Intro to Computer Vision

Object detection with Detectron2

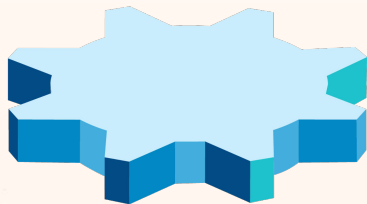# Heyo!

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Cockroach, Ex Google, PayPal SWE

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Agenda

Today's Goals

Today's Goals

We will

- Discuss Computer Vision
  - Concepts
  - Problems
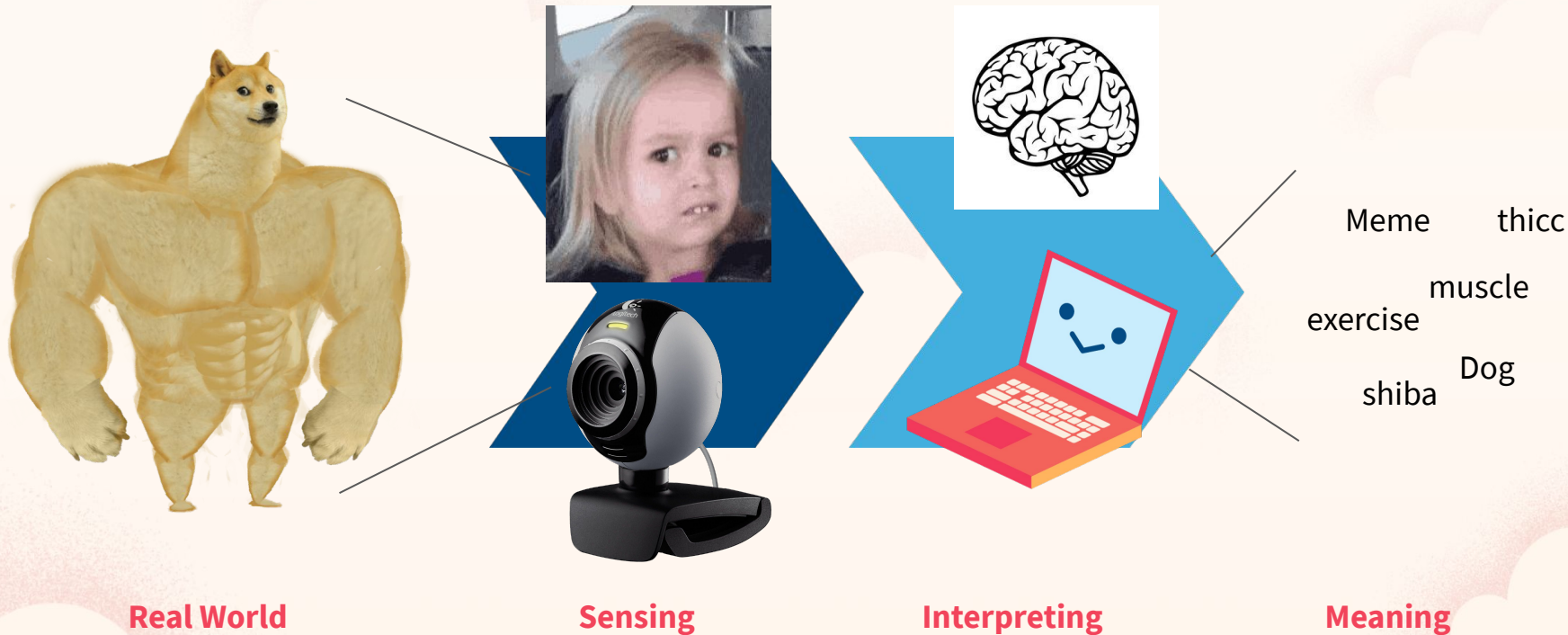 - Highlevel solutions
- Use an existing model for object detection

We will NOT:

- Train our own models
- Do an in depth guide on machine learning tools

What is Computer Vision?

What is vision?

Real World   **Sensing**   **Interpreting**   **Meaning**

Meme   thicc
muscle
exercise
shiba   Dog

What does a computer see?

170	238	85	255	221	0
68	136	17	170	119	68
221	0	238	136	0	255
119	255	85	170	136	238
238	17	221	68	119	255
85	170	119	221	17	136

What do we see?

