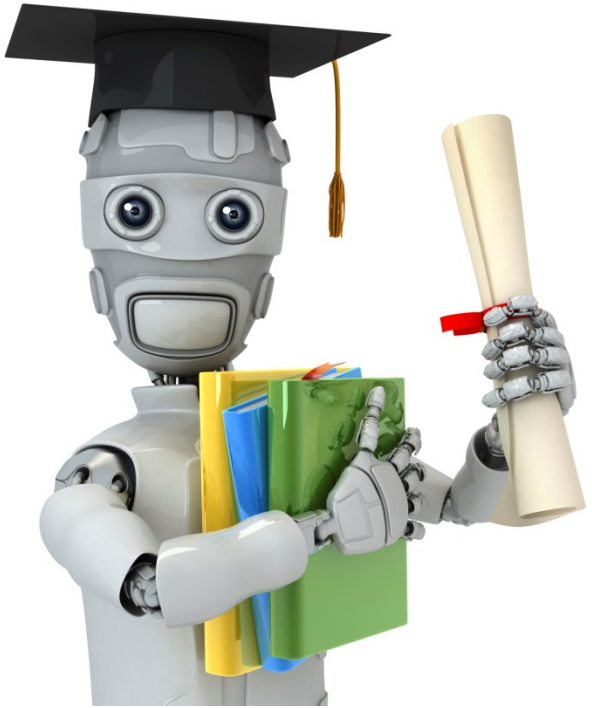


Machine Learning

Application example: Photo OCR

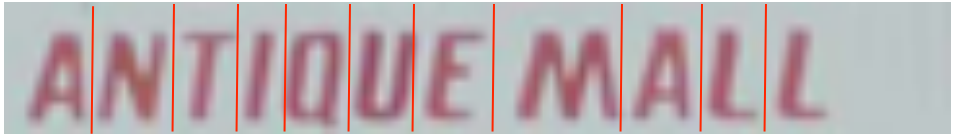
Problem description and pipeline

The Photo OCR problem

Photo OCR pipeline

1. Text detection

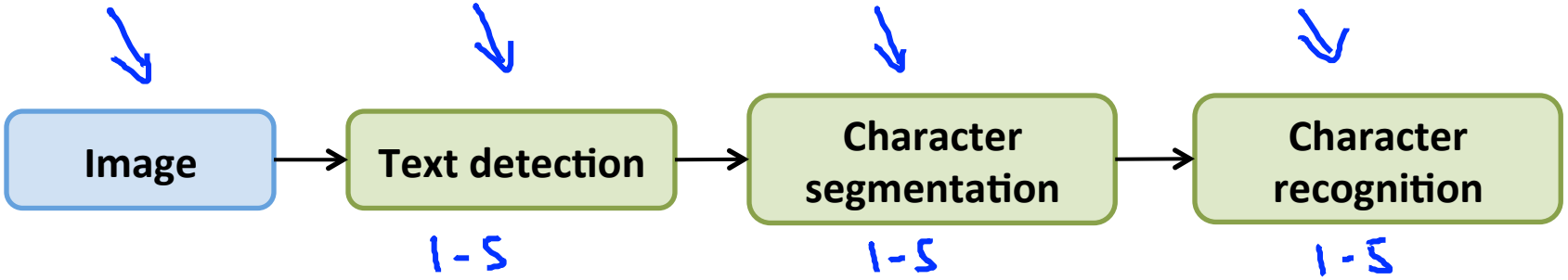
2. Character segmentation

