

# EECS 442

## Computer Vision

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Fall 2019, University of Michigan

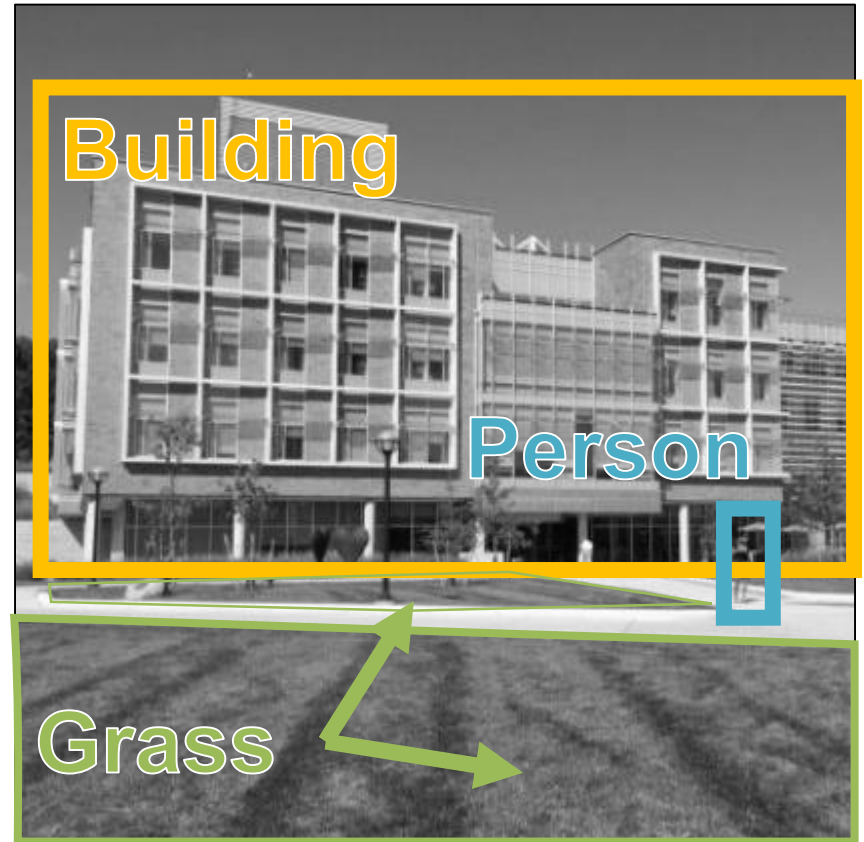
[http://web.eecs.umich.edu/~fouhey/teaching/EECS442\\_F19/](http://web.eecs.umich.edu/~fouhey/teaching/EECS442_F19/)

