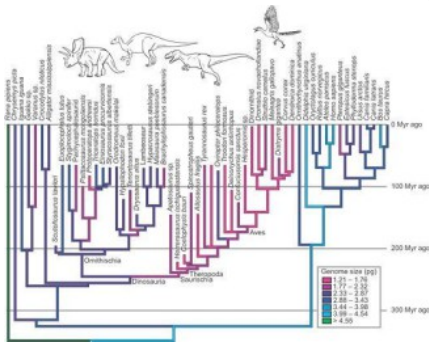
- **Reinforcement Learning**
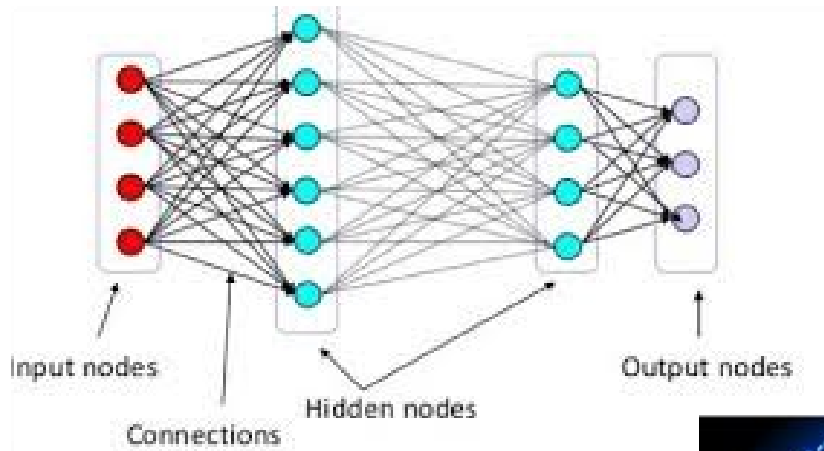
Decision Trees

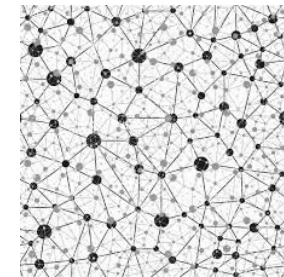
Decision Tree

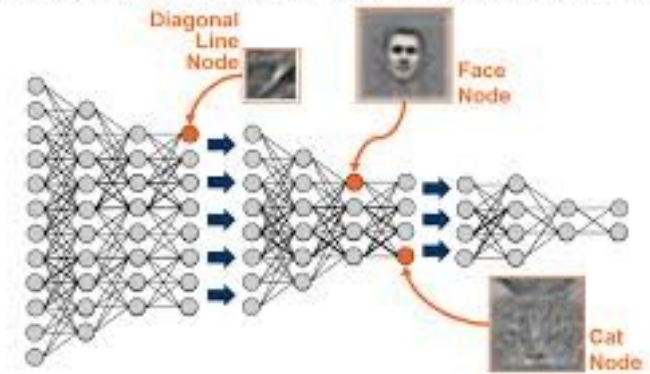Decision trees are used for classification