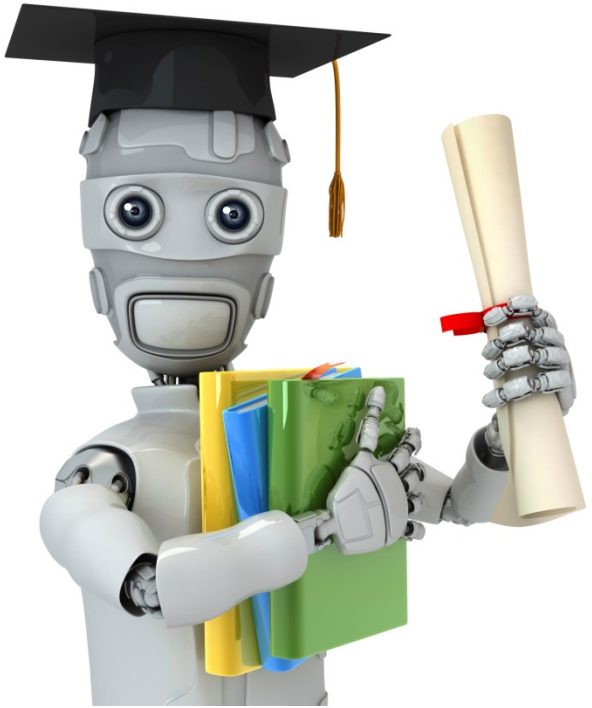


3. Character classification

Cleaning ⇒ Cleaning

Photo OCR pipeline





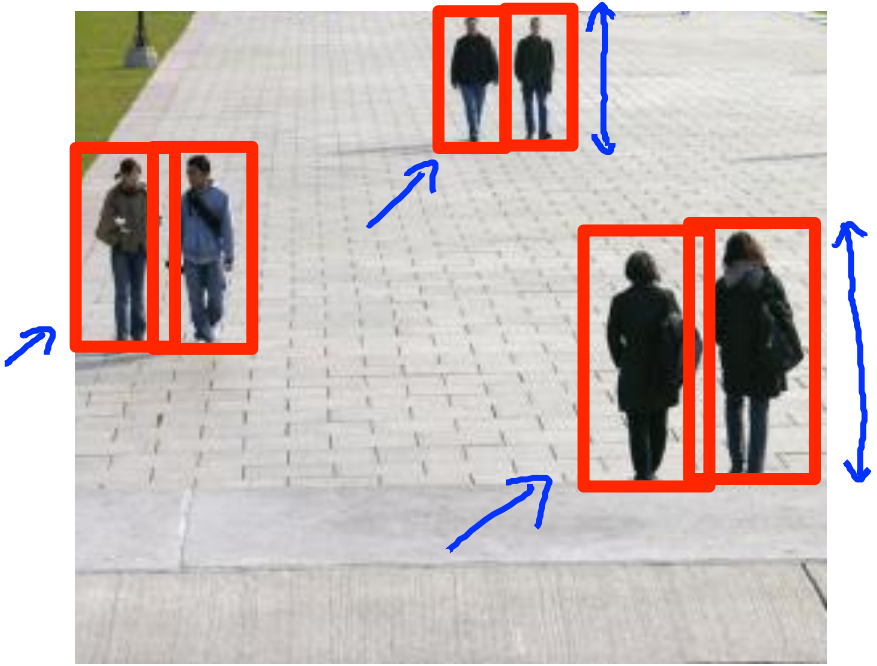
Machine Learning

Application example: Photo OCR

Sliding windows

Text detection

Pedestrian detection



Supervised learning for pedestrian detection

