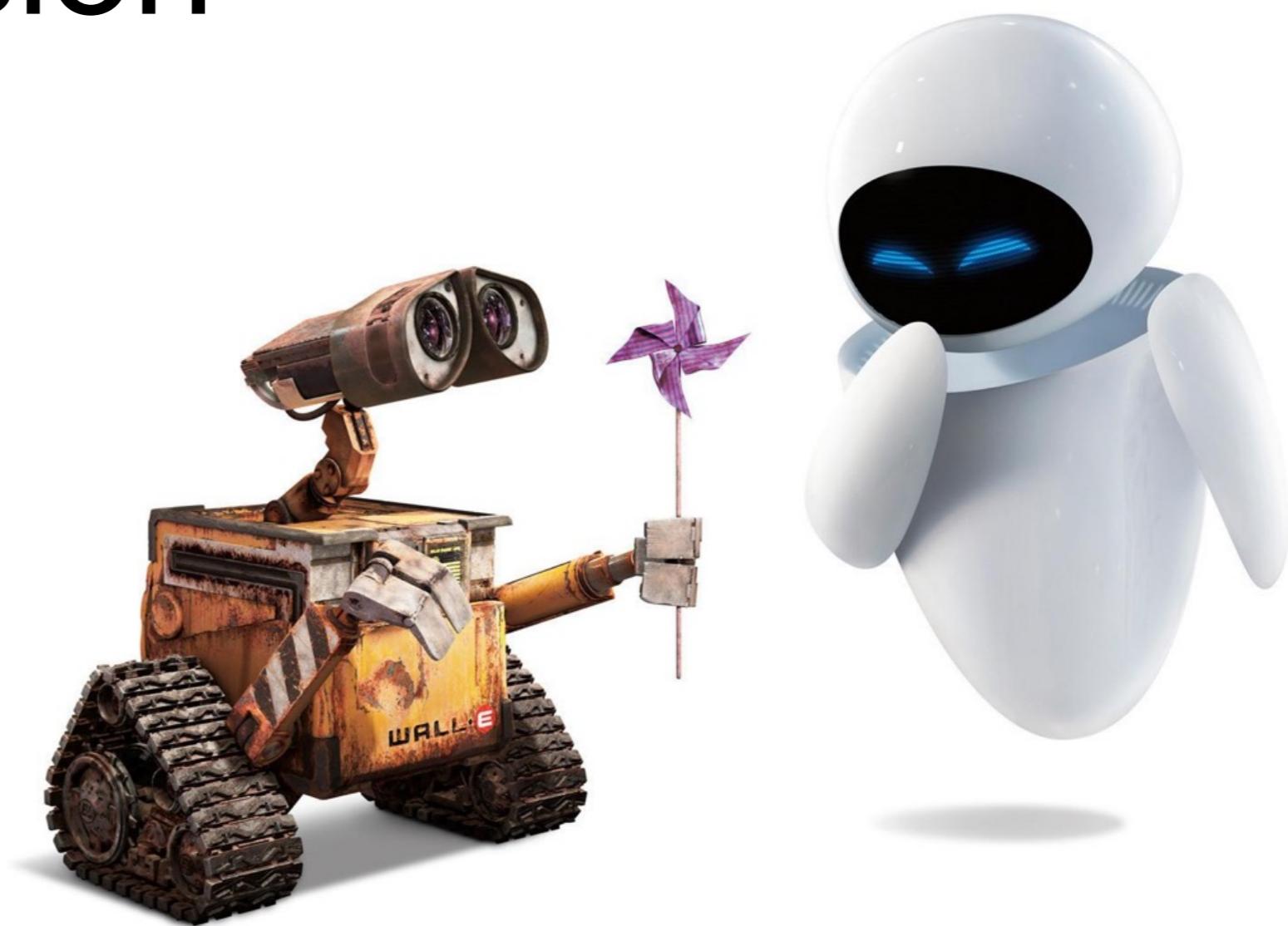


CMPT 412/762

Computer Vision



Andrea Tagliasacchi
<https://theialab.ca>

Today

- Slide credits
- My introduction
- What is computer vision?
- Course fast-forward and logistics

Slide credits

Most of these slides were adapted directly from:

- Yasutaka Furukawa (SFU, Fall 2023)
- Ioannia Gkioulekas (CMU 16-385, Spring 2018)
- Kris Kitani (CMU 15-463, Fall 2016).

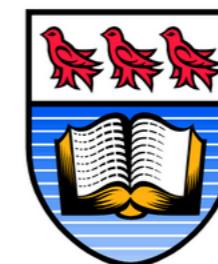
Inspiration and some examples also came from:

- Fredo Durand (Digital and Computational Photography, MIT).
- Kayvon Fatahalian (15-769, Fall 2016).

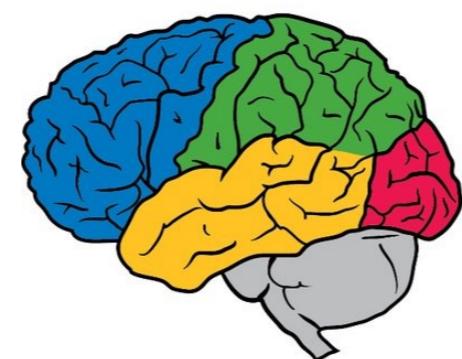
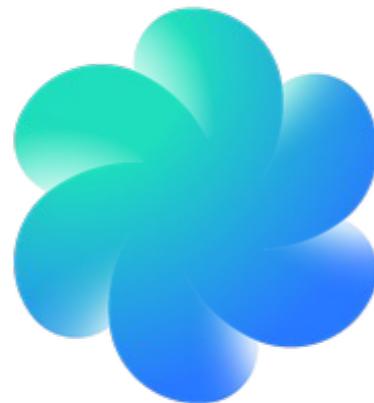
My Past Affiliations



POLITECNICO
MILANO 1863



University
of Victoria



UNIVERSITY OF
TORONTO

My Current Affiliations



100%

+

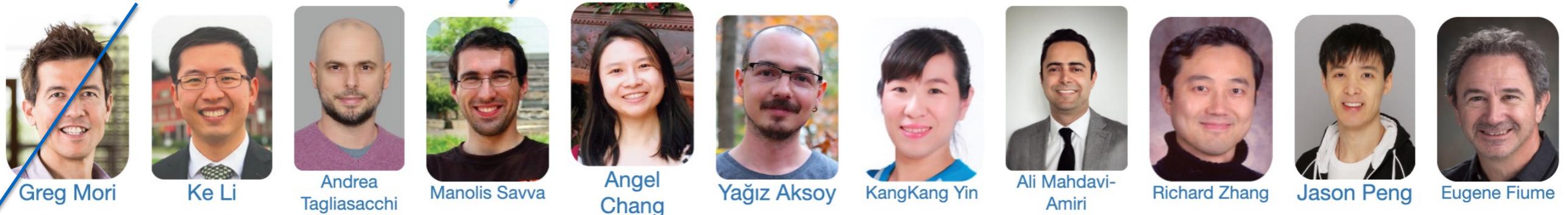
Google DeepMind

20%

Why SFU?

16 SFU Visual Computing Groups

(Ranked 12th in the world in Computer Vision and Graphics as of 2022.01)



CSRankings: Computer Science Rankings

CSRankings is a metrics-based ranking of top computer science institutions around the world. Click on a triangle (►) to expand areas or institutions. Click on a name to go to a faculty member's home page. Click on a chart icon (the bar chart icon after a name or institution) to see the distribution of their publication areas as a bar chart. Click on a Google Scholar icon (gs) to see publications, and click on the DBLP logo (db) to go to a DBLP entry. Applying to grad school? Read this first. For info on grad stipends, check out CSStipendRankings.org. Do you find CSrankings useful? Sponsor CSrankings on GitHub.

Rank institutions in the world by publications from 2014 to 2024

All Areas [off | on]

AI [off | on]

- Artificial intelligence
- Computer vision
- Machine learning
- Natural language processing
- The Web & information retrieval

Systems [off | on]

- Computer architecture
- Computer networks
- Computer security
- Databases
- Design automation
- Embedded & real-time systems
- High-performance computing
- Mobile computing
- Measurement & perf. analysis
- Operating systems
- Programming languages
- Software engineering

Theory [off | on]

- Algorithms & complexity
- Cryptography
- Logic & verification

Interdisciplinary Areas [off | on]

- Comp. bio & bioinformatics

#	Institution	Count	Faculty
1	► Zhejiang University	68.2	61
2	► Carnegie Mellon University	59.0	43
3	► ETH Zurich	58.8	17
4	► Peking University	56.8	77
5	► Stanford University	48.2	24
6	► Massachusetts Institute of Technology	47.7	37
7	► Univ. of California - San Diego	45.0	31
8	► Max Planck Society	43.0	9
9	► Chinese University of Hong Kong	37.5	23
10	► KAIST	34.6	43
11	► KAUST	31.8	9
12	► Tsinghua University	30.0	57
13	► Nanyang Technological University	29.5	31
14	► Chinese Academy of Sciences	29.3	36
15	► TU Munich	28.9	14
16	► Simon Fraser University	27.5	18
17	► Univ. of California - Berkeley	26.5	29
18	► Tel Aviv University	26.3	8
19	► EPFL	26.1	14
20	► University of Maryland - College Park	25.5	22
21	► New York University	24.4	21
22	► Cornell University	23.4	21



What is
computer vision?

What is Computer Vision? For 5 years old...



What is Computer Vision?

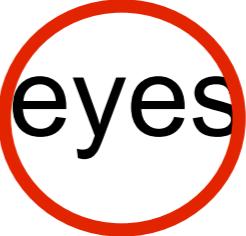
“Make computers do what our eyes do”

but this is not really correct...

What is Computer Vision?

visual system (eyes and brain)

“Make computers do what our **eyes** do”



but this is not really correct...

What is the shape of this thing?



What is the shape of this thing?



What is Computer Vision?

“Make computers do what our **eyes** do”

but this is not really correct...

What is Computer Vision?

For certain tasks,
Computer Vision can do much more

“Make computers do what our eyes do”

but this is not really correct...

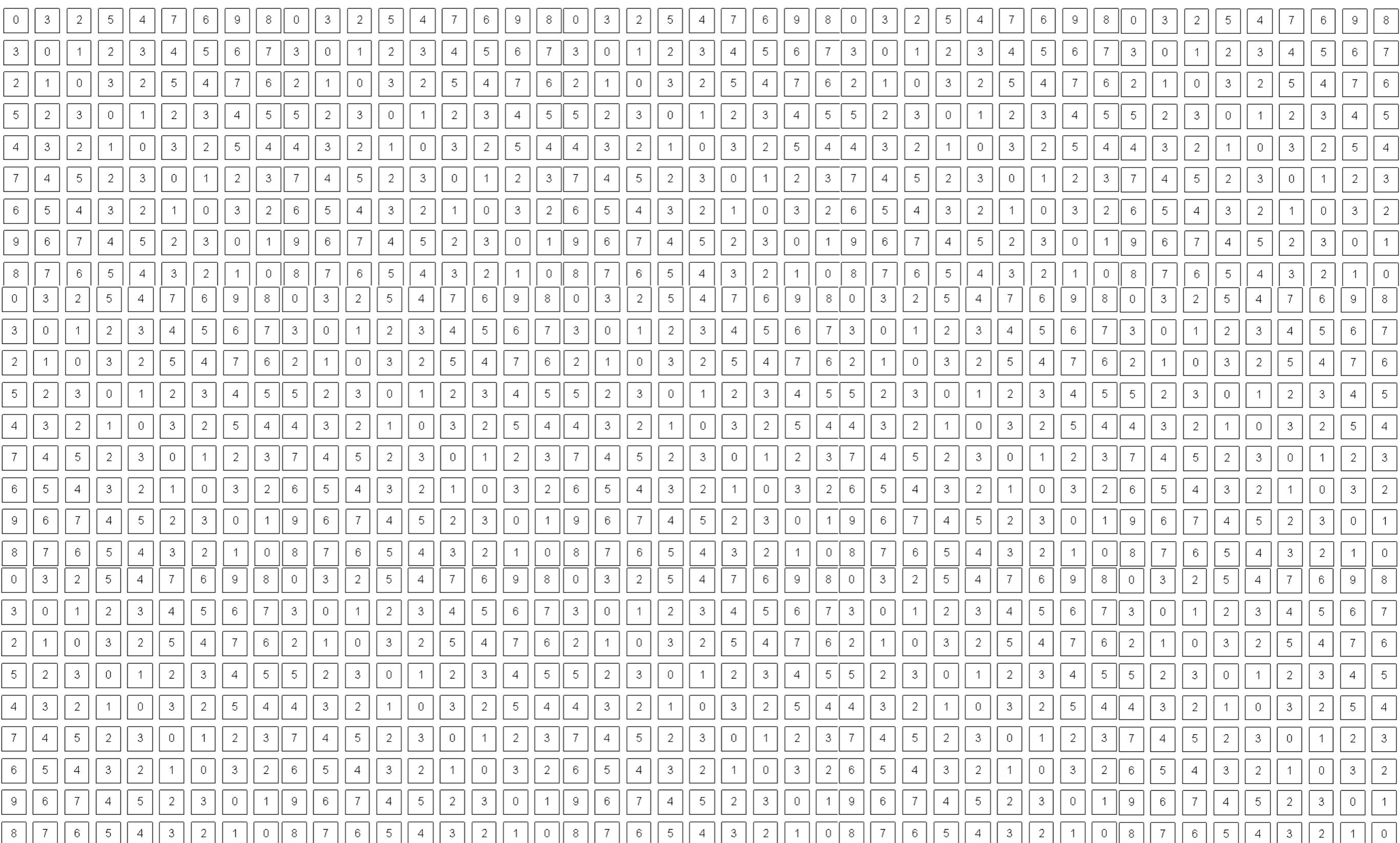
What is Computer Vision?