# Goals of Computer Vision

Get a computer to understand



# Goal: Naming

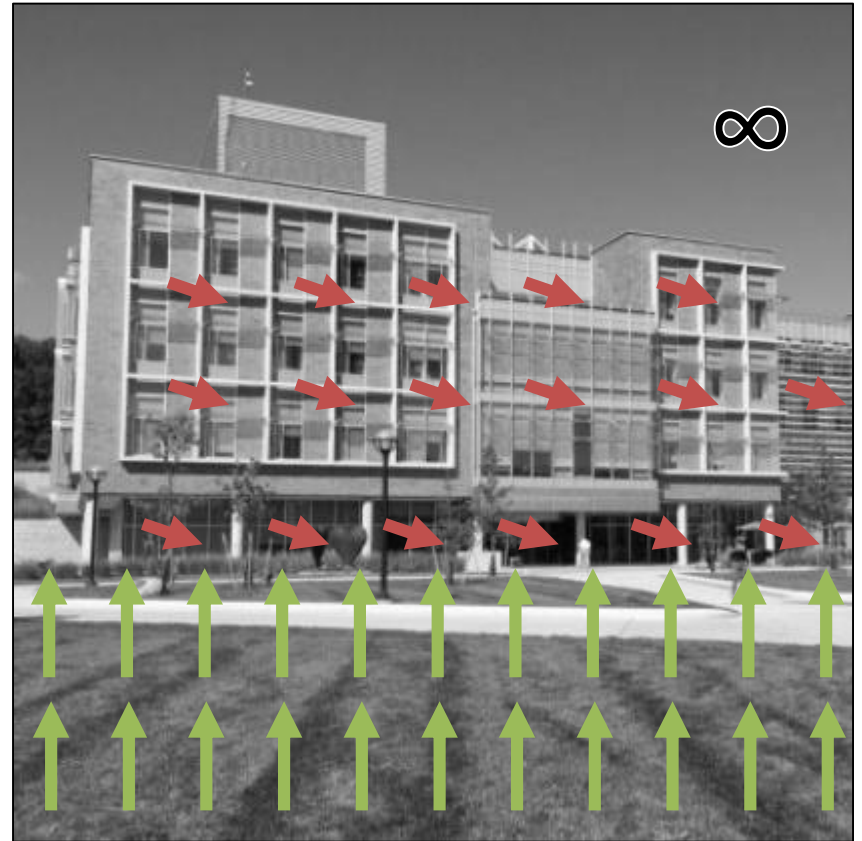


# Goal: Naming



The picture shows a building with many windows and grass in front of it. There is a person walking on the right...

# Goal: 3D



# Goal: Actions



# Seems Obvious, Right?

- **Key concept to keep in mind throughout the course:** you see with both your eyes **and** your brain.

# Why is it Hard?







# Why is it Hard?



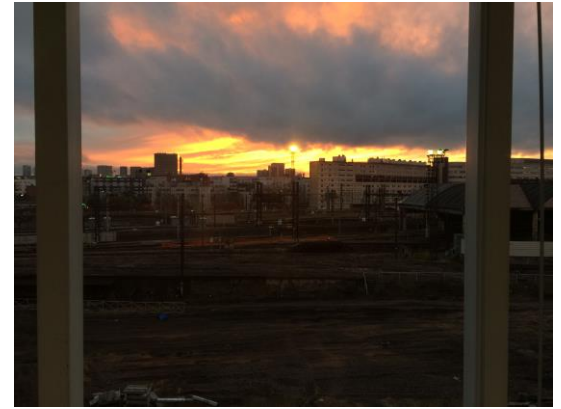
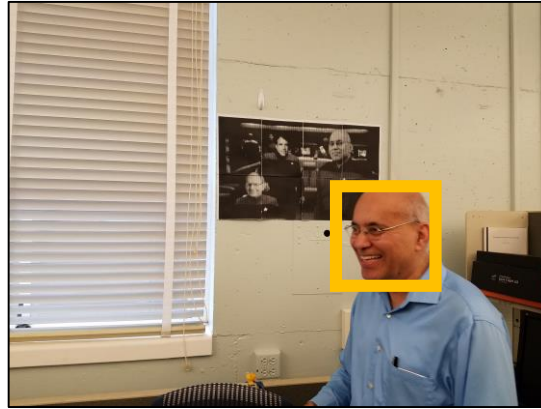
# Goal of computer vision

097	097	097	097	097	097	097	097	096	097	097	096	096	096
100	100	100	100	100	100	101	101	102	101	100	100	100	099
105	105	105	105	105	105	105	103	102	102	101	103	104	105
109	109	109	109	109	110	107	118	145	132	120	112	106	103
113	113	113	112	112	113	110	129	160	160	164	162	157	151
118	117	118	123	119	118	112	125	142	134	135	139	139	175
123	121	125	162	166	157	149	153	160	151	150	146	137	168
127	127	125	168	147	117	139	135	126	147	147	149	156	160
133	130	150	179	145	132	160	134	150	150	111	145	126	121
138	134	179	185	141	090	166	117	120	153	111	153	114	126
144	151	188	178	159	154	172	147	159	170	147	185	105	122
152	157	184	183	142	127	141	133	137	141	131	147	144	147
130	147	185	180	139	131	154	121	140	147	107	147	120	128
035	102	194	175	149	140	179	128	146	168	096	163	101	125