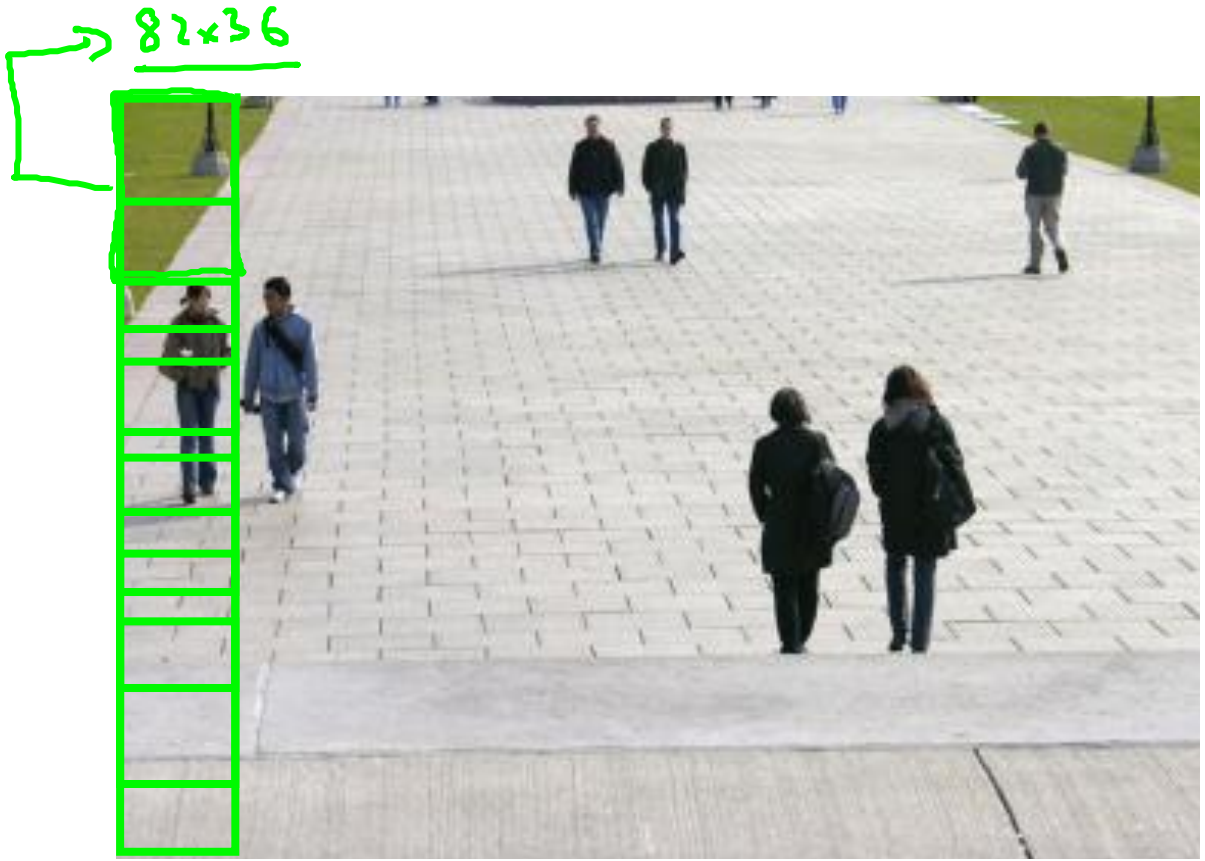
$x =$ pixels in 82x36 image patches

Positive examples $(y = 1)$

Negative examples $(y = 0)$

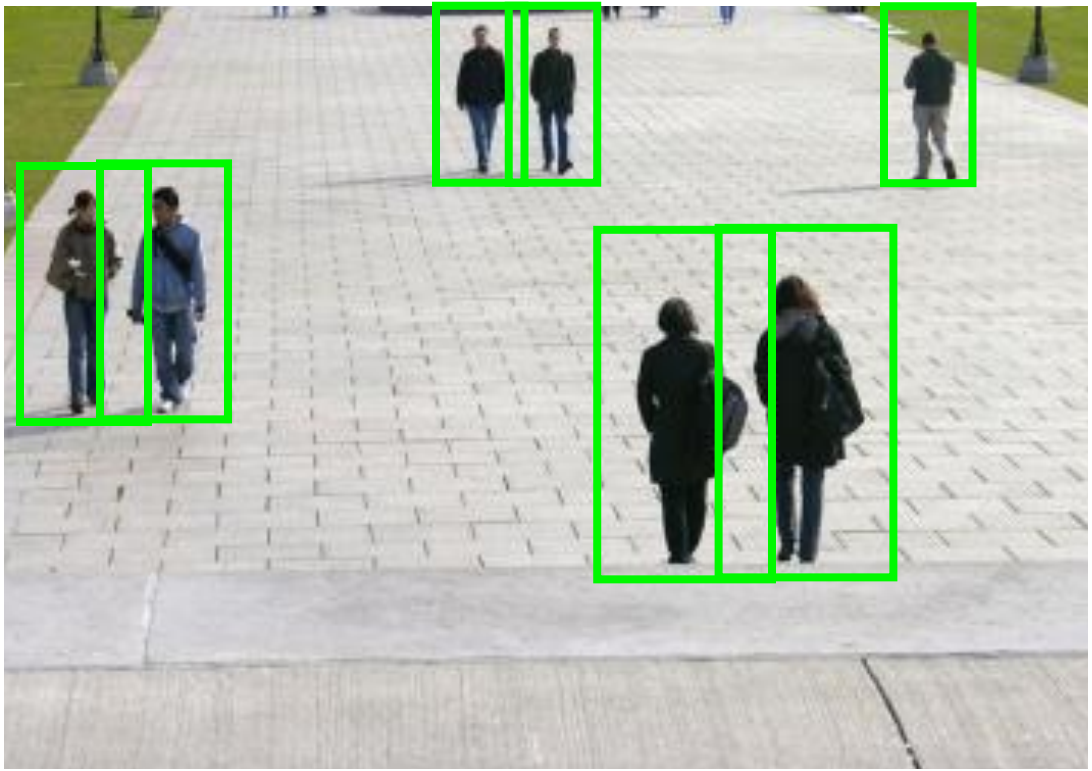
Sliding window detection

Sliding window detection



Sliding window detection

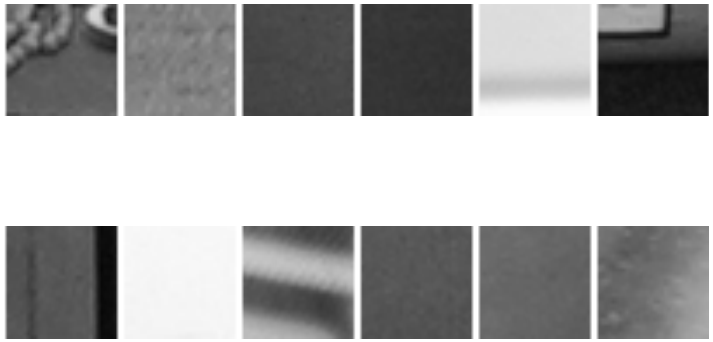
Sliding window detection



