[KNU Global Summer School]
Introduction to Intelligent Systems

Introduction to Machine Learning

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Artificial Intelligence and Machine Learning

Motivation (1)

Read the following sentence. While you are reading it, count the F's in that sentence. Count them ONLY ONCE. Do not go back and count them again.

FINISHED FILES ARE THE RESULT OF YEARS
OF SCIENTIFIC STUDY COMBINED WITH THE
EXPERIENCE OF YEARS.

Can you understand the text to the below?

Sleon une édtue de l'Uvinertisé de Cmabrigde, l'odrre des ltteers dans les mtos n'a pas d'ipmrotncae, la suele coshe ipmrotnate est que la pmeirère et la drenèire soit à la bnnoe pclae. Le rsete peut êrte dnas un dsérorde ttoal et vuos puoevz tujoruos lrie snas porlbème. C'est prace que le creaveu hmauin ne lit pas chuaqe ltetre elle-mmêe, mias le mot cmome un tuot.

Main topics of Artificial Intelligence (AI)

1. Problem-solving,
2. Knowledge and reasoning,
3. Communicating, perceiving and acting,
4. Learning.

In this course, we are going to focus only on the **Learning** aspect.

Artificial Intelligence (AI) and Machine Learning (ML)

The goal of AI is to create machines that can mimic human mind. To satisfy this goal, these machines need the learning capabilities, knowledge representation, reasoning, and abstract thinking.

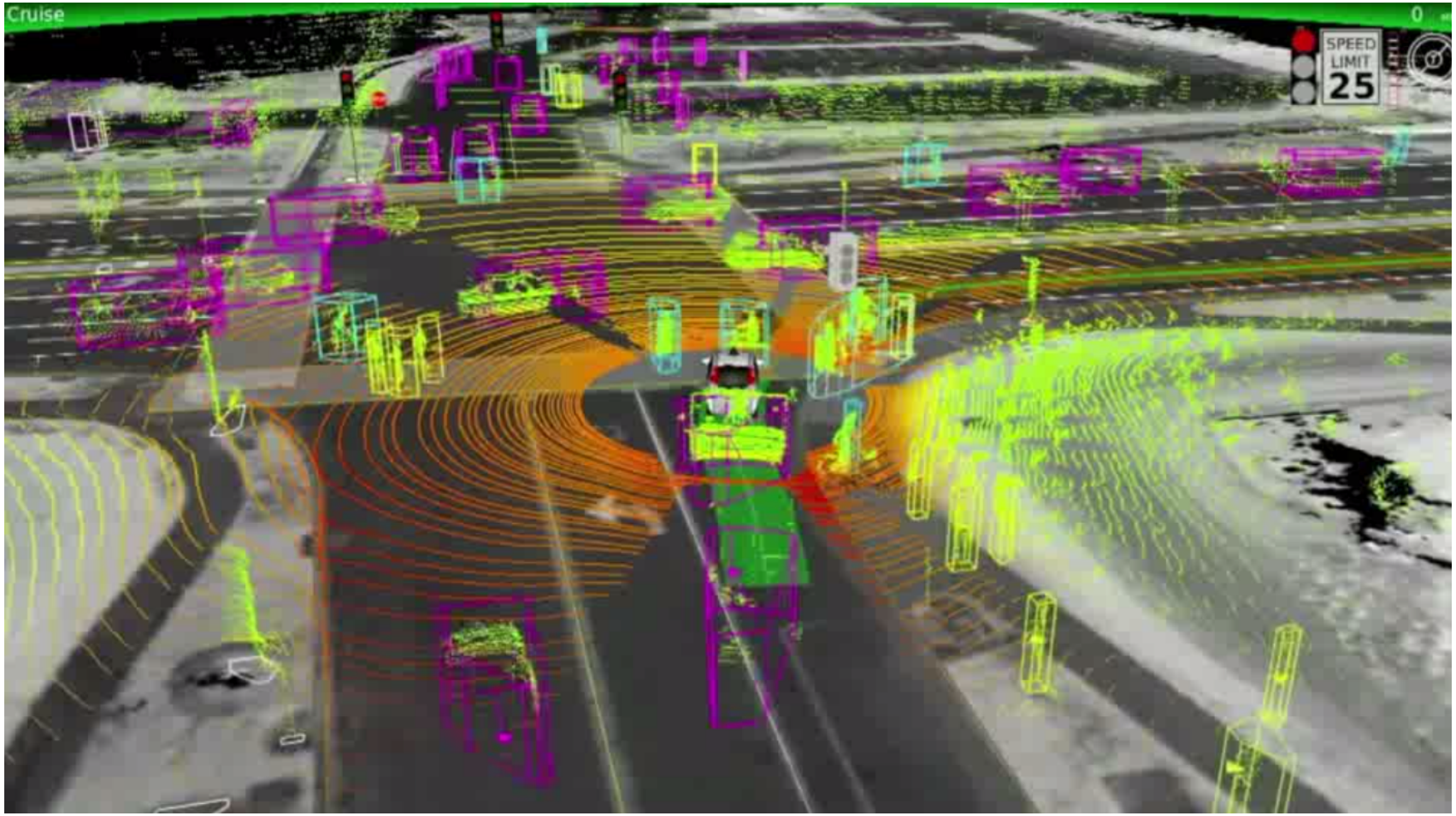
ML is solely focused on writing software that can learn from past experience. Hence, ML is closely related to *data mining* and *statistical analysis*.

