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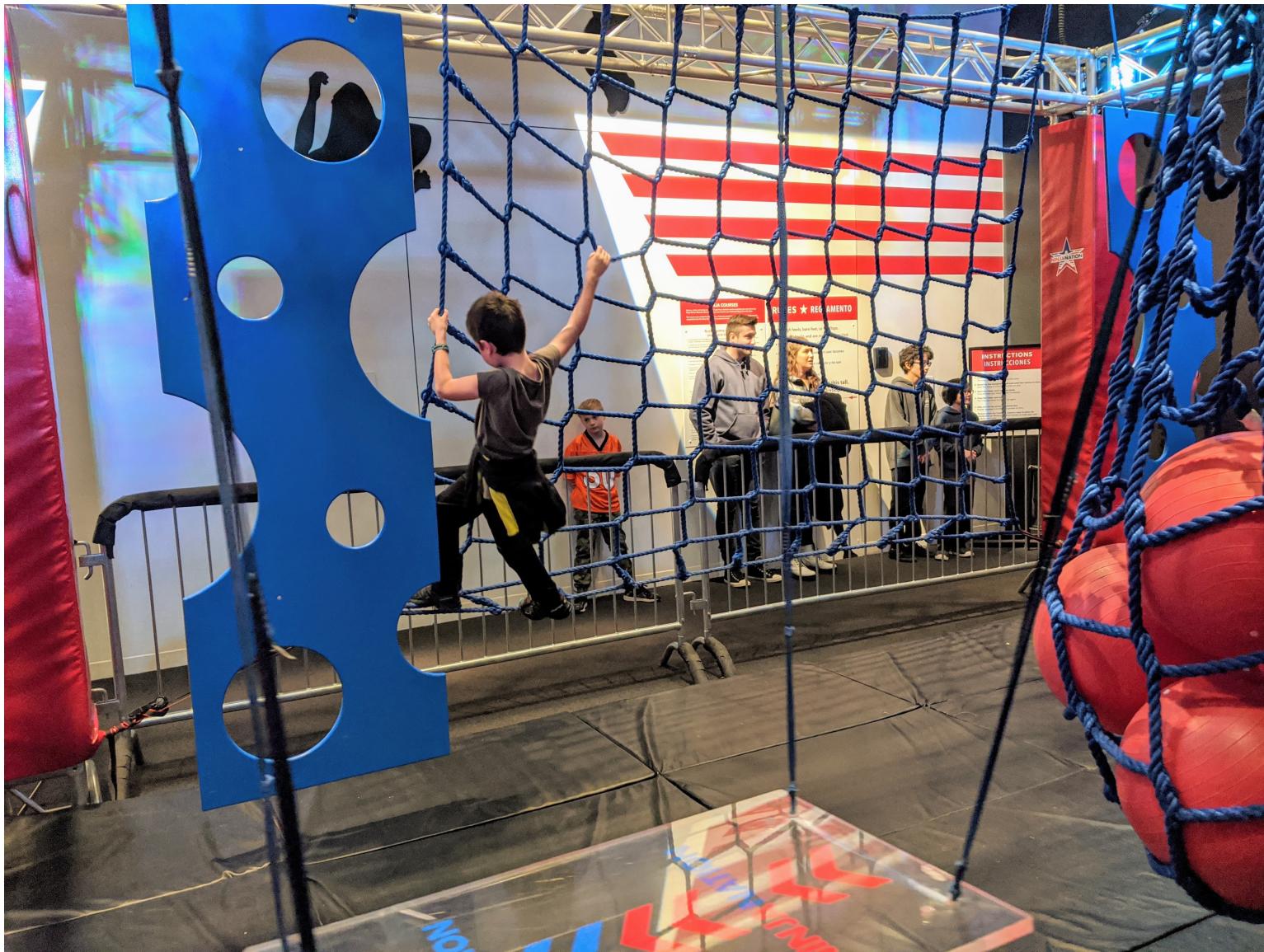
Deep Learning Applications for Computer Vision

Lecture 10: From Object Recognition to Image
Classification in Classic Computer Vision



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What is Object Recognition?