# Despite This, We've Made Progress

- Few of these problems are **solved** (*and there are lots of dangers to pretending things are solved when they aren't*)
- But we do have systems with performance ranging from non-embarrassing to super-human (with the right caveats)

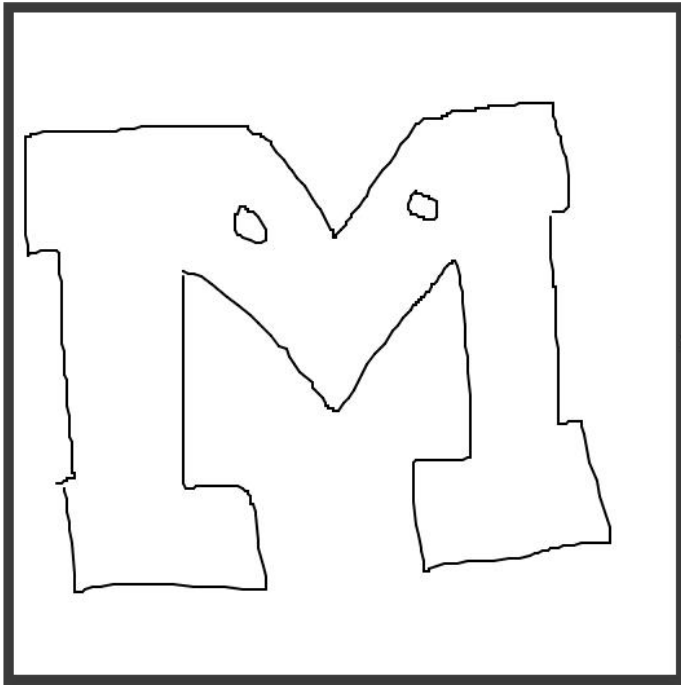
# Look at Your Phone



# Graphics

<https://affinelayer.com/pixsrv/>

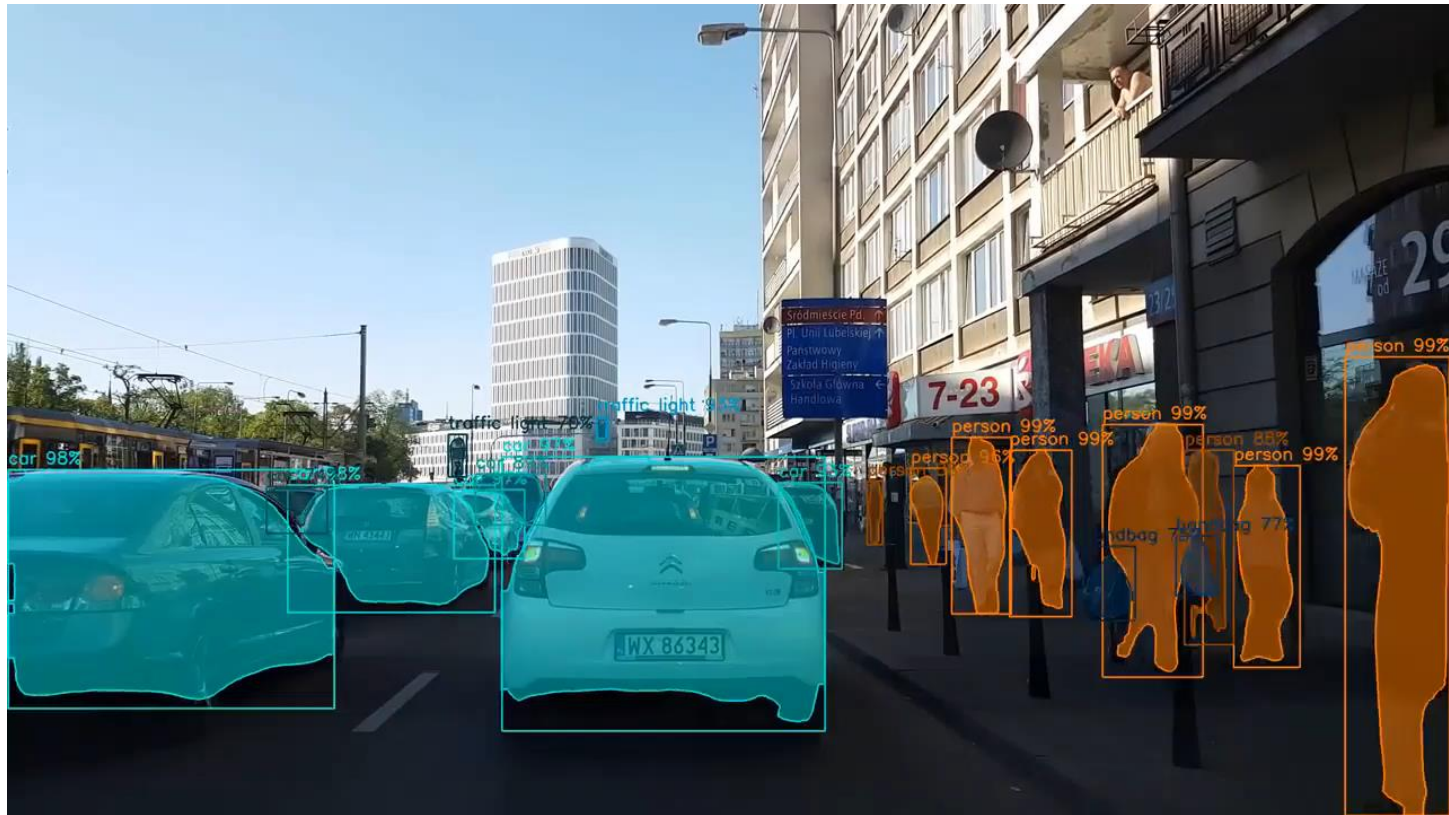
INPUT



OUTPUT



# Recognition



He et al. *Mask RCNN*. ICCV 2017.

Video Credit: Karol Majek (<https://www.youtube.com/watch?v=OOT3UIXZztE>)

# 3D





# Administrivia

- Waitlist
- Prerequisites
- Websites
- Textbook
- Evaluation
- Academic Integrity

# Meetings

- Class:
  - Mon/Wed 5:30pm – 7pm, 1571 GGBL
- Discussion Sections
  - Thursday 4:00PM - 5:00PM, 1018 DOW
  - Friday 10:30AM - 11:30AM, 1200 EECS
  - Friday 12:30PM - 1:30PM, 1012 FXB
- Office Hours
  - Five office hours!
  - Show up with a concrete question

# General Advice

- Lectures are recorded and you can show up or not – you're all adults.
- You can also eat ice cream for every meal until you develop scurvy. This is one of the difficulties of being an adult
- Falling behind in this class is really not fun. Don't fall behind.

# Doing Well

- Study and work in groups. I've made a thread for this. Read the syllabus for what's allowed
