CME 216, ME 343 - Spring 2020

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A definition of machine learning

Tom Mitchell in *Machine Learning* provides a formal definition of the concept of learning by computer programs (page 2).

Definition: A computer program is said to learn from experience *E* with respect to some class of tasks *T* and performance measure *P* if its performance at tasks in *T*, as measured by *P*, improves with experience *E*.

Please read section 5.1.1-3 in Deep Learning for examples of tasks in machine learning.

The key in this definition is that the accuracy of our prediction improves with *E*, for example, if we acquire more data (increase m above) or improve the quality of the data (if we assume that the data is noisy or somehow corrupted).

This is therefore qualitatively different from the previous approach described at the beginning, based on deriving and applying general physical laws.

Machine learning is, therefore, most effective when deriving such laws or mathematical model *a priori* (that is in the absence of data) is difficult.

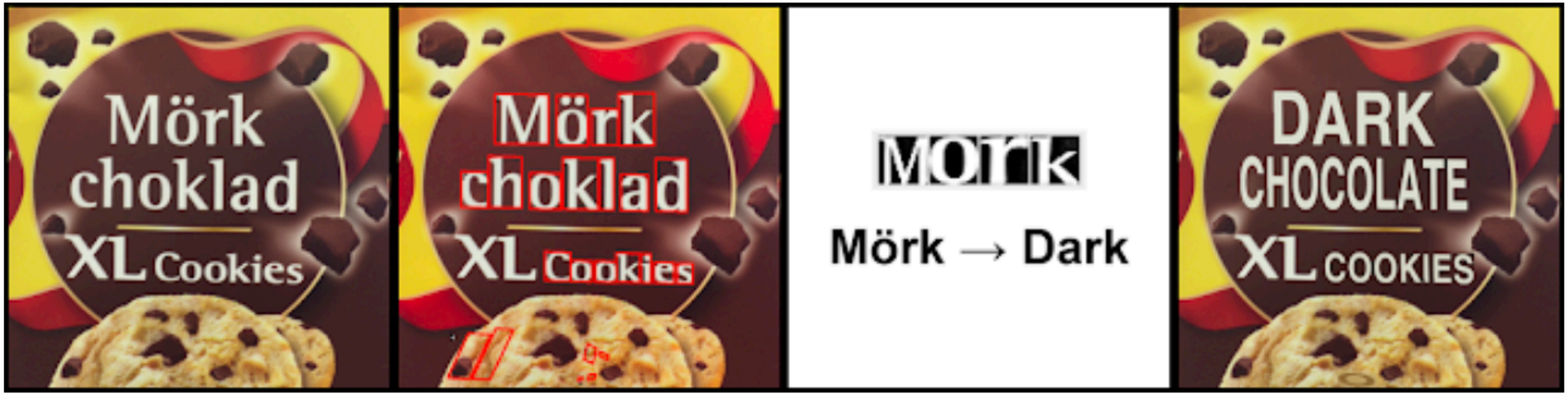
Machine learning relies on many disciplines in mathematics and statistics, such as

- statistical modeling (mathematical models of stochastic/random processes)
- computational statistics (interface between statistics and computer science)
- optimization (finding minima and maxima for functions of multiple variables)