Course program

#	**Topic**
1	Introduction to AI
2	Non-regularized Regression (SL)
3	Regularized regression (SL)
4	Feedforward neural network (SL)
5	Recurrent neural network (SL)
6	K-means and principal component analysis (UL)
7	Policy iteration (PI) and Value iteration (VI) (RL)
8	Discriminative and generative models

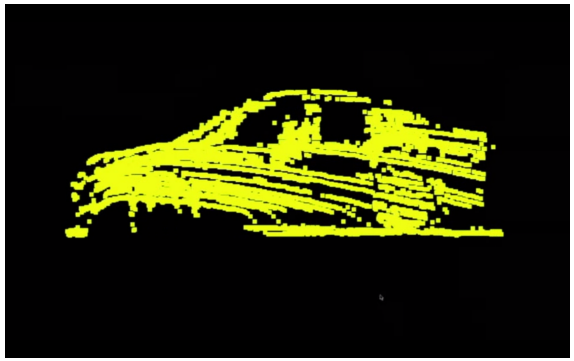
Introduction to Machine Learning

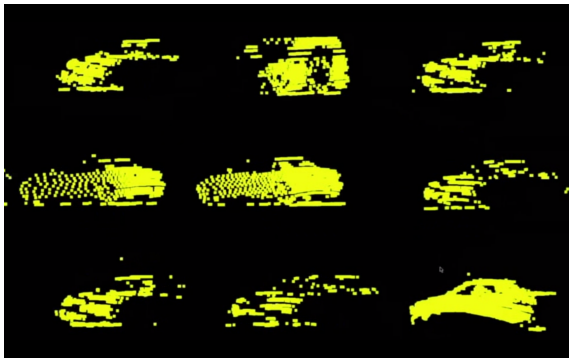
Motivation (1): Classifications for autonomous driving