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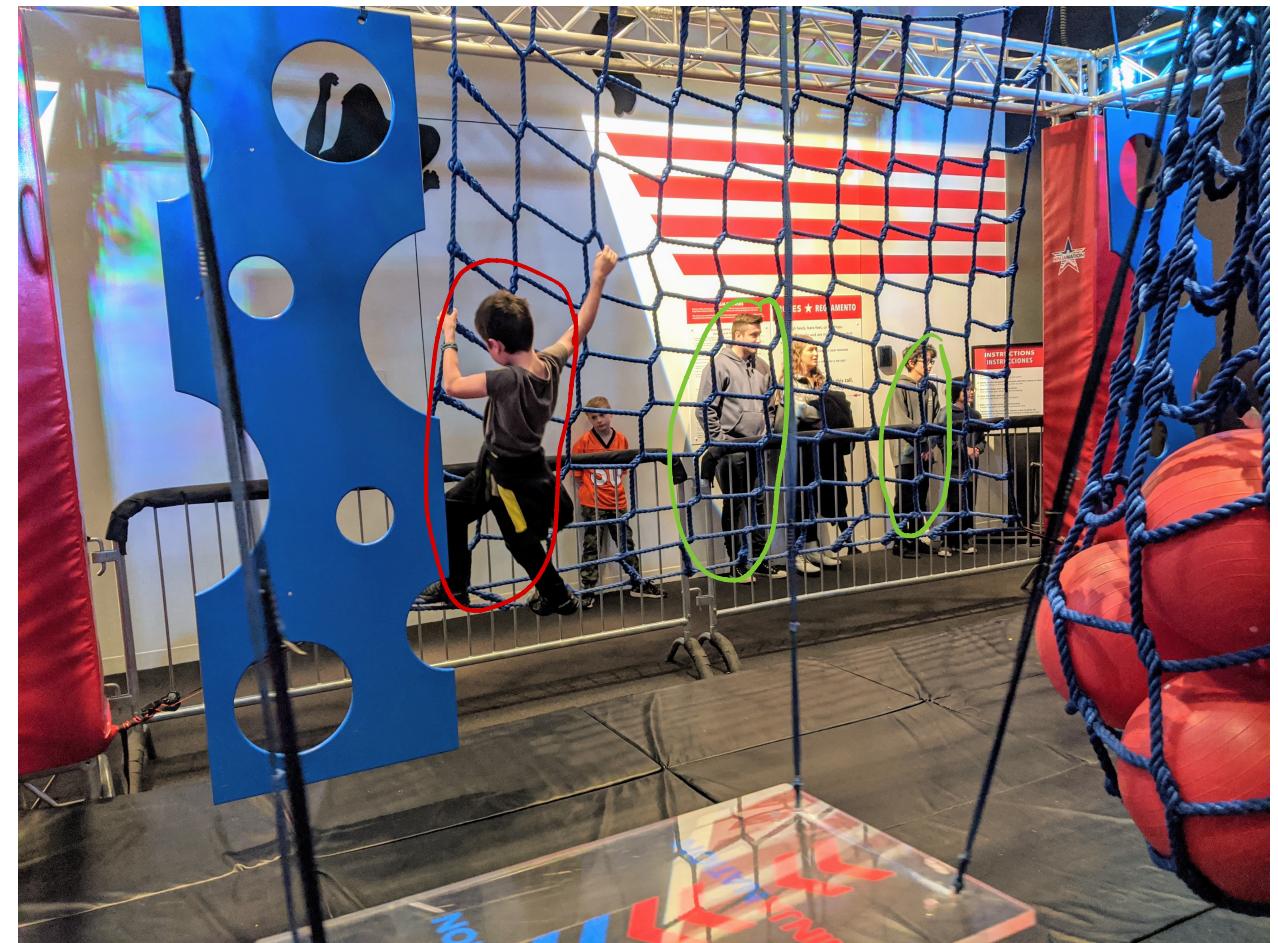
Outputs

Yes/No Questions:

car?

person?

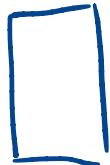
bicycle?



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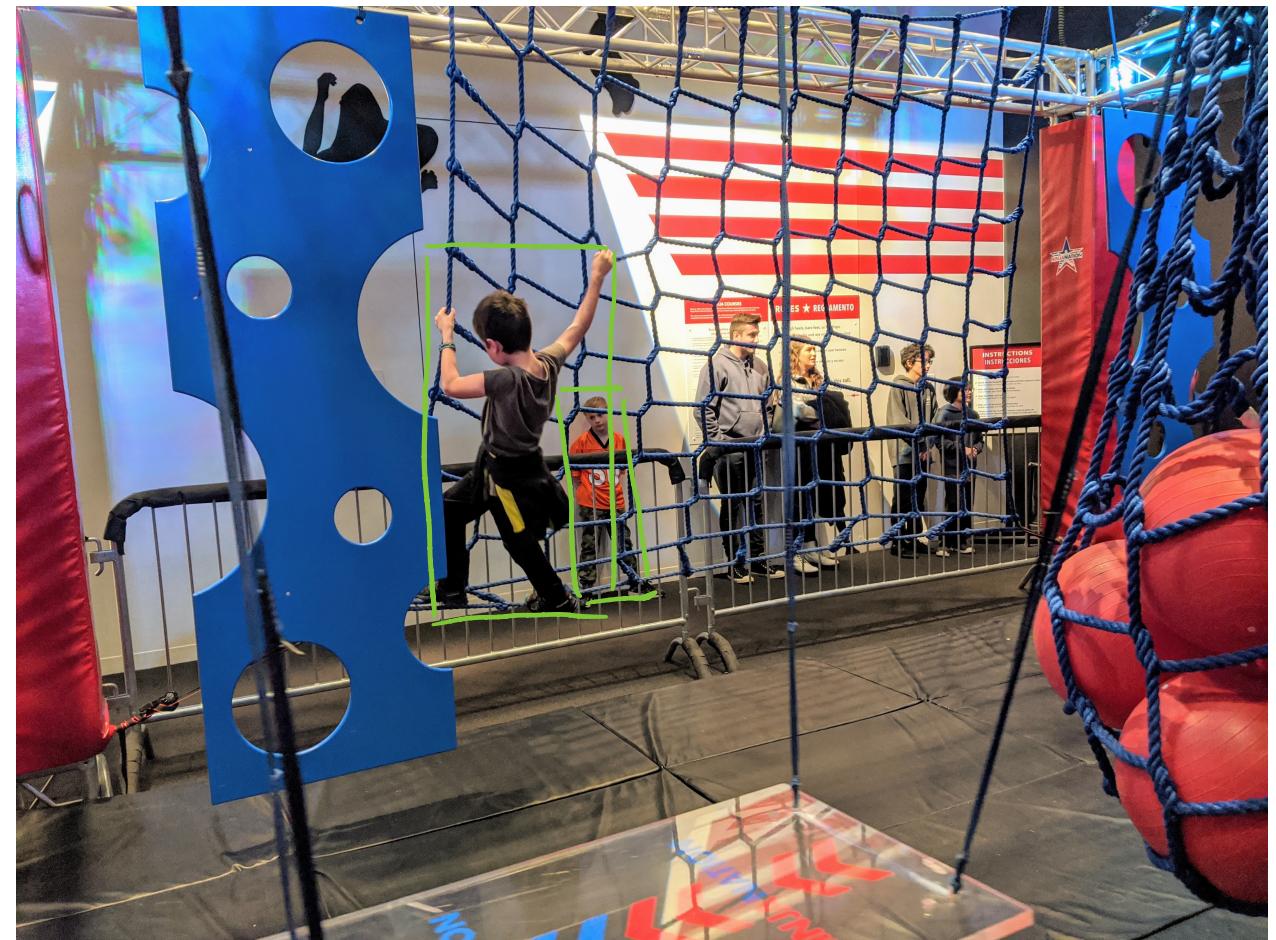
Outputs