- Invest in learning how to debug well early on
- Start early
- Read the tips
- If you're mathematically far behind, you're going to have a bad time
- Some fraction will be head-bangingly difficult and not fun, but not all learning is fun

# Waitlist Policy

- The waitlist is huge. I am limited by room capacity and ability to hire course staff
- Policies:
  - I do not reorder the waitlist –this leads to me making arbitrary decisions with limited information
  - If you are a MS, there are no more slots. Take 442 next semester, or 504 next semester

# Prerequisites

You **absolutely** need: EECS 281 and corresponding programming ability.

You will **struggle continuously** without: Basic knowledge of linear algebra, calculus. Linear algebra is a prerequisite for future iterations. I will teach a two-class refresher course in it.

You'll have to learn: Numpy+PyTorch, a little tiny bit of continuous optimization

# Prerequisites

Suppose  $\mathbf{K}$  in  $\mathbb{R}^{3 \times 3}$ ,  $\mathbf{x}$  in  $\mathbb{R}^3$ . Should know:

- How do I calculate  $\mathbf{Kx}$ ?
- When is  $\mathbf{K}$  invertible?
- What is  $\mathbf{x}$  if  $\mathbf{Kx} = \lambda\mathbf{x}$  for some  $\lambda$ ?
- What's the set  $\{\mathbf{y}: \mathbf{x}^T\mathbf{y} = 0\}$  geometrically?