Regression trees follow a similar idea

Artificial Neural Networks (ANNs) and Deep Learning

Input nodes
Connections
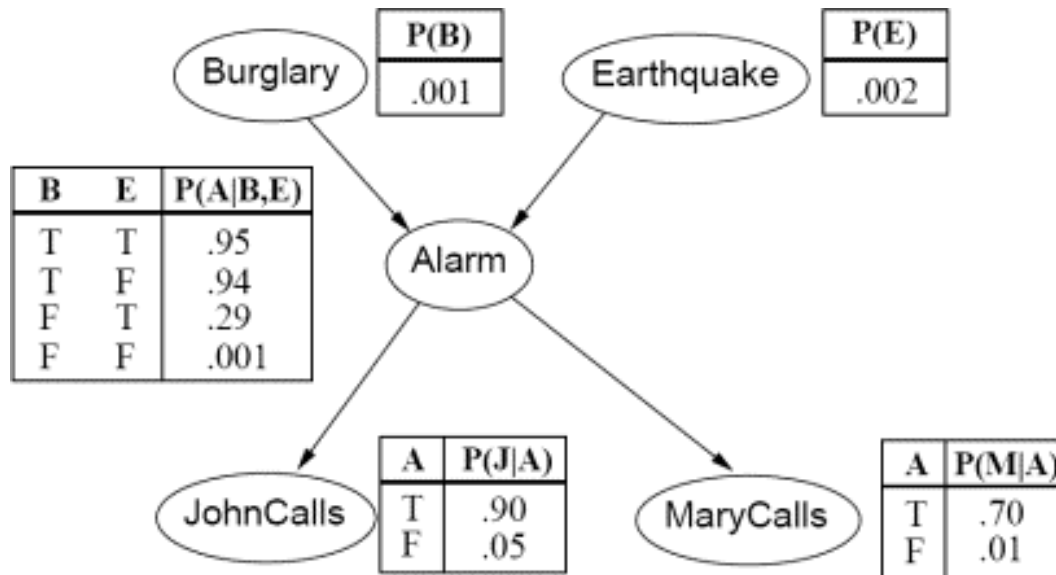Hidden nodes
Output nodes

Deep Learning

Lots of Data + Neural Nets + Training = Hierarchical & Associational Feature Representation

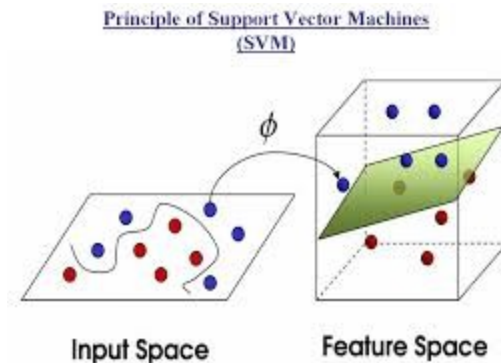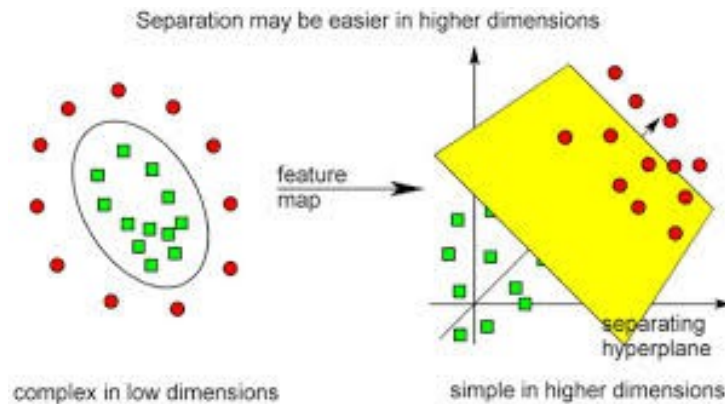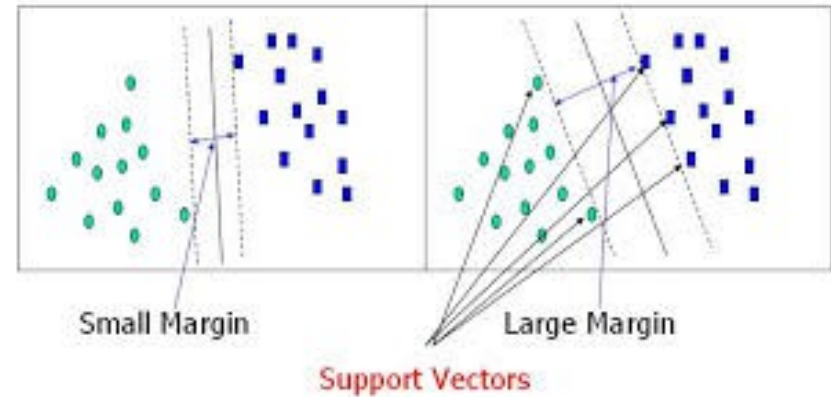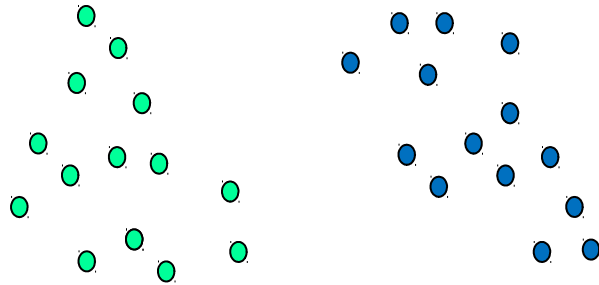Diagonal Line Node
Face Node
Cat Node
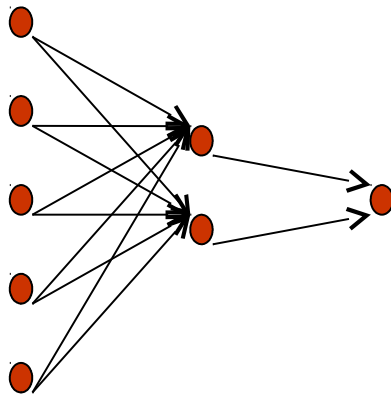
ANNs / Deep Learning can be used for classification, regression, or unsupervised learning (e.g., self-organizing maps)