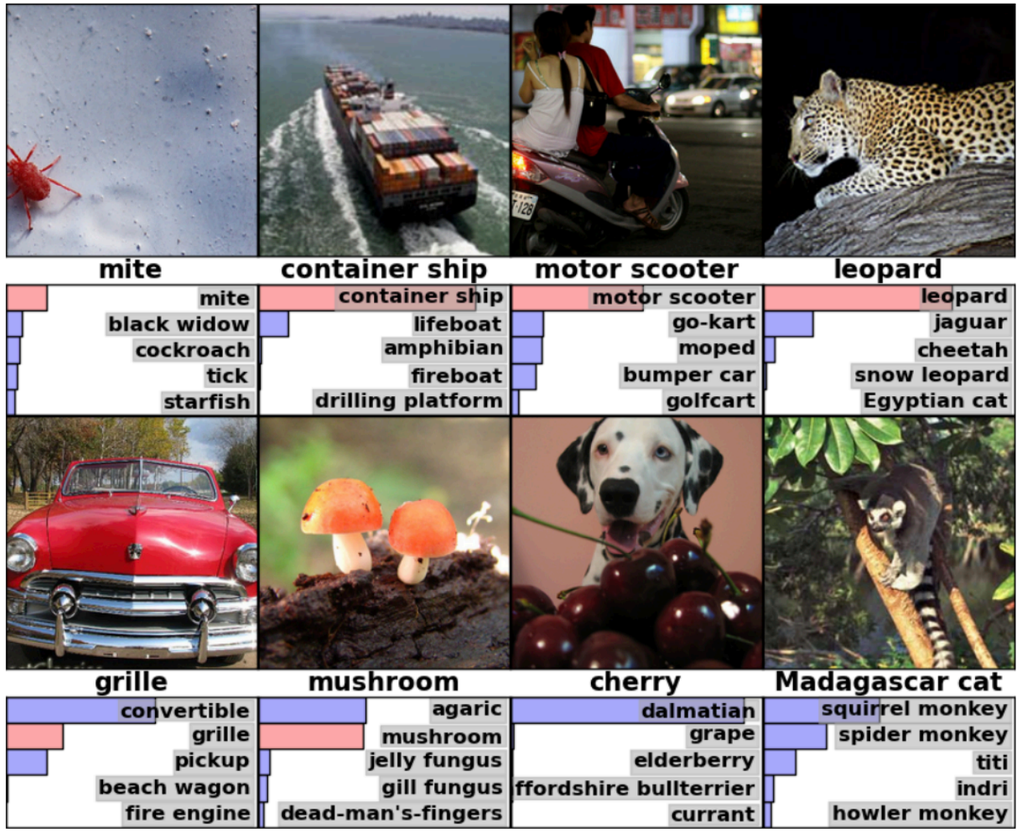
Some success stories in machine learning

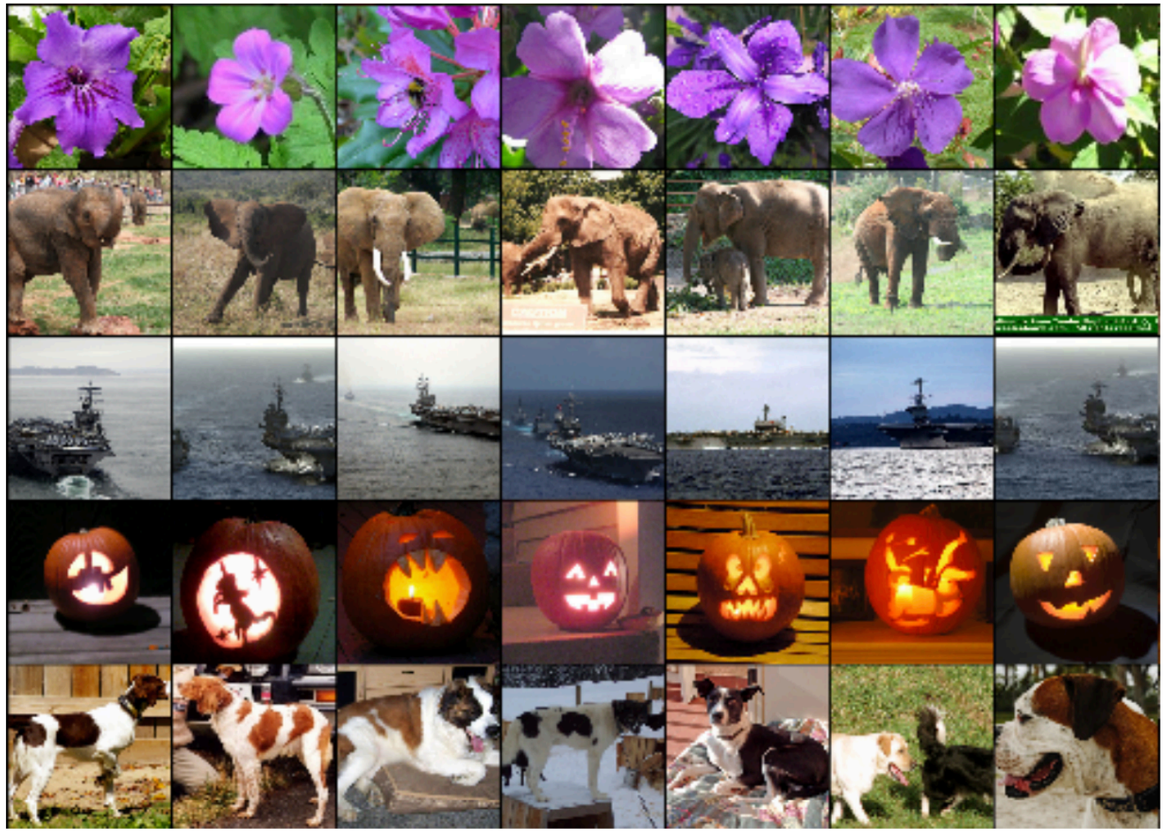
We focus on applications of deep learning, e.g., using deep neural networks, since this is the focus of this class.

