

EECS 395/495 Machine Learning

Aggelos K. Katsaggelos

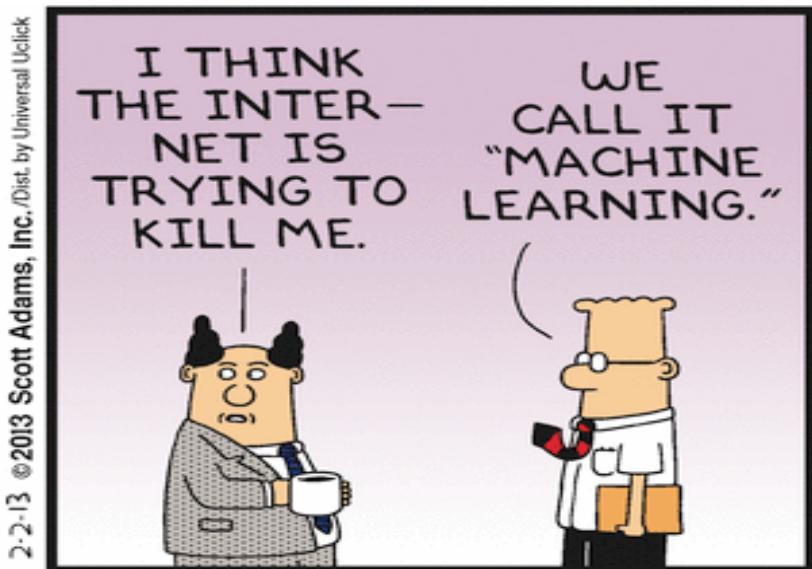
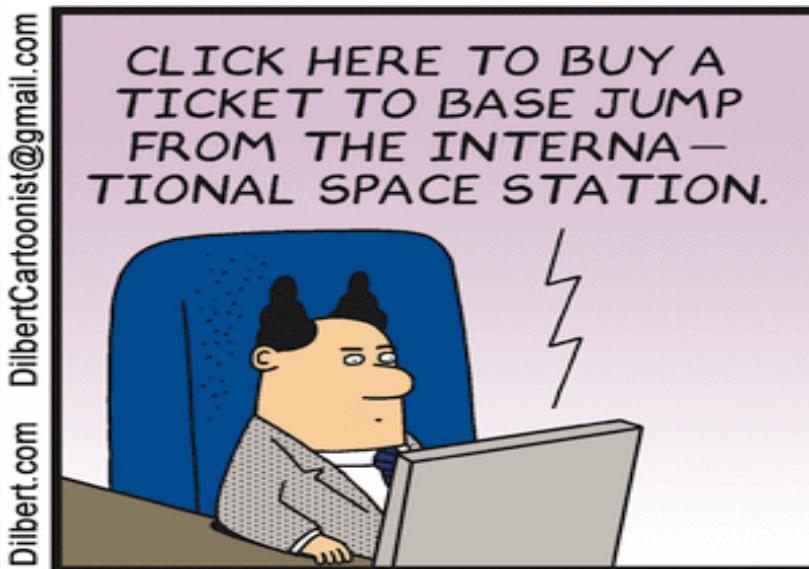
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What is ML commonly used for today?

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- **Target advertising:** recommend advertisements and products to users based on some understanding of their tastes, their consumption history, how they think, etc.,



What is ML commonly used for today?

- **General recommendation/matching**

- Business partners – job websites e.g., LinkedIn
- Products – e.g., Amazon
- Romantic partners: e.g., Okcupid, match.com



Dating Research from OkCupid

What is ML commonly used for today?

- **Object detection and recognition:**
 - driver assisted and self-driving cars



Image taken from <http://www.wsj.com/articles/panasonic-in-deal-to-help-computers-learn-on-the-job-1433840398>



There is a video here! Click on the whitespace above to bring out the window.

Regression

Predicting a *continuous-valued* variable

Classification

Predicting a *discrete-valued* variable
i.e., distinguishing between different classes of data

Regression

Predicting a *continuous-valued* variable

Ex. Financial modeling

Brent crude oil prices, January 2014 - January 2016



Source: Bloomberg

BBC

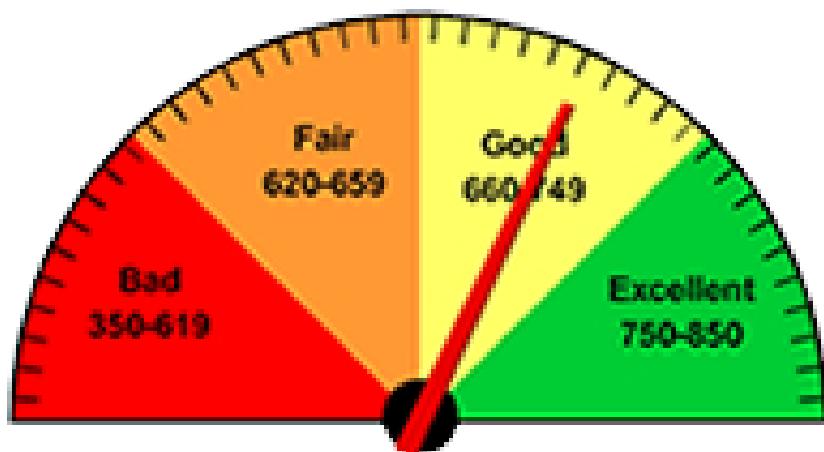
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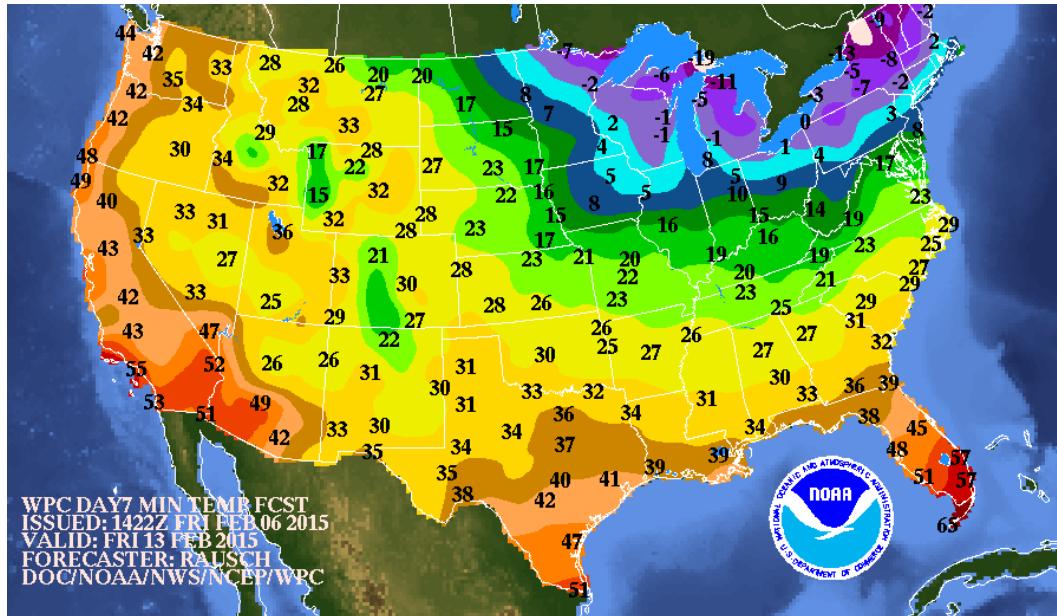
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Regression

Predicting a *continuous-valued* variable

Ex. Weather forecasting



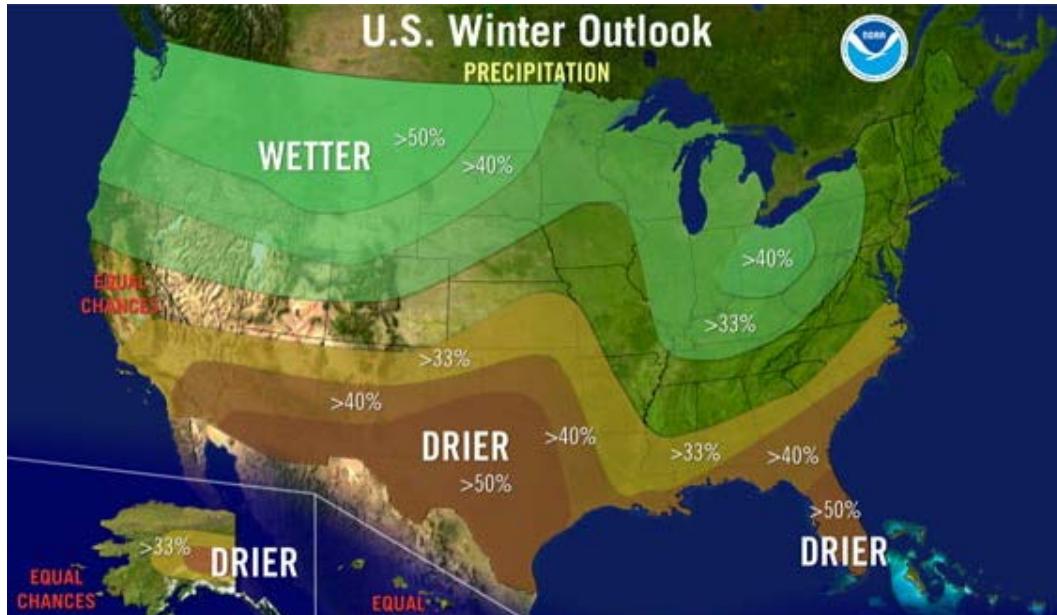
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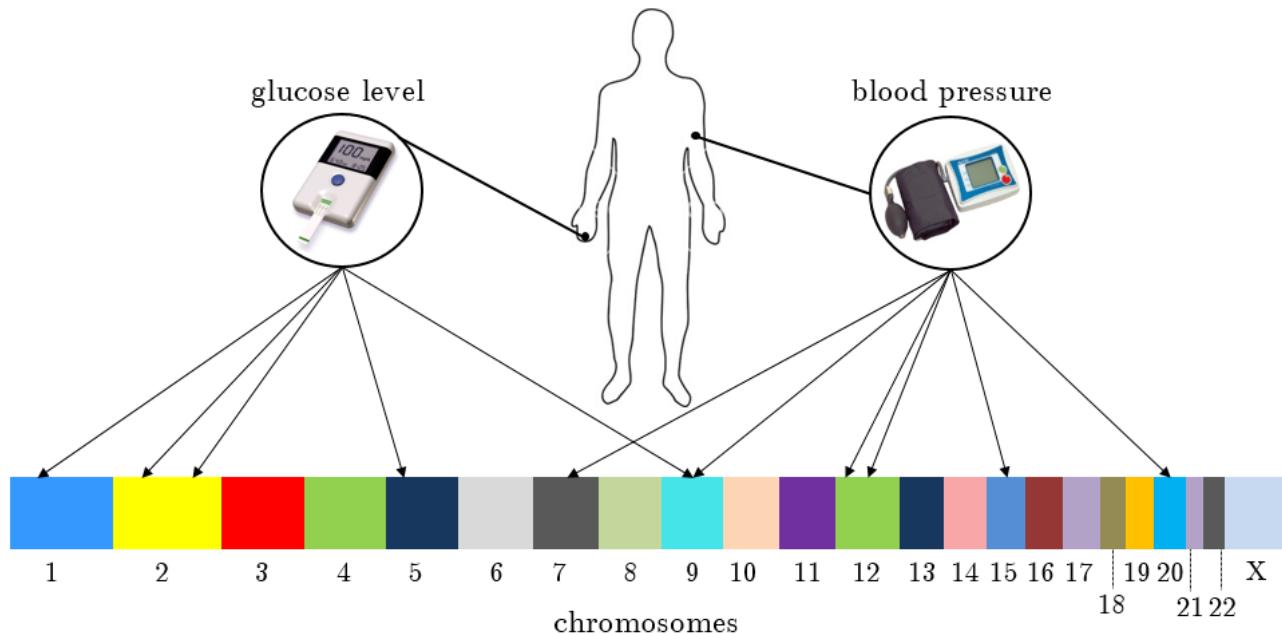
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Regression

