Introduction



16-385 Computer Vision Fall 2023, Lecture 1

Overview of today's lecture

- Teaching staff introductions
- What is computer vision?
- Course fast-forward and logistics

Teaching staff introductions



Matthew O'Toole (Instructor)



Jinhyung (David) Park



Tianyi Zhang



Minh Tran

What is computer vision?



What a person sees

Ω ſ -3 -3 -3 -0 -3 -5 -5 -9 -5 -3 Ο -3 q Ω q Û -3 -5 -3 -5 - 3 Ω Û -3 -3 -3 -3 - 3 -6

What a computer sees



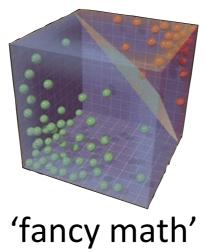
Why are we able to interpret this image?

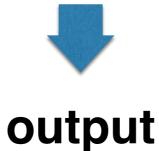
The goal of computer vision is to give computers (super) human-level perception

typical perception pipeline

representation



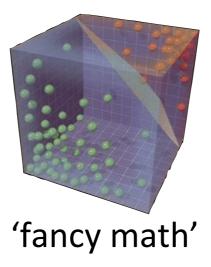




typical perception pipeline

representation



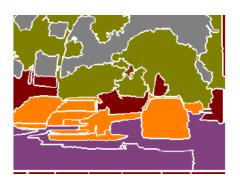




output



what should we look at? (image features)



what can we understand? (semantic segmentation)

Important note:

In general, computer vision does not work

Important note:

In general, computer vision does not work

(except in certain situations/conditions)