Achieve (super) human-level perception

Is computer vision
hard?



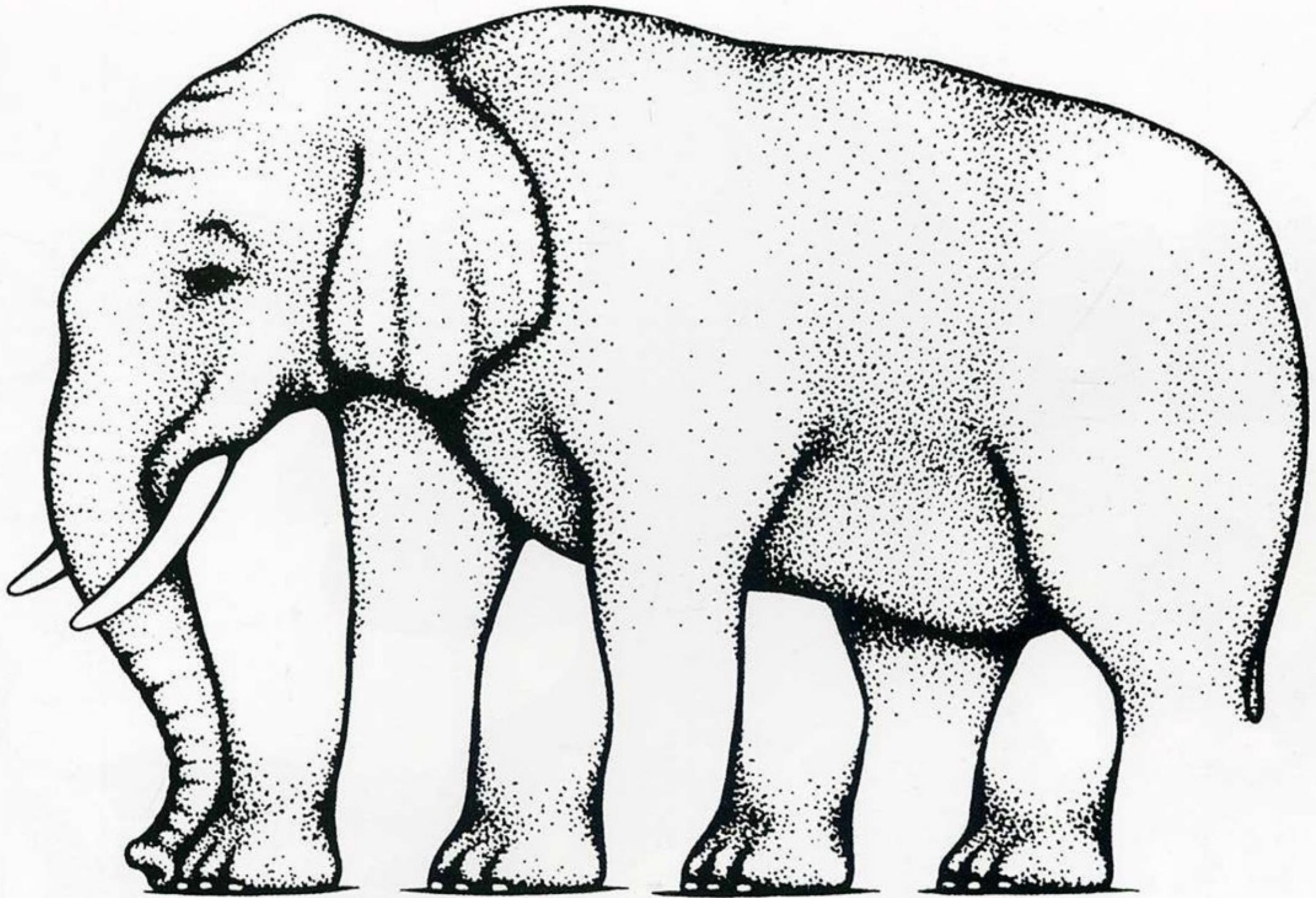
What a person sees



What a computer sees

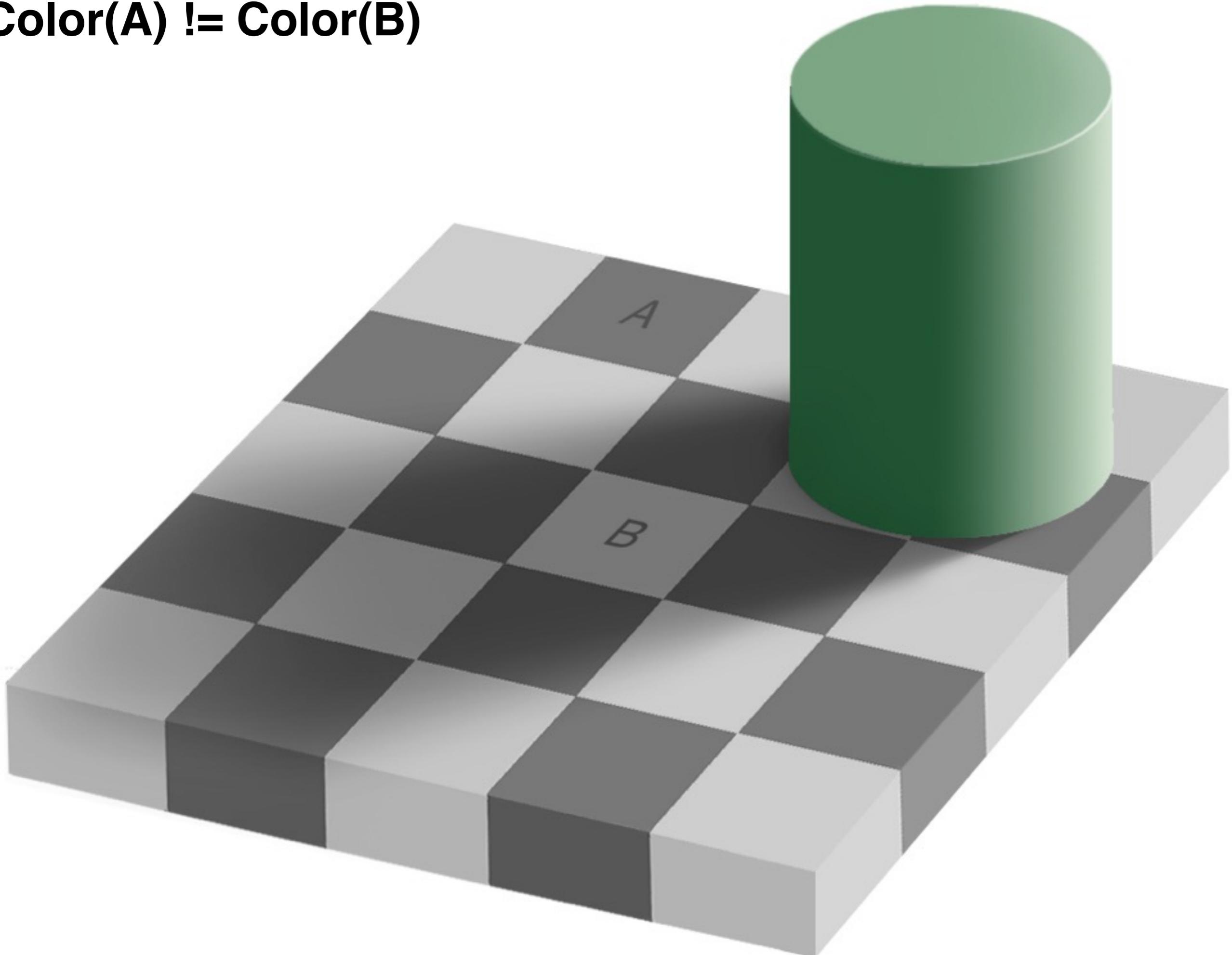


Why are we able to interpret this image?



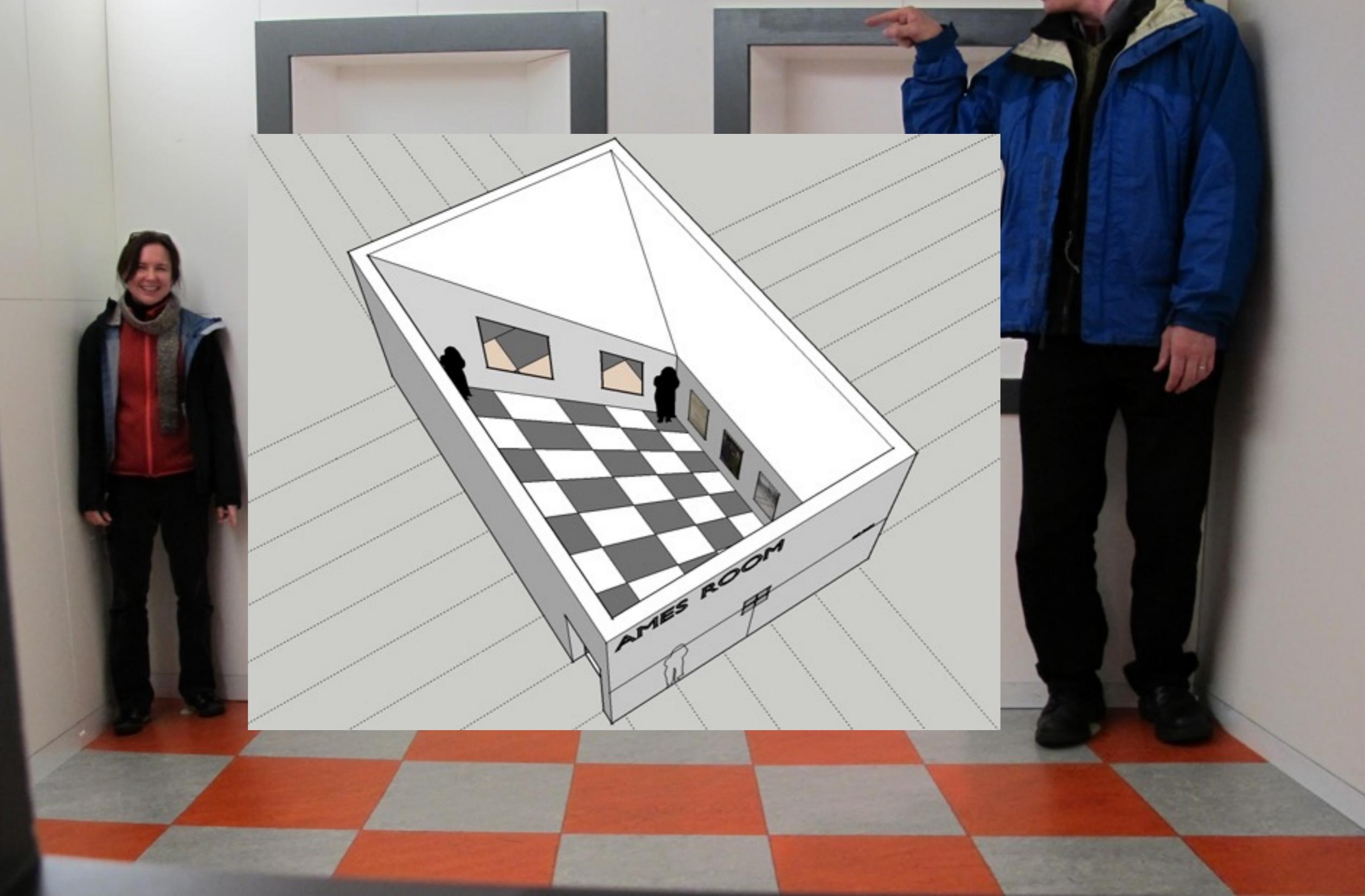
Why are we able to interpret this image?