Predicting a *continuous-valued* variable

Ex. Genetics



Classification

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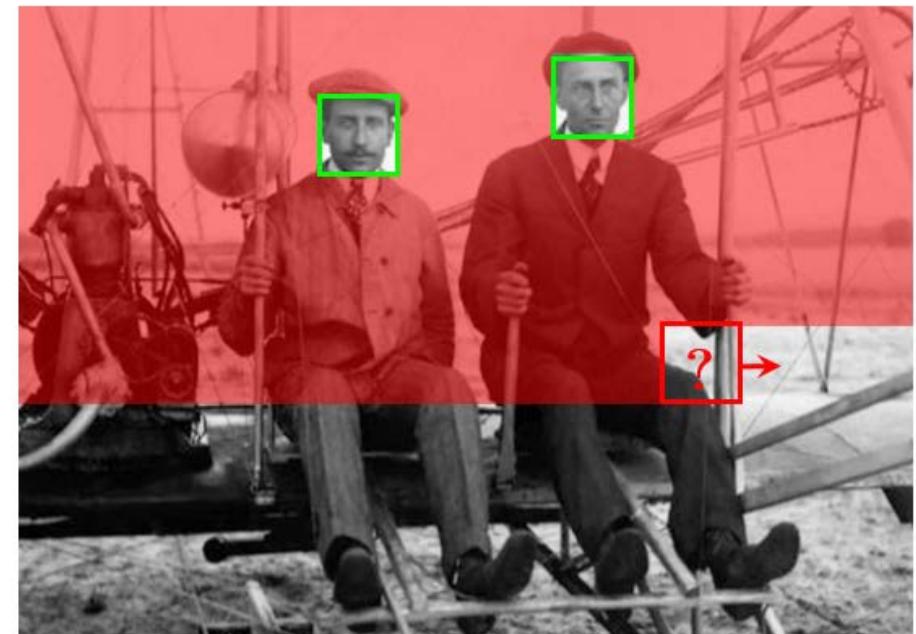
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Predicting a *continuous-valued* variable