- Topical Meme
- Sad, white, fluffy cat
- Laptop in mid ground
- Laptop is on a website
- Room has white lighting
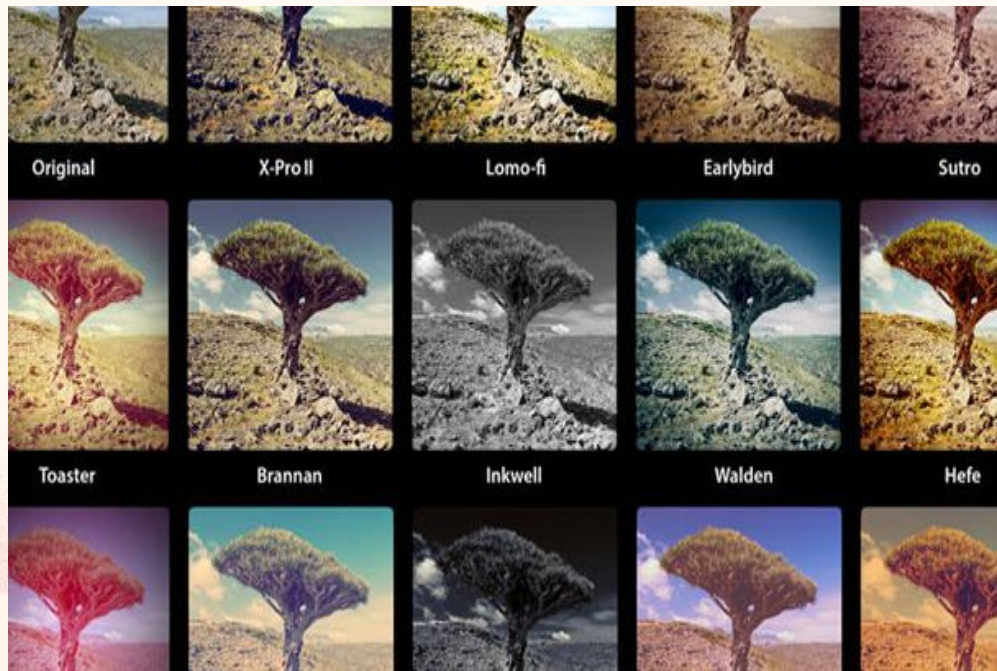- Room has shutters

… and more!

Computer Vision Problems

Computer Vision Problems

- Filtering
- Transformations
- Depth maps
- 3D model from image
- Semantic segmentation
- And many more!

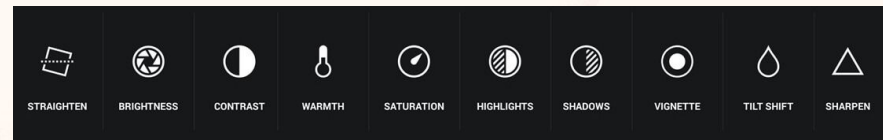# Computer Vision Problems
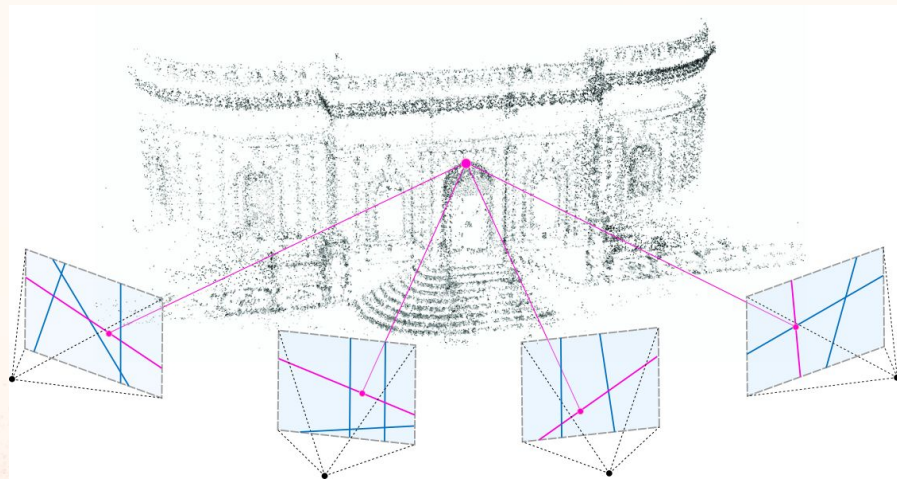
Filtering