Color(A) != Color(B)

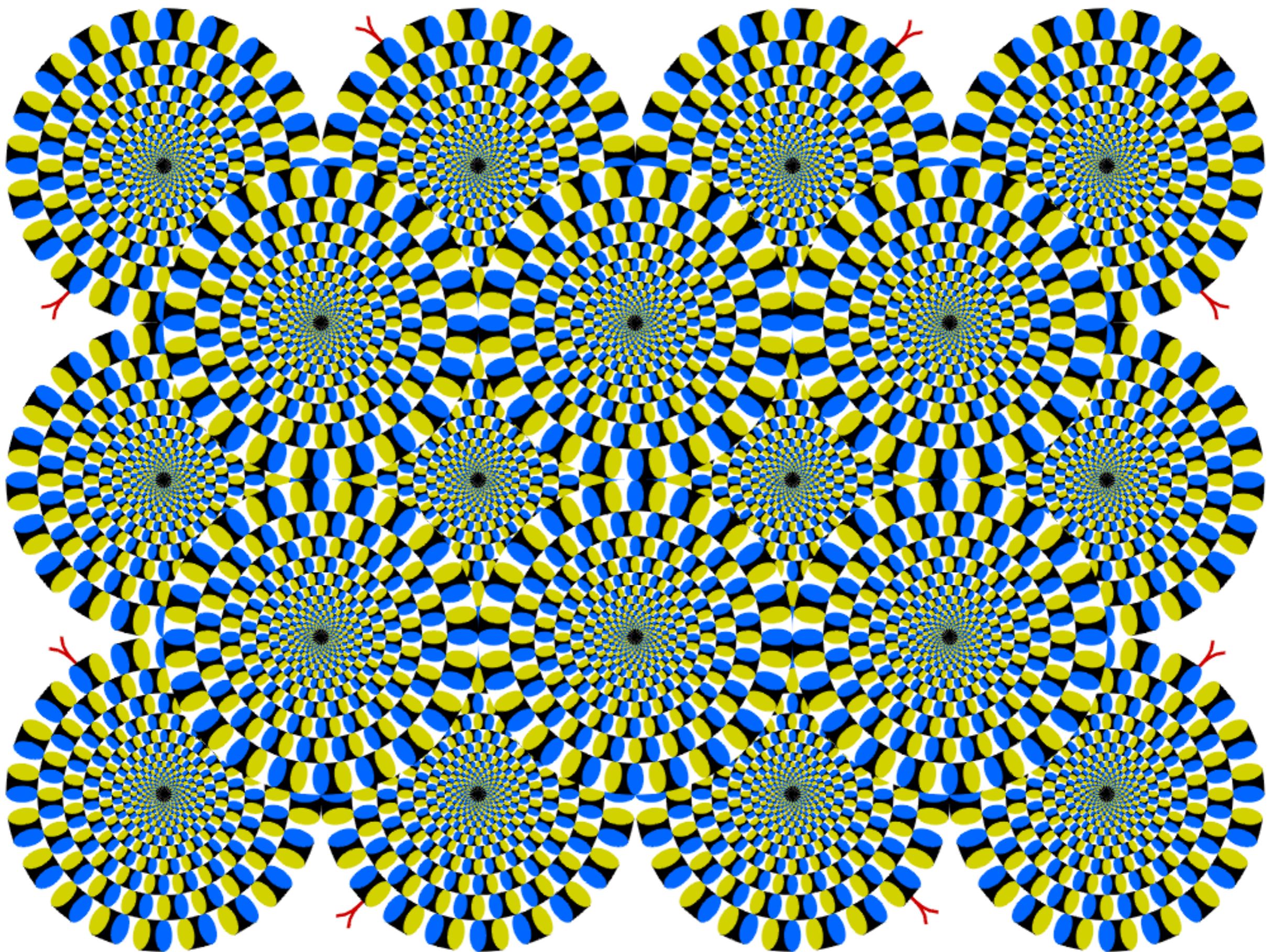


A

B



[Camera Obscura museum]



[A. Kitaoka, 2003]

Important note:

In general, computer vision does not work
(except in certain situations/conditions)

Important note:

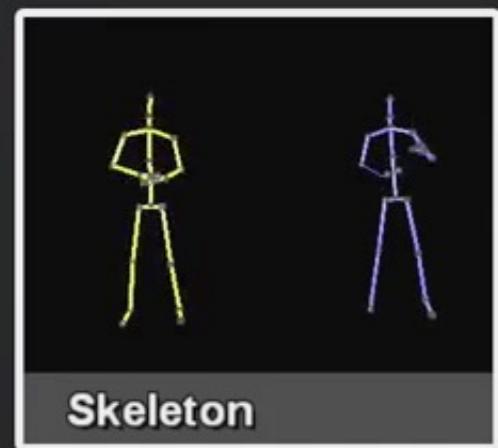
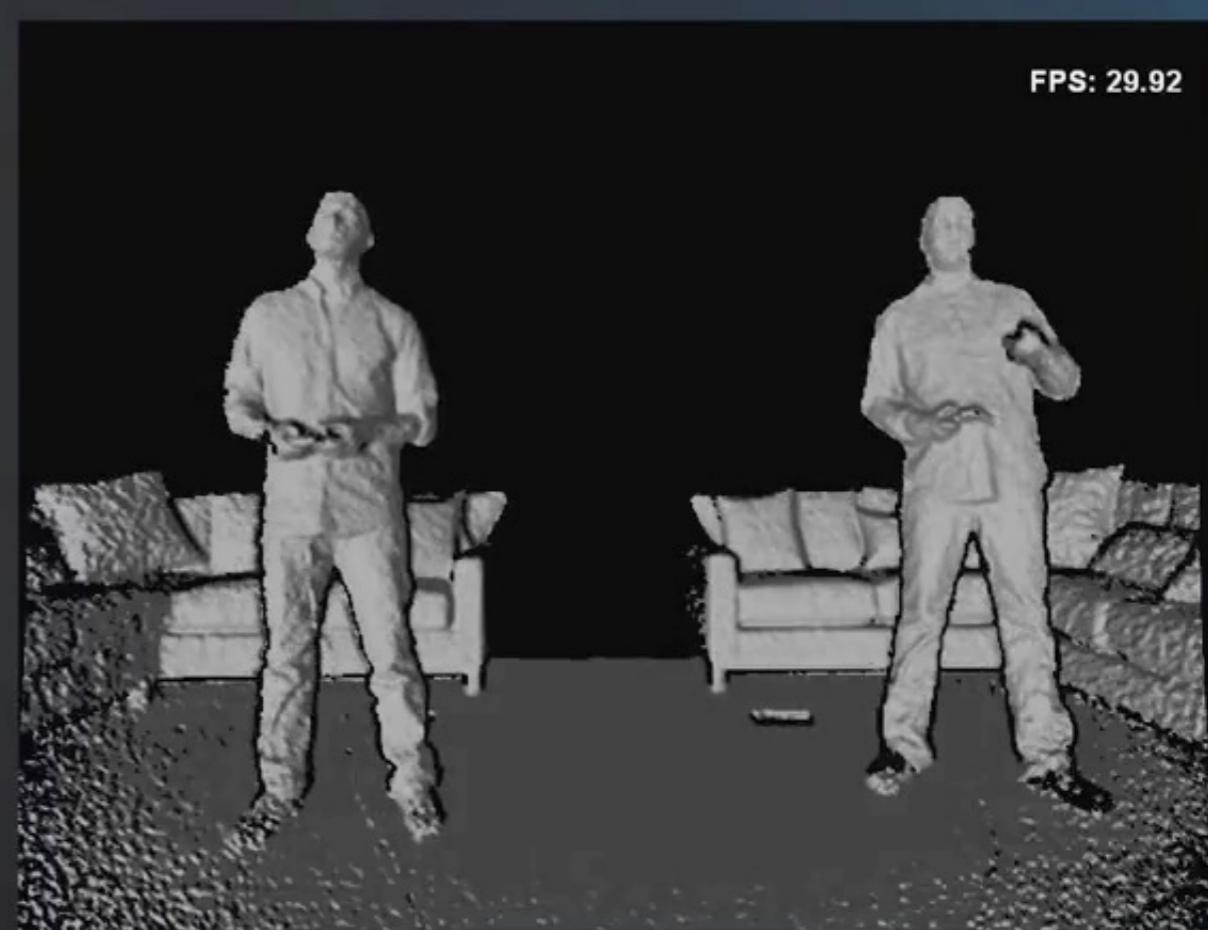
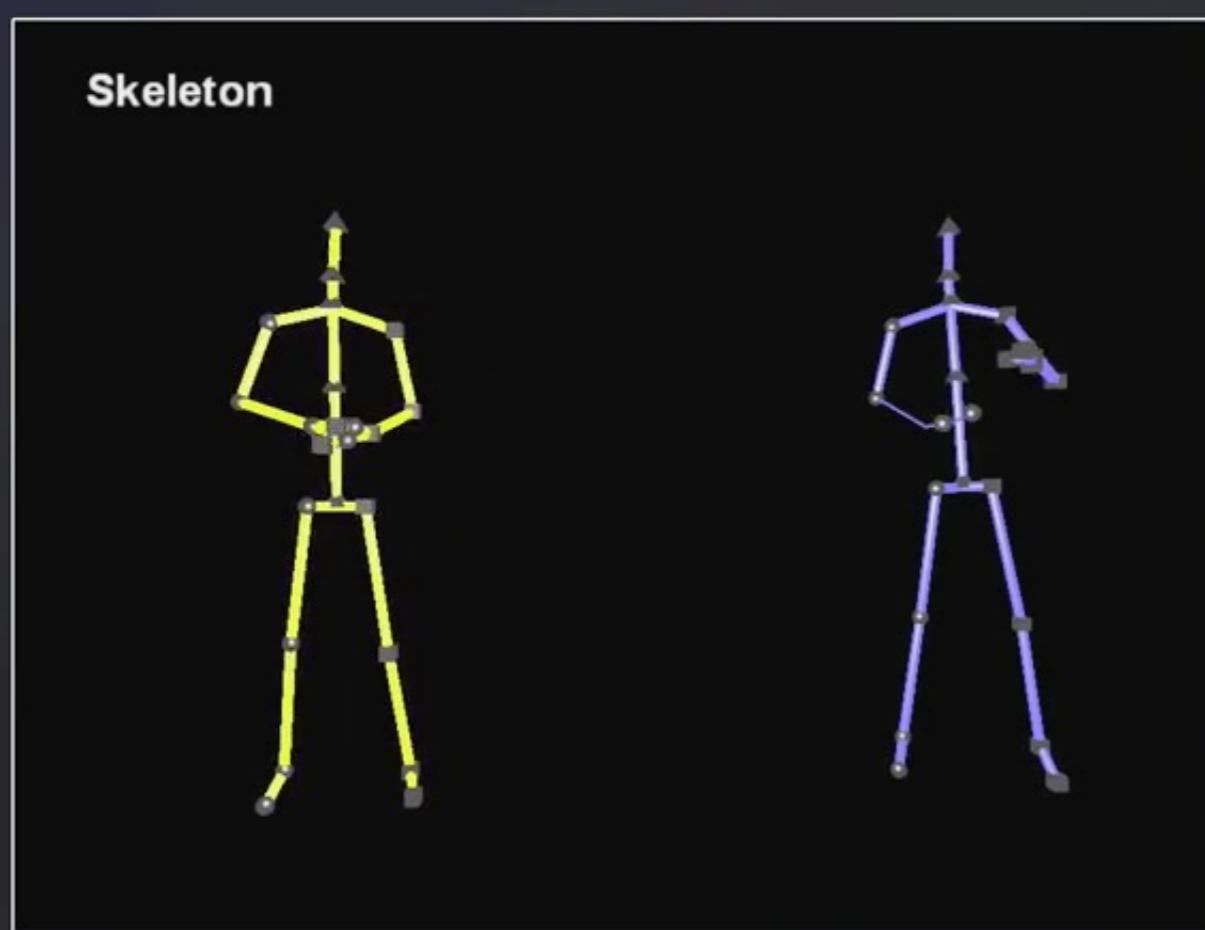
In general, computer vision does not work
(except in certain situations/conditions)

10 years ago...