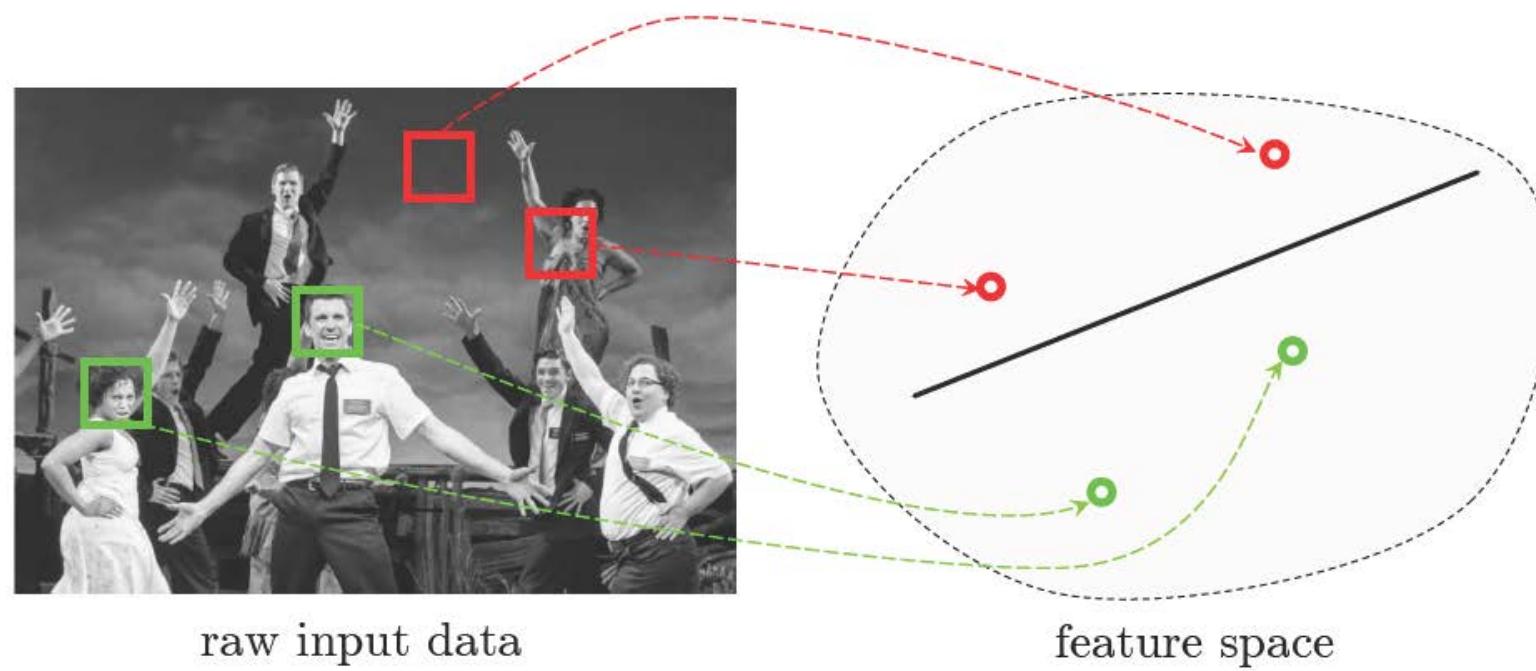
Classification

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Ex. Face detection



Face Detection



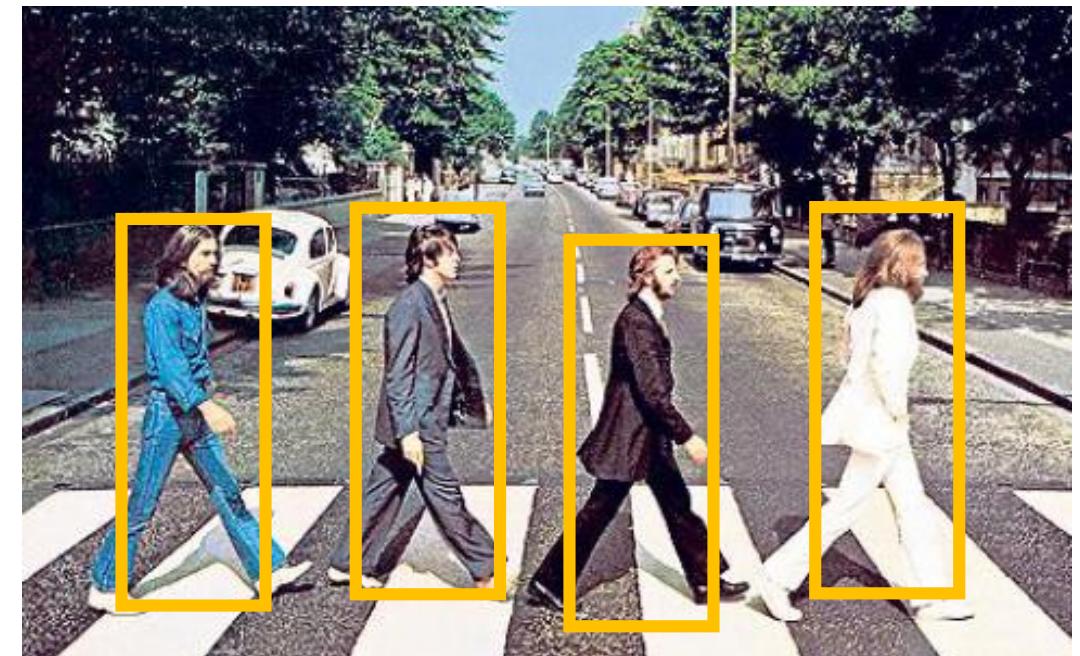
Regression

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Classification

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Ex. Pedestrian detection



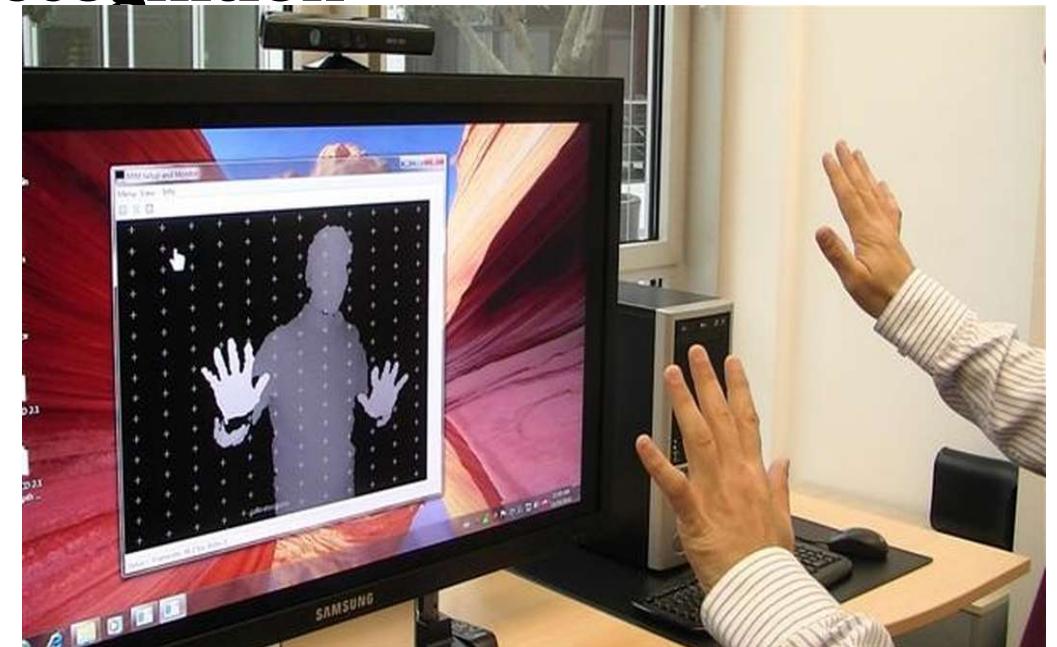
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Ex. Hand gesture recognition



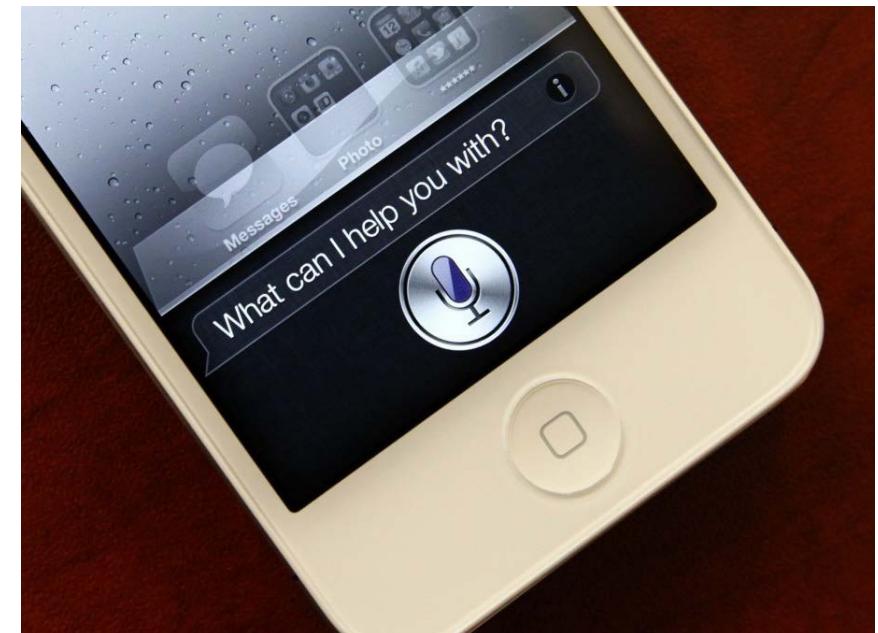
Regression

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Classification

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Ex. Speech recognition



Regression

Predicting a *continuous-valued* variable

Classification

Predicting a *discrete-valued* variable
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Ex. Optical character recognition



$$\sqrt{2}/\alpha$$

Regression

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Classification

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Ex. Sentiment analysis

Customer Revs
Apple Airport Expr

45 Reviews

Star Rating	Count
5 star	(20)
4 star	(13)
3 star	(5)
2 star	(2)
1 star	(5)

The most helpful favorable review

20 of 21 people found the following review helpful:

★★★★★ **Airport Express Set-up Instructions**

The CD that comes with the Airport Express has been useless to me in setting up a Windows XP computer to work with an AE. The instructions below should get you up and running.

1. First download the latest version of both the Airport Update and Airport Express Firmware Updater from [...]
2. Run the latest version of the Airport Update (4.1 at the...
[Read the full review >](#)

Published 3 months ago by S. Monroe

The most helpful critical review

6 of 7 people found the following review helpful:

★★★☆☆ **Works fine after a painfully difficult set up.**

It took me a full day to work out the bugs in setting my Express up to work with my Mac Mini and my wife's Mac Powerbook. First it worked on one, but the other could not find it. Then it didn't work at all. There is a lot more involved in setting up your own wireless network and making decisions as to what level of security you want (with no ready explanation of what the...
[Read the full review >](#)

Published 3 months ago by David Haggith

> See more [3 star](#), [2 star](#), [1 star](#) reviews

Vs.