Text detection

Text detection

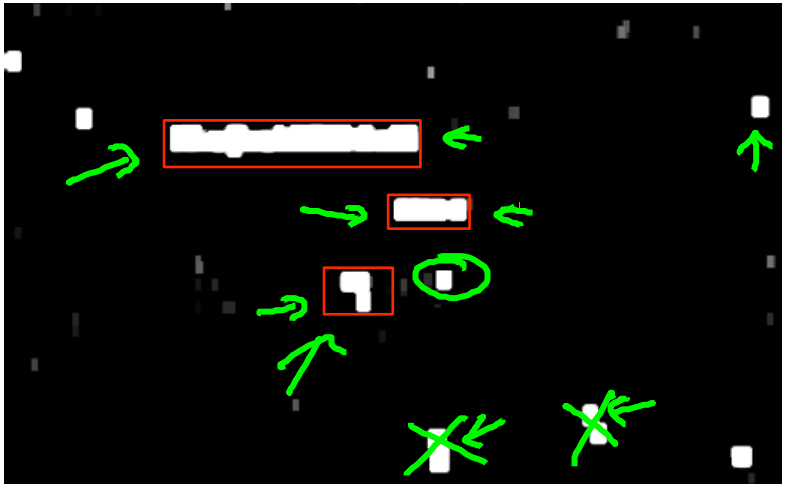
Positive examples $(y = 1)$



Negative examples $(y = 0)$

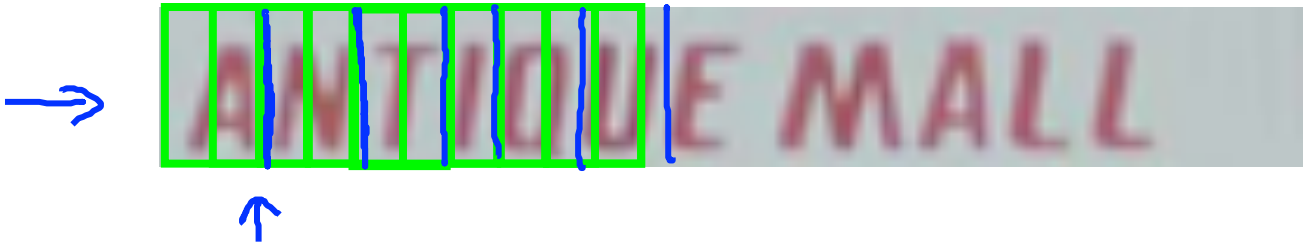
Text detection

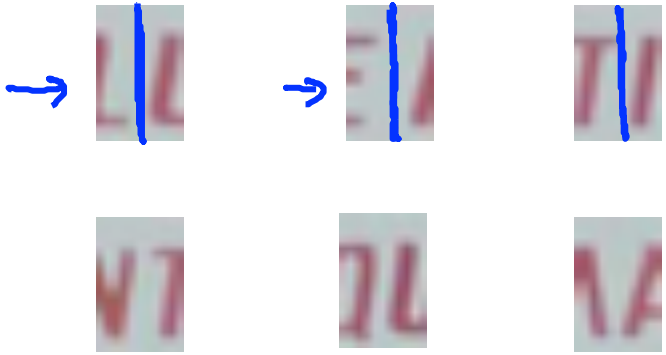
"expansion"



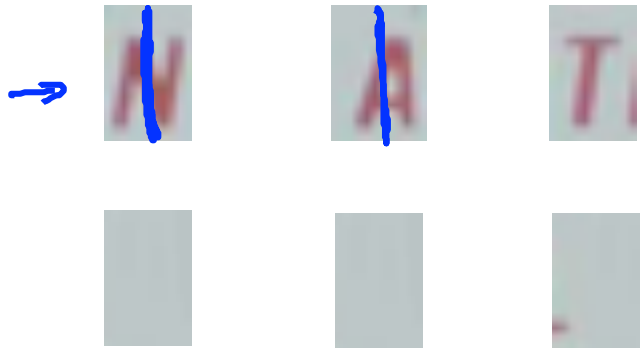
[David Wu]

