



Machine Learning

# Application example: Photo OCR

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## Problem description and pipeline

# The Photo OCR problem

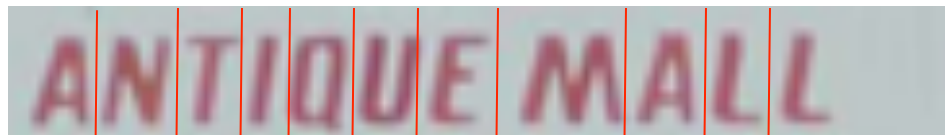


# Photo OCR pipeline

→ 1. Text detection



→ 2. Character segmentation

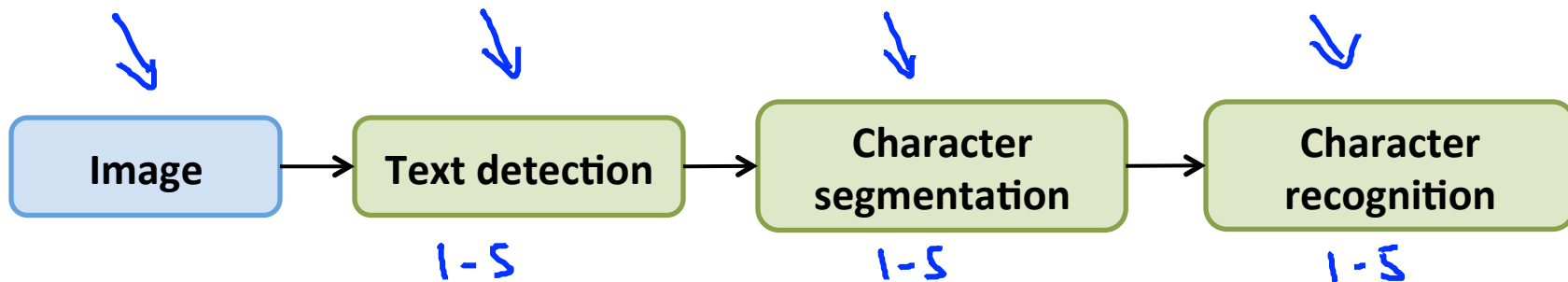


→ 3. Character classification



~~Cleaning~~ → ~~Cleaning~~

# Photo OCR pipeline





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Application example:  
Photo OCR

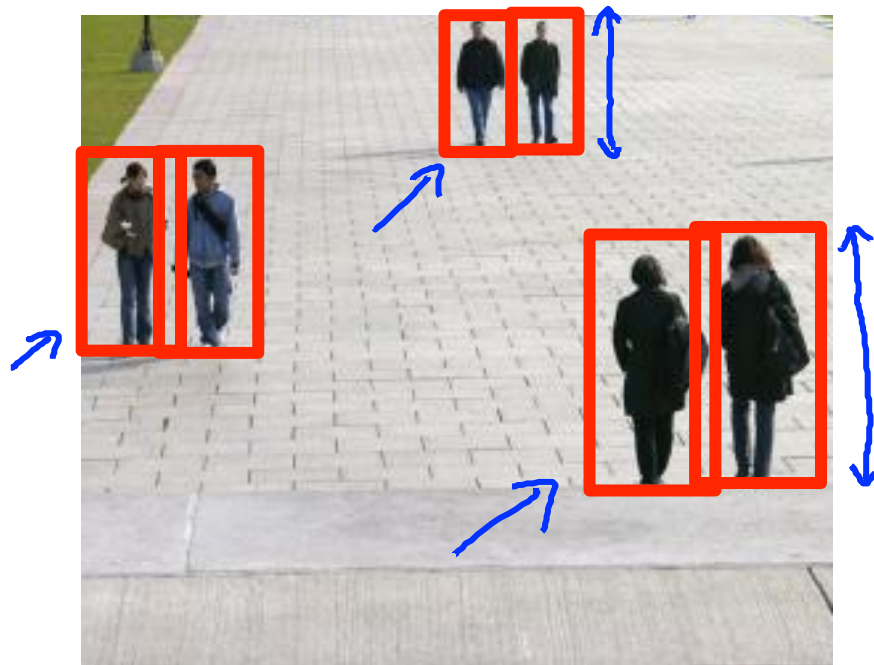
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Sliding windows

## Text detection



## Pedestrian detection



# Supervised learning for pedestrian detection

$x$  = pixels in 82x36 image patches

1,000  
10,000  
...