Regression

Predicting a *continuous-valued* variable

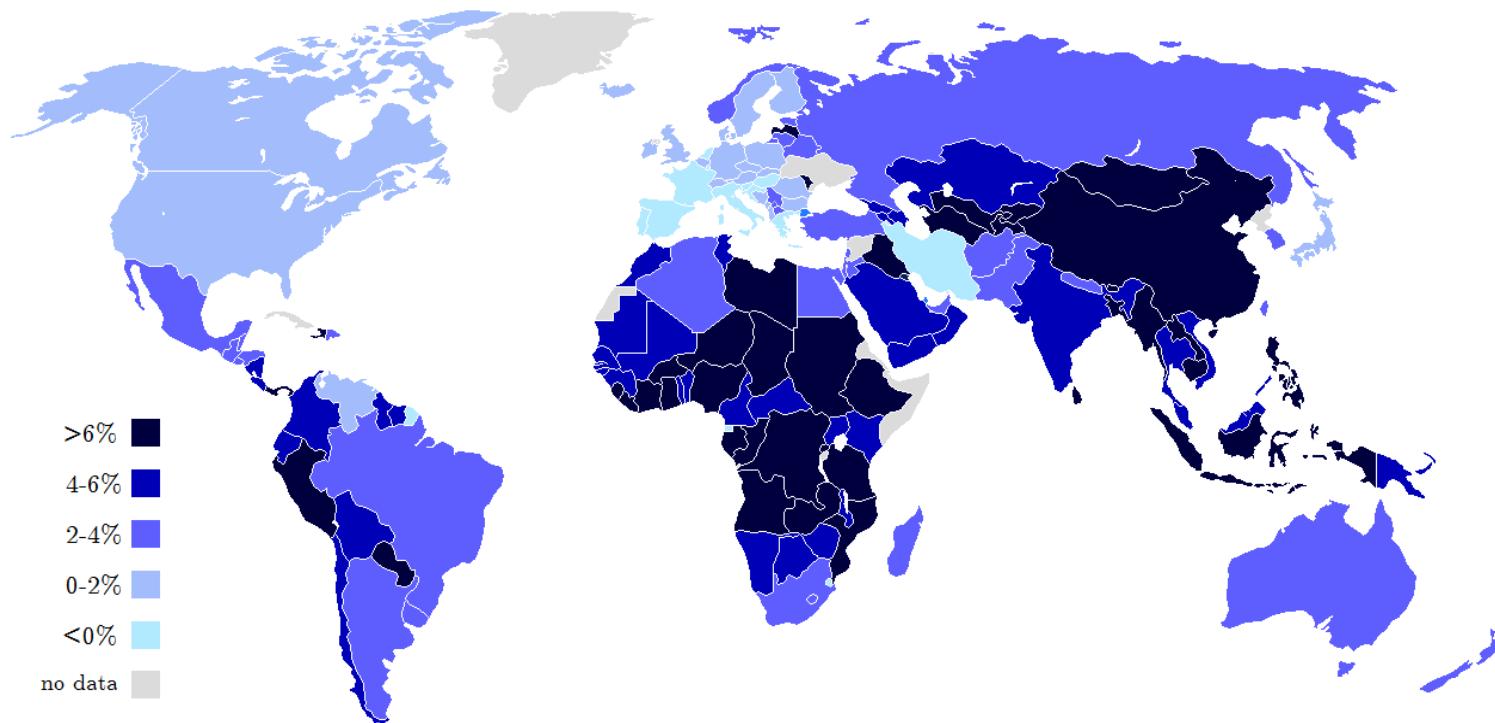
Classification

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Ex. Spam detection



Econometrics



Population density

Fraction of tropical area

Size of economy

Defense spending

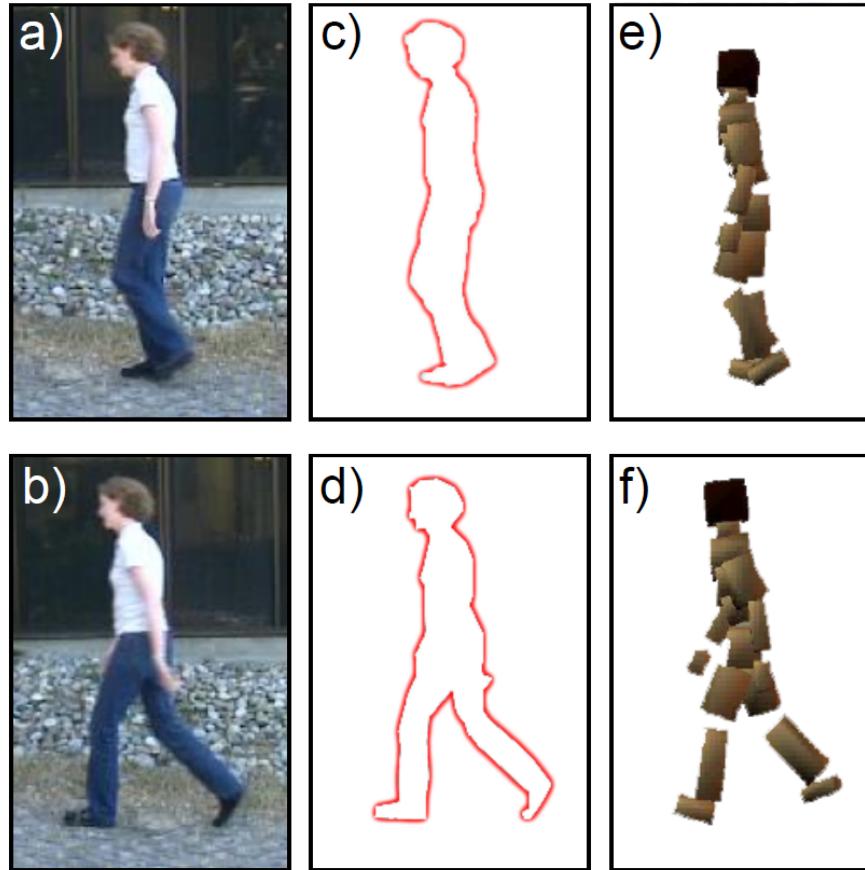
Life expectancy

Public investment

•
•
•

Land area

Estimation of the Pose using a Regression Model



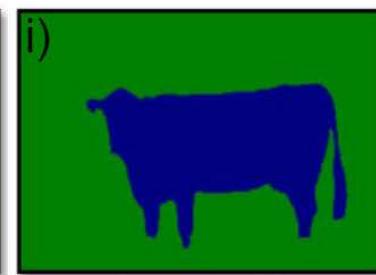
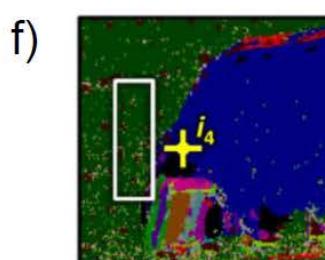
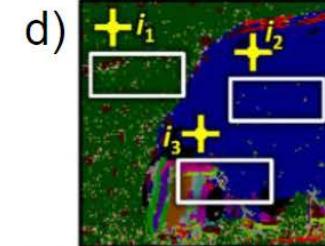
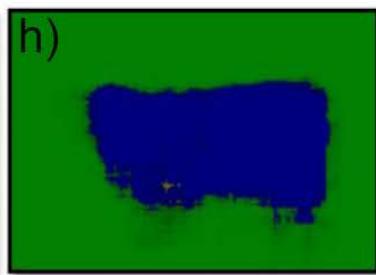
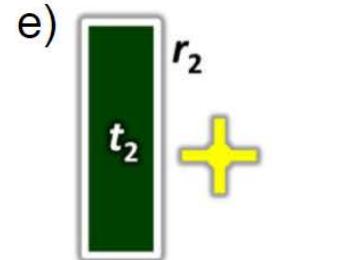
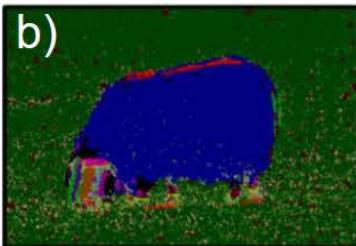
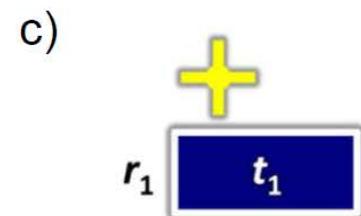
The pose is encoded as a 55×1 vector. It contains three angles in 18 major joints of the body and the global azimuth.

We encode the silhouette as a 100×1 vector. From this vector, we want to calculate the pose as a 55×1 vector and learn the relation between the features and the pose.

Gender Classification

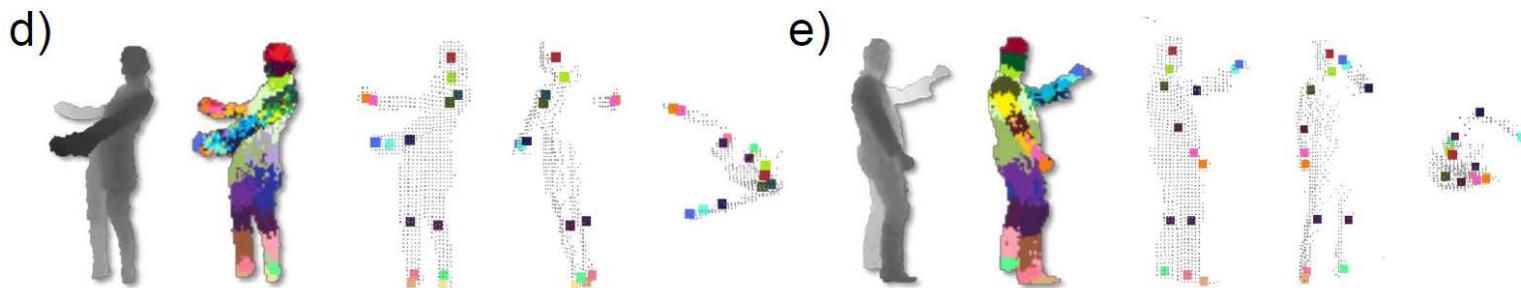
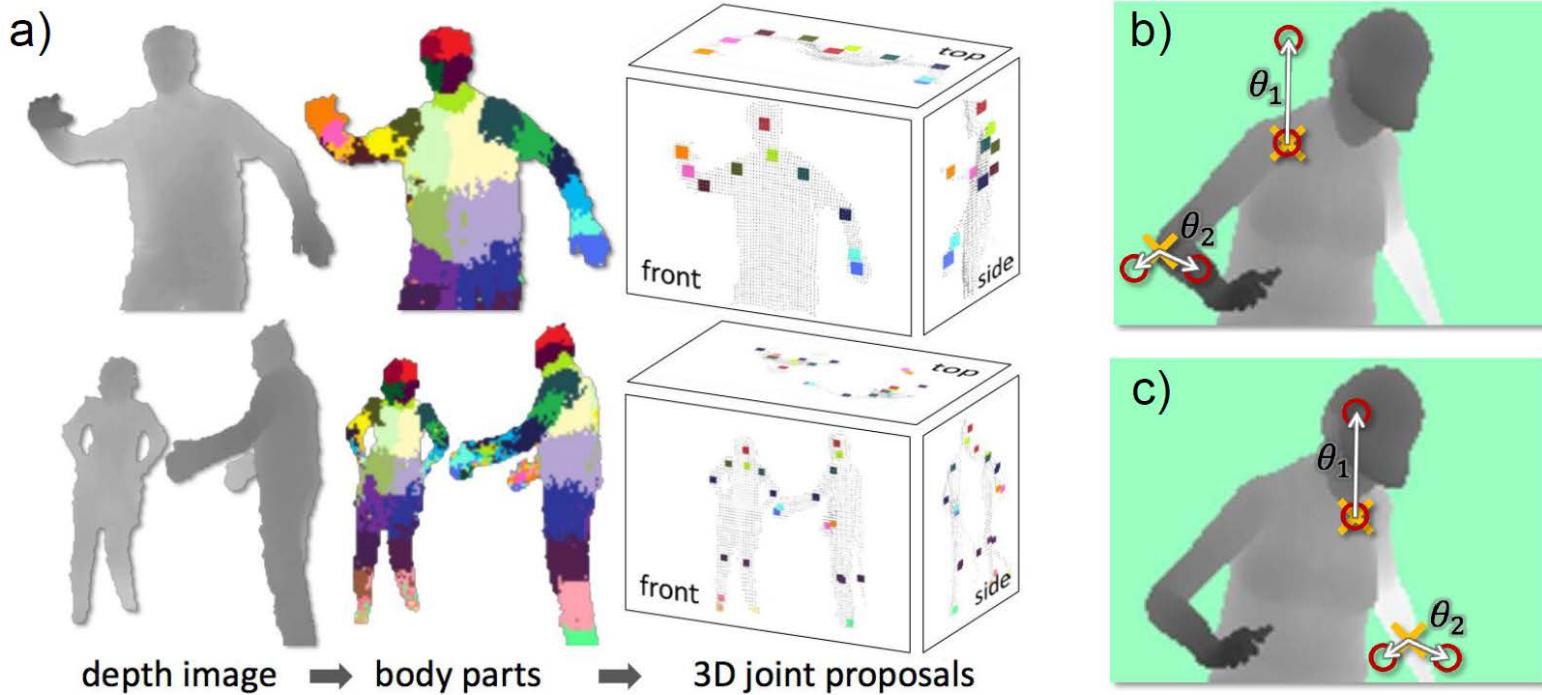


Semantic segmentation



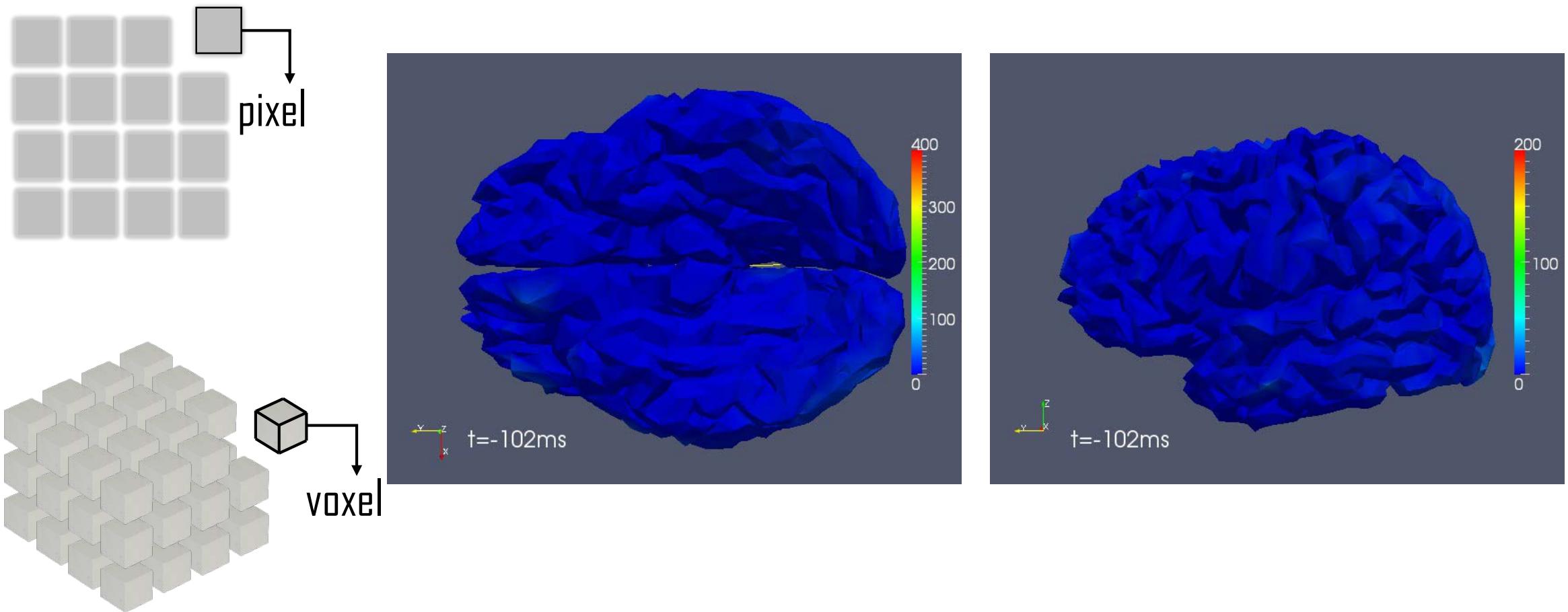
Shotton *et al.* (2009)