Important note:
**In many important tasks,
computer vision works**

Now

Microsoft Kinect 2.0



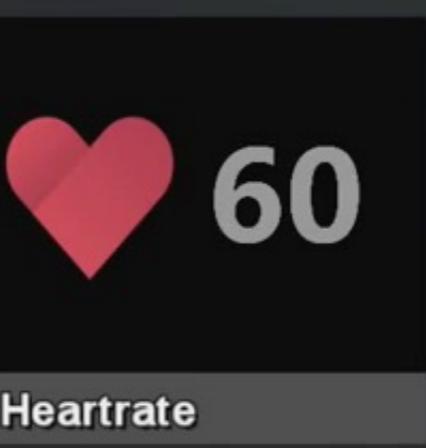
Skeleton



Orientation



Muscle+Force



Heartrate



Expression

Face2Face: Real-time Face Capture and Reenactment of RGB Videos

*Justus Thies¹, Michael Zollhöfer²,
Marc Stamminger¹, Christian Theobalt²,
Matthias Nießner³*

¹University of Erlangen-Nuremberg

²Max-Planck-Institute for Informatics

³Stanford University

CVPR 2016 (Oral)

Real-Time Facial Motion Capture

[Faceshift]



RGBZ



MODEL

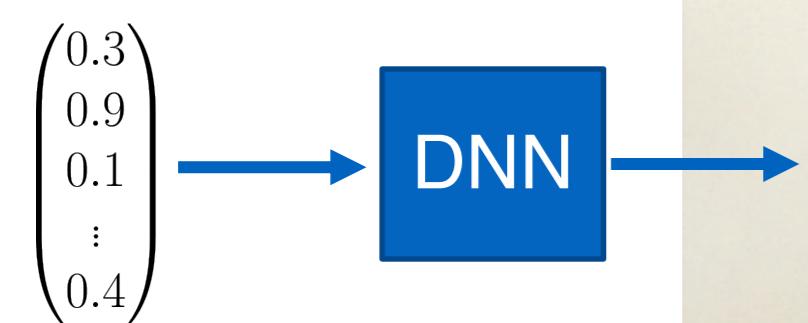


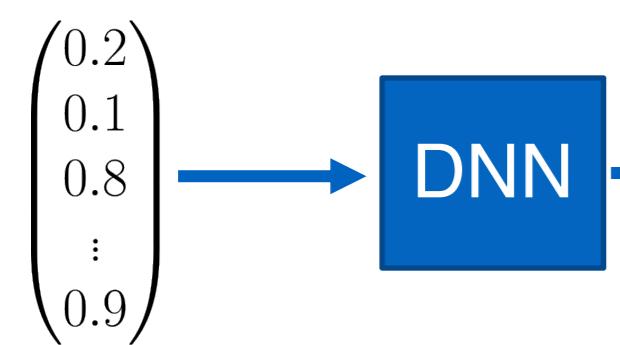
VIRTUAL CHARACTERS





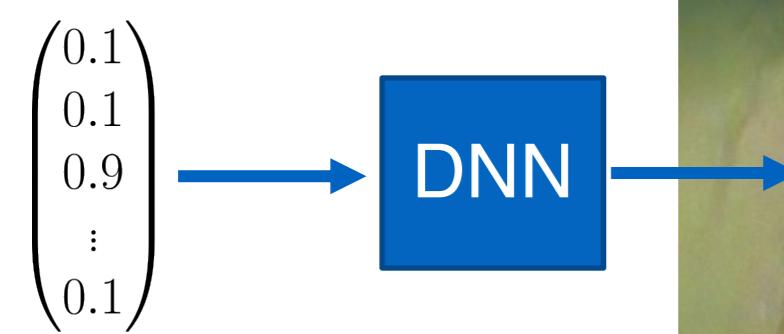
<https://www.youtube.com/watch?v=nTBMghzcrzY>

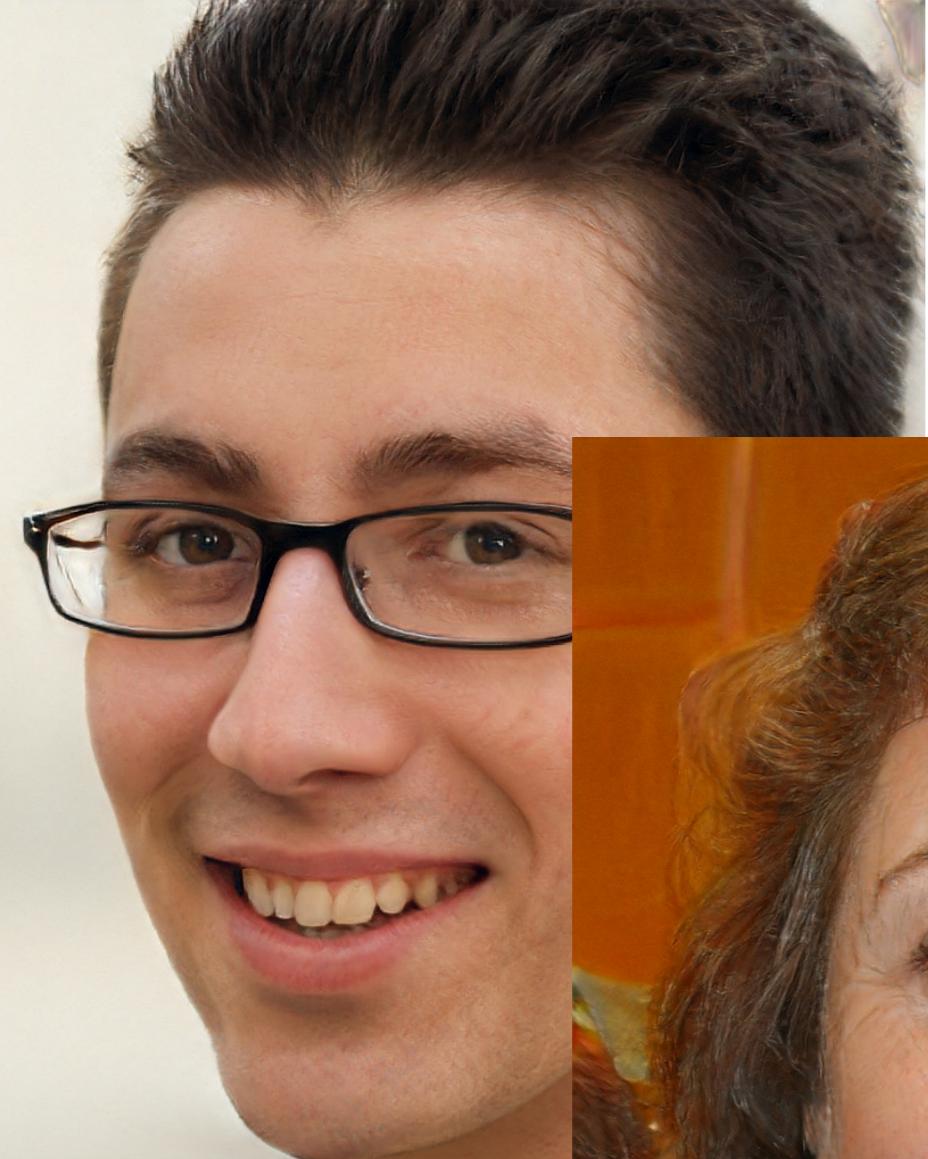




$$\begin{pmatrix} 0.7 \\ 0.7 \\ 0.2 \\ \vdots \\ 0.1 \end{pmatrix}$$







<https://thispersondoesnotexist.com/>
<http://whichfaceisreal.com/index.php>

An A.I.-Generated Picture Won an Art Prize. Artists Aren't Happy.

“I won, and I didn’t break any rules,” the artwork’s creator says.

[Give this article](#)

1.5K



Jason Allen's A.I.-generated work, "Théâtre D'opéra Spatial," took first place in the digital category at the Colorado State Fair. via Jason Allen

Diffusion Models



vibrant portrait painting of Salvador Dalí with a robotic half face



a shiba inu wearing a beret and black turtleneck



a close up of a handpalm with leaves growing from it



an espresso machine that makes coffee from human souls, artstation



panda mad scientist mixing sparkling chemicals, artstation



a corgi's head depicted as an explosion of a nebula

Dall-E2

It's a good time to do
computer vision

Platinum Donors



Gold Donors



Silver Donors



Bronze Donors



Startup Donors



Industry aggressively hiring CV graduates, or even students!

(strong dominant industrial presence at conferences
for recruitment)

[facebook research](#) [Research Areas](#) [Publications](#) [People](#) [Programs](#) [Downloads](#) [Careers](#) [Blog](#) [Q](#)

JULY 21, 2017

Advancing computer vision technologies at CVPR 2017

By: Facebook Research

 [Google Research Blog](#)