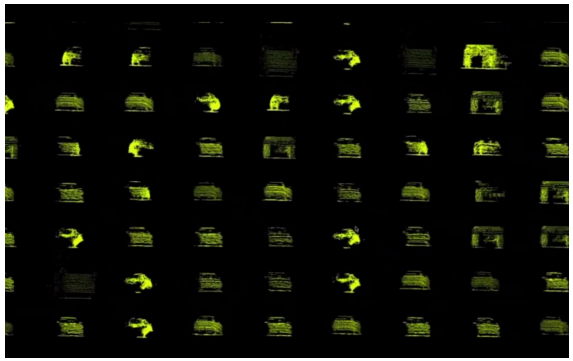


Motivation (1): Classifications for autonomous driving

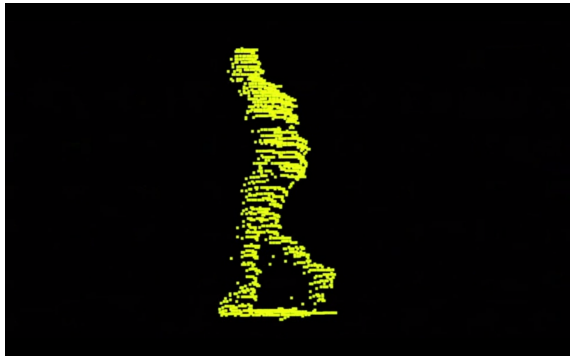
Car classification

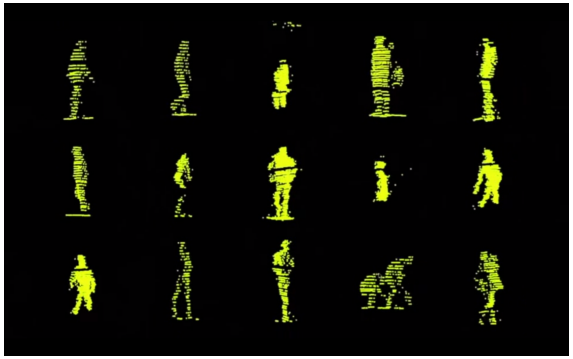




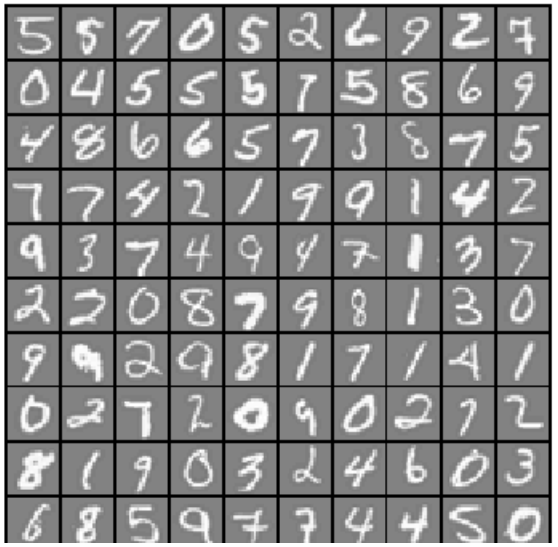


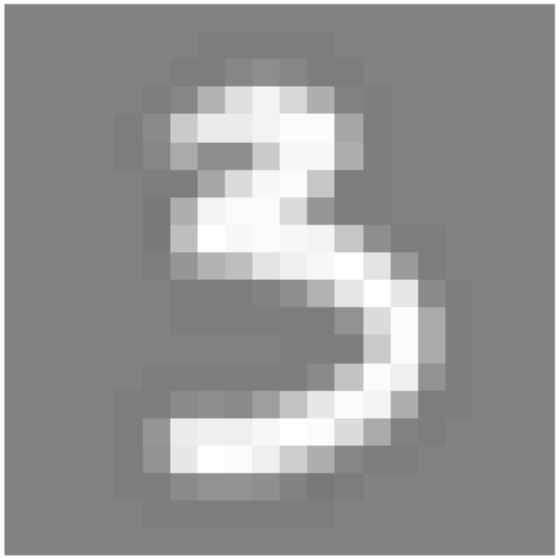
Human classification

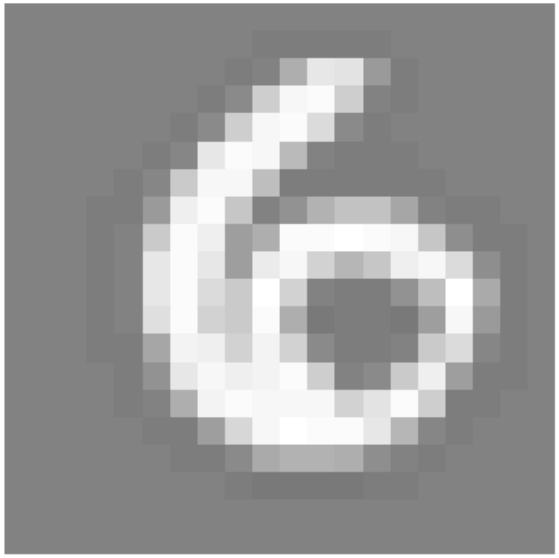




Motivation (2): Hand-writing classification







Definition of Machine Learning (ML)

Machine learning is a field of study that gives computers the ability to learn without being explicitly programmed. (Arthur Samuel, 1959)

A computer program is said to *learn* from experience 'E' with respect to some task 'T' and performance measure 'P', if its performance on T, as measured by P, improves with experience E. (Tom Mitchell, 1998)

Definition of Machine Learning

> Machine learning is the *extraction of knowledge from data* and the *subsequent usage of this knowledge* to find solutions for previously unseen observations.