Identifying Human Parts



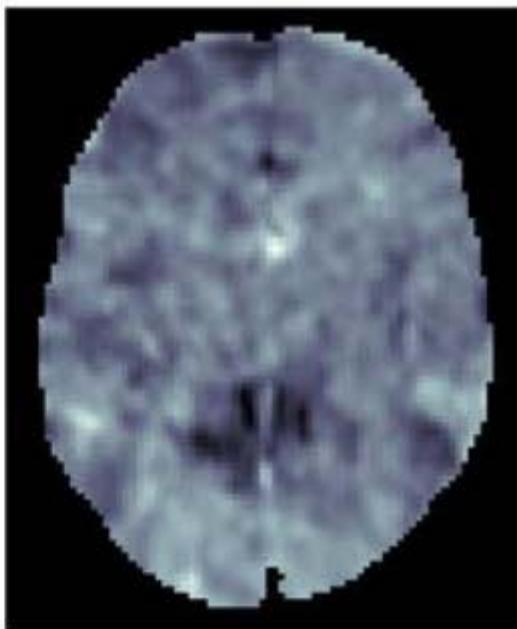
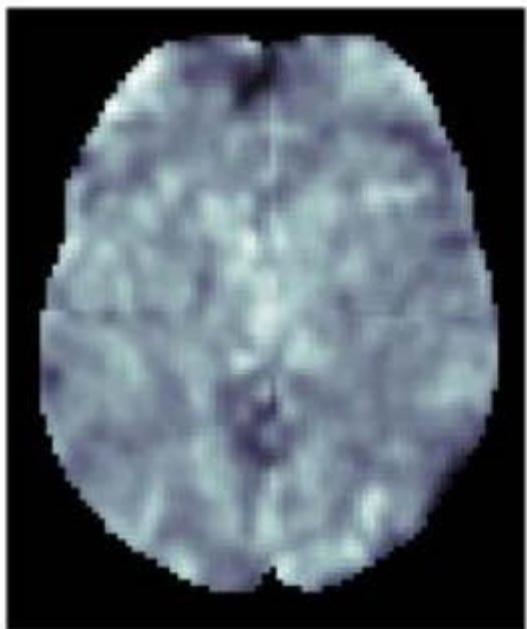
Adapted from Shotton *et al.* (2011)

Neuroscience

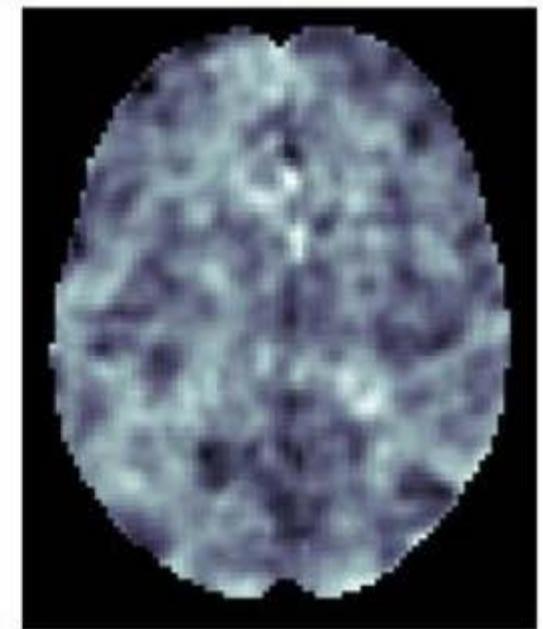
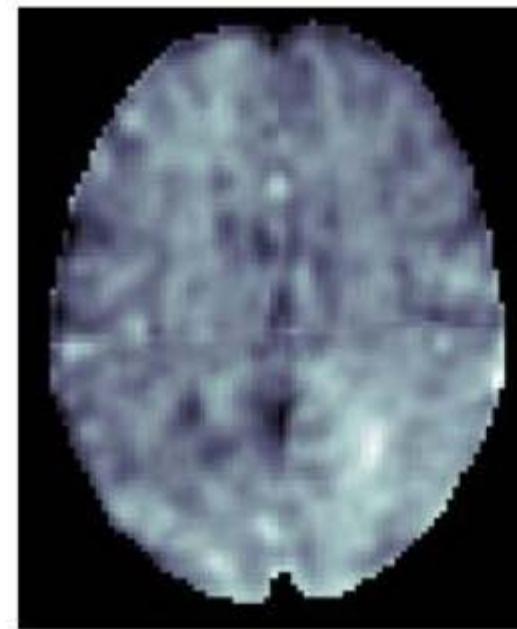