Detection



Scene

indoor
outdoor

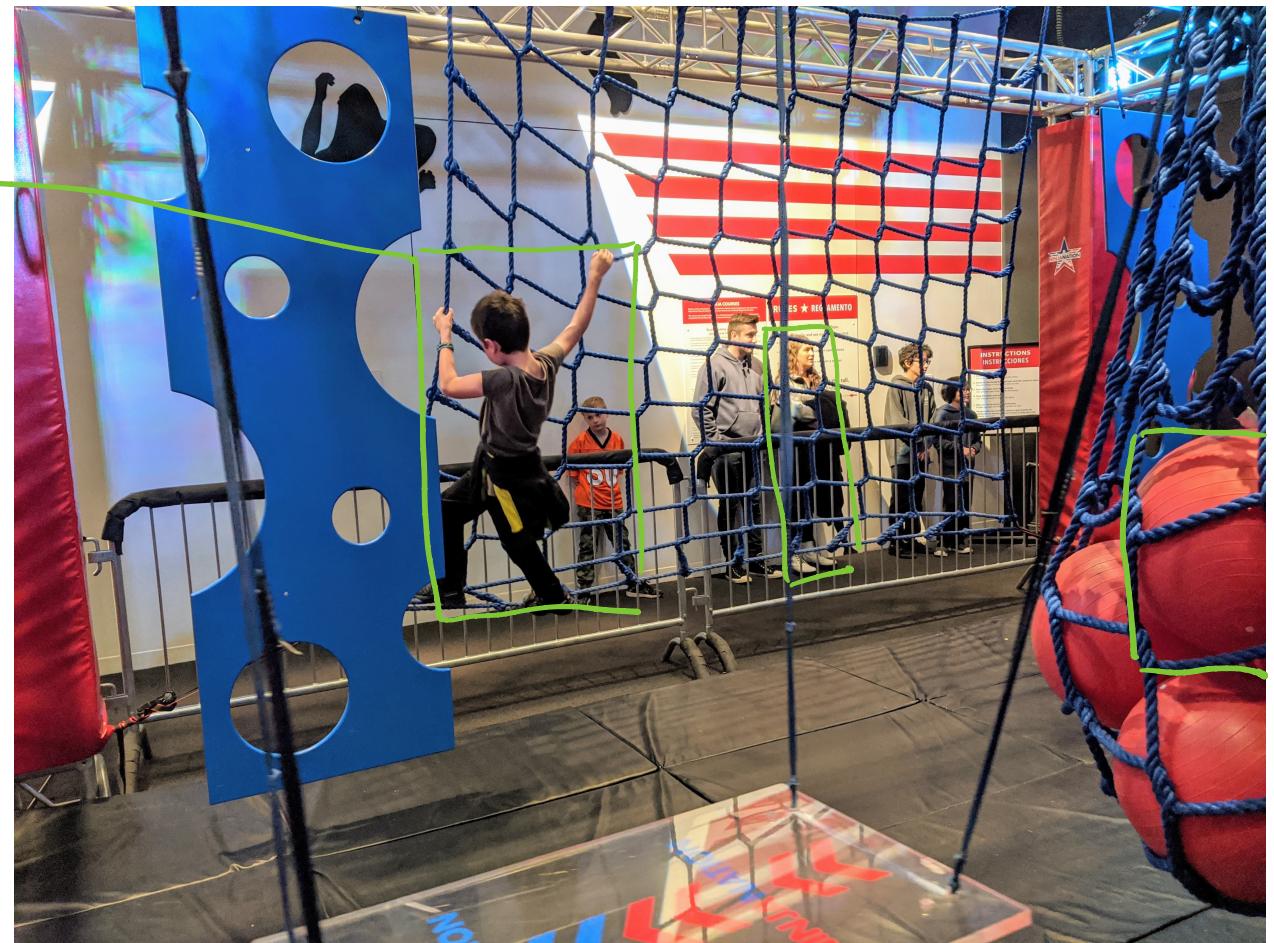


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Outputs

Object Attributes:

- . person, back view
- . person, side view
- . ball, red, rubber

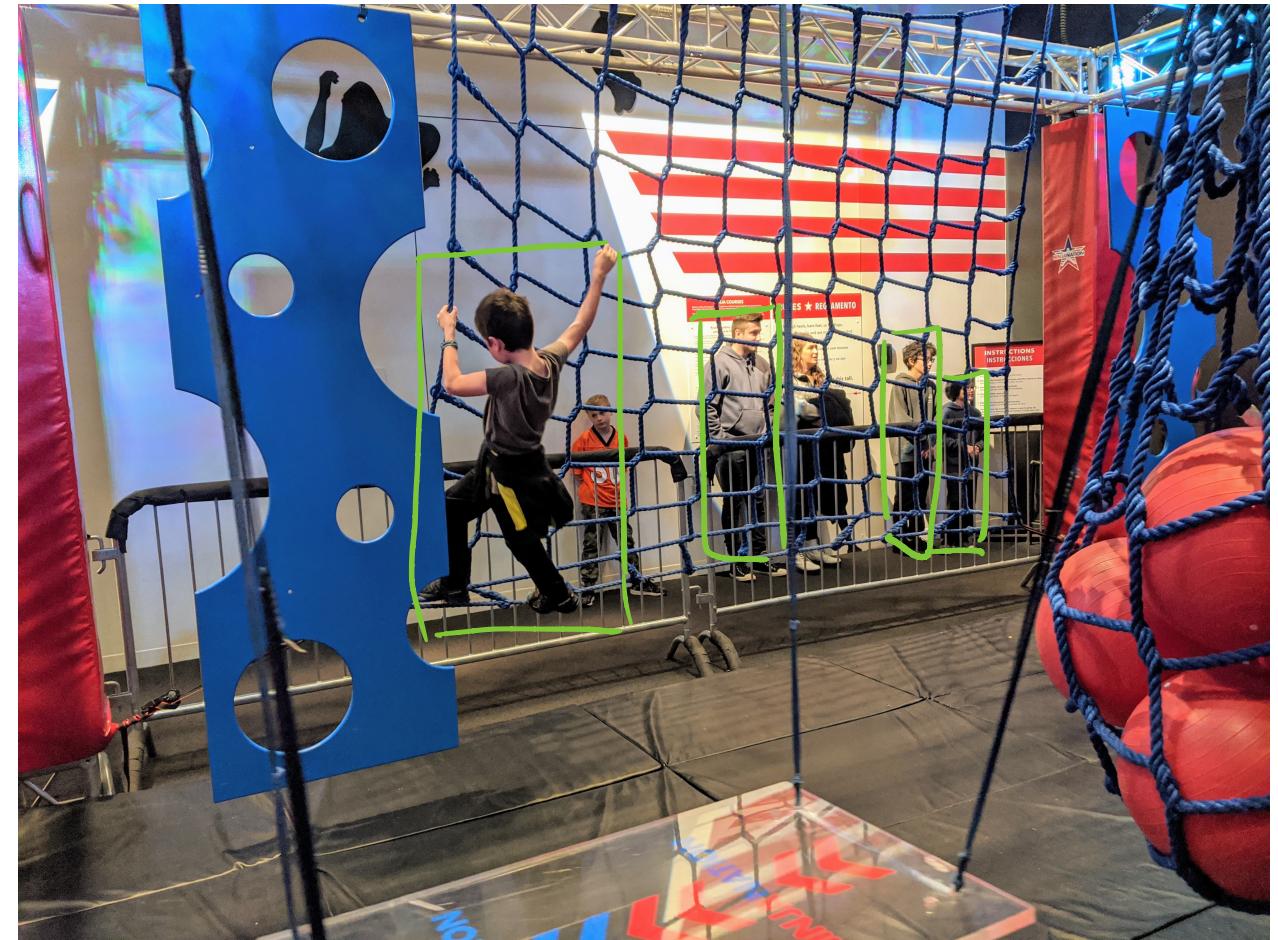


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Outputs

Activities:

- standing
- running
- walking
- climbing
- playing soccer



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Challenges

1. Variations in camera viewpoint



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Challenges

2. Variations in illumination



↗ shaded areas
- light source



shadows



shadows



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Challenges

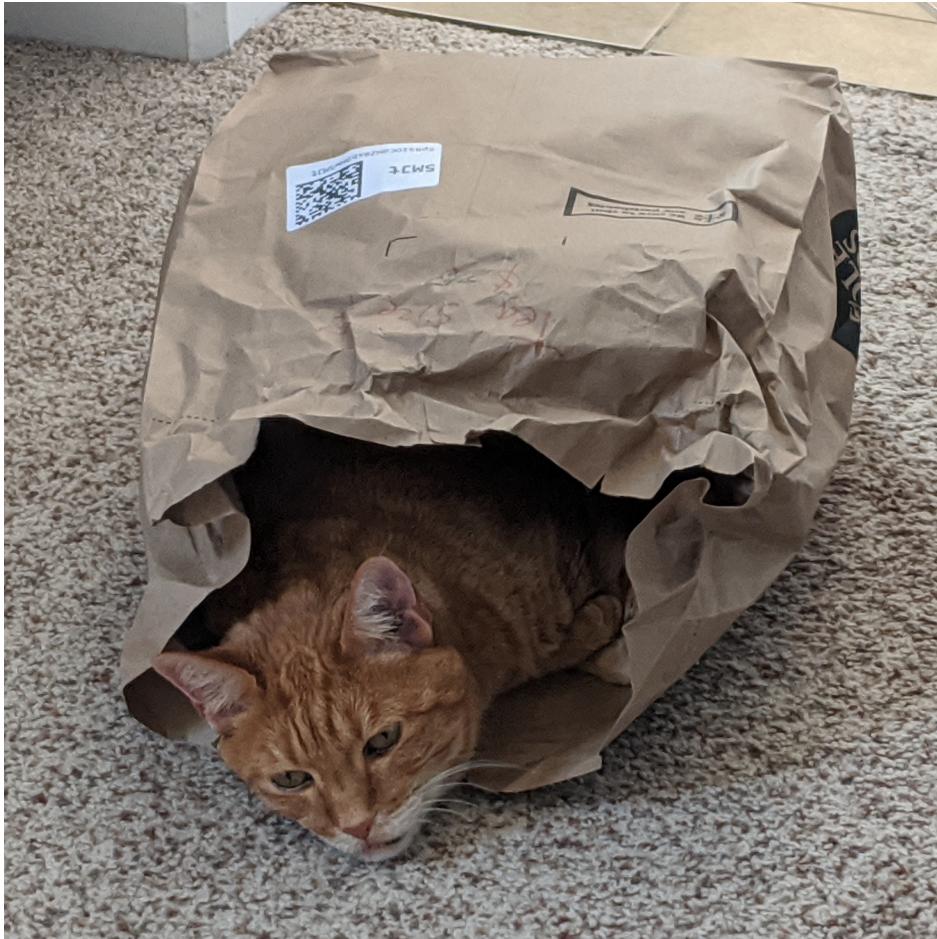
3. Variations in scale



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Challenges

4. Occlusions



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Challenges

Rigid objects: car, building

5. Deformations



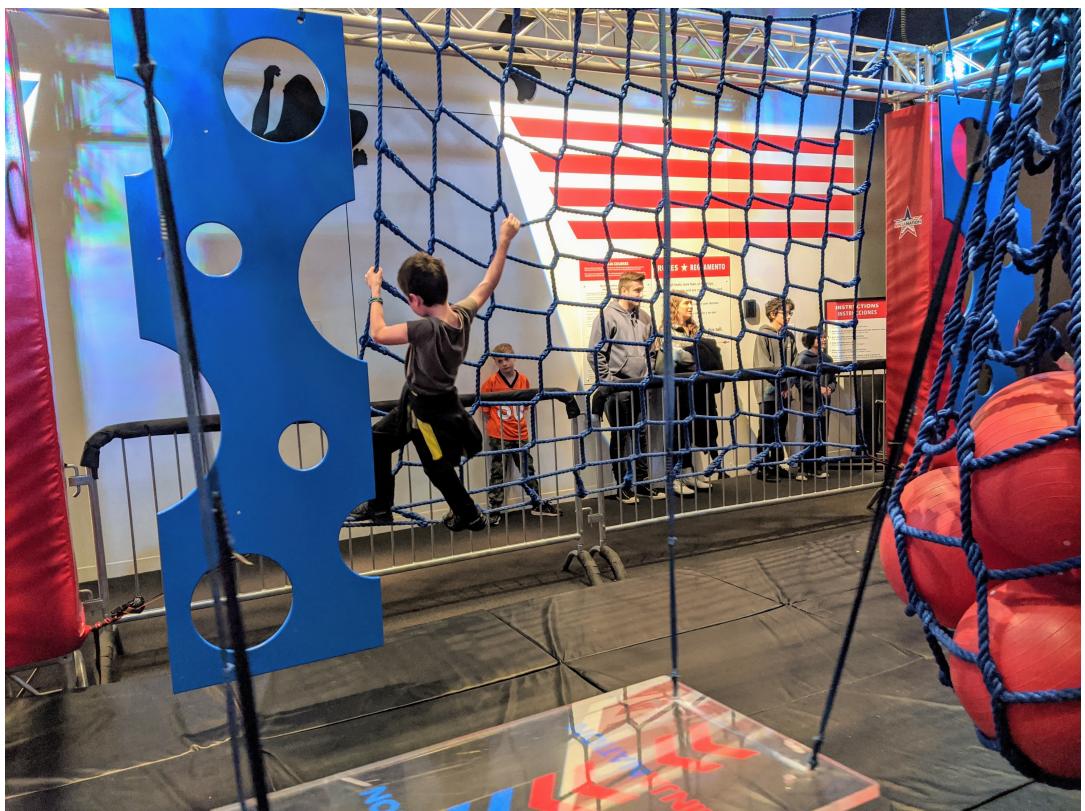
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Challenges

6. Background clutter



cat, doll, books, bed



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Challenges

7. Scope

- How many object categories? 100? 1000? 10 000?
- ImageNet: 3.2 M images, 5000 concepts
- Billions of images
- Smartphones → 1.5 B sales of new smartphones
2021
- Human recognizable object categories