The latest news from Research at Google

Google at CVPR 2017

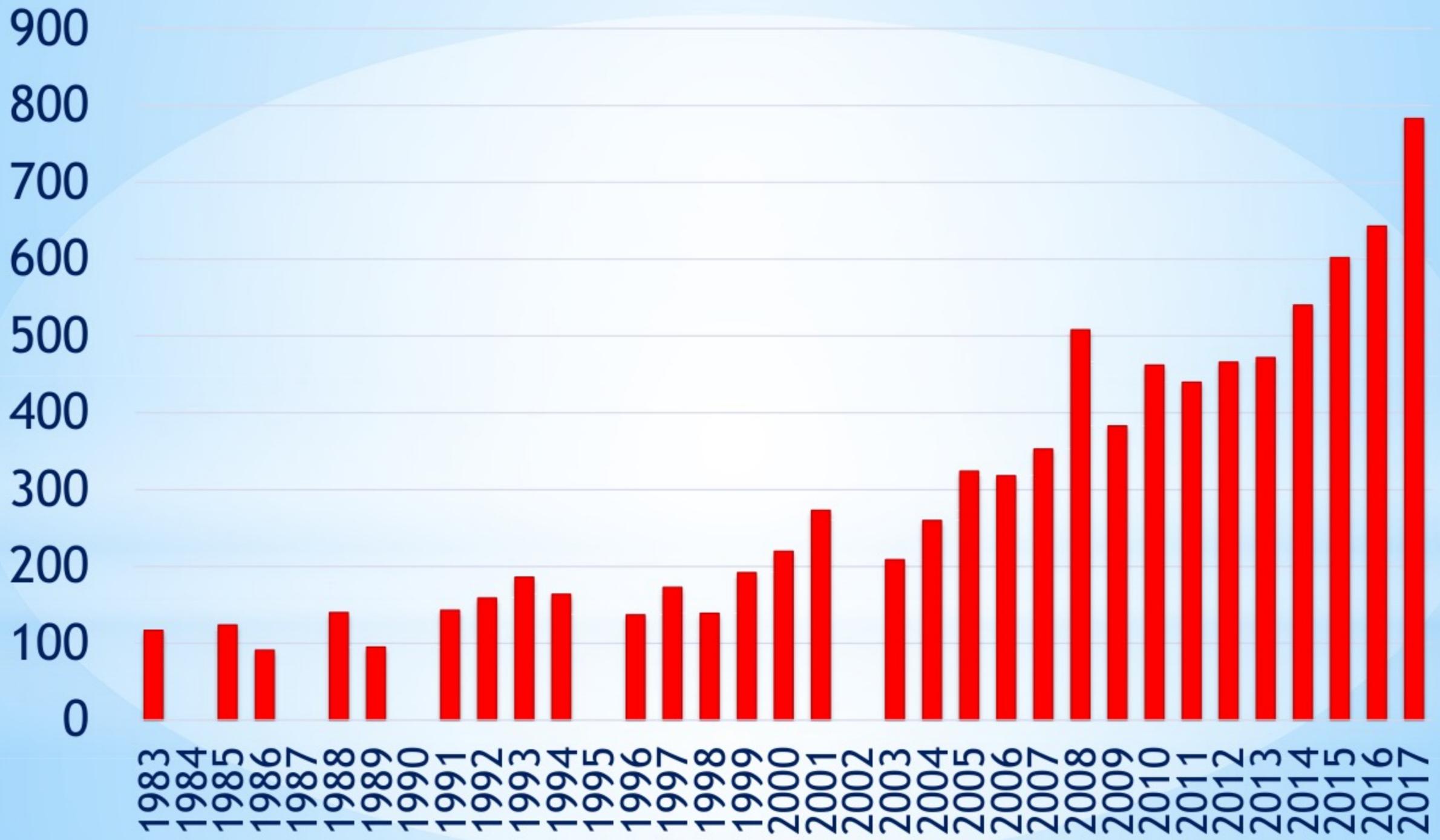
Friday, July 21, 2017



CVPR GROWTH

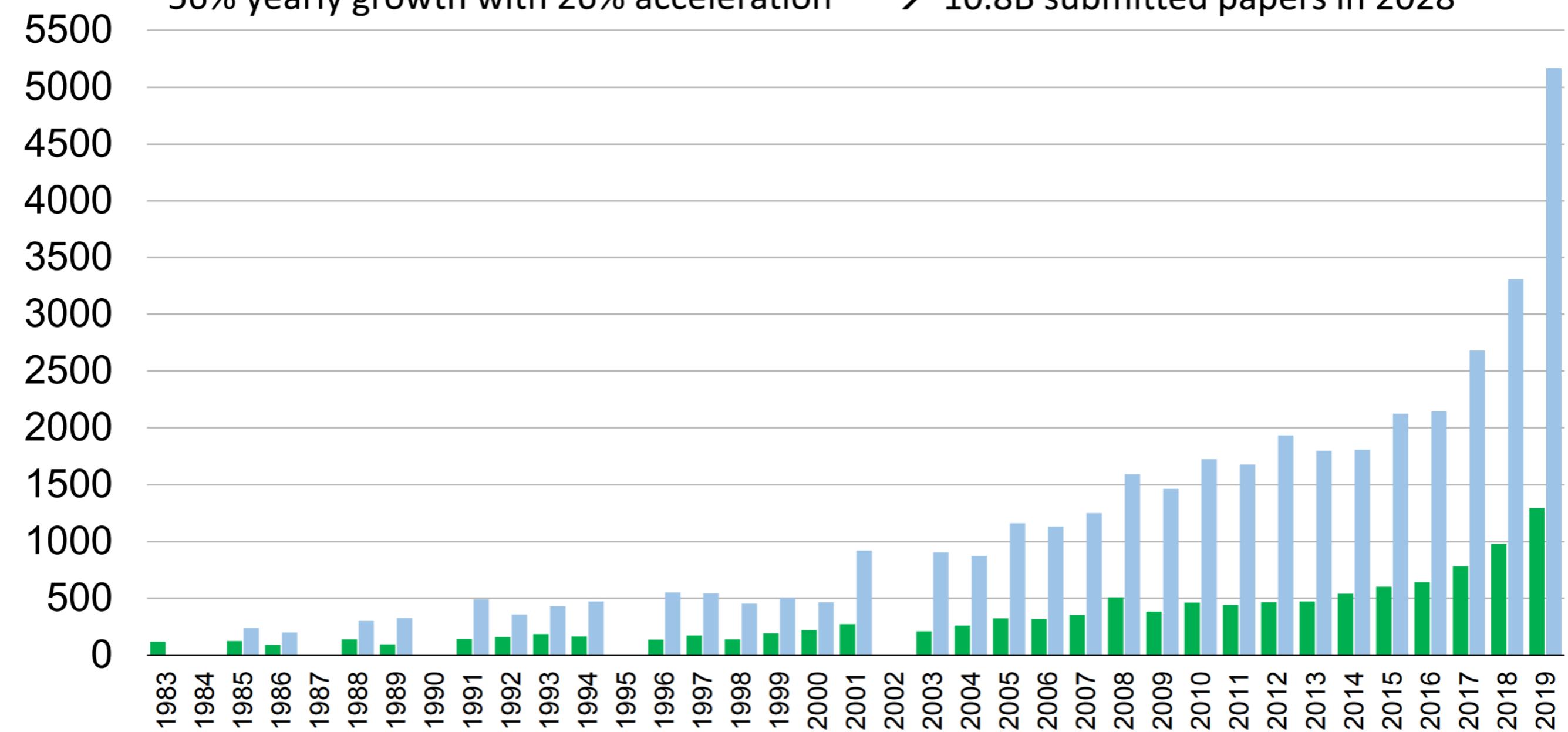
Number of **papers** at CVPR

*Original slide
courtesy of
CVPR 2016*



CVPR Submitted and Accepted Papers

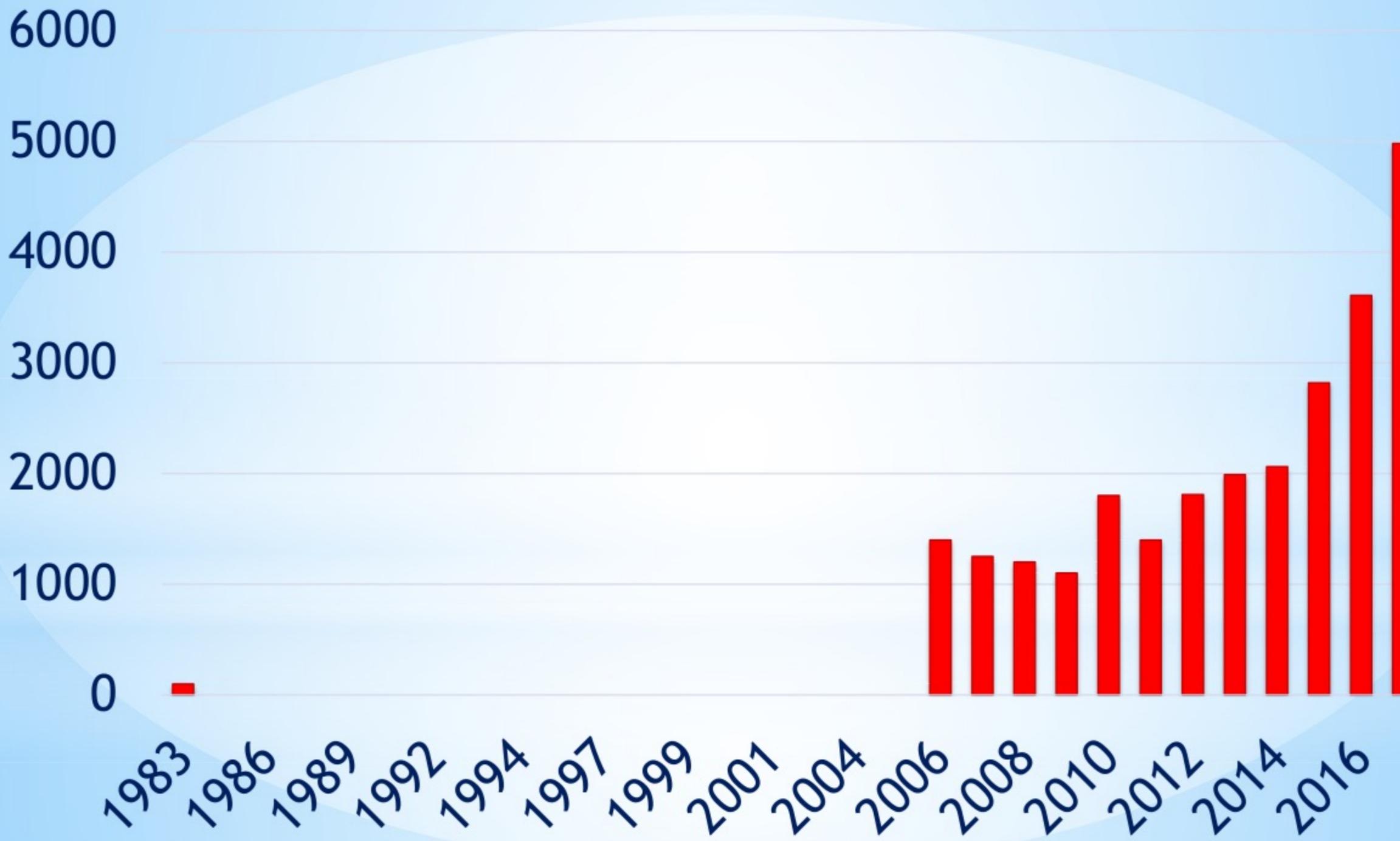
56% yearly growth with 26% acceleration → 10.8B submitted papers in 2028



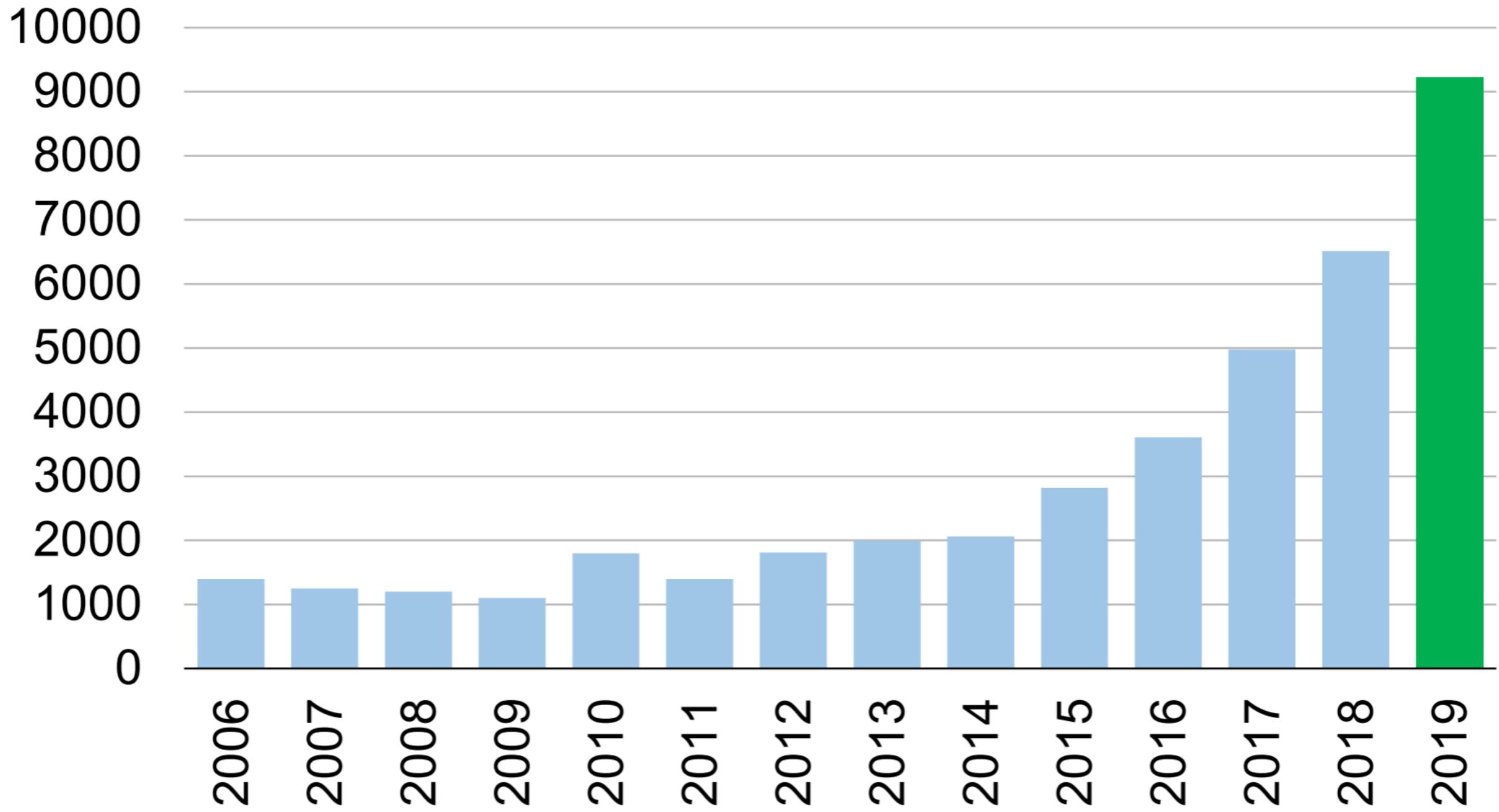
CVPR GROWTH

Number of attendees at CVPR

*Original slide
courtesy of
CVPR 2016*



CVPR Attendance Trend



Course logistics

Spring 2025

Home

Pages

Discussions

Grades

People

Course Experience
Surveys

Recent Announcements

Computer Vision (CMPT412/762)

Links

- [Official schedule](#) (global source of truth)
- [Official course outline](#)

Github classroom sign-up links

- hw0: [github classroom](#) (not graded)
- hw1: neural nets

Office hours

- Instructor ([Andrea Tagliasacchi](#)): Thursdays 5:20pm–6:20pm @ TASC1 9205
- TA ([Shrisudhan Govindarajan](#)): Tuesdays 3:00–4:00 @ ASB9808
- TA ([Yalda Foroutan](#)): Mondays 11:00–12:00 @ ASB9804

Grading

- Homeworks only; see schedule for % distribution

Disclaimer (Github Classroom)

Github Classroom collects personal information on behalf of SFU under the authority of the University Act (RSBC 1996, c.468) and the Freedom of Information and Protection of Privacy Act (RSBC 1996, c.165). The personal information collected includes your github account username, and its association with your SFU email. It is related directly to and needed by the University to help TAs to grade coding assignments effectively, and provide students with interactive auto-grading tools to self-assess the completion of assignments. The information will be used to associate the work submitted to Github Classroom with an SFU student, for the purpose of assigning a grade. This information may be disclosed to the TAs and other students of the class. If you have any questions about the collection and use of this information please contact: Lee Greenough, Manager of Research and Instructional Computing, leegreen@sfu.ca, +1 778 782 6597.