Computer Vision Problems

Transformations

STRAIGHTEN BRIGHTNESS CONTRAST WARMTH SATURATION HIGHLIGHTS SHADOWS VIGNETTE TILT SHIFT SHARPEN

ooo wow panorama

Computer Vision Problems

Structure From Motion

Computer Vision Problems

Depth

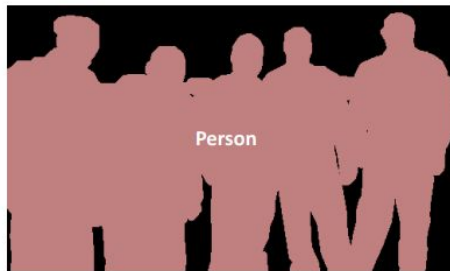left image (reference)   right image (smaller baseline)   (scaled) ground truth disparity map
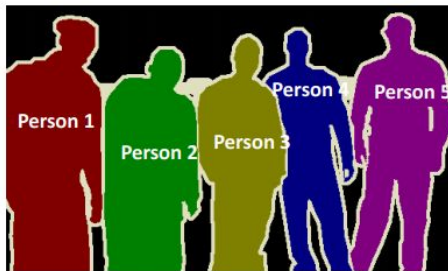
Computer Vision Problems

Segmentation

Computer Vision Problems

Segmentation

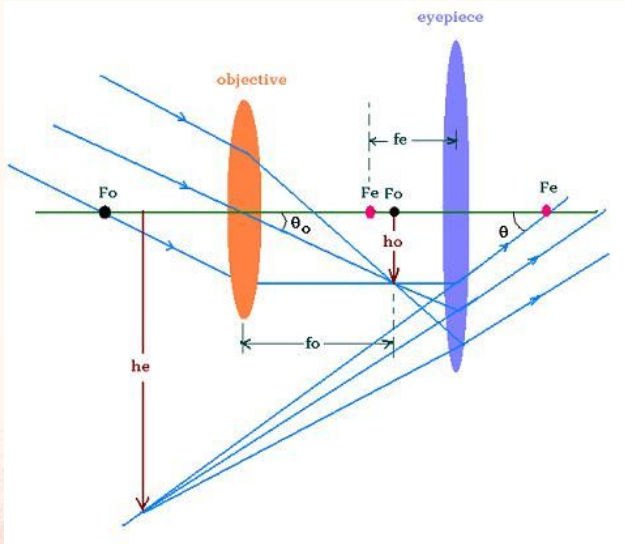Semantic Segmentation   Instance Segmentation
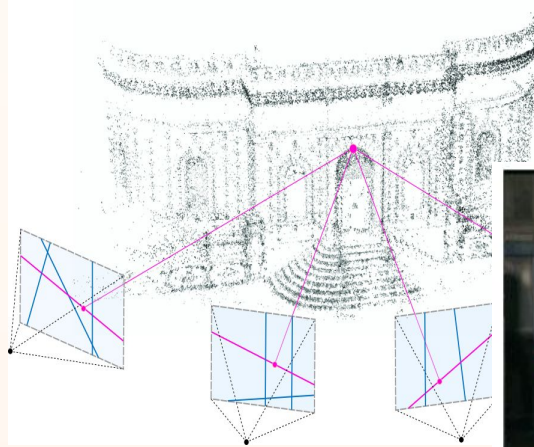
Any Questions?

Traditional Solutions

Traditional Solutions
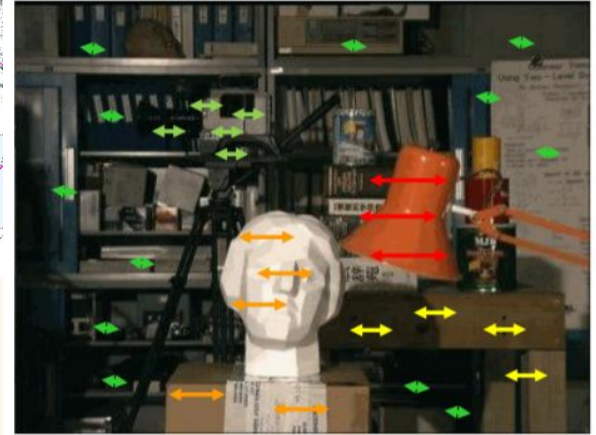
Take advantage of real world geometry and m a t h
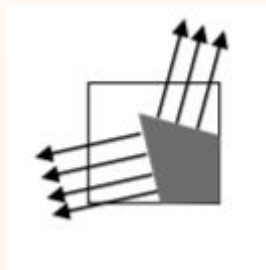

Real world has reliable geometry!