Applications of computer vision

Object Recognition



Toshiba Tech IS-910T



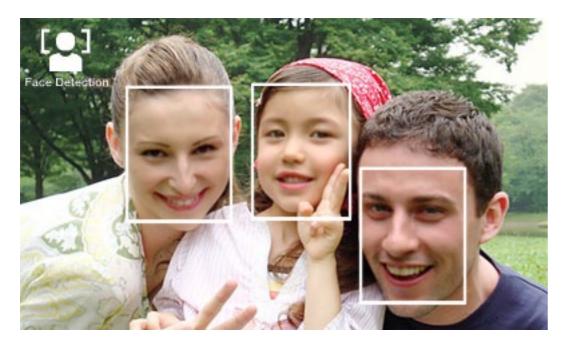


DataLogic LaneHawk LH4000 2012

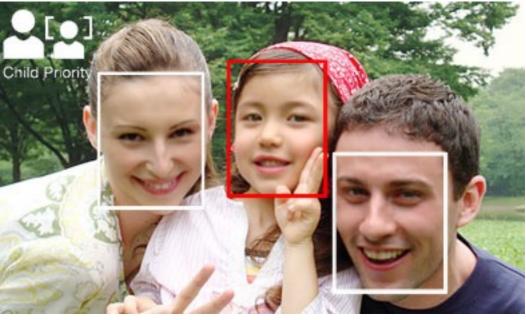
Object Recognition



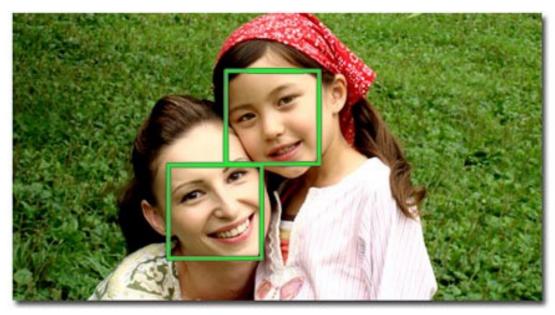
Face detection