ADHD

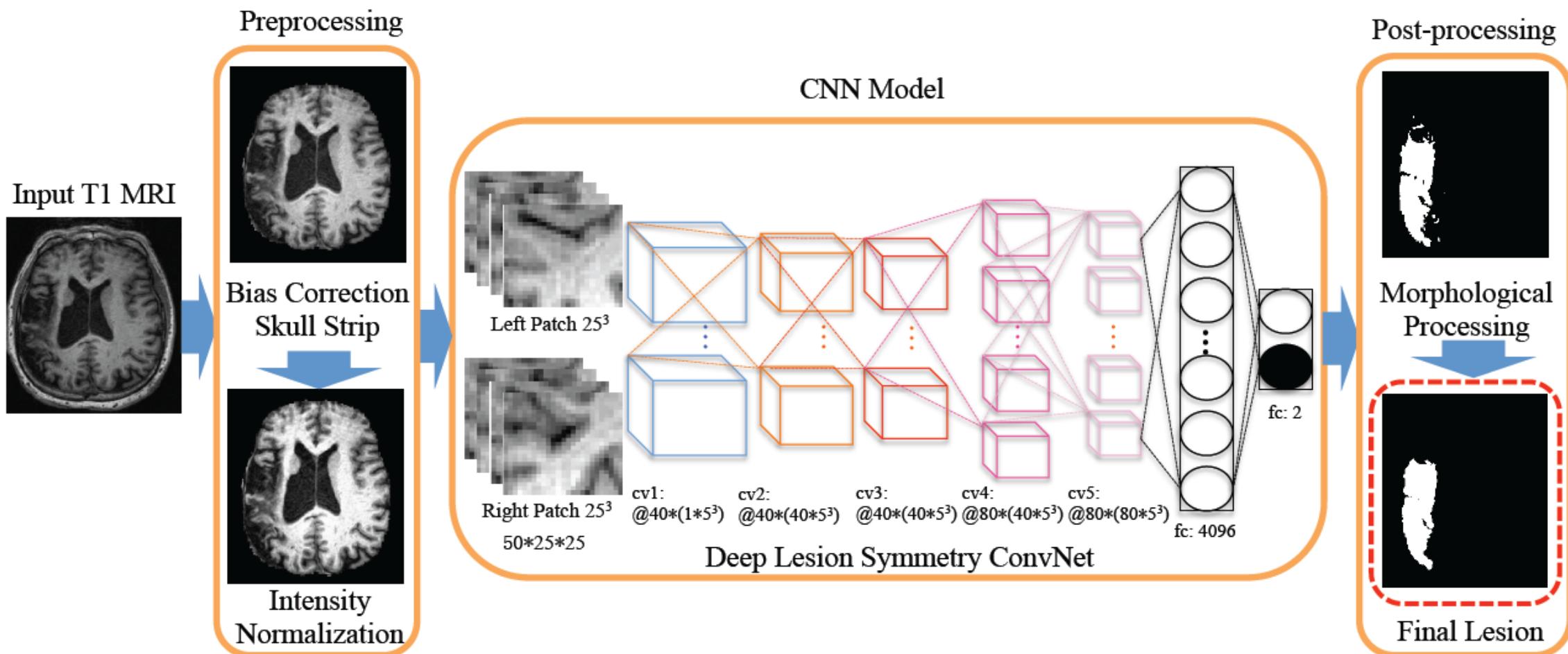
Normal



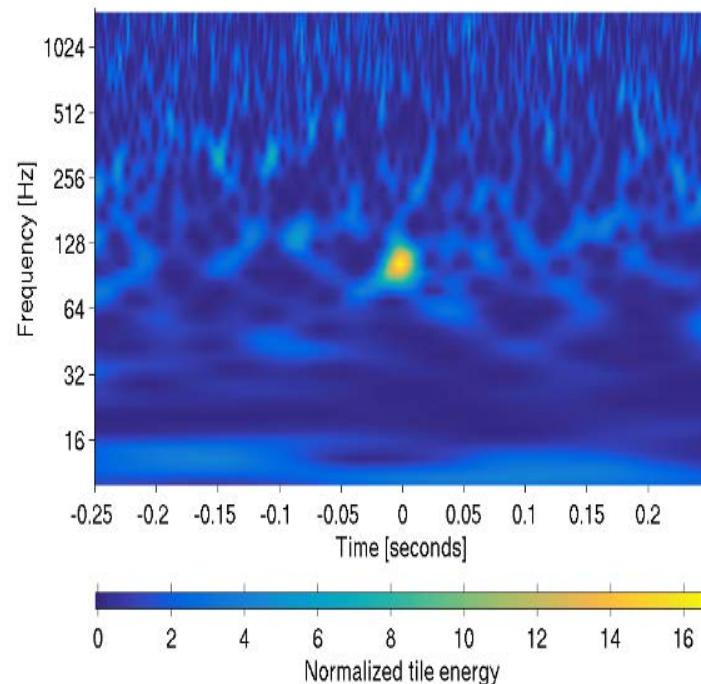
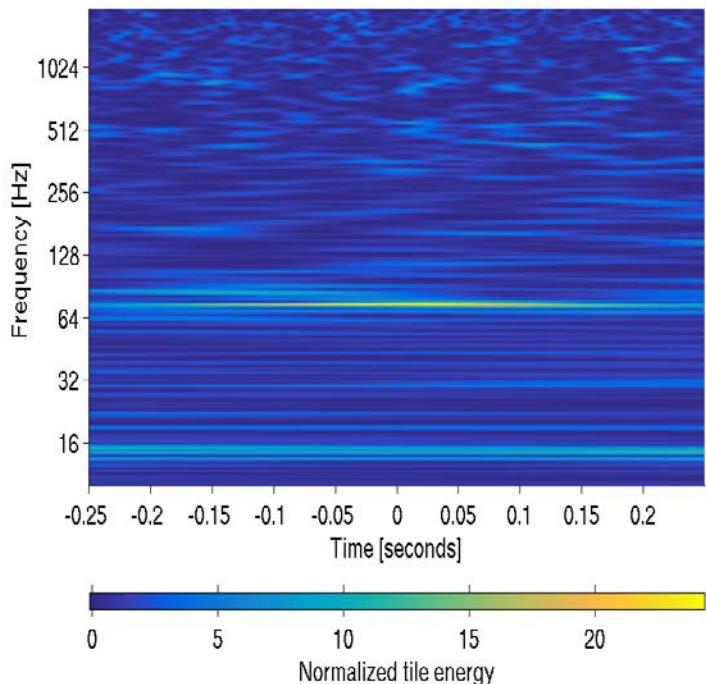
ADHD



Lesion Classification

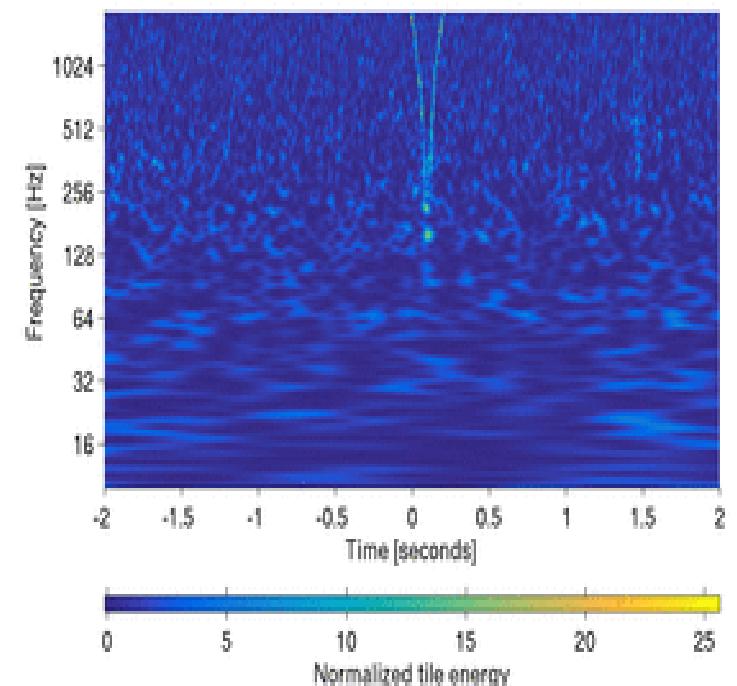
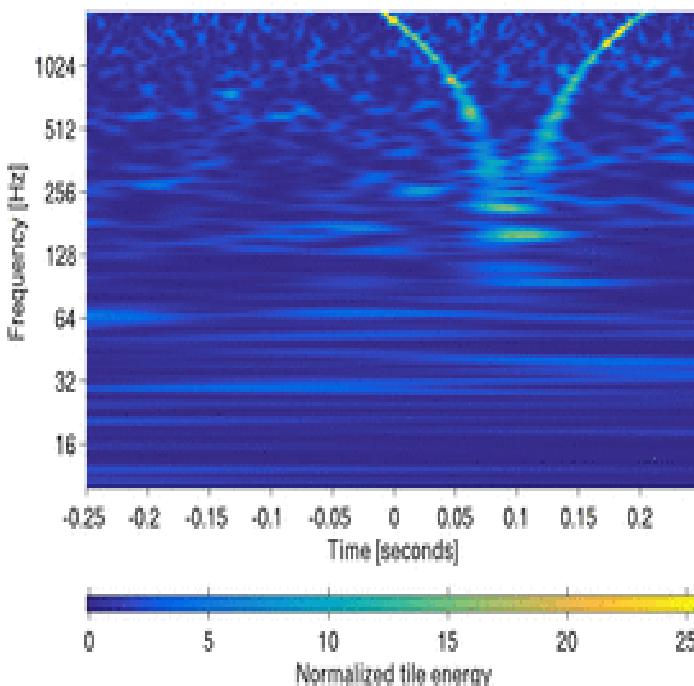


- LIGO (Laser Interferometer Gravitational wave Observatory) data “glitches”
- Visualized as images on a time-frequency plane that display visually recognizable shapes
- 5930 images/ 20 classes

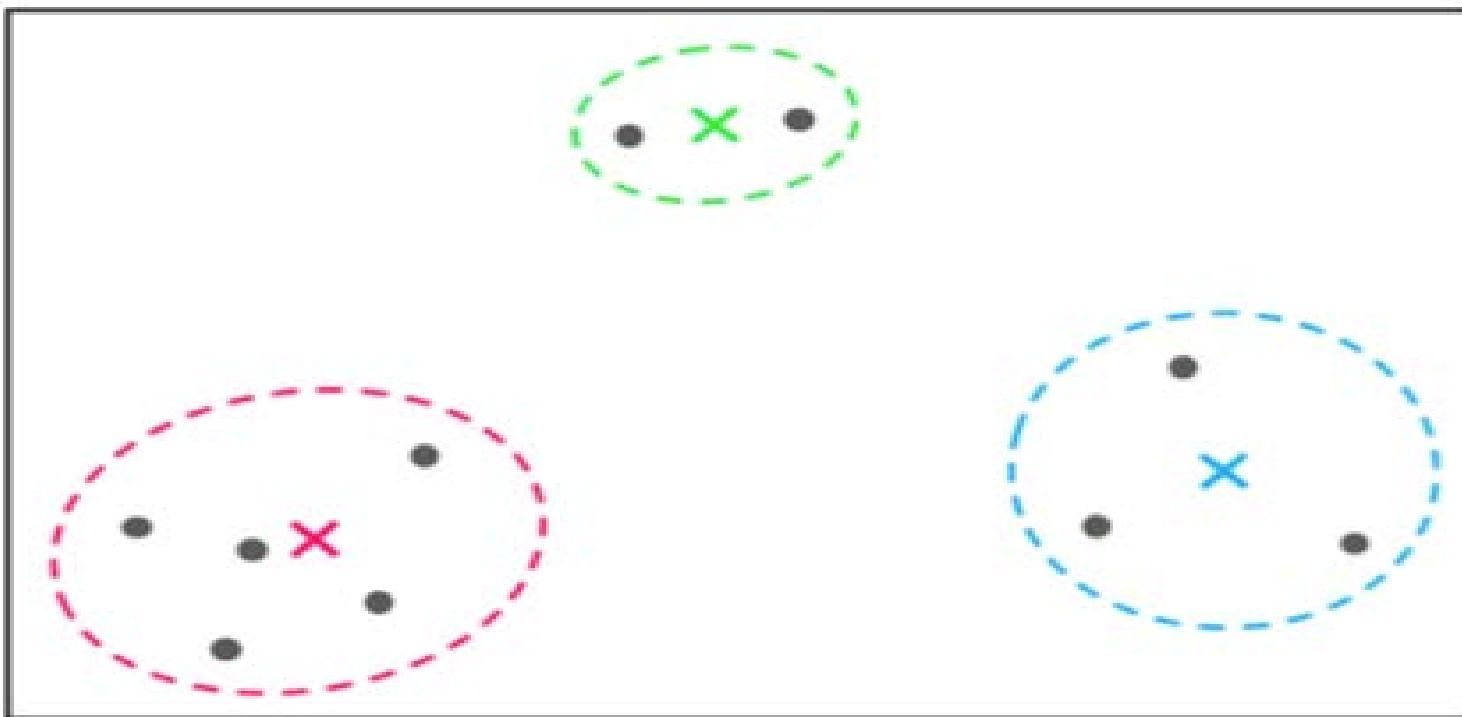


Fusion of Multiple Time Duration Images Classification

- Image classification using multiple time duration images
- An example of “whistle” image with two different time durations