**You should also be able to remember some notion of a derivative**

# Websites

- Course website:  
[http://web.eecs.umich.edu/~fouhey/teaching/ECS442\\_F19/](http://web.eecs.umich.edu/~fouhey/teaching/ECS442_F19/)
- Piazza:  
<https://piazza.com/umich/fall2019/eecs442/>
- We'll be using Piazza for all communication apart from canvas for code submission and gradescope for writeup submission. Sign up



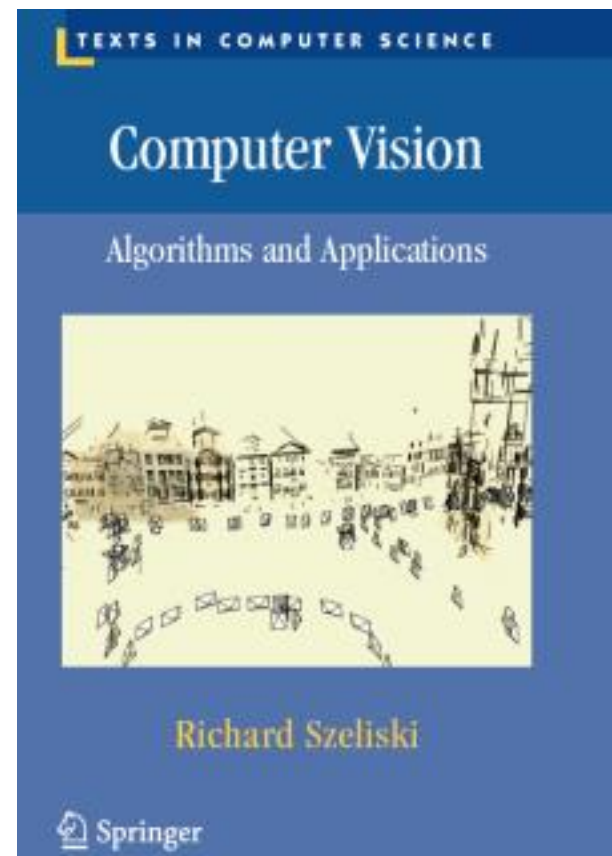
# Piazza

- Please ask questions on Piazza so we can answer the question once, officially, and quickly
- We will monitor Piazza in a systematic way, but we do not guarantee instant response times
- Same goes for email

# Textbooks

No textbook, but Szeliski, *Computer Vision: Algorithms and Applications*, is a good reference and available online.

<http://szeliski.org/Book/>



# Evaluation

- Practicals assignment (5%) – make all your mistakes in a low-stakes setting.
- Homework (6x10%) – six mini-project homeworks with a writeup
- Project (5%+10%+20%) – a semester-long project done in a team

# Evaluation: Homework Late Policy

- Penalty: 1% per hour, rounded to nearest
- Example:
  - Due: Midnight Mon. (1s after 11:59:59pm Mon)
  - Submitted at 12:15am Tue: No penalty!
  - Submitted at 6:50am Tue: 7% penalty (specifically 90% -> 83%)
- Exceptions only for exceptional circumstances.
- Everyone gets 72 free late hours, applied automatically

# Copying: Better Options Exist

- Read the syllabus – it pays
- Copying is usually *painfully* obvious and I don't have many options
- Submit it late (*that's why we have late days*), half-working (*that's why we have partial credit*), or take the zero on the homework – I guarantee you won't care about one bad homework in a year
- If you're overwhelmed, talk to us

# Evaluation: Term Project

- Work in a team of 3-5 to do *something cool*
- There will be a piazza thread for pairing up
- Could be:
  - Applying vision to a problem you care about
  - Independent re-implementation of a paper
  - Trying to build and extend an approach
- Should be 2 homeworks worth of work per person