In this sense, ML is related to *statistical analysis* and *data mining*.

A non-ML program and for an ML program

A non-ML program is one that has fully defined parameters that characterize a task to be performed.

An ML program is one that has the capability to learn the parameters that characterize a task to be performed.

Example for a non-ML program and for an ML program

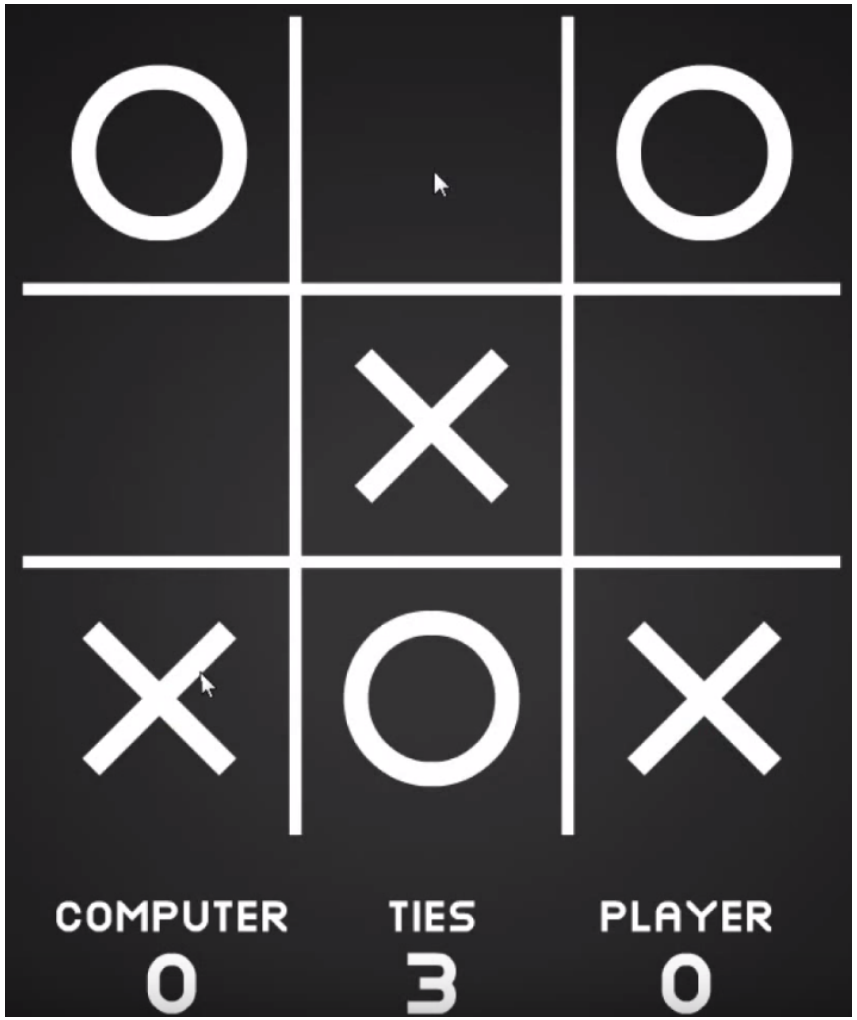


Figure: Tic-Tac-Toe game

Example for a non-ML program and for an ML program

If a programmer has coded a program with a built-in winning strategy, then such a program is not an ML.

However, a program that has no predefined strategy but only a set of rules that define the legal moves, then we can make it learn parameters that define strategies. And, by repeatedly playing the games, the program can find strategies to win the games.

Types of Machine Learning

ML can be categorized in three types:

- Supervised learning
- Unsupervised learning
- Reinforcement learning

ML type I: Supervised learning

Supervised learning is an area of ML where the machine is taught or trained using a data set with its solutions (i.e., outcomes or labels).

Once the machine is trained, it should be able to find an answer for a new previously-unseen data. The learning algorithm uses the past experience to give such an outcome.