Automatic Machine Translation



Object Classification and Detection in Photographs





Automatic Text Generation

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KING LEAR:
O, if you were a feeble sight, the courtesy of your law,
Your sight and several breath, will wear the gods
With his heads, and my hands are wonder'd at the deeds,
So drop upon your lordship's head, and your opinion
Shall be against your honour.
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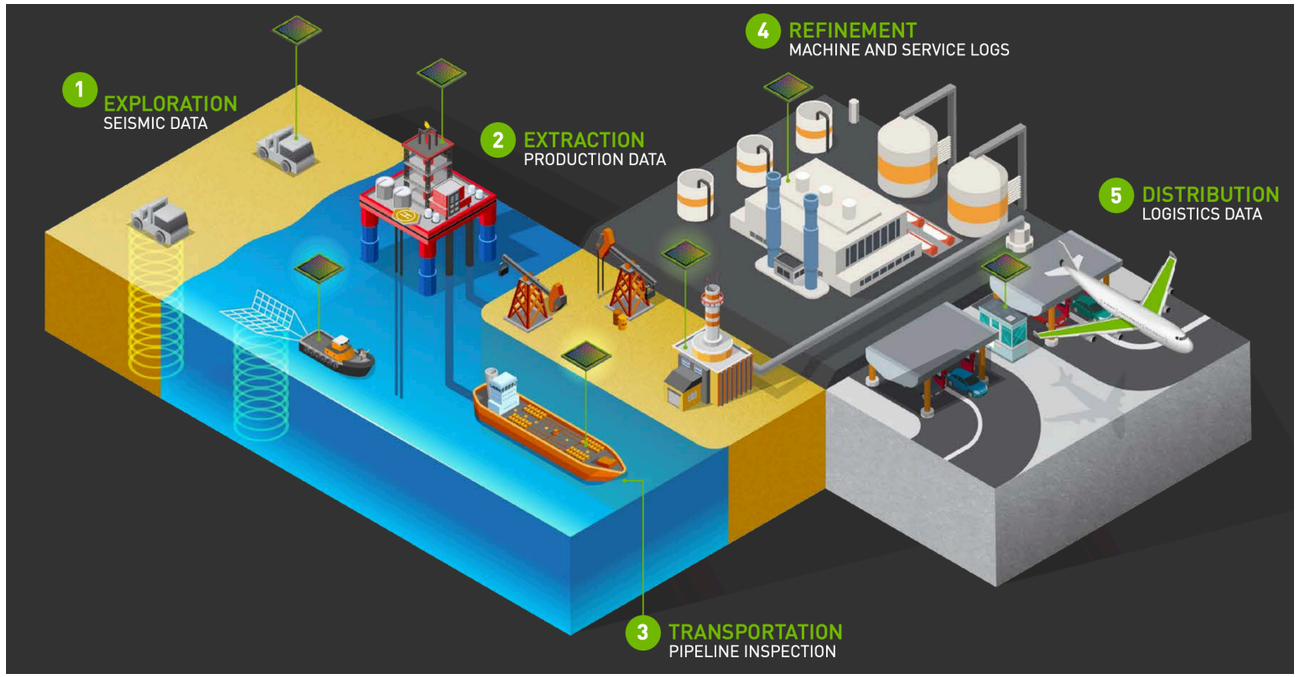
[AlphaGo]