Sony Cyber-shot

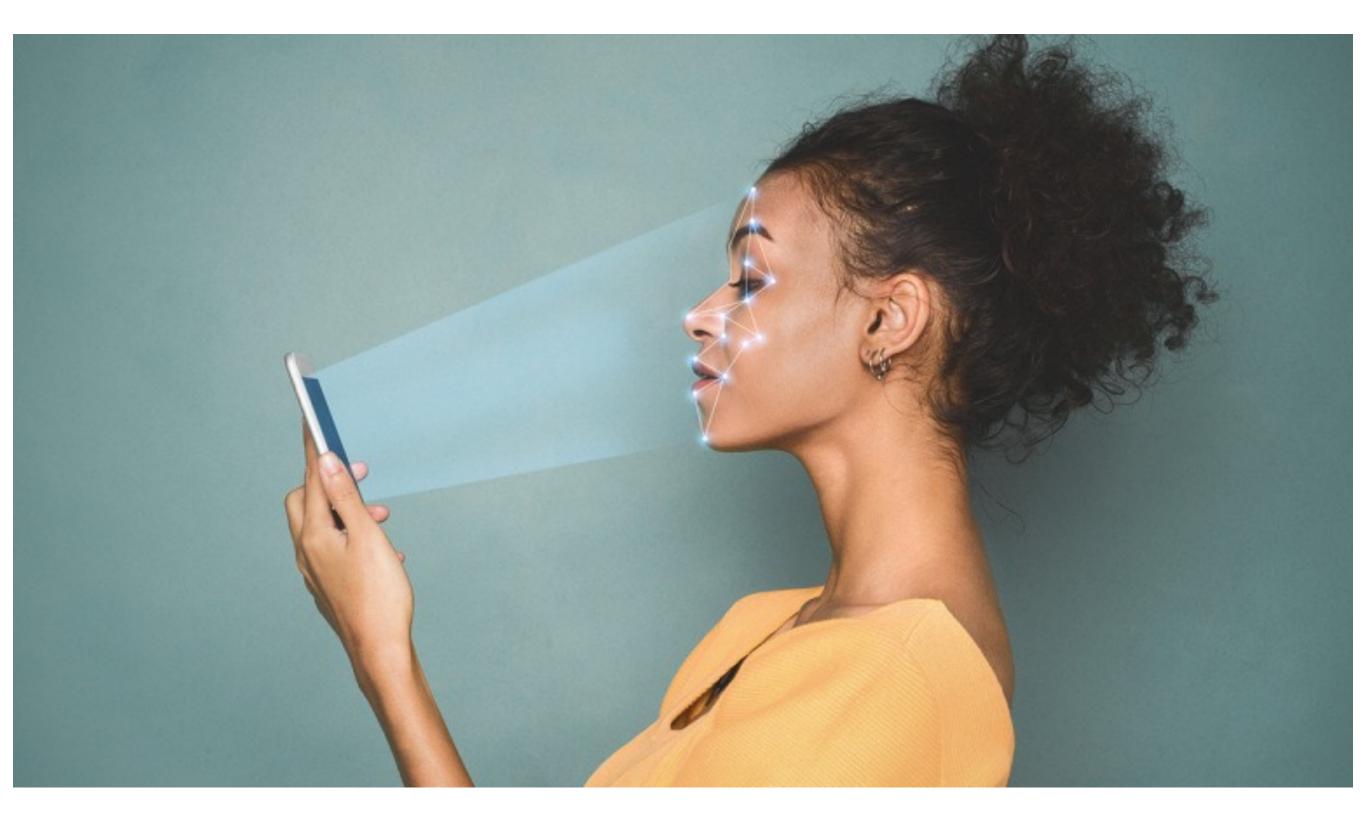


Age recognition



Smile recognition

Face ID



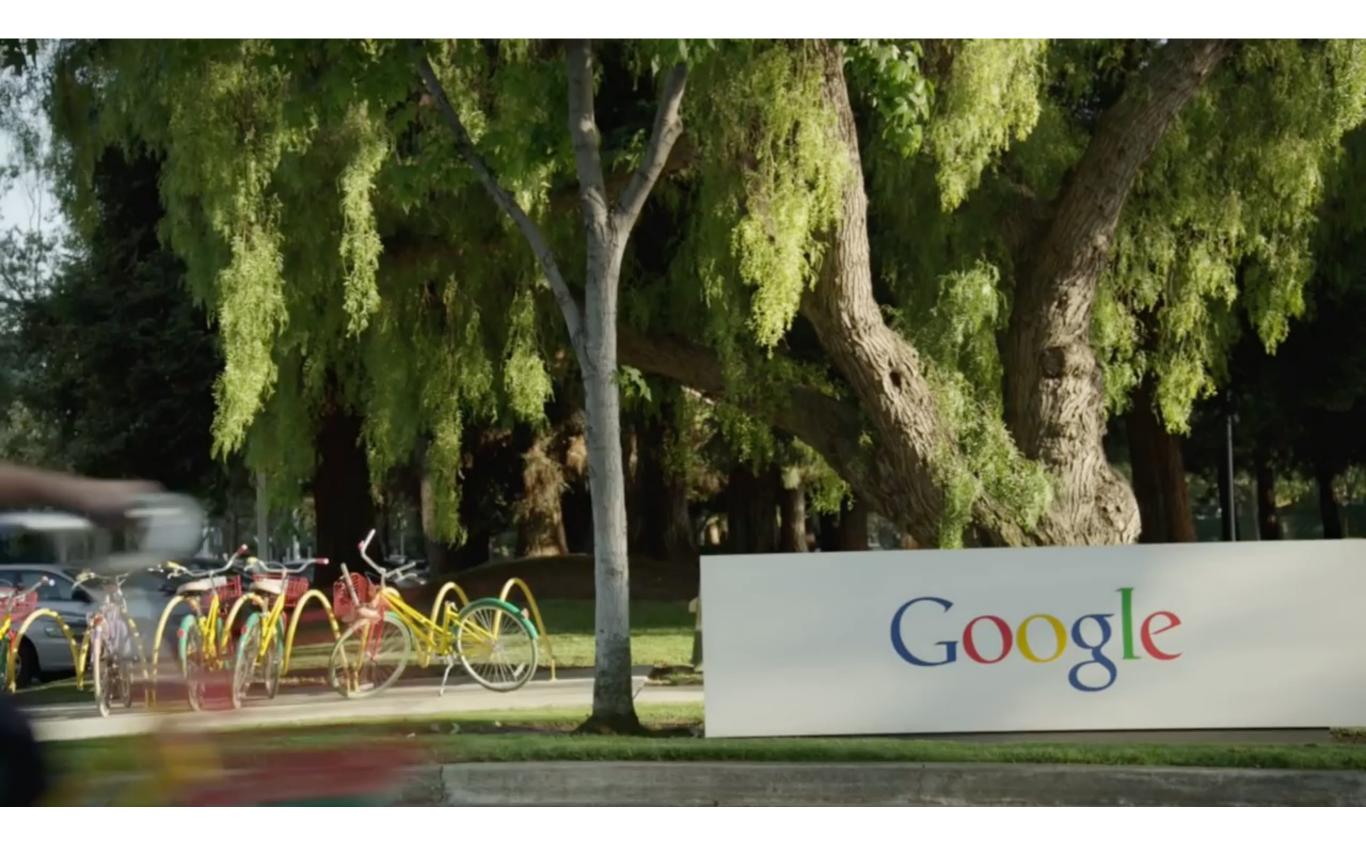
Face ID



Identifying plants



Google translate



First-down line



Vision in Cars

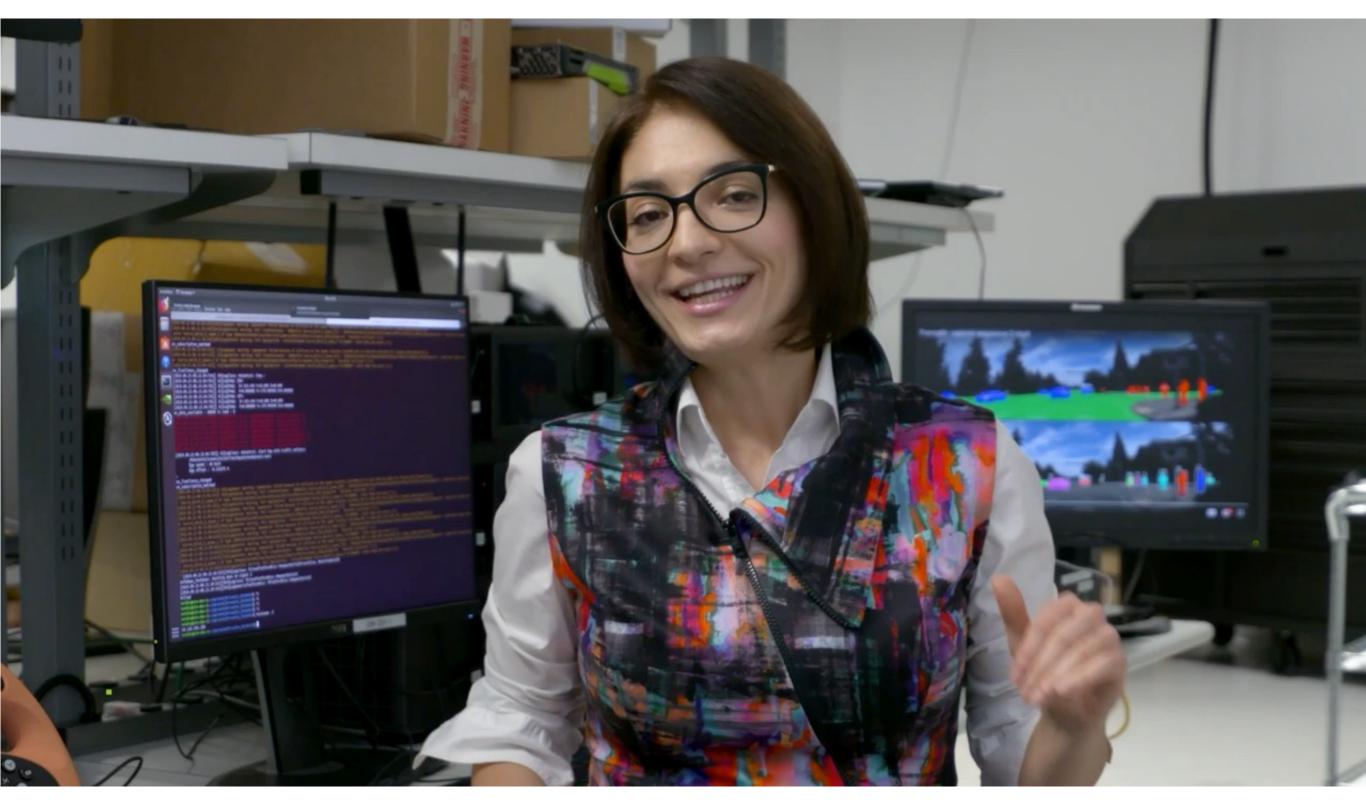