Examples for supervised learning (1): classification

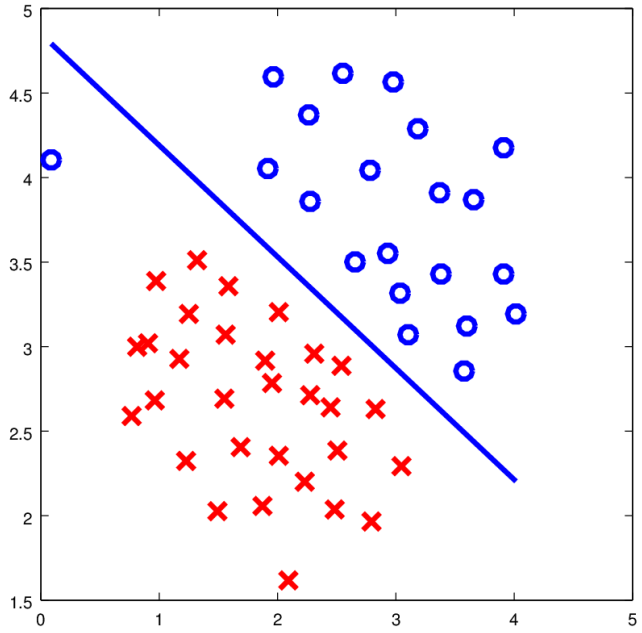


Figure: Linear classification

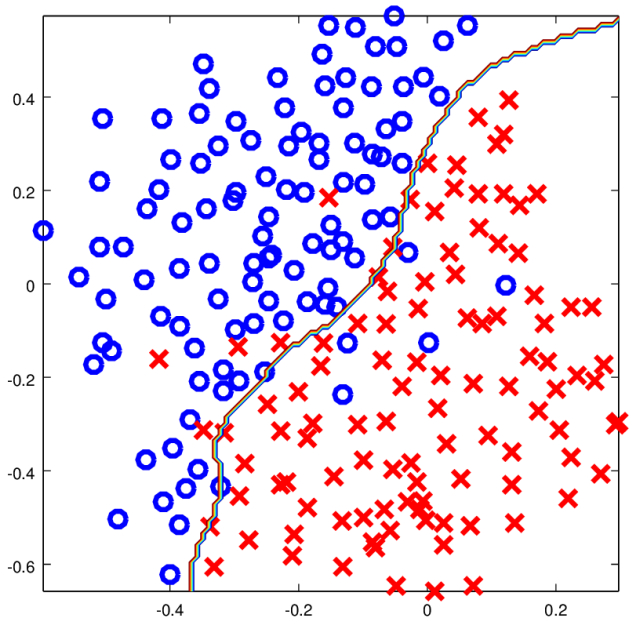
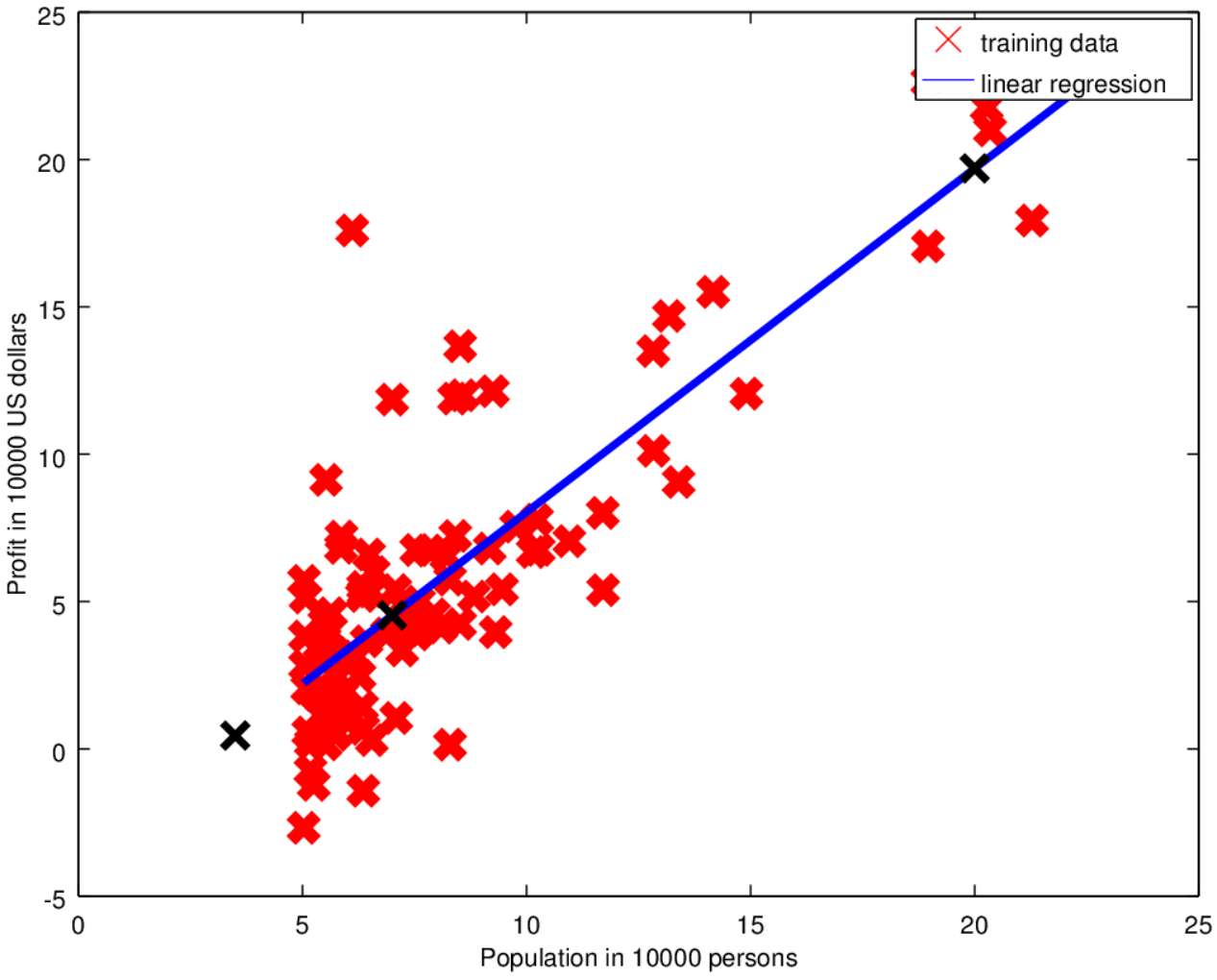