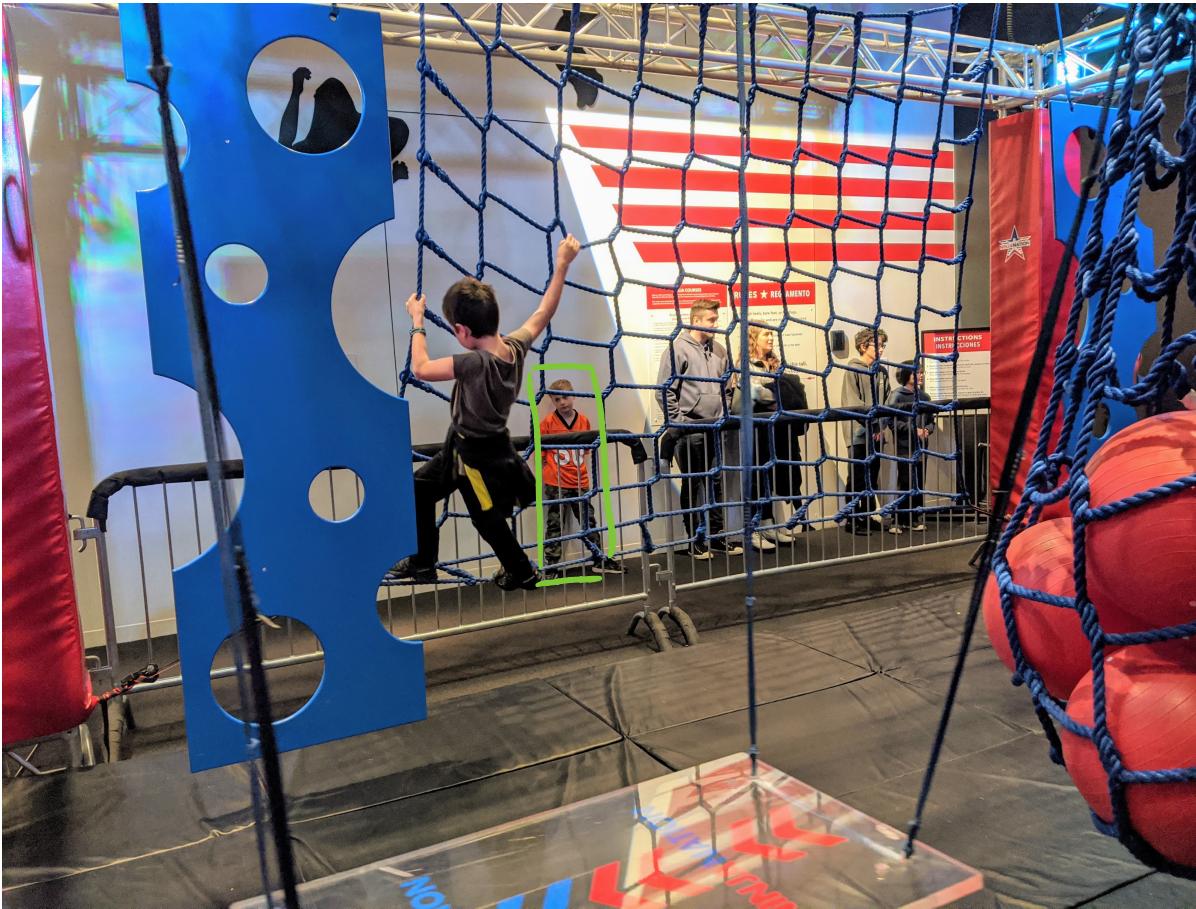


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Challenges

?

8. Describing Context



Annotate :
...
...



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Two Separate Areas

1. Detecting *specific objects*: the Eiffel Tower, my neighbor Joe, a box of Cheerios, a bar of Milka, ...
 - matching
 - geometric relationship - verification
2. Generic object category recognition and detection
 - car
 - . statistical models
 - . learned
 - building
 - bicycle



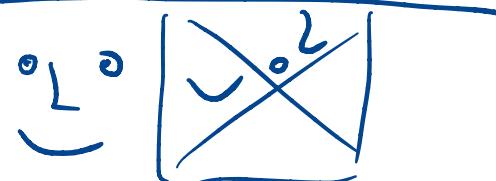
Detecting Specific Objects

Strategy:

1. Extract features from images
 - corners, + neighborhood
 - SIFT, SURF, GPU SURF, HOG features
2. Match feature vectors
 - find correspondences
 - similarity search
3. Check for the geometric relationships
 - verification