Read the disclaimer!

Disclaimer (Github Classroom)

Github Classroom collects personal information on behalf of SFU under the authority of the University Act (RSBC 1996, c.468) and the Freedom of Information and Protection of Privacy Act (RSBC 1996, c.165). The personal information collected includes your github account username, and its association with your SFU email. It is related directly to and needed by the University to help TAs to grade coding assignments effectively, and provide students with interactive auto-grading tools to self-assess the completion of assignments. The information will be used to associate the work submitted to Github Classroom with an SFU student, for the purpose of assigning a grade. This information may be disclosed to the TAs and other students of the class. If you have any questions about the collection and use of this information please contact: Lee Greenough, Manager of Research and Instructional Computing, leegreen@sfu.ca, +1 778 782 6597.

Course Schedule

2:30PM–5:20PM Lecture @ K9500

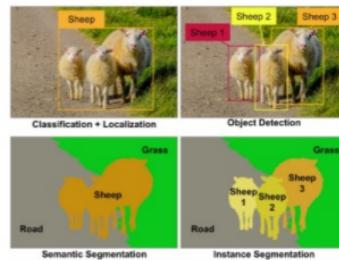
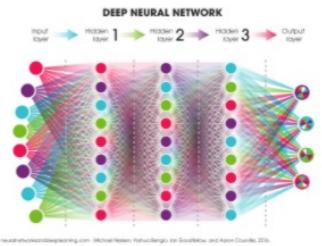
1	Thu, Jan 9	Introduction Neural Networks
2	Thu, Jan 16	Convolutional Neural Networks Training CNNs
3	Thu, Jan 23	Classics (features + bag of words) Intro to pytorch (shri@colab)
4	Thu, Jan 30	Detection CNNs Segmentation CNNs (pt1)
5	Thu, Feb 6	Segmentation CNNs (pt2) Metric learning techniques
6	Thu, Feb 13	CNN applications (pt1) CNN applications (pt2)
	Thu, Feb 20	READING BREAK – NO CLASSES
7	Thu, Feb 27	RNNs and GNNs Transformer and GANs
8	Thu, Mar 6	Self-supervised Learning Image homographies
9	Thu, Mar 13	Camera Models (pt1) Camera Models (pt2)
10	Thu, Mar 20	Two-view Geometry (pt1) Two-view Geometry (pt2)
11	Thu, Mar 27	Stereo Structure from Motion / SLAM
12	Thu, Apr 3	Multi-view stereo

Pattern
Recognition

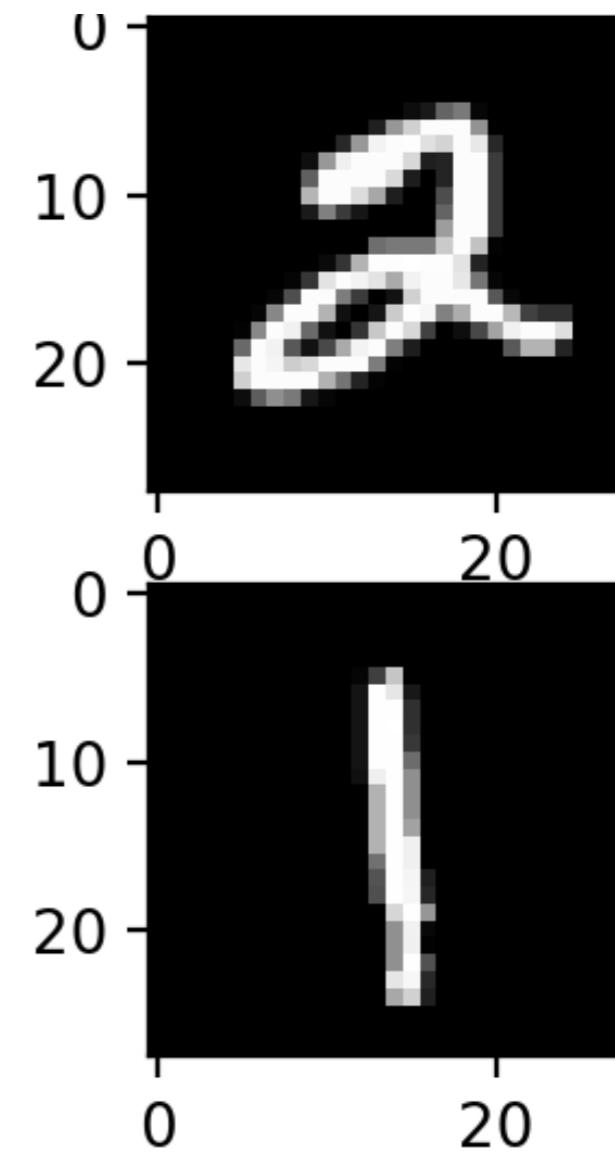
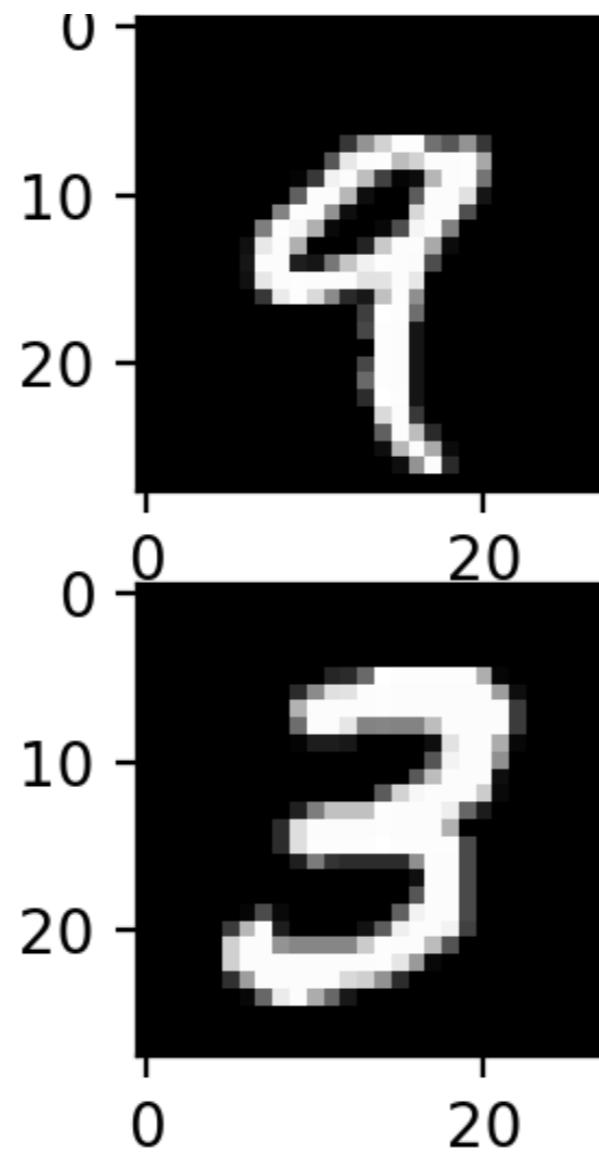
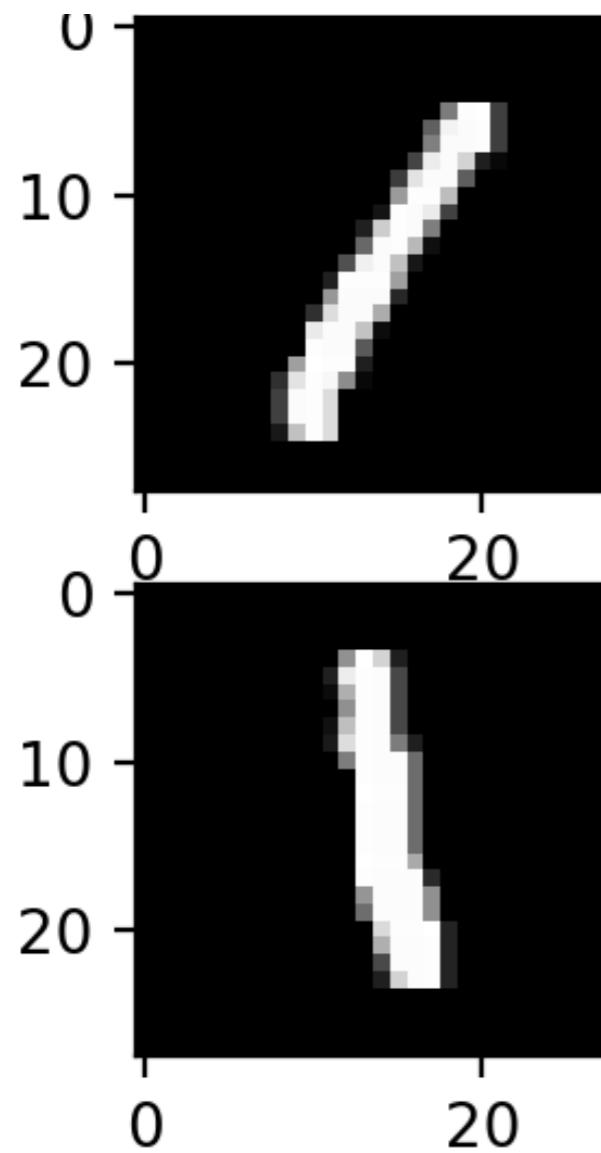
Geometric
Vision

Assignments (Python)

	2:30PM–5:20PM	Lecture @ K9500	Hw (due 11:59pm)
1	Thu, Jan 9	Introduction Neural Networks	Hw1 – 13% Neural Nets + Convs (due Jan. 29)
2	Thu, Jan 16	Convolutional Neural Networks Training CNNs	Hw 2 – 15% Classification (due Feb. 12 on kaggle)
3	Thu, Jan 23	Classics (features + bag of words) Intro to pytorch (shri@colab)	Hw3 – 33% Segmentation + Detection (due Mar. 12 on kaggle)
4	Thu, Jan 30	Detection CNNs Segmentation CNNs (pt1)	Hw4 – 17% Epipolar Geometry (due Mar. 27)
5	Thu, Feb 6	Segmentation CNNs (pt2) Metric learning techniques	Hw5 – 22% Stereo Matching (due Apr. 9)
6	Thu, Feb 13	CNN applications (pt1) CNN applications (pt2)	
	Thu, Feb 20	READING BREAK – NO CLASSES	
7	Thu, Feb 27	RNNs and GNNs Transformer and GANs	
8	Thu, Mar 6	Self-supervised Learning Image homographies	
9	Thu, Mar 13	Camera Models (pt1) Camera Models (pt2)	
10	Thu, Mar 20	Two-view Geometry (pt1) Two-view Geometry (pt2)	
11	Thu, Mar 27	Stereo Structure from Motion / SLAM	
12	Thu, Apr 3	Multi-view stereo	