Positive examples ( $y = 1$ )



Negative examples ( $y = 0$ )



# Sliding window detection

step-size / stride





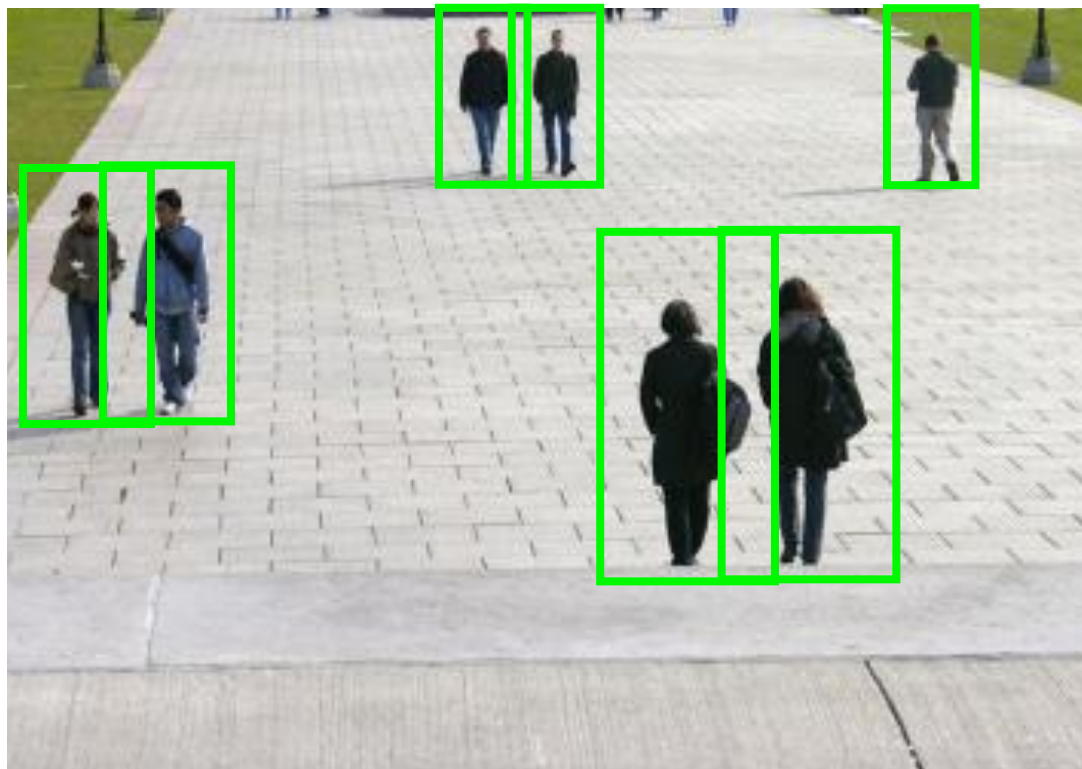
# Sliding window detection



# Sliding window detection



# Sliding window detection



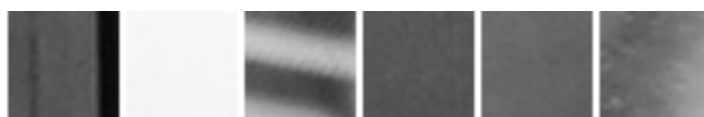
# Text detection



# Text detection



Positive examples ( $y = 1$ )

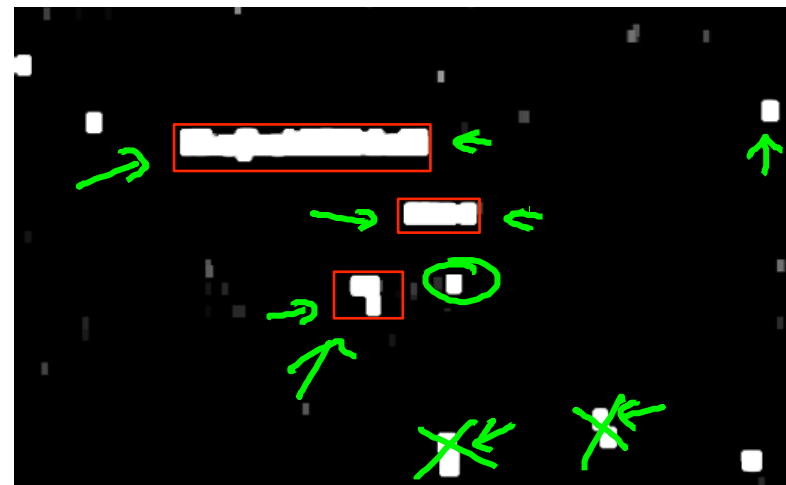
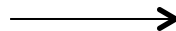


Negative examples ( $y = 0$ )