Figure: Nonlinear classification

Examples for supervised learning (2): regression



ML type II: Unsupervised learning

Unsupervised learning is an area of ML where the machine is taught or trained using a data set that is not labelled (i.e., the solution is unknown for the provided data set.)

That is, the learning algorithm does not know yet what the given data set represents.

Examples of unsupervised learning (1)

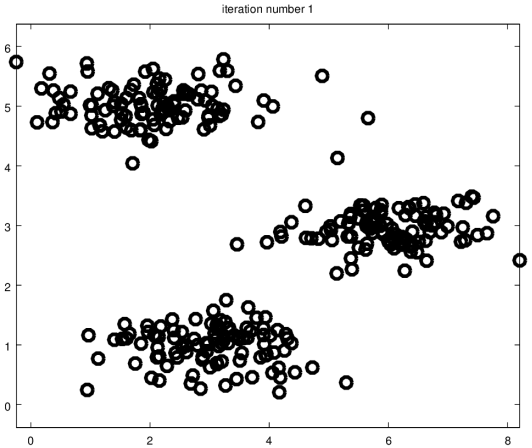


Figure: Unlabeled data

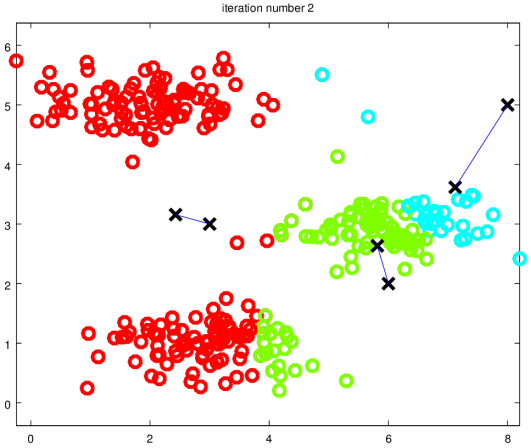


Figure: 3-means (1 iteration)

