MACHINE LEARNING – CS643

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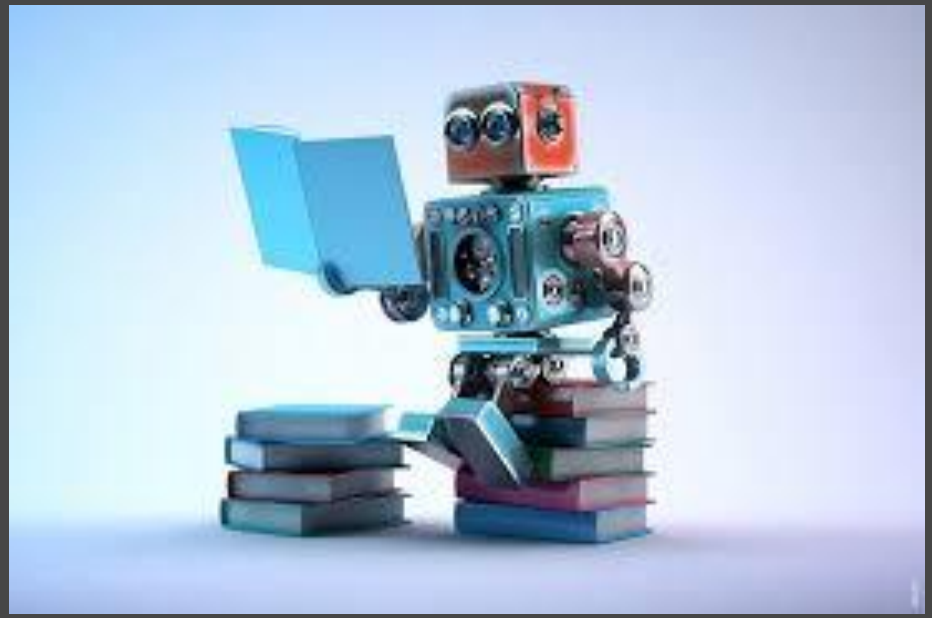
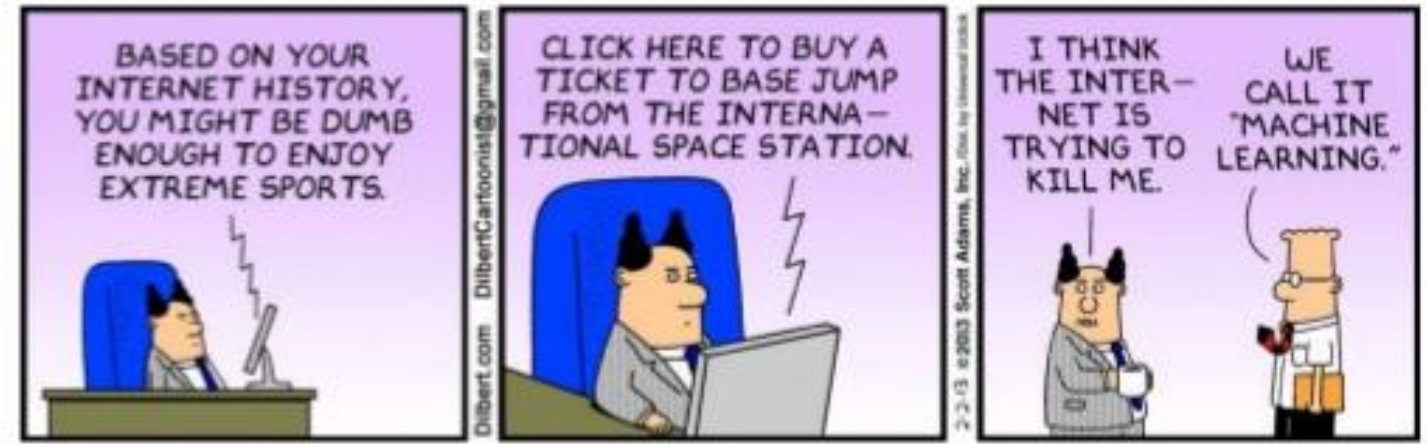


Overview

- Introduction
- Machine Learning Concepts
- Applications

WHAT IS MACHINE LEARNING?