[AlphaGo - The Movie]

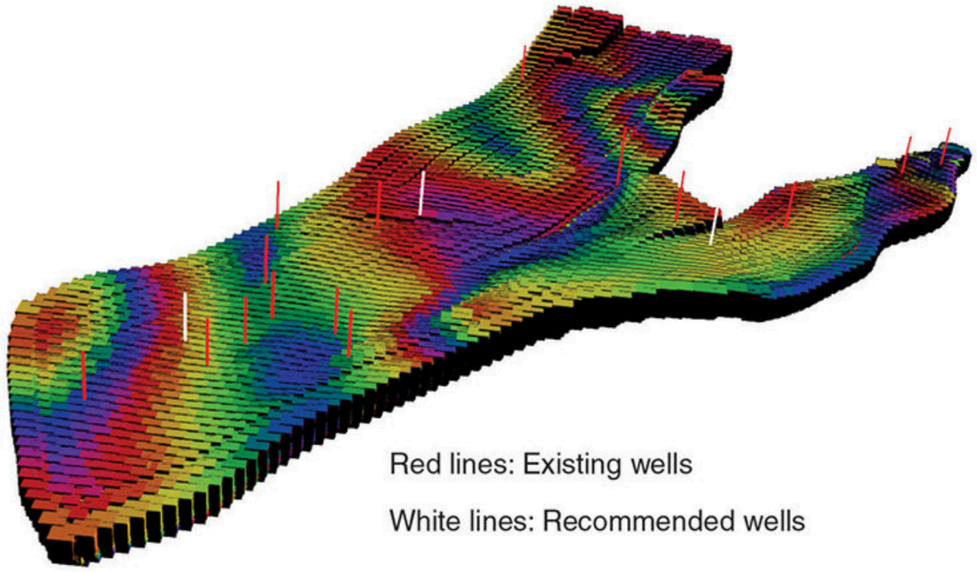
Oil and gas industry

Baker Hughes (a GE Company)