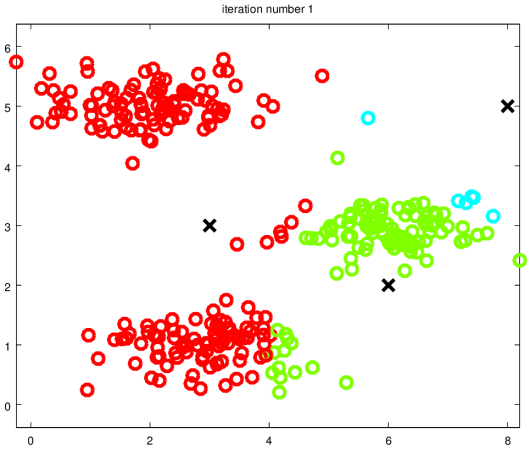


Figure: 3-means (initial)

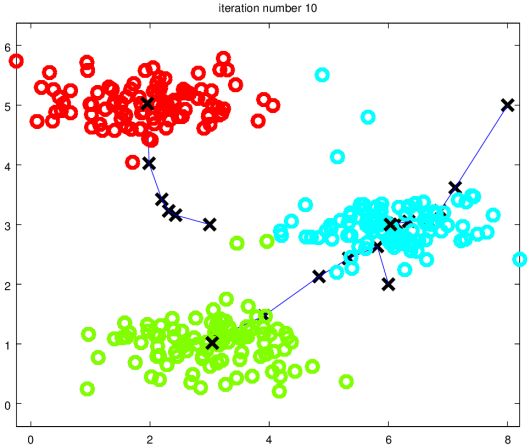


Figure: 3-means (10 iterations)

Examples of unsupervised learning (2)