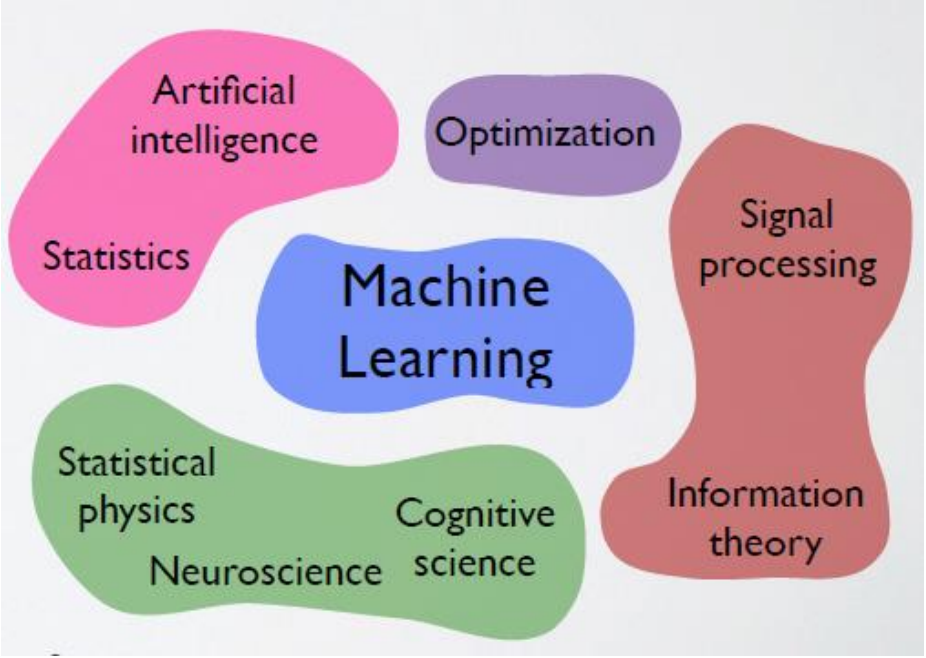


What if Things become Intelligent?

http://cdn2.hubspot.net/hubfs/338908/images/Blog_Pictures/Humor_in_IoT.jpg

Machine Learning

- "The science of getting computers to act without being explicitly programmed" - Andrew Ng (Stanford/Coursera)



Machine Learning

Machine Learning
- Grew out of work in AI
- New capability for computers

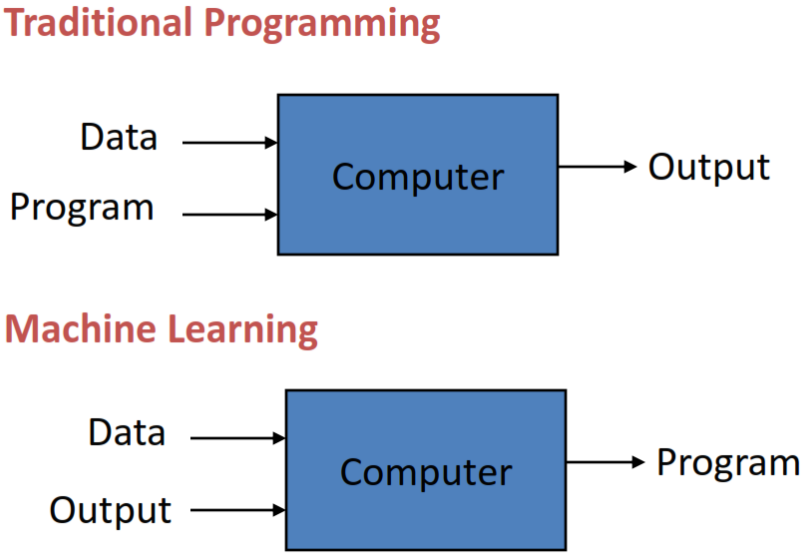
Examples:
- Database mining
  Large datasets from growth of automation/web.
  E.g., Web click data, medical records, biology, engineering
- Applications can't program by hand.
  E.g., Autonomous helicopter, handwriting recognition, most of Natural Language Processing (NLP), Computer Vision.
- Self-customizing programs
  E.g., Amazon, Netflix product recommendations
- Understanding human learning (brain, real AI).