Hw1: Neural Nets



Hw2: Classification

bird



cat



deer



dog



frog



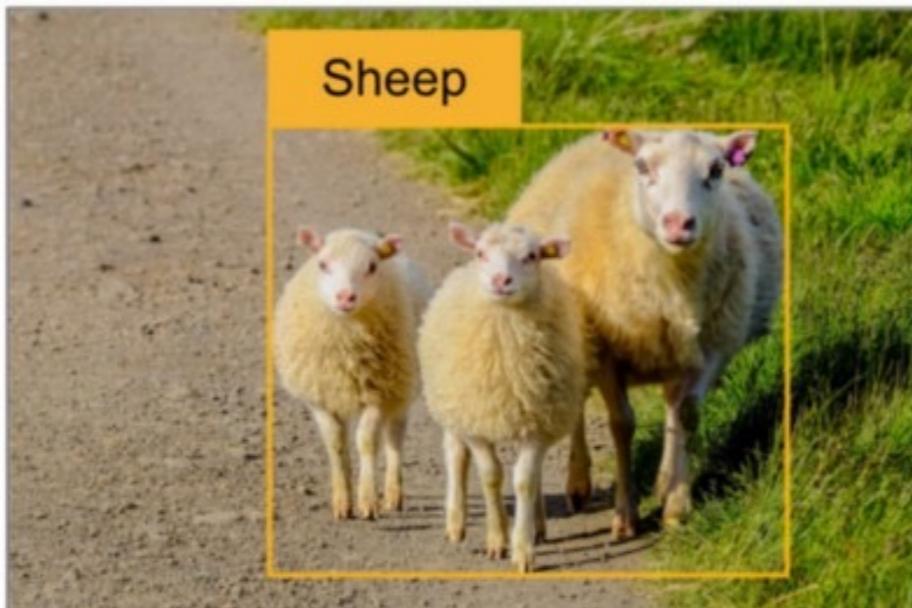
horse



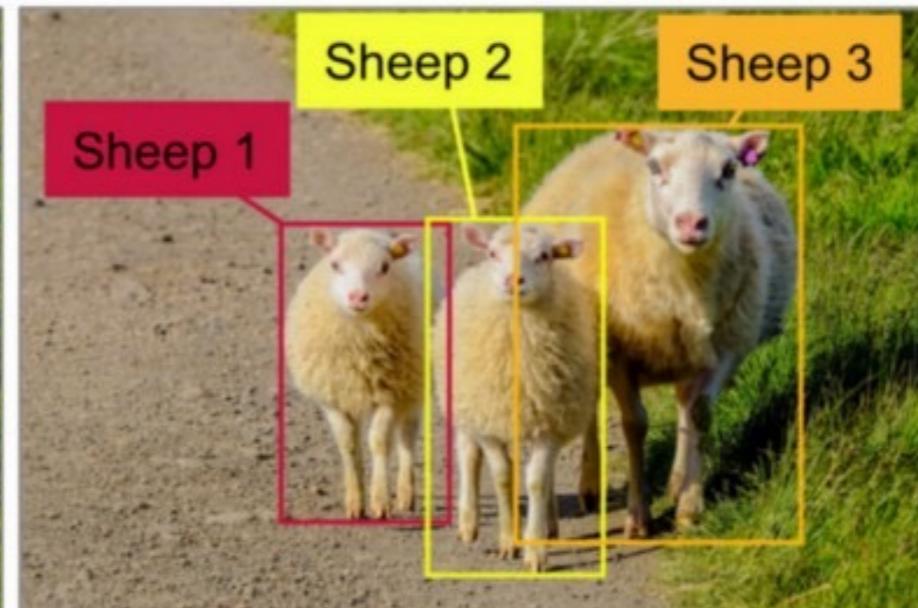
ship



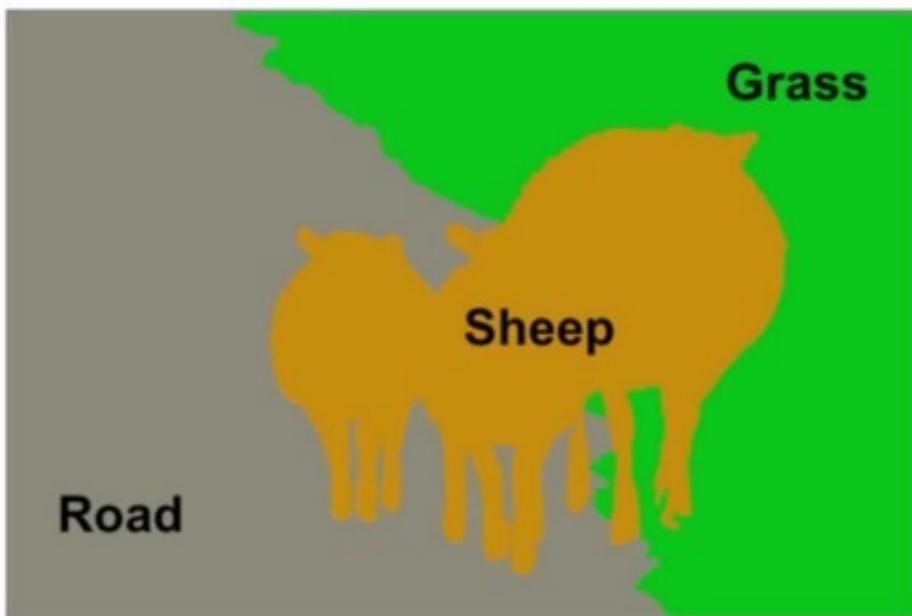
Hw3: Segmentation/Detection



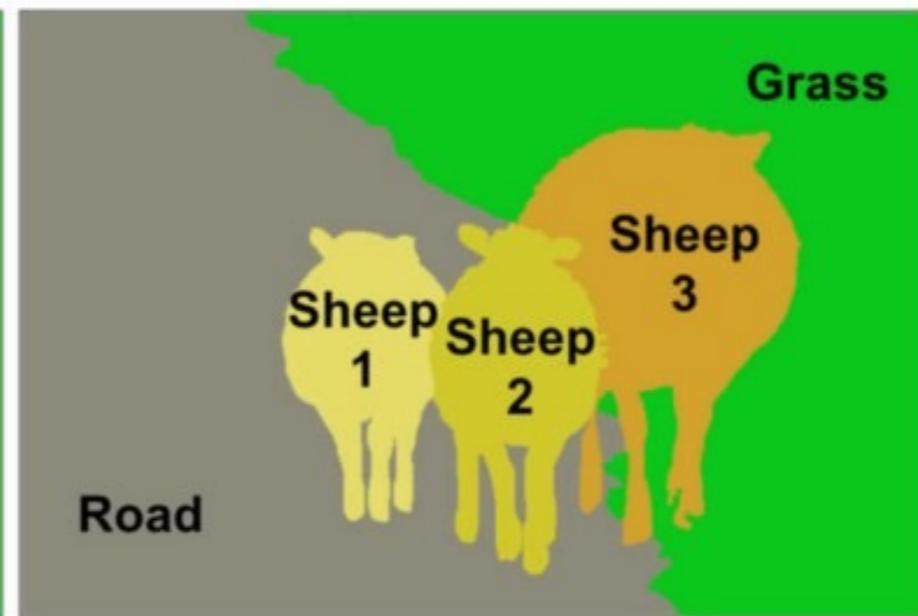
Classification + Localization



Object Detection



Semantic Segmentation



Instance Segmentation

Hw4: Epipolar Geometry

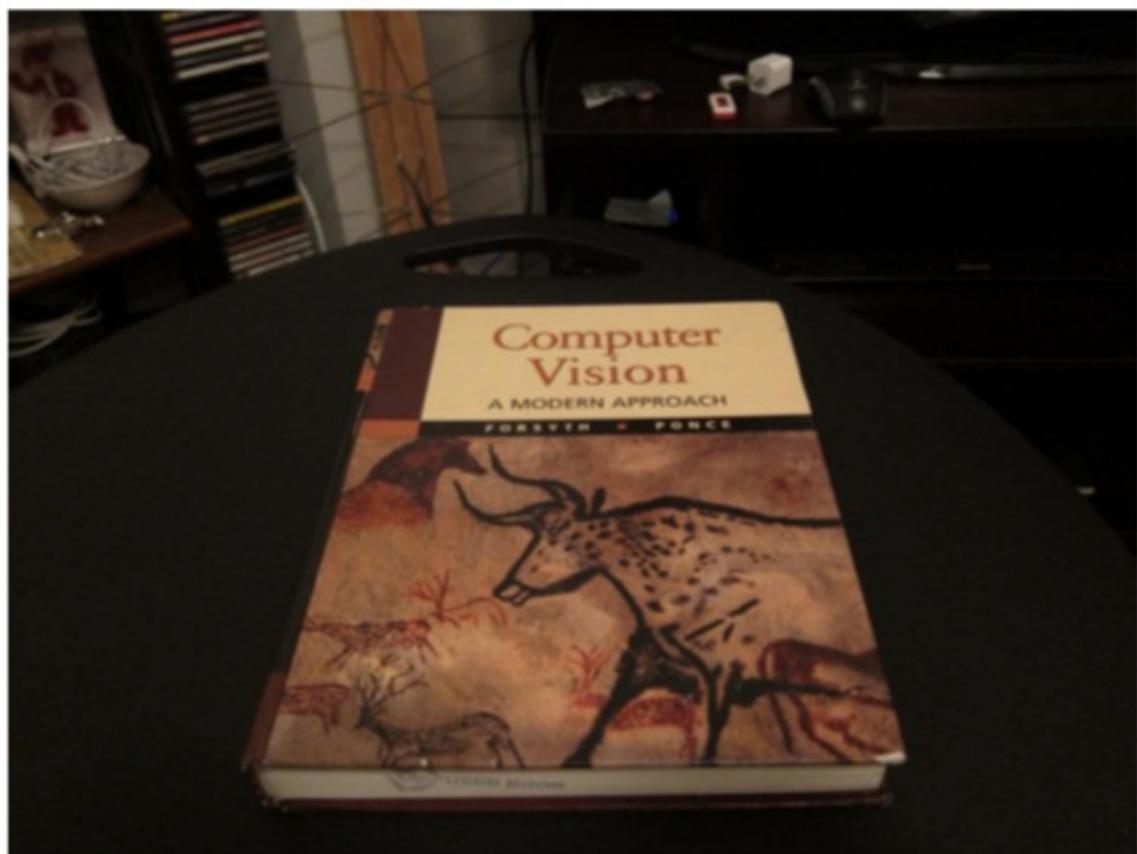


Figure 3: Text book

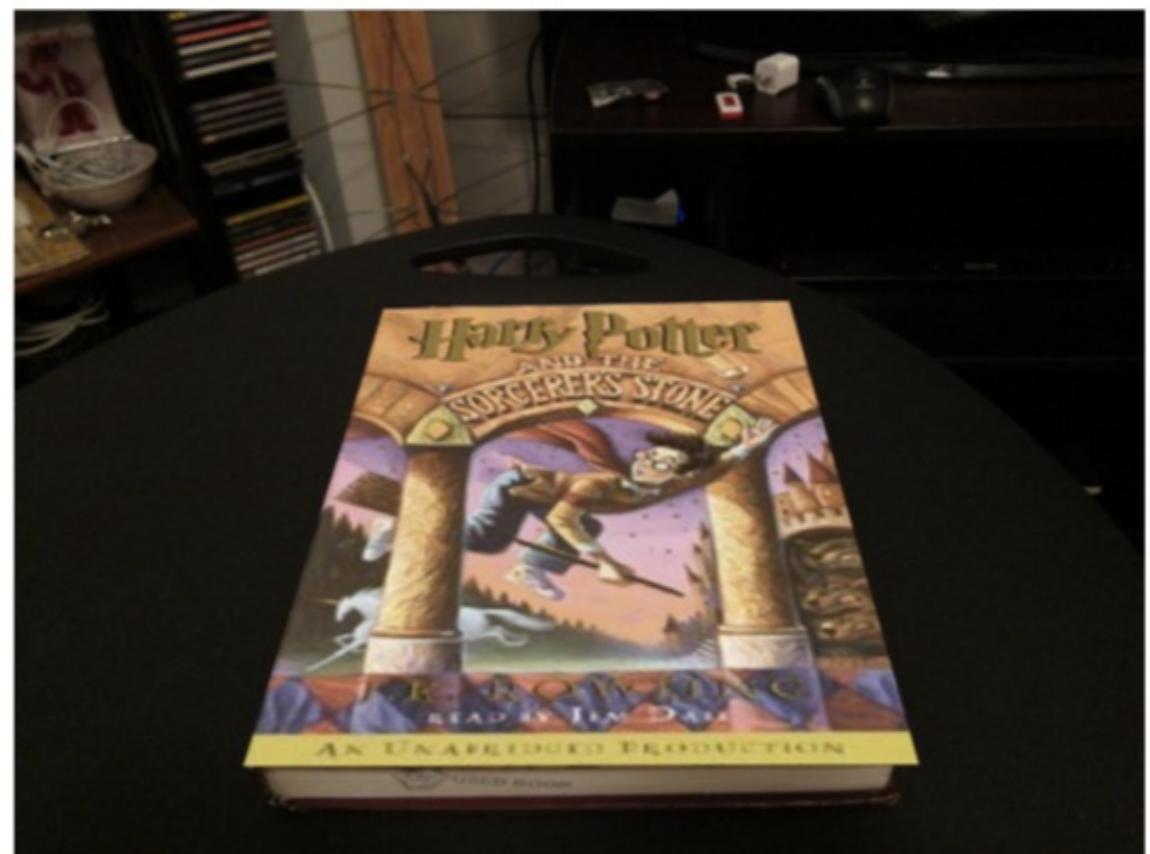
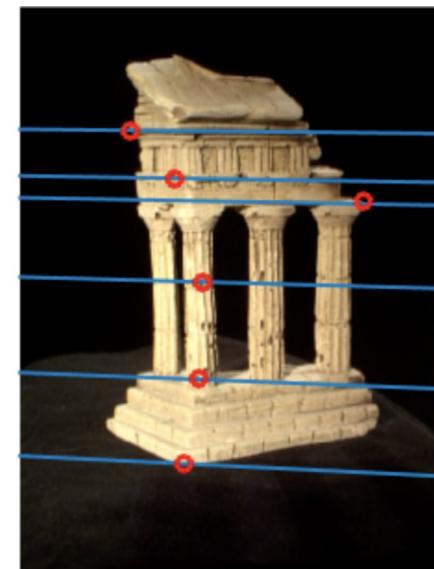


Figure 4: HarryPotterized Text book

Hw5: Stereo Matching



Select a point in this image
(Right-click when finished)



Verify that the corresponding point
is on the epipolar line in this image

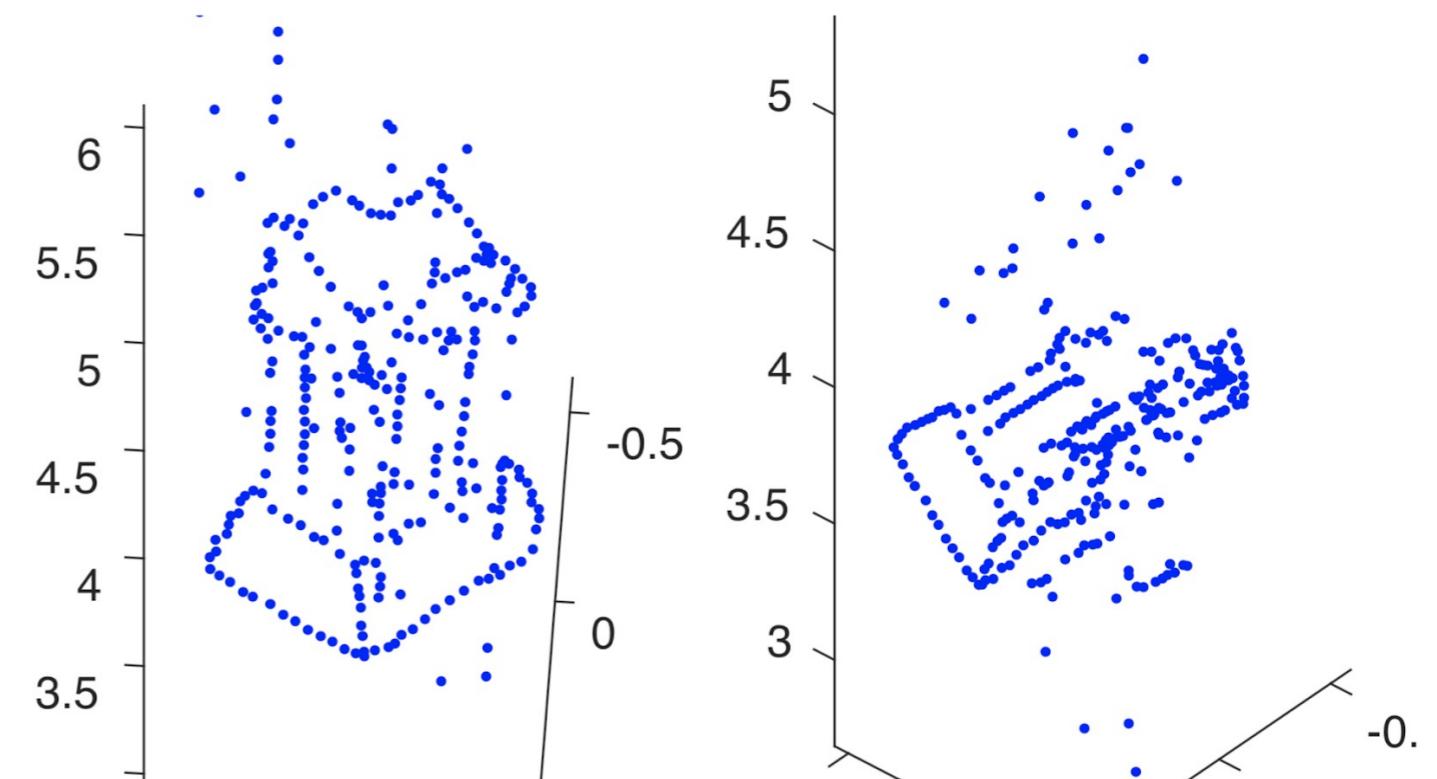


Figure 7: Epipolar Match visualization. A few errors are alright, but it should get most easy points correct (corners, dots, etc...)

Figure 8: Sample Reconstructions

Assignments (Python)

	2:30PM–5:20PM	Lecture @ K9500	Hw (due 11:59pm)
1		Introduction Thu, Jan 9 Neural Networks	
2		Convolutional Neural Networks Thu, Jan 16 Training CNNs	Hw1 – 13% Neural Nets + Convs (due Jan. 29)
3		Classics (features + bag of words) Thu, Jan 23 Intro to pytorch (shri@colab)	
4		Detection CNNs Thu, Jan 30 Segmentation CNNs (pt1)	Hw 2 – 15% Classification (due Feb. 12 on kaggle)
5		Segmentation CNNs (pt2) Thu, Feb 6 Metric learning techniques	
6		CNN applications (pt1) Thu, Feb 13 CNN applications (pt2)	
7	Thu, Feb 20	READING BREAK – NO CLASSES	
8		RNNs and GNNs Thu, Feb 27 Transformer and GANs	Hw3 – 33% Segmentation + Detection (due Mar. 12 on kaggle)
9		Self-supervised Learning Thu, Mar 6 Image homographies	
10		Camera Models (pt1) Thu, Mar 13 Camera Models (pt2)	Hw4 – 17% Epipolar Geometry (due Mar. 27)
11		Two-view Geometry (pt1) Thu, Mar 20 Two-view Geometry (pt2)	
12		Stereo Thu, Mar 27 Structure from Motion / SLAM	Hw5 – 22% Stereo Matching (due Apr. 9)
		Thu, Apr 3 Multi-view stereo	

kaggle Competitions Datasets Models Code Discussions Courses

Level up with the largest AI & ML community

Join over 21M+ machine learners to share, stress test, and stay up-to-date on all the latest ML techniques and technologies. Discover a huge repository of community-published models, data & code for your next project.

[Register with Google](#) [Register with Email](#)

groups up to 3 students

Grading

- 5 coding assignments (sum up to 100%)
 - New this year: bonus questions!
- Relative components/competitions in grading

412 and 762 separately (?)