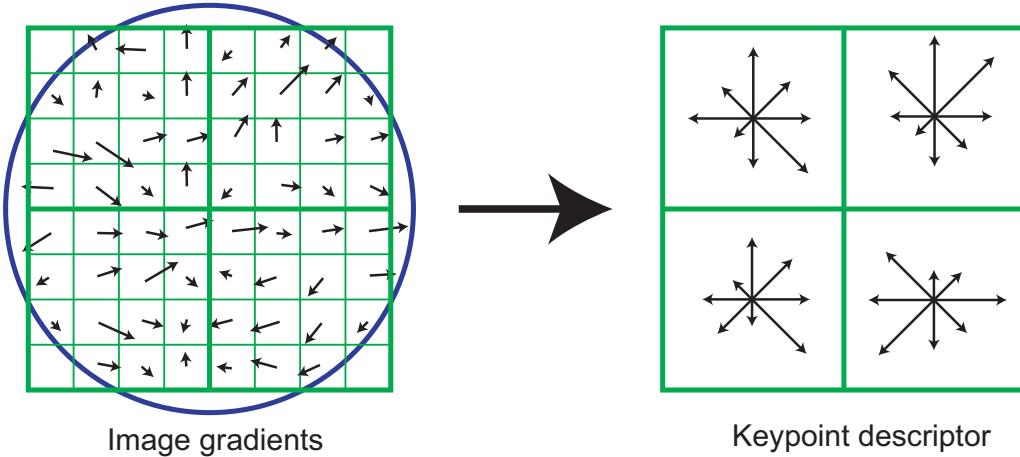
training

new image

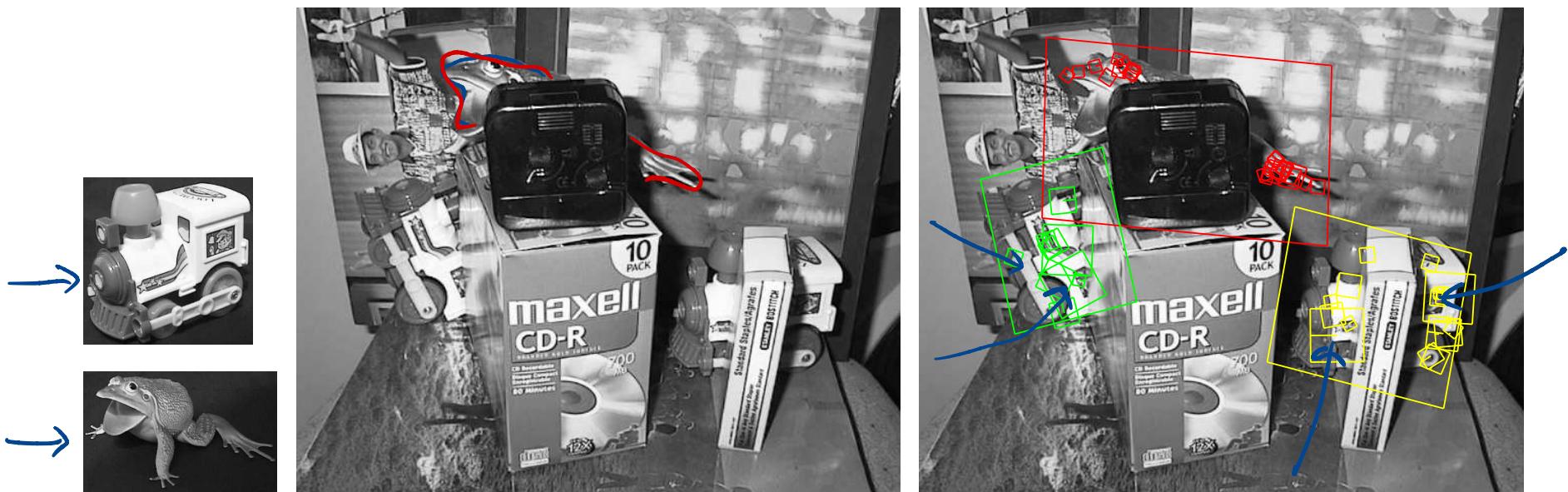


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Feature Extraction - SIFT



- scale-invariant feature transform
- invariant to scale, translation, rotation

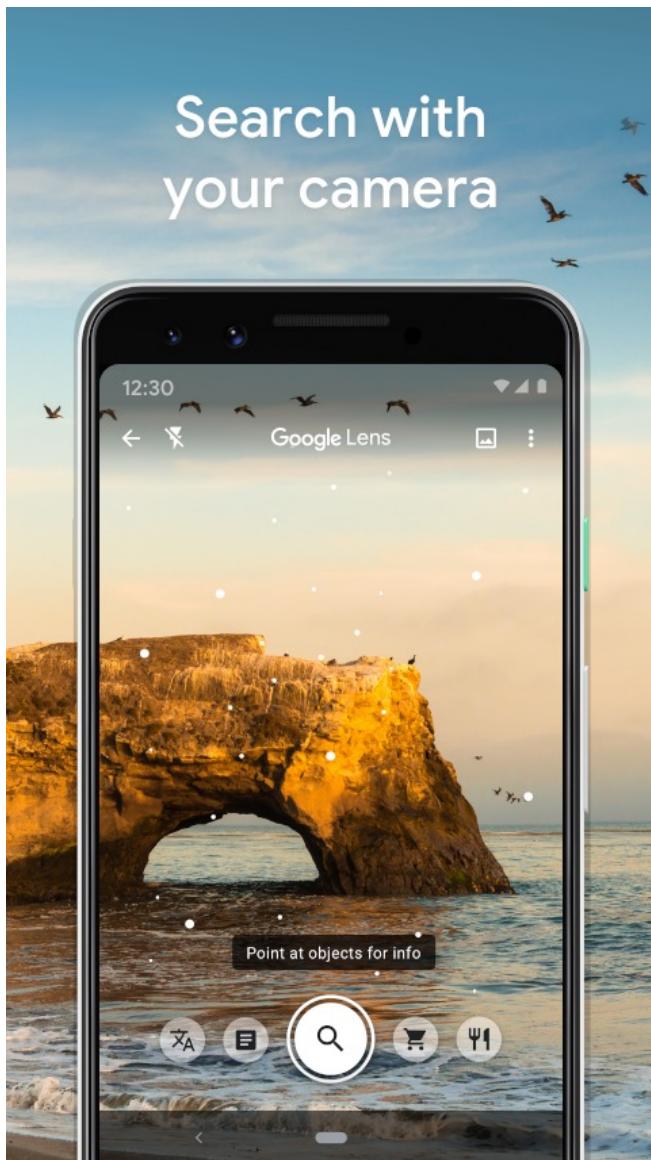


David G. Lowe. *Object Recognition from Local Scale-Invariant Features*. ICCV, 1999.



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Application: Mobile visual search



lens.google



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Generic Category Classification

Strategy:

1. Build and train model (learned or built)
 - choose a representation
 - learn/fit parameters of the model
2. Look for candidate matches in the new image
 - assign scores
3. Select the best ones
 - avoid duplicates

hand-craft

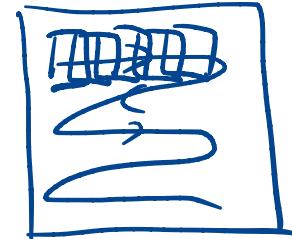


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Representation Choice

A. Window-based detection

- *entire picture or sub-window*
- *feature descriptors (SIFT, texture), bag of words*
- *contour and shape features*