Machine Learning

- “A breakthrough in machine learning would be worth ten Microsofts” (Bill Gates, Microsoft)
- “Machine learning is the next Internet” (Tony Tether, Former Director, DARPA)
- Machine learning is the hot new thing” (John Hennessy, President, Stanford)
- “Web rankings today are mostly a matter of machine learning” (Prabhakar Raghavan, Dir. Research, Yahoo)
- “Machine learning is going to result in a real revolution” (Greg Papadopoulos, CTO, Sun)

Traditional Programming and Machine Learning

- Developers map business problems to programs
- *Machine Learning is different*
- Business problems are solved by focusing on how to harvest untapped knowledge from data



Machine Learning Definition

- Tom Mitchel's definition of Machine Learning:
  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*.

Machine Learning Concept

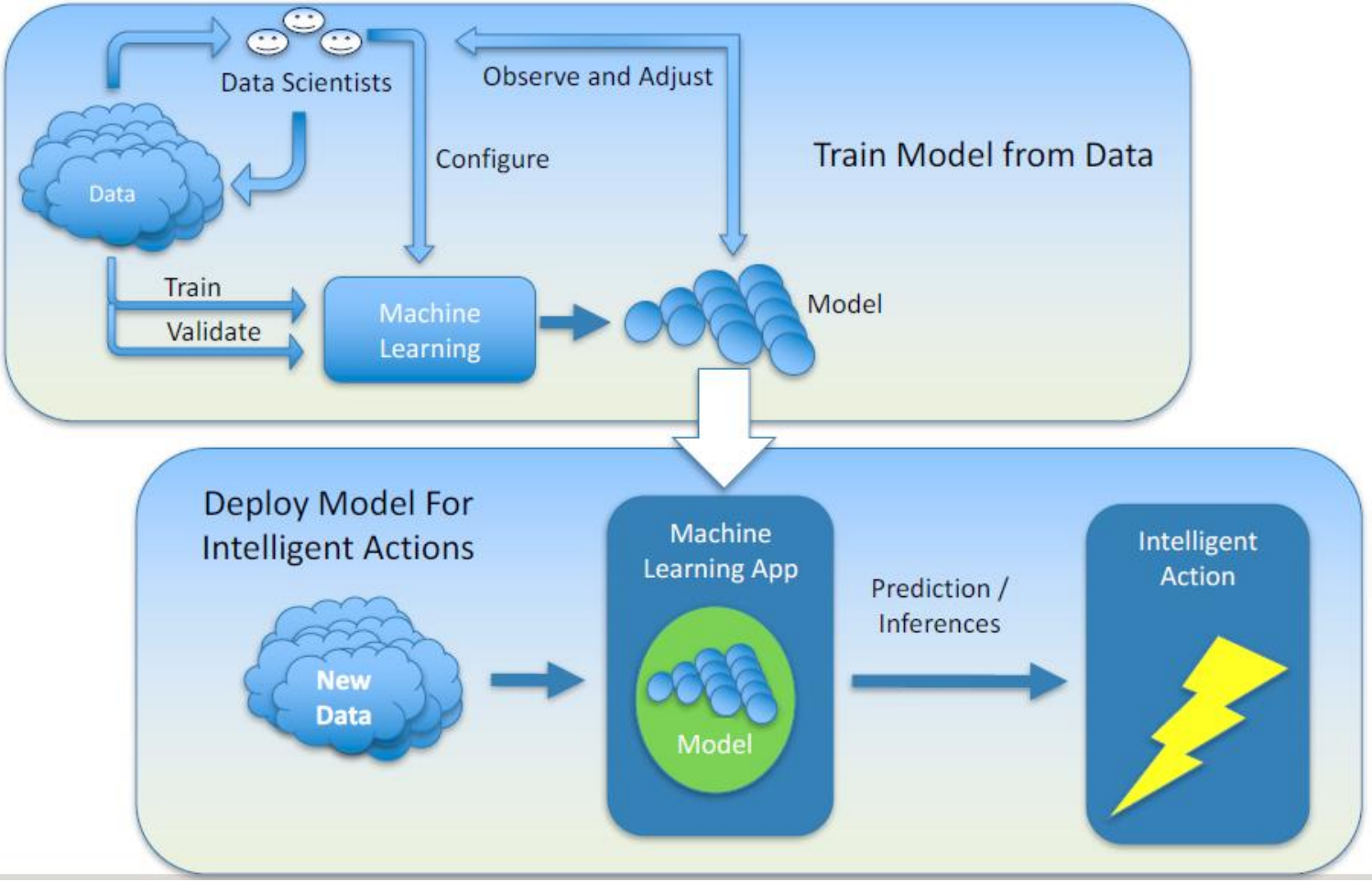
- Practical aspects:
  - Ask a question that can be answered from data
  - Prepare selected data sources for machine processing
  - Apply ML processing to produce *models* from data
  - Use these models to *predict* or *infer* various outcomes based on new data
- Based on Data Science:
  - Numerical techniques and algorithms for analyzing data to predict characteristics of new data

So What is Machine Learning?