Dimension reduction: create a simpler representation of a dataset



Common preprocessing step for regression/classification

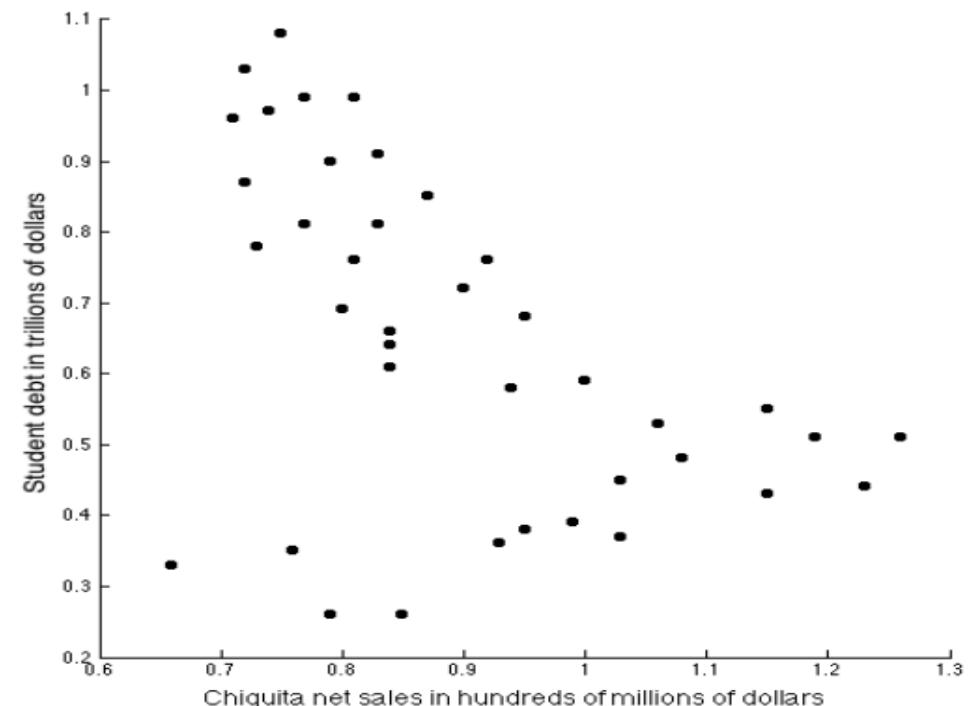
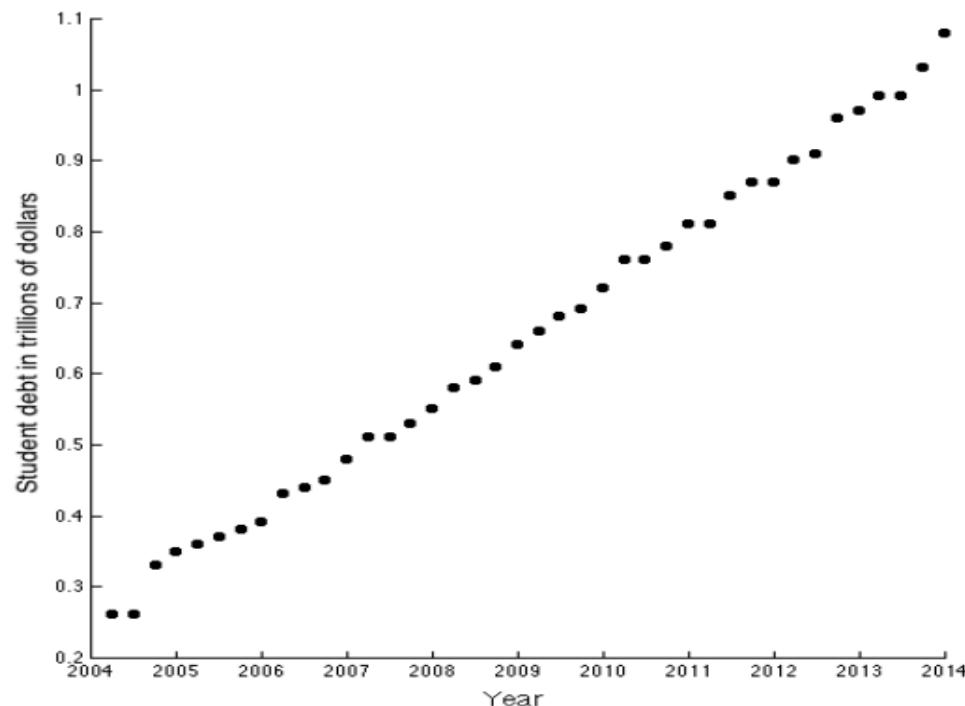
Inpainting /Imputation of missing values

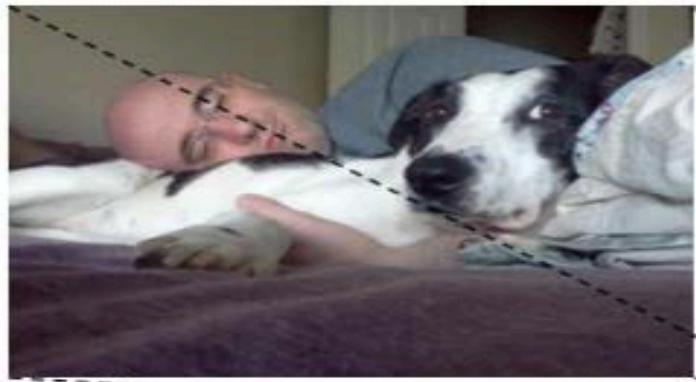


Two crucial ingredients

Features: characteristics of a dataset that allow for optimal learning

- crucial to the performance of the basic building blocks





Day-to-day Life Apps

- Virtual Personal Assistants (Siri, Alexa, Google Now)
- Predictions while Commuting
 - Traffic Predictions
 - Online Transportation Networks (Uber)
- Video Based Surveillance
- Social Media Services
 - People you may know
 - Face Recognition
 - Similar Pins (objects)
- Email Spam and Malware Filtering

Day-to-day Life Apps

- Online Customer Support (chatbots)
- Search Engine Results Refining
- Product Recommendations
- Online Fraud Detection

Top 10

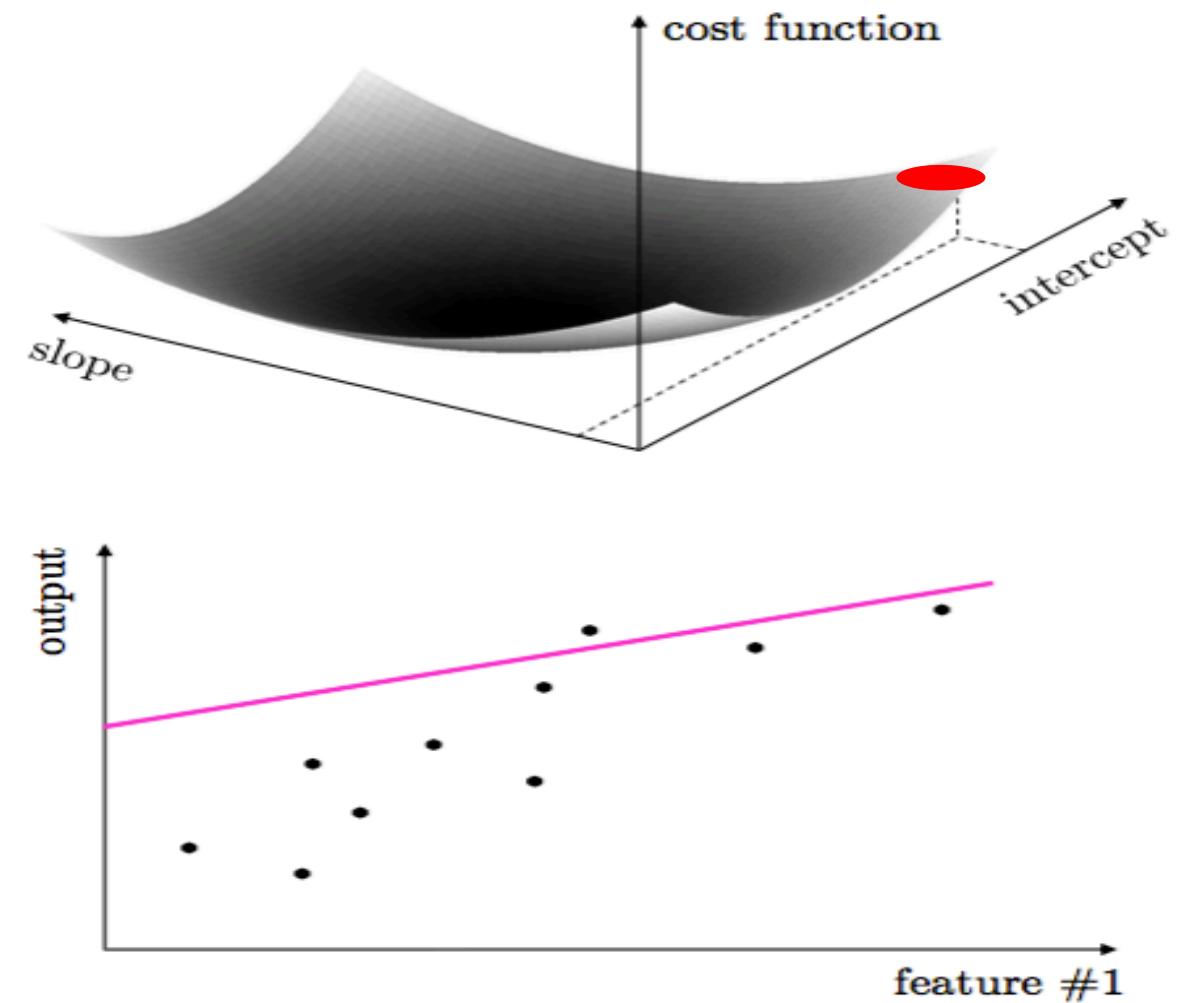
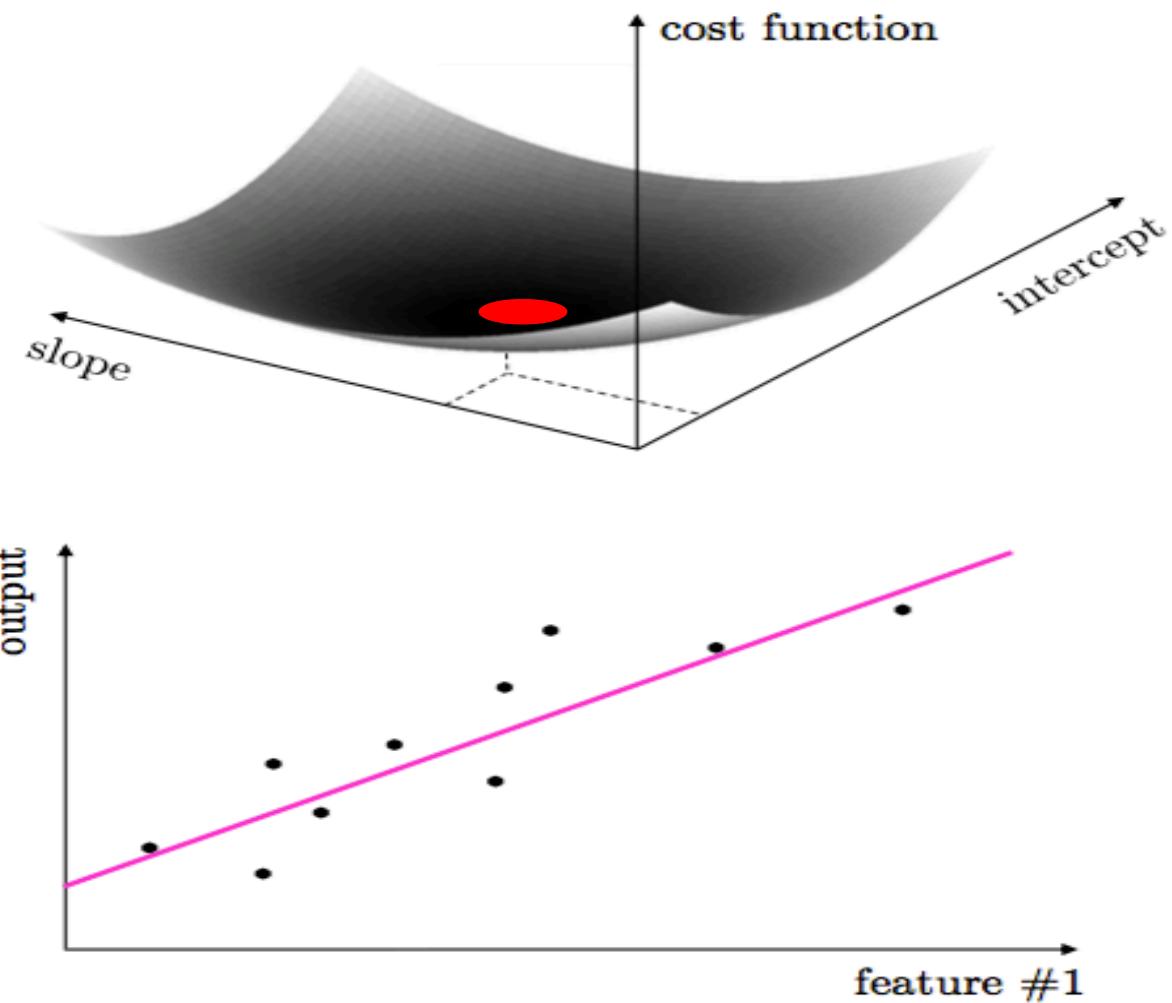
1. Data Security
2. Personal Security
3. Financial Trading
4. Healthcare
5. Marketing Personalization
6. Fraud Detection
7. Recommendations
8. Online Search
9. Natural Language Processing
10. Smart Cars