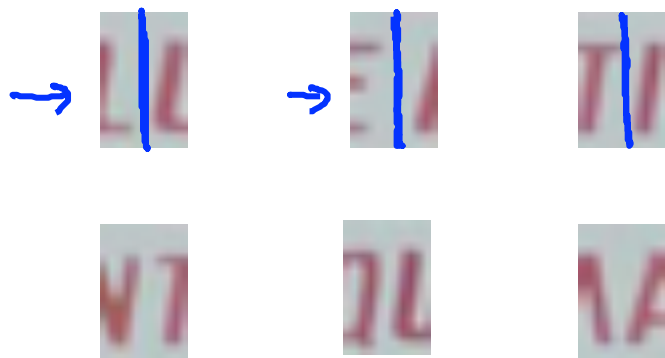
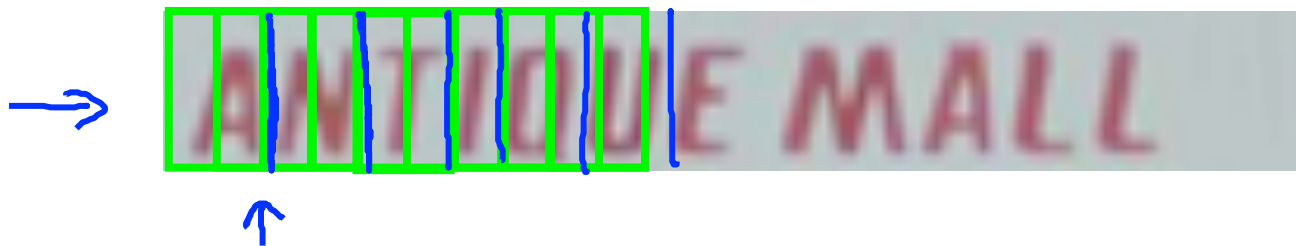
# Text detection



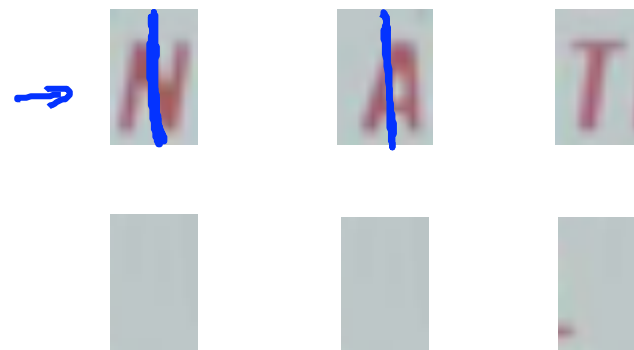
"expansion"



# 1D Sliding window for character segmentation



Positive examples ( $y = 1$ )



Negative examples ( $y = 0$ )

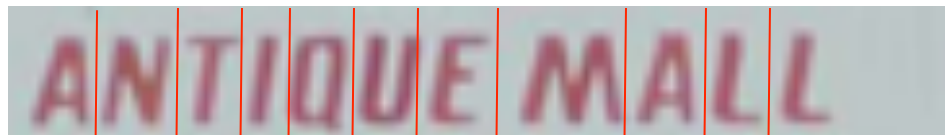


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→ 2. Character segmentation



→ 3. Character classification





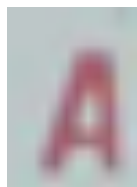
Machine Learning

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## Getting lots of data: Artificial data synthesis