Clever math!

Closer objects 'move' more

Traditional Solutions

Take advantage of real world geometry and m a t h

Edges can be
detected with math

Face Detection

Traditional Solutions

Take advantage of real world geometry and m a t h

Group 'similar' stuff together

Zoom backgrounds

Deep Learning Solutions

Deep Learning Solutions

Models (grossly oversimplified)

- Training Data
    - Input & target solution
- Loss functions
    - Cat vs Dog has different loss functions!
- N number of weights
- Find weights that minimize loss over training data
- Active area of research

right image (smaller baseline)   (scaled) ground truth disparity map
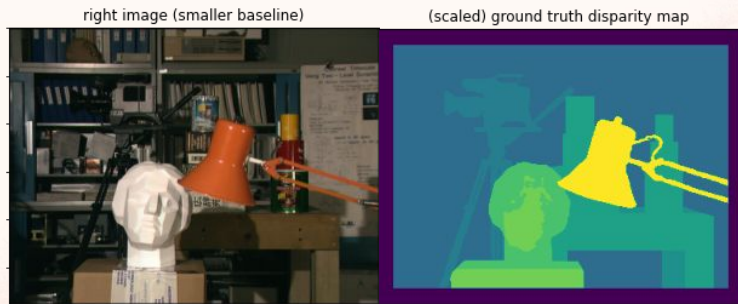
Handwritten digit detection model
(1989)

Deep Learning Solutions

- Improved technology enable training!
- Clever loss functions improve solutions to existing problems
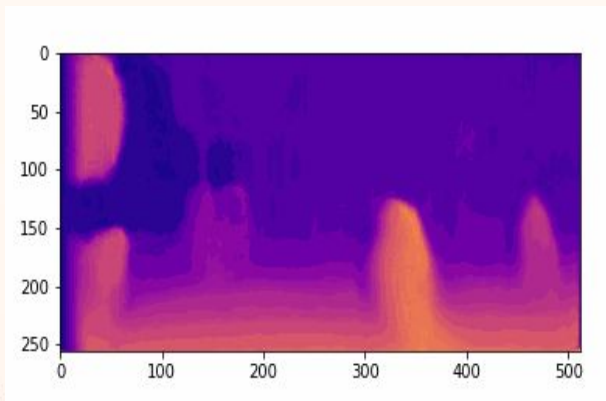
Single view depth estimation
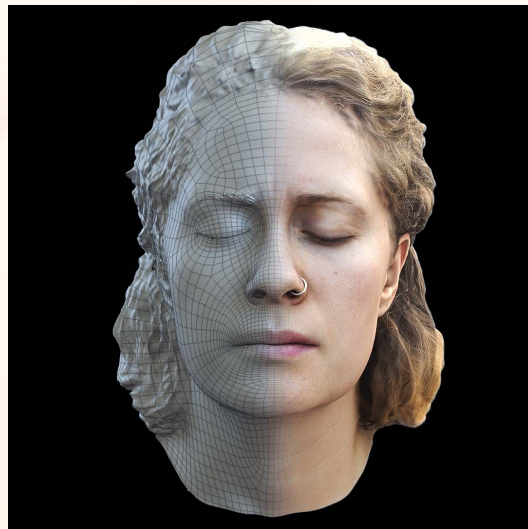
Single view photogrammetry
(structure from no motion)