Bayesian Networks

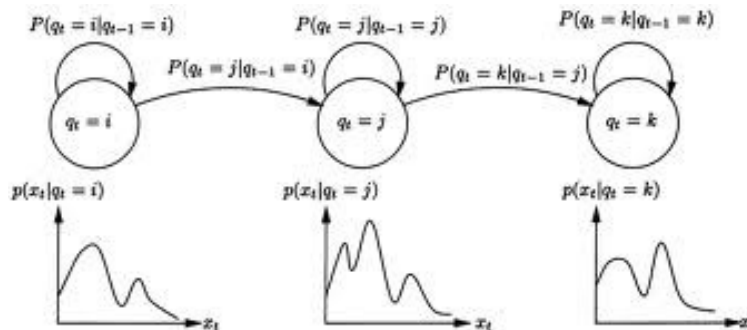Can be used for classification, for regression, or for dependency analysis

Support Vector Machines (SVMs)

Small Margin   Large Margin

Support Vectors

Separation may be easier in higher dimensions

feature
map

separating
hyperplane

complex in low dimensions   simple in higher dimensions

Principle of Support Vector Machines (SVM)

ϕ

Input Space   Feature Space

Hidden Markov Models
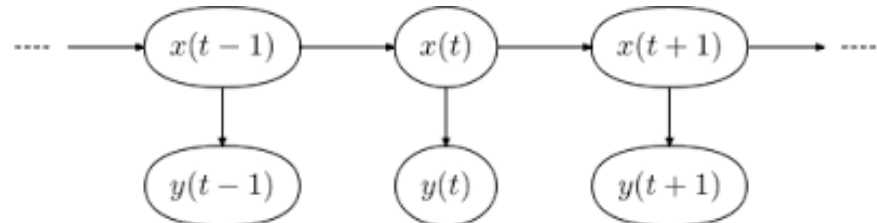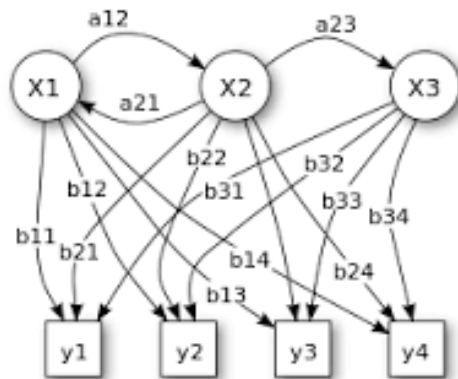
CS539 Machine Learning

Keep in mind:

Although this course is taken by students from different departments and programs

(BCB, CS, DS, ECE, MA, RBE, …)

- this course focusses on CS aspects of machine learning across these disciplines

- students may explore aspects of machine learning related to their own discipline in the *course project*

So much to talk about so little time!

Thanks