# Character recognition



→ **A**



→ **N**



→ **T**



→ **I**

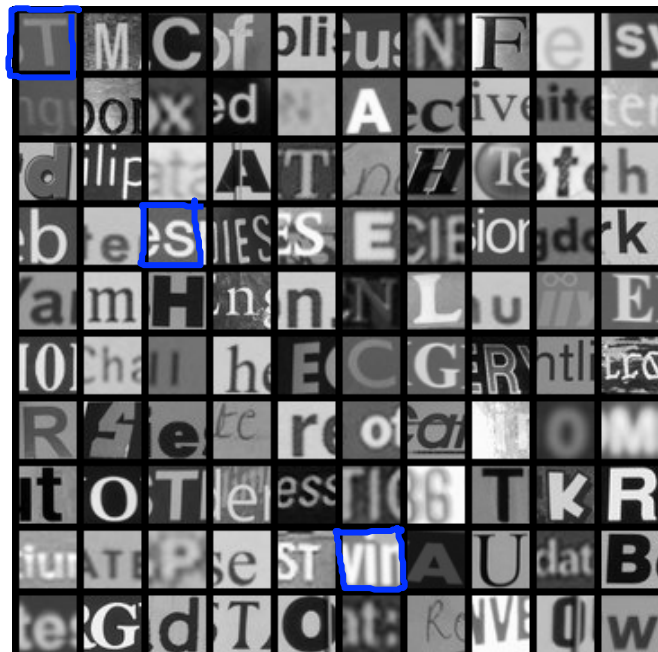


→ **Q**



→ **A**

## Artificial data synthesis for photo OCR



Real data

Abcdefg  
Abcdefg  
Abcdefg  
Abcdefg  
Abcdefg  
Abcdefg

# Artificial data synthesis for photo OCR

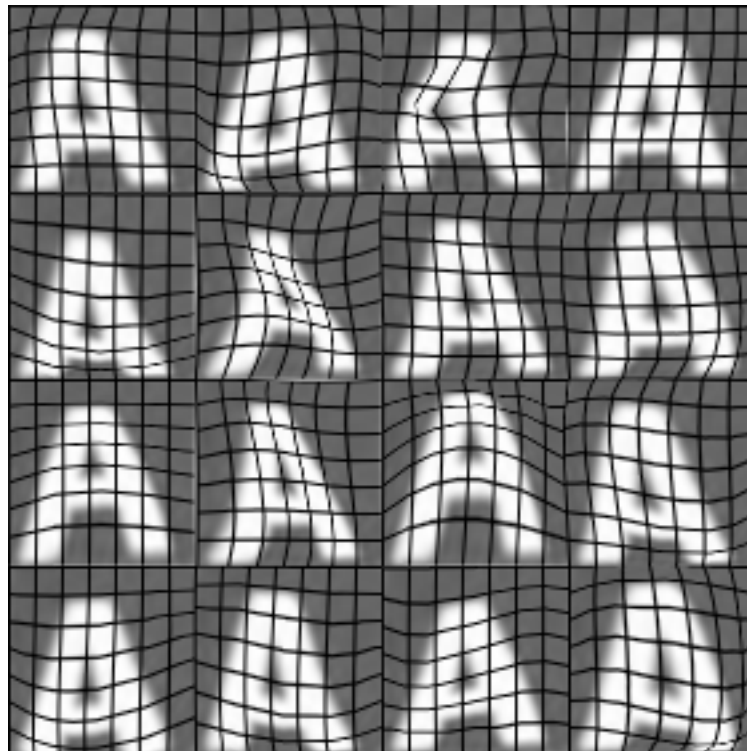
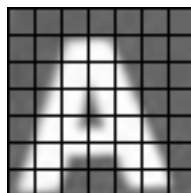


Real data



Synthetic data

# Synthesizing data by introducing distortions



# Synthesizing data by introducing distortions: Speech recognition



Original audio: 



Audio on bad cellphone connection



Noisy background: Crowd

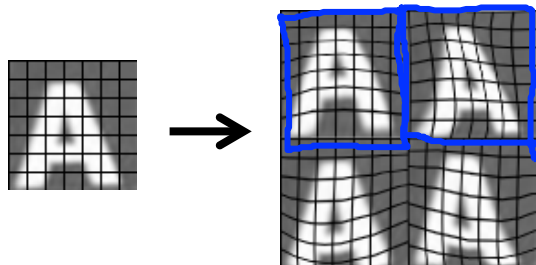


Noisy background: Machinery



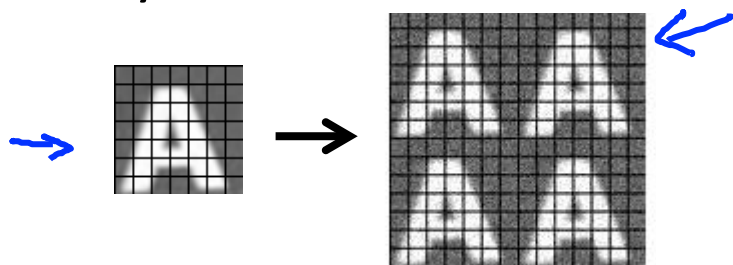
# Synthesizing data by introducing distortions

- 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  $i$
- $x_i \leftarrow x_i + \text{random noise}$