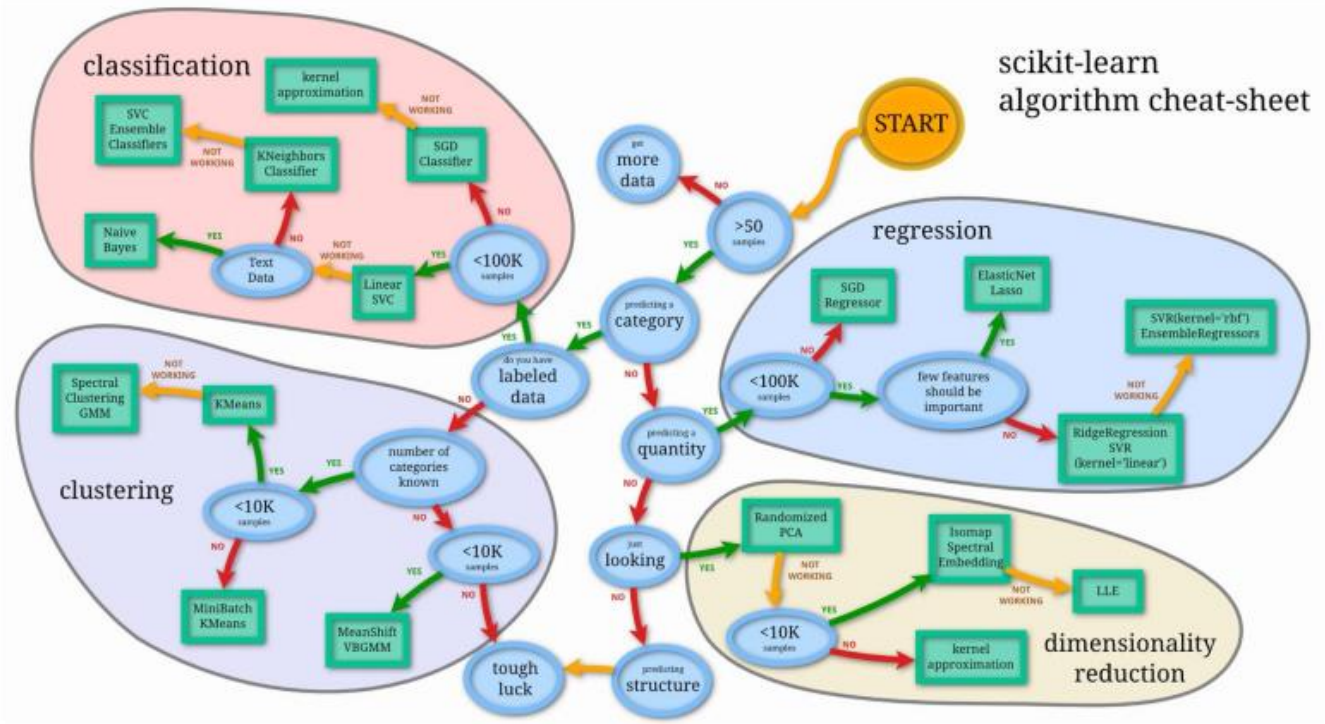
- Automating Automation
- Getting Computers to Program themselves

- Writing Software is the bottleneck
- Let the data to do the work instead!