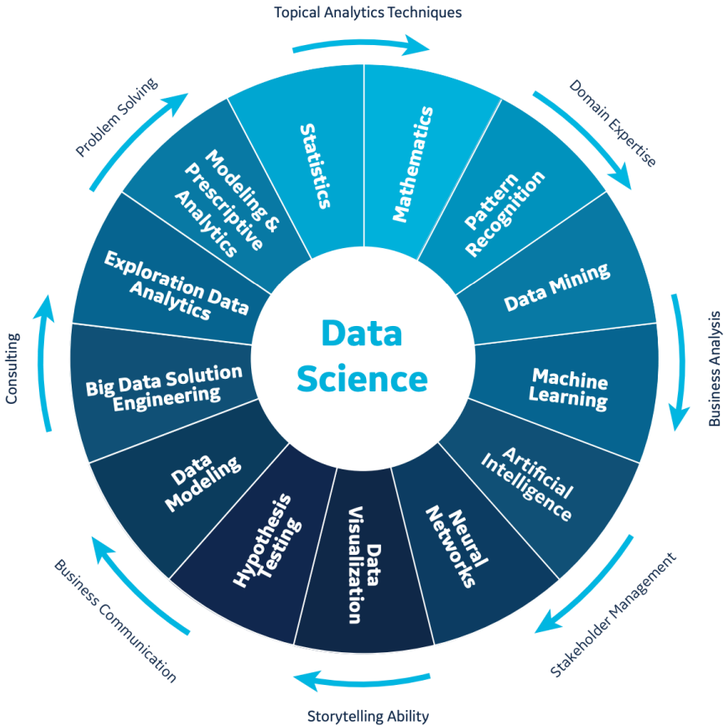


Oil and gas industry

BP and AI start-up Beyond Limits



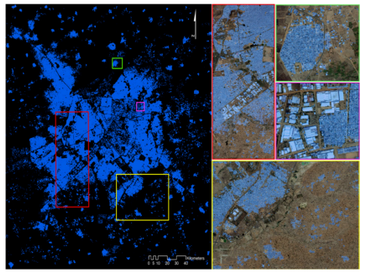
Electric turbines and generators
GE Power and data science at GE



Population distribution

Mapping and analysis of population distribution around the globe

Oak Ridge National Laboratory



Kano subsets

High energy physics

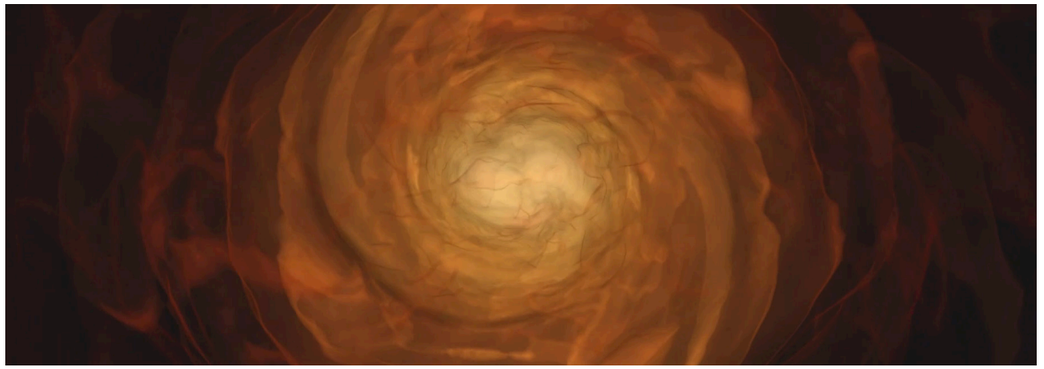
Predicting disruptions in a tokamak fusion reactor

Princeton University

Astrophysics

Detection of gravitational waves millions of light years away in real-time

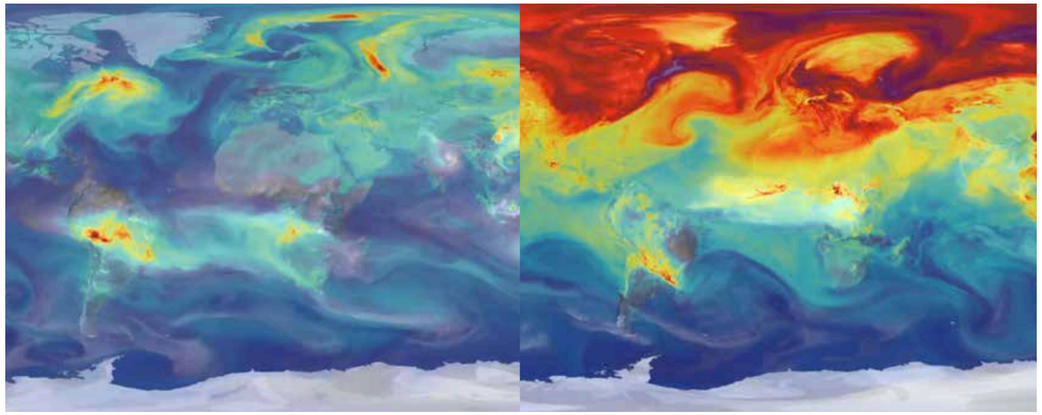
Laser Interferometer Gravitational Wave Observatory (LIGO)



Satellite imaging

Image classification; land surface changes and impact on carbon and climate monitoring

NASA Ames Research Center



Autonomous driving

BMW, Tesla, Waymo