## 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)

→ #hours?  $n = 1,000$   
→ 10 secs/example  $n = 10,000$  ←

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  - Artificial data synthesis
  - Collect/label it yourself
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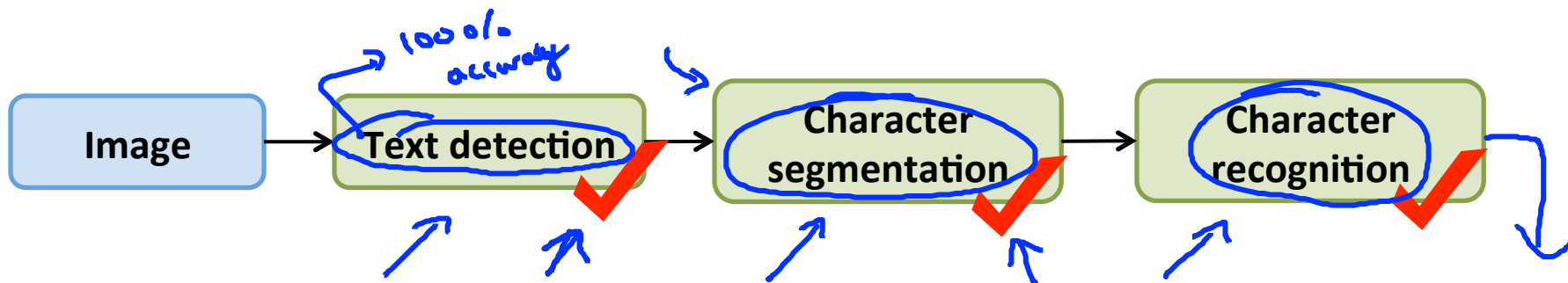
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Ceiling analysis: What  
part of the pipeline to  
work on next

## Estimating the errors due to each component (ceiling analysis)

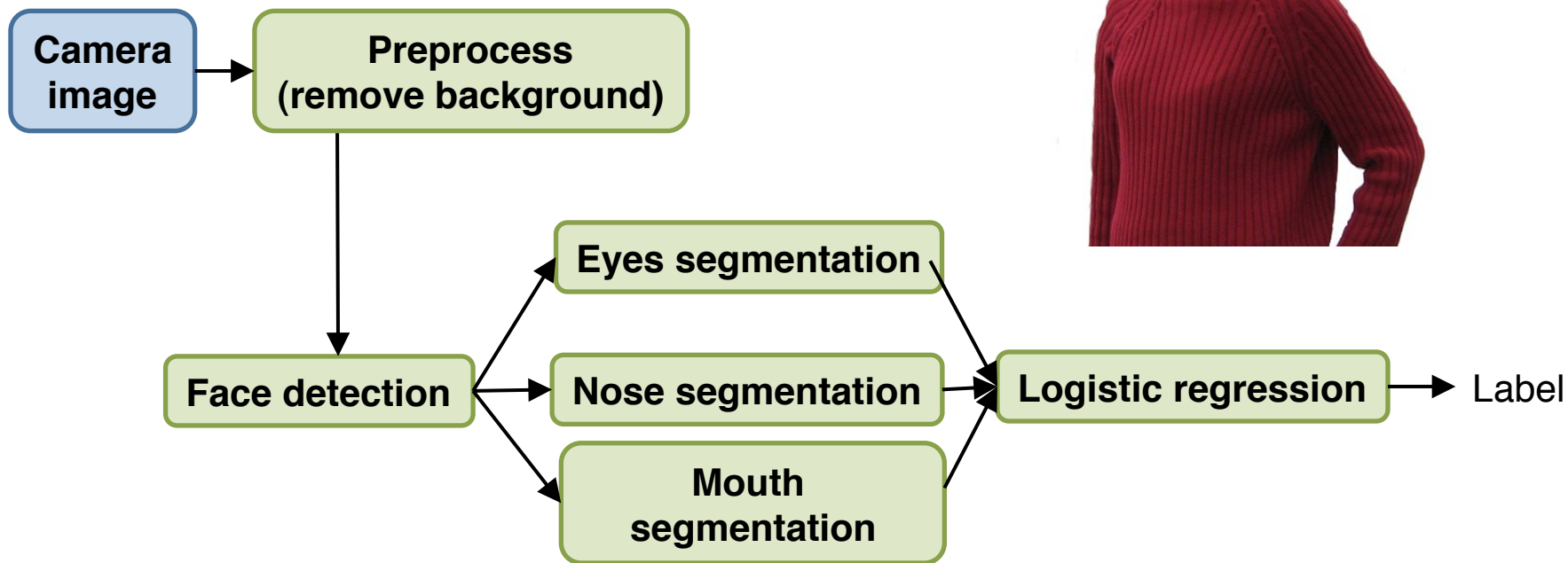


What part of the pipeline should you spend the most time trying to improve?

Component	Accuracy
Overall system	72%
→ Text detection	89%
Character segmentation	<u>90%</u>
Character recognition	100%

## Another ceiling analysis example

Face recognition from images  
(Artificial example)



## Another ceiling analysis example