1D Sliding window for character segmentation





Positive examples $(y = 1)$

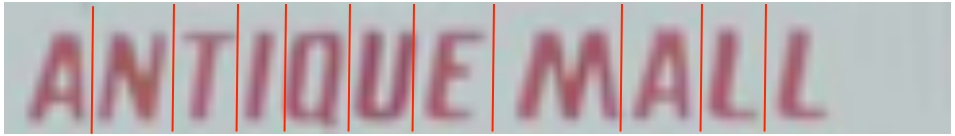


Negative examples $(y = 0)$

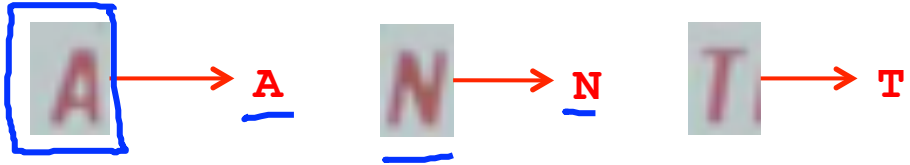
Photo OCR pipeline

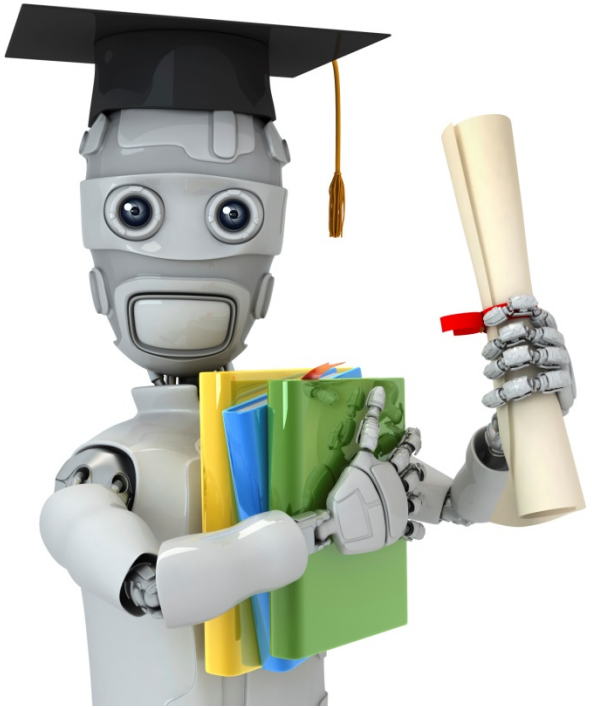
1. Text detection

2. Character segmentation



3. Character classification



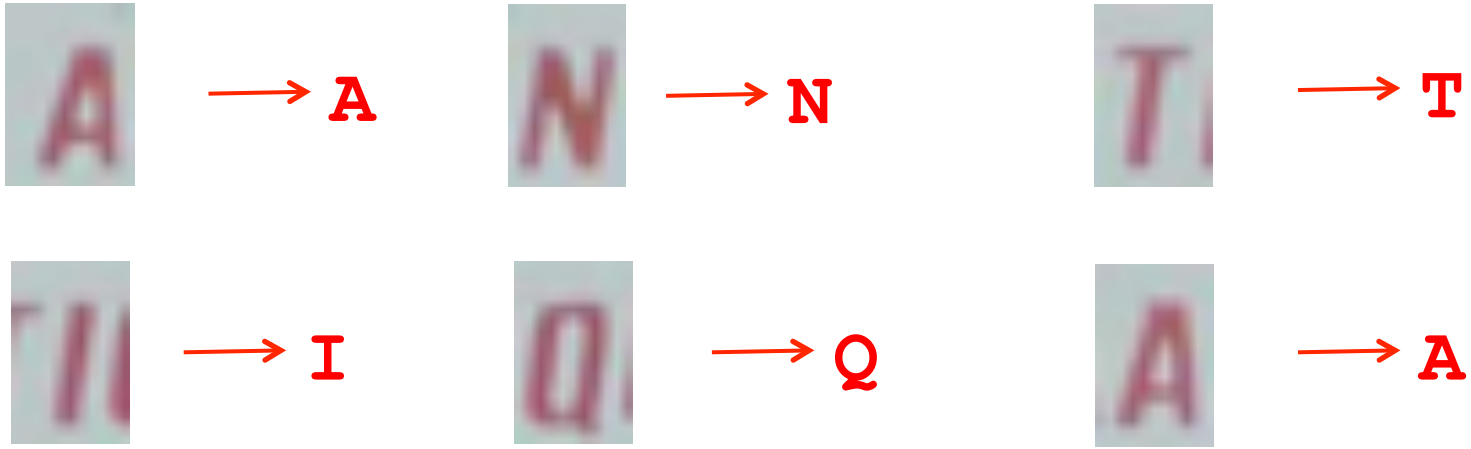


Machine Learning

Application example: Photo OCR

Getting lots of data: Artificial data synthesis