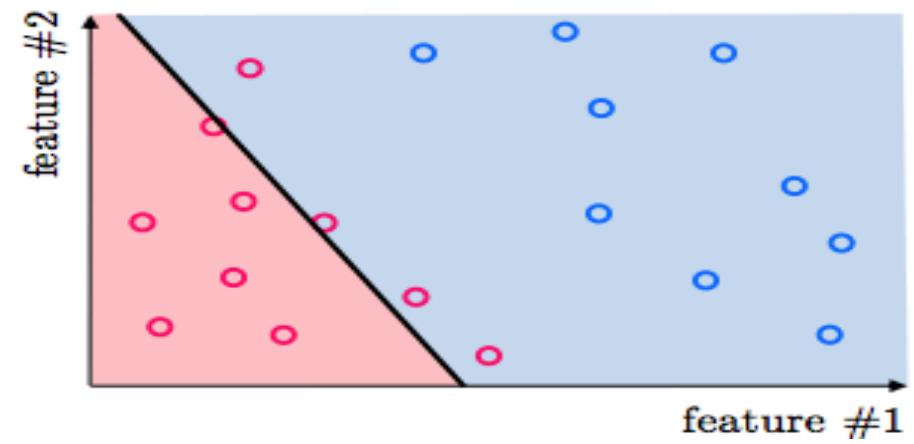
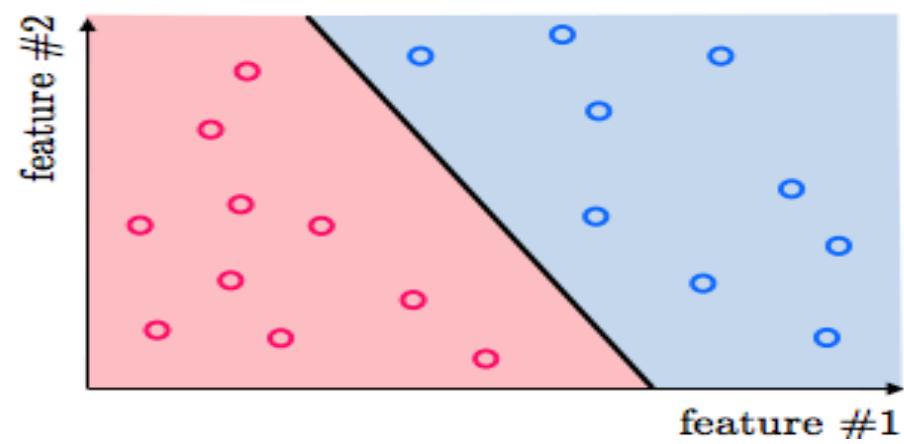
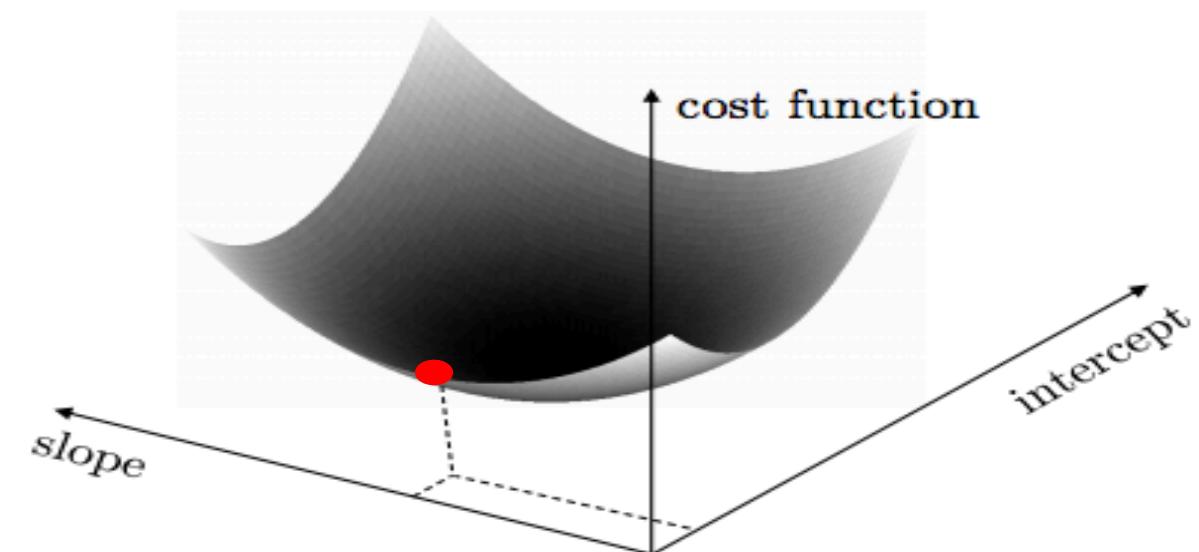
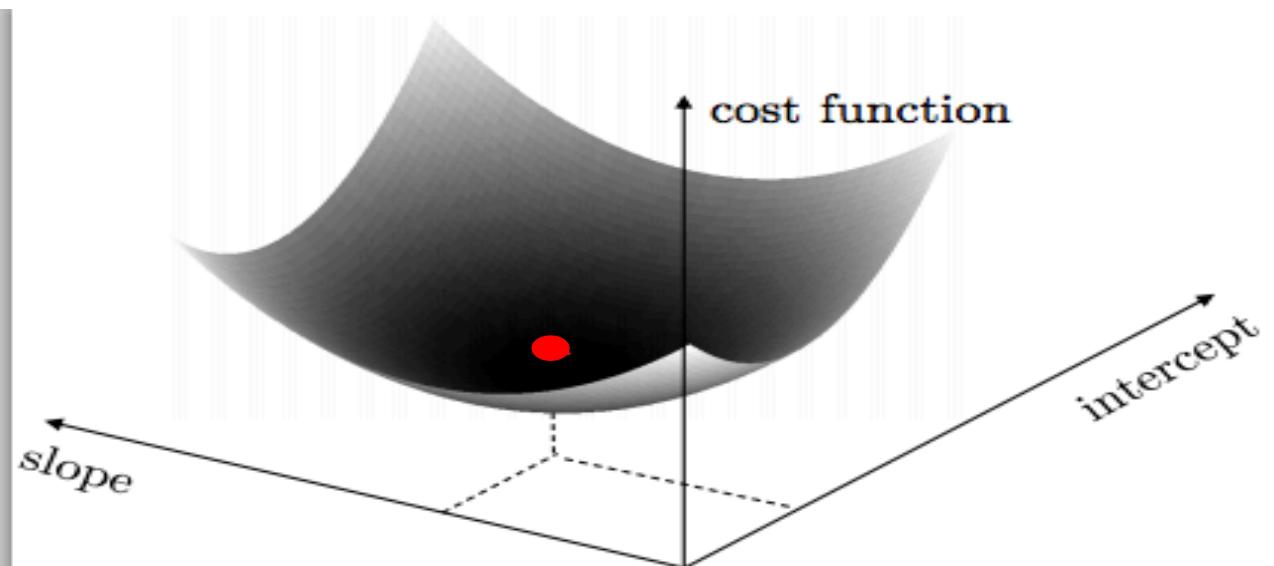
Features: characteristics of a dataset that allow for optimal learning

- crucial to the performance of the basic building blocks
- how well we can design features dependent on our understanding of a phenomenon

Numerical optimization: how we properly determine parameters of a model

- the search for proper parameters is codified in a mathematical *cost function*
- cost function take in model parameters and return score indicating how well we have performed a given task
- the *lower* the score the *better* the choice of parameters





All together