Machine Learning Workflow



Machine Learning Mind Map



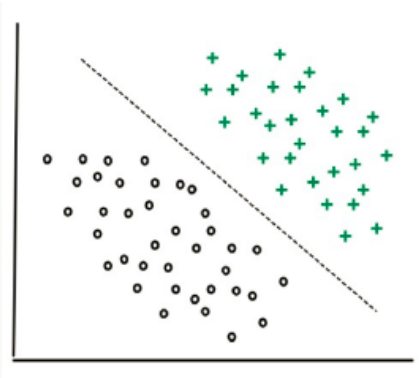
Source: http://scikit-learn.org/

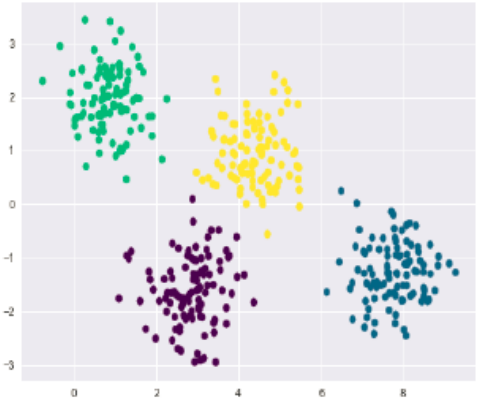
Prediction Types

Regression	Classification	Clustering	Recommender	Action
Predict a Number • House price	**Predict a Class** • Positive or negative sentiment • Intent • Spam or Ham?	**Group Related Items** • Related news articles	**Suggest Items** • Products on Amazon • Movies on Netflix	**Predict What To Do** • Game moves • Autonomous Vehicle driving

Learning Modes

Supervised	Unsupervised	Reinforcement
Examples with labels or known answers provided • Known house sales prices and house size, number of rooms, location, etc. • Customer reviews with known sentiment – positive or negative	**Examples with no labels or categories provided** • Group examples based upon common features	**Actions with feedback** • Positive or negative rewards for each action • Tradeoff between Exploitation and Exploration



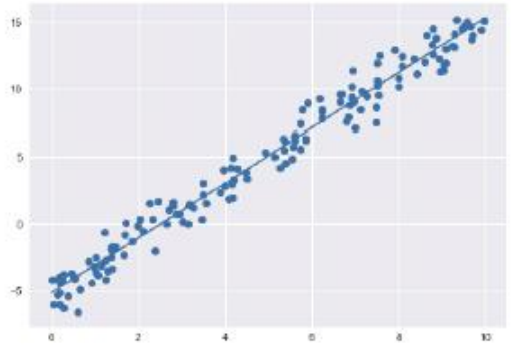


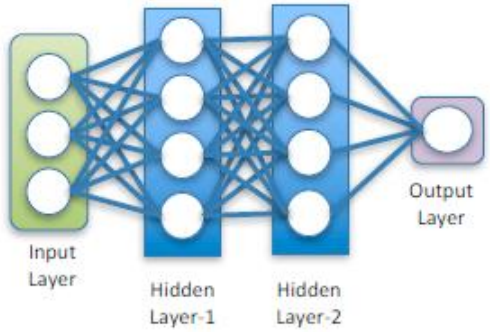
OpenAI Gym BETA

A toolkit for developing and comparing reinforcement learning algorithms. It supports teaching agents everything from walking to playing games like Pong or Go.

Learning Models

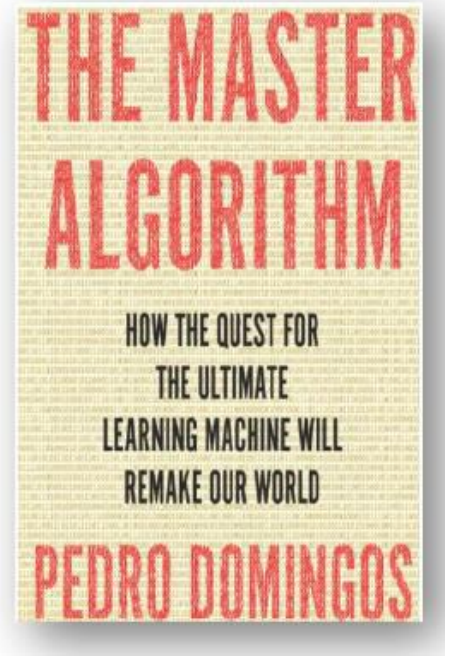
Decision Trees	Linear Regression Models	Deep Neural Networks





Learning Tribes

Tribe	Origins	Algorithm
Symbolists	Logic, Philosophy	Inverse Deduction
Connectionists (DL)	Neuroscience	Backpropogation
Evolutionaries	Evolutionary Biology	Genetic Programming
Bayesian	Statistics	Probabilistic Inference
Analogizers	Psychology	Kernel Machines