Deep Learning Solutions

- Classification/regression problems
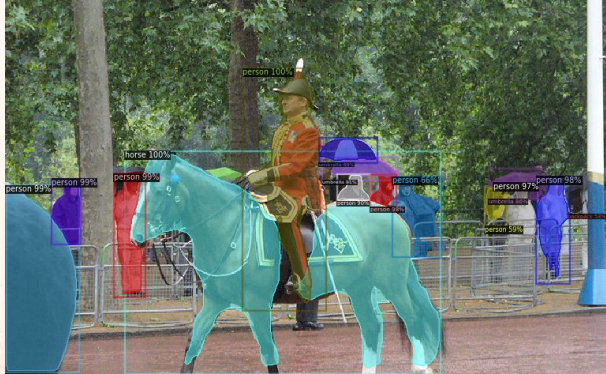
Object Classification
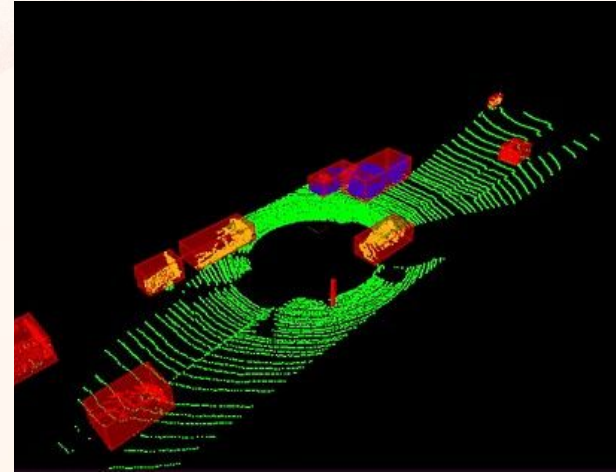
3d Lidar object classification

Deep Learning Solutions

Lighting Prediction
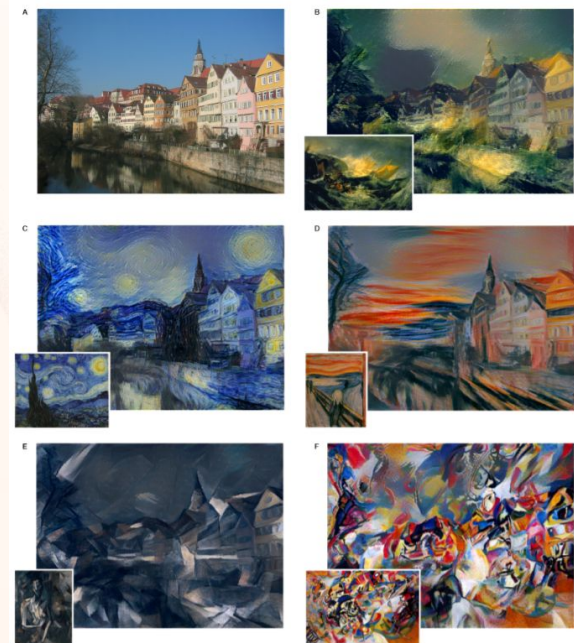
Generative Art

Any Questions?

U can also slide into my dms too lol

Detectron2 Example

What is Detectron2?

- Trained model
  - "Plug and play"
- Open source
- State-of-the-art object detection
  - And more! See their /projects
- Made by Facebook AI

What is Jupyter Notebook and CoLab?

Jupyter Notebook

- Machine learning + Data Sci Python tool
- Not important, just fast to prototype

CoLab

- Cloud notebook platform
- Clean environment
- Free GPU for training models

Let's open up CoLab!

(or jupyter notebook)

How do I actually put this all together!?

- Using Detectron2:
  - "Intro to API's", make python API and directly respond to requests with Detectron2
- Not interested in object detection for hackathon project?
  - Detectron2 can be used in **pose estimation** and **panoptic segmentation**
    - See /detectron2/projects/
  - Monocular depth estimation
  - 3D Semantic Segmentation
  - Pose estimation
  - Much more at paperswithcode.com
  - Read repos carefully - each model has it's own set up
- Making your own model:
  - Warning: Might spend the entire hackathon training your model!
  - "Establishing a Productive Machine Learning Workflow" Wed Jan 13th
  - Implementing papers directly is a good exercise

Further Reading (see HackPack!)

[Advanced CoLab tutorial from authors](). They go into detail how you can use Detectron2 as the basis for a new model to be trained.

Other Ready-To-Use Models

[Browse papers alongside pretrained models]().

- [Pytorch]() will be crucial in loading these models.

Computer Vision Courses

UWaterloo: [CS484](), prereqs (AMATH 242/CS 371 or CS 370) and STAT 230 or STAT 240. Strong linear algebra background will be valuable.

[Udacity]()

[Coursera]()

Interesting Papers

There's a great [reddit thread]() with tons of papers I am also slowly getting through!

There are also lists on github:

- t[erryum's "Awesome Deep Learning Papers"]()
- [Floodsong's "Deep Learning Papers Reading Roadmap"]()

Any Questions?

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