Character recognition



Artificial data synthesis for photo OCR

Real data

Abcdefg

Abcdefg

Abcdefg

Abcdefg

Abcdefg

[Adam Coates and Tao Wang]

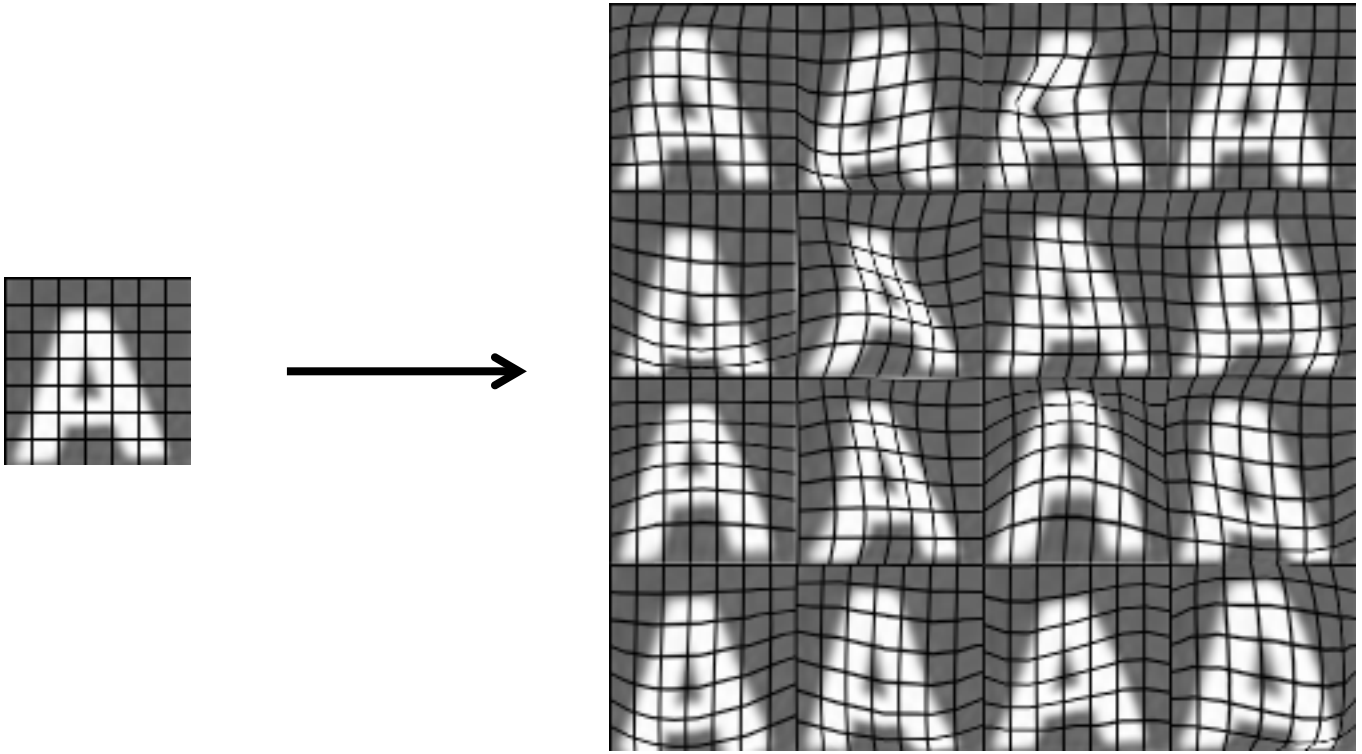
Artificial data synthesis for photo OCR

Real data

Synthetic data

[Adam Coates and Tao Wang]

Synthesizing data by introducing distortions



[Adam Coates and Tao Wang]

Synthesizing data by introducing distortions: Speech recognition

Original audio:

Audio on bad cellphone connection

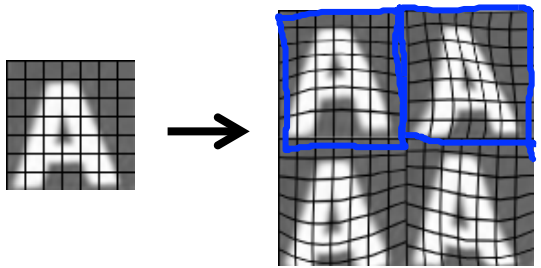
Noisy background: Crowd

Noisy background: Machinery

[www.pdsounds.org]

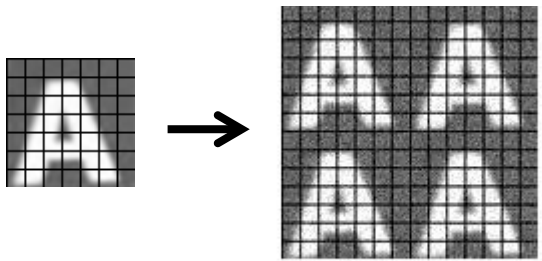
Synthesizing data by introducing distortions

- Distortion introduced should be representation of the type of noise/distortions in the test set.



- Audio:
  Background noise,
  bad cellphone connection

- Usually does not help to add purely random/meaningless noise to your data.

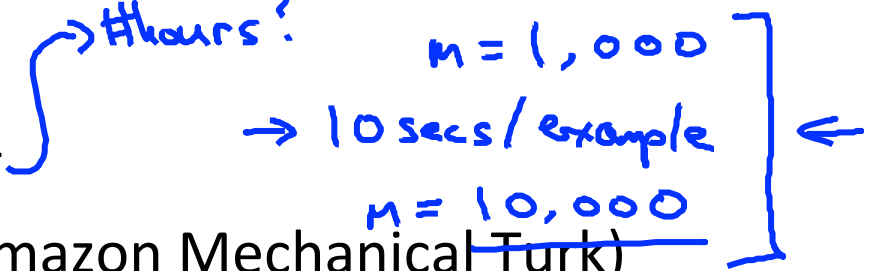


- x_i = intensity (brightness) of pixel i
- $x_i \leftarrow x_i +$ random noise

[Adam Coates and Tao Wang]

Discussion on getting more data

1. Make sure you have a low bias classifier before expending the effort. (Plot learning curves). E.g. keep increasing the number of features/number of hidden units in neural network until you have a low bias classifier.
2. "How much work would it be to get 10x as much data as we currently have?"
   - Artificial data synthesis
   - Collect/label it yourself
   - "Crowd source" (E.g. Amazon Mechanical Turk)



Discussion on getting more data

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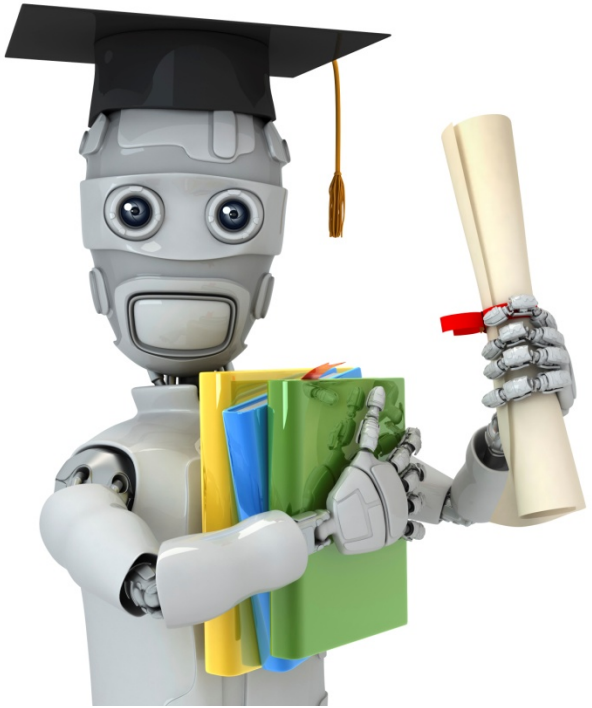
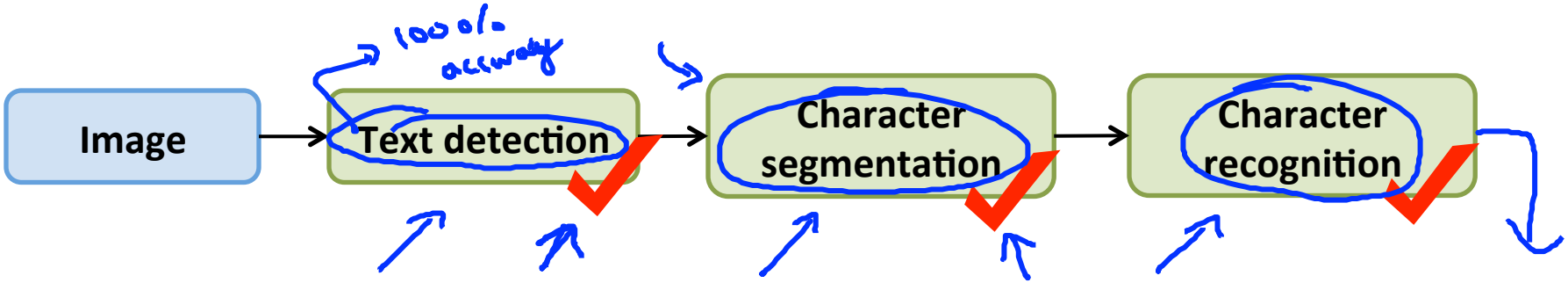