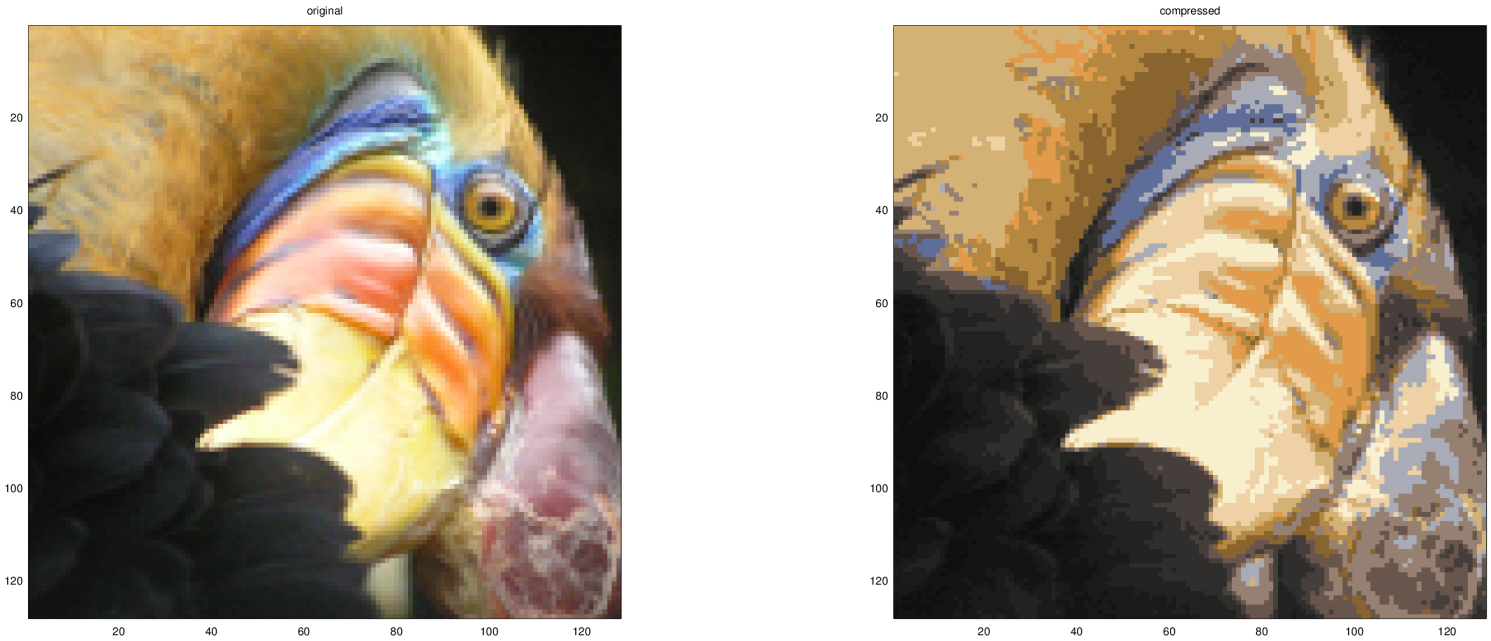
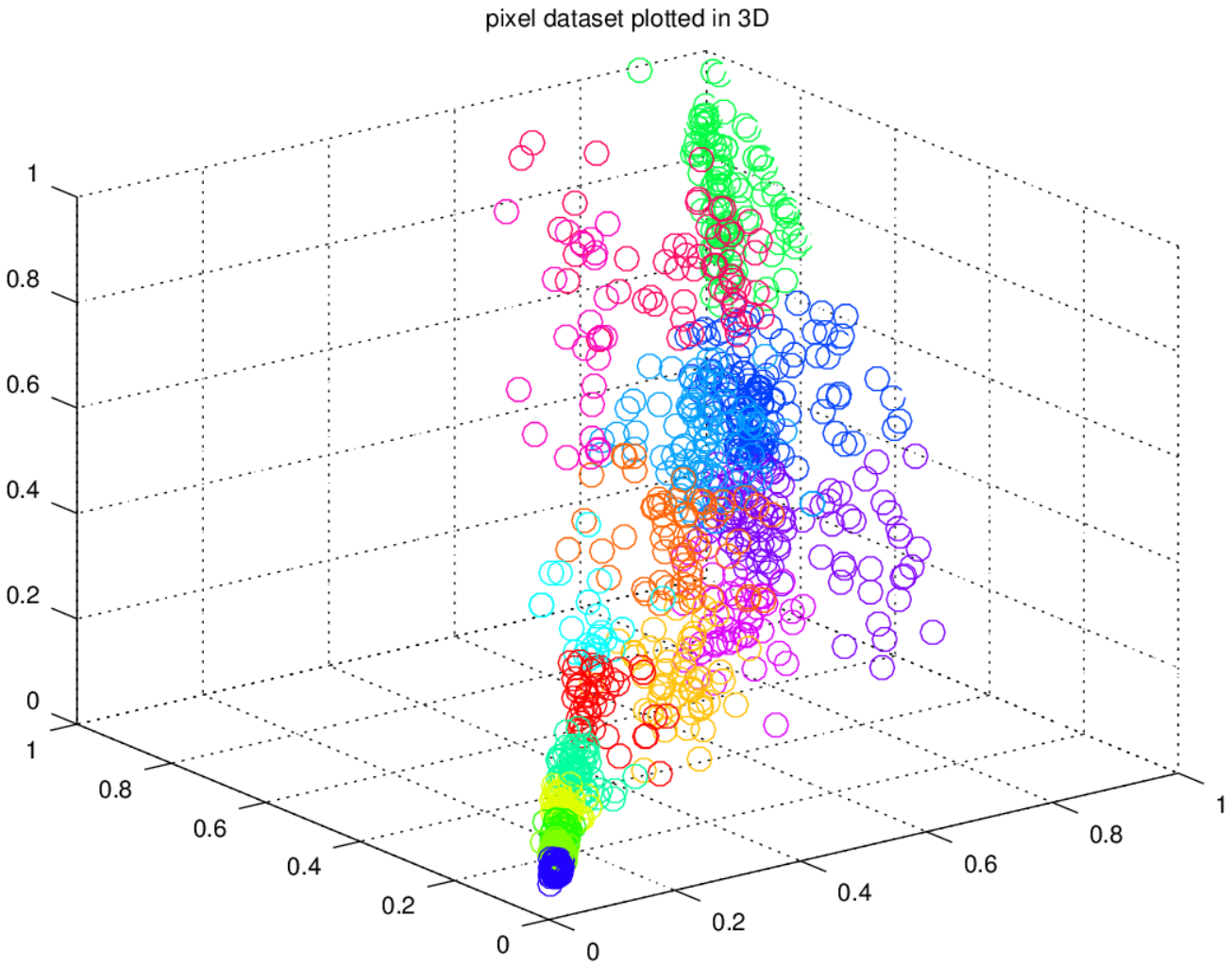


Figure: Image compression

Examples of unsupervised learning (2)

RGB pixel representation with K-means (K=16)



ML type III: Reinforcement learning

Reinforcement learning is an area of ML that concerns on how software agents ought to take actions in an environment so as to maximize some notion of cumulative reward.