B. Part-based model

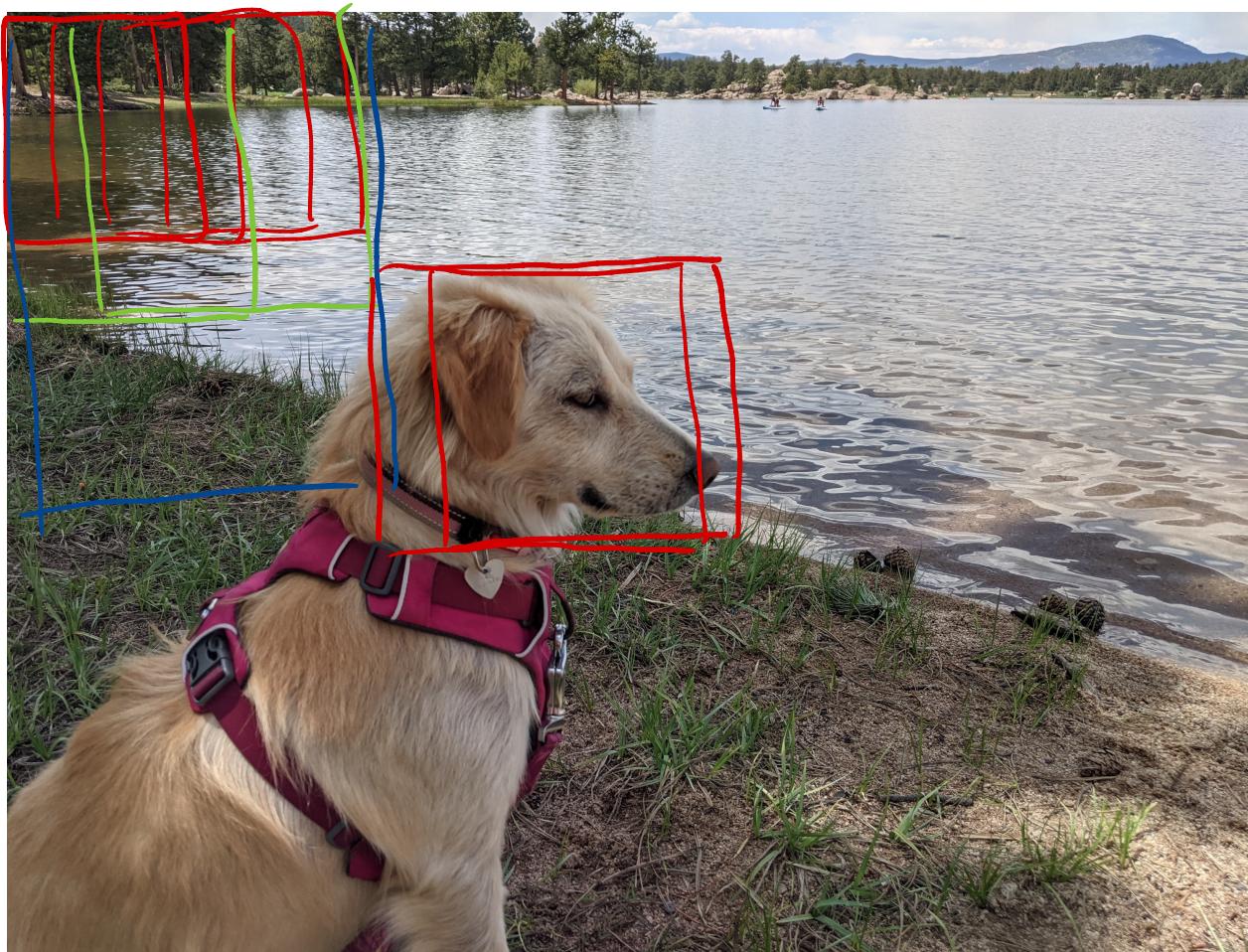
- *if all the parts are there, and if the geometric configuration agrees, then an object of that class is there*



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Window-based search

How do we perform an efficient search?



- 30 orientations
- 4-5 scales
- thousands of locations
- avoid duplicates



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Part-based models

1. Combining classifiers - lots of training data
2. Require voting – generalized Hough transform
↳ position , angle / viewpoint , scale

Advantages:

- deals better with occlusions

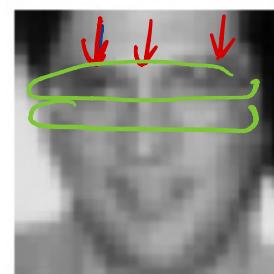
Challenges:

- capturing the variability within a class of objects
- huge configuration space to search

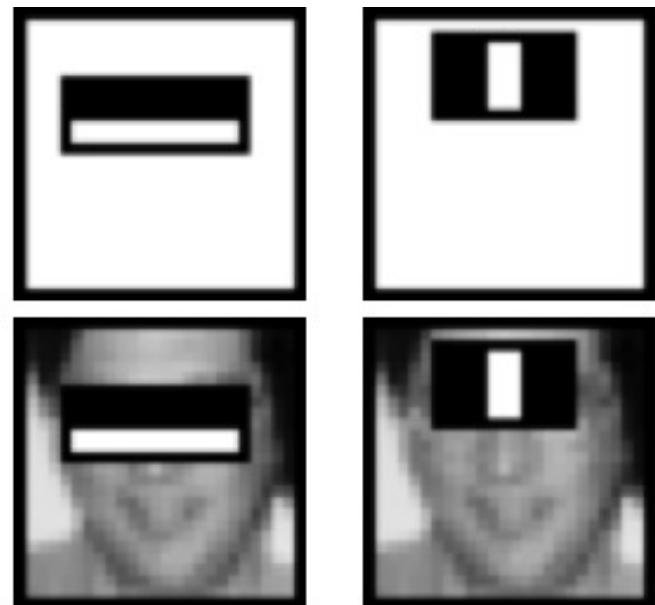


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Example: the Viola-Jones face detector



Haar features
frontal
profile
race



P. Viola, M. Jones, Rapid Object Detection using a Boosted Cascade of Simple Features, IEEE, 2001



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Summary

- From edges to features to classifiers
 - remember gradients and filters
- What works? digits (zip codes, bank checks), faces
objects with planar surfaces
- Still challenging:
 - Training data – hugely important
 - Choose your technique wisely!
DL or CV?



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