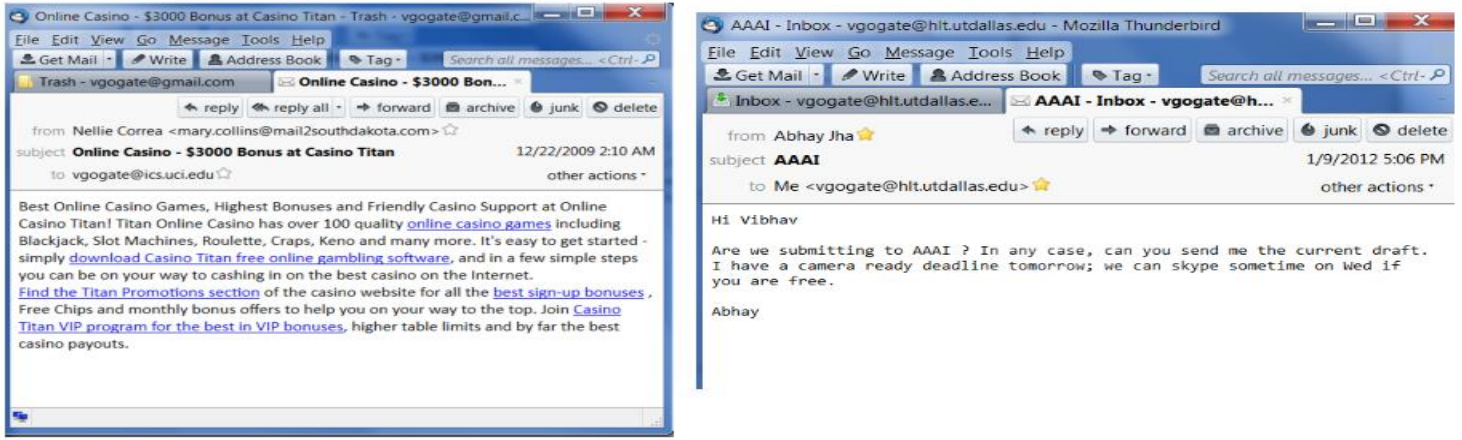


Tools for Machine Learning

https://github.com/aymericdamien/TensorFlow-Examples

Applications

Classification Example: Spam Filtering



Classify as "Spam" or "Not Spam"

Applications

Classification Example: Weather Prediction

Applications

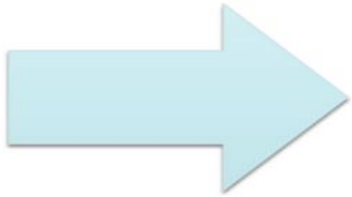
Regression example: Predicting Gold/Stock prices

Good ML can make you rich (but there is still some risk involved).

Given historical data on Gold prices, predict tomorrow's price!

Applications

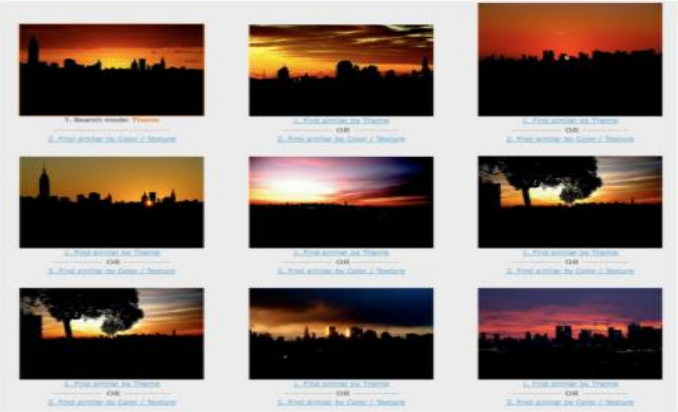
Clustering images

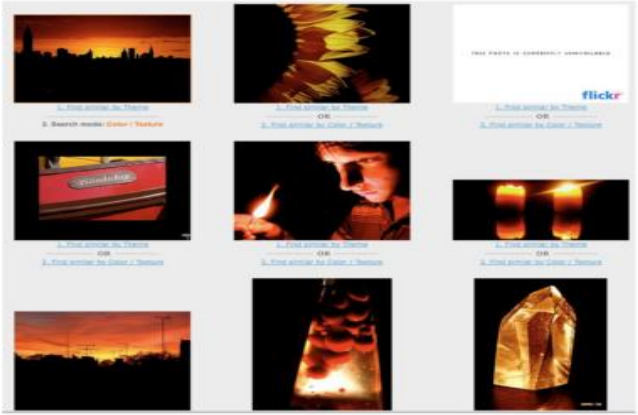


[Goldberger et al.]

Applications

Similarity Determination





Applications

Smart Cars

“Bad news — the scale is threatening to cut off our access to the fridge…’