Assignments:

- a lot of programming
in Python (and pyTorch)
- hours and hours of programming
- days and days of debugging

Please:

- register on canvas
- post questions on canvas
- ask and answer questions

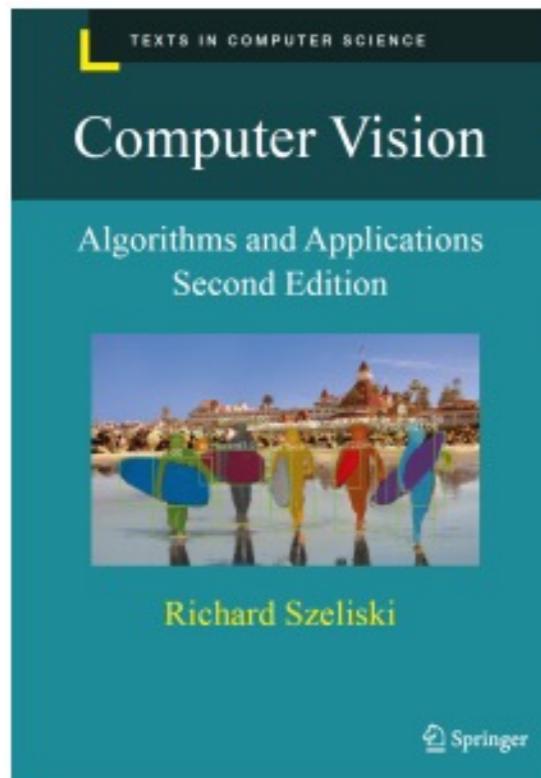
Late Policy (Mori's Law)

- 5 free late-days in total
- Your call whether you spend 5 late days on hw1, and 0 late days on everything else
- >5 days... hw* gets graded at 0% (no mercy)
- Non integer lateness is quantized up
(i.e. 3m late == 1day late... submit early)

Reference Textbook

Computer Vision: Algorithms and Applications, 2nd ed.

© 2022 [Richard Szeliski](#), The University of Washington



Free PDF online!!!

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

Prerequisites

- Take Intro to Visual Computing first (CMPT 361)
 - Exception granted? I assume you will catch up:
<https://yaksoy.github.io/introvc>
- Solid background on linear algebra and coding experience
- Warning: Computer Vision is cool but requires very solid math and coding skills.

Final note

- We expect that you see all the posts on Canvas
- Ask questions on Canvas to be shared by everybody
- Do not send emails to me or the TA... use Canvas.
- Do not post code/solutions publicly on GitHub
 - Copyright violation... accounts suspended

Let's try Github Classroom!

- Time to take out your laptop!
- Go on canvas, click the hw0 link
- Check out the repository locally
- Complete the task + test with pytest
- Commit and push your changes upstream
- Verify the automation executed against your push

Questions?

	2:30PM–5:20PM	Lecture @ K9500	Hw (due 11:59pm)
1	Thu, Jan 9	Introduction Neural Networks	Hw1 – 13% Neural Nets + Convs (due Jan. 29)
2	Thu, Jan 16	Convolutional Neural Networks Training CNNs	Hw 2 – 15% Classification (due Feb. 12 on kaggle)
3	Thu, Jan 23	Classics (features + bag of words) Intro to pytorch (shri@colab)	
4	Thu, Jan 30	Detection CNNs Segmentation CNNs (pt1)	
5	Thu, Feb 6	Segmentation CNNs (pt2) Metric learning techniques	
6	Thu, Feb 13	CNN applications (pt1) CNN applications (pt2)	Hw3 – 33% Segmentation + Detection (due Mar. 12 on kaggle)
	Thu, Feb 20	READING BREAK – NO CLASSES	
7	Thu, Feb 27	RNNs and GNNs Transformer and GANs	
8	Thu, Mar 6	Self-supervised Learning Image homographies	Hw4 – 17% Epipolar Geometry (due Mar. 27)
9	Thu, Mar 13	Camera Models (pt1) Camera Models (pt2)	
10	Thu, Mar 20	Two-view Geometry (pt1) Two-view Geometry (pt2)	
11	Thu, Mar 27	Stereo Structure from Motion / SLAM	Hw5 – 22% Stereo Matching (due Apr. 9)
12	Thu, Apr 3	Multi-view stereo	