Machine Learning

Application example: Photo OCR

Ceiling analysis: What part of the pipeline to work on next

Estimating the errors due to each component (ceiling analysis)

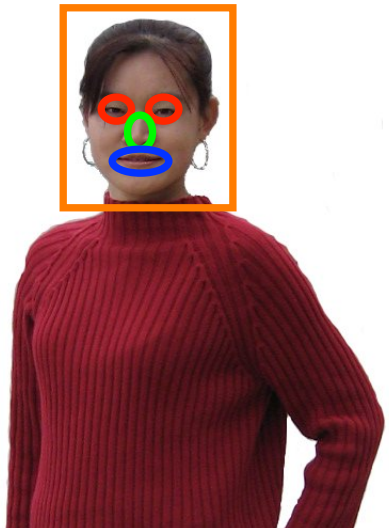


What part of the pipeline should you spend the most time trying to improve?

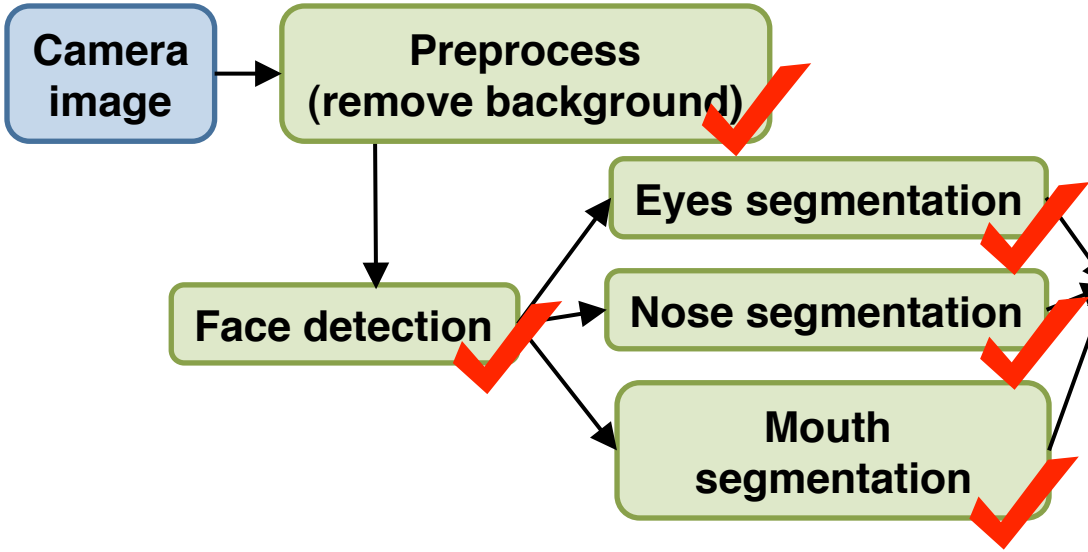
Component	Accuracy
Overall system	72%
Text detection	89%
Character segmentation	90%
Character recognition	100%

Another ceiling analysis example

Face recognition from images
(Artificial example)



Another ceiling analysis example



Component	Accuracy
Overall system	85%
Preprocess (remove background)	85.1%
Face detection	91%
Eyes segmentation	95%
Nose segmentation	96%
Mouth segmentation	97%
Logistic regression	100%

0.1%
5.9%
4%
1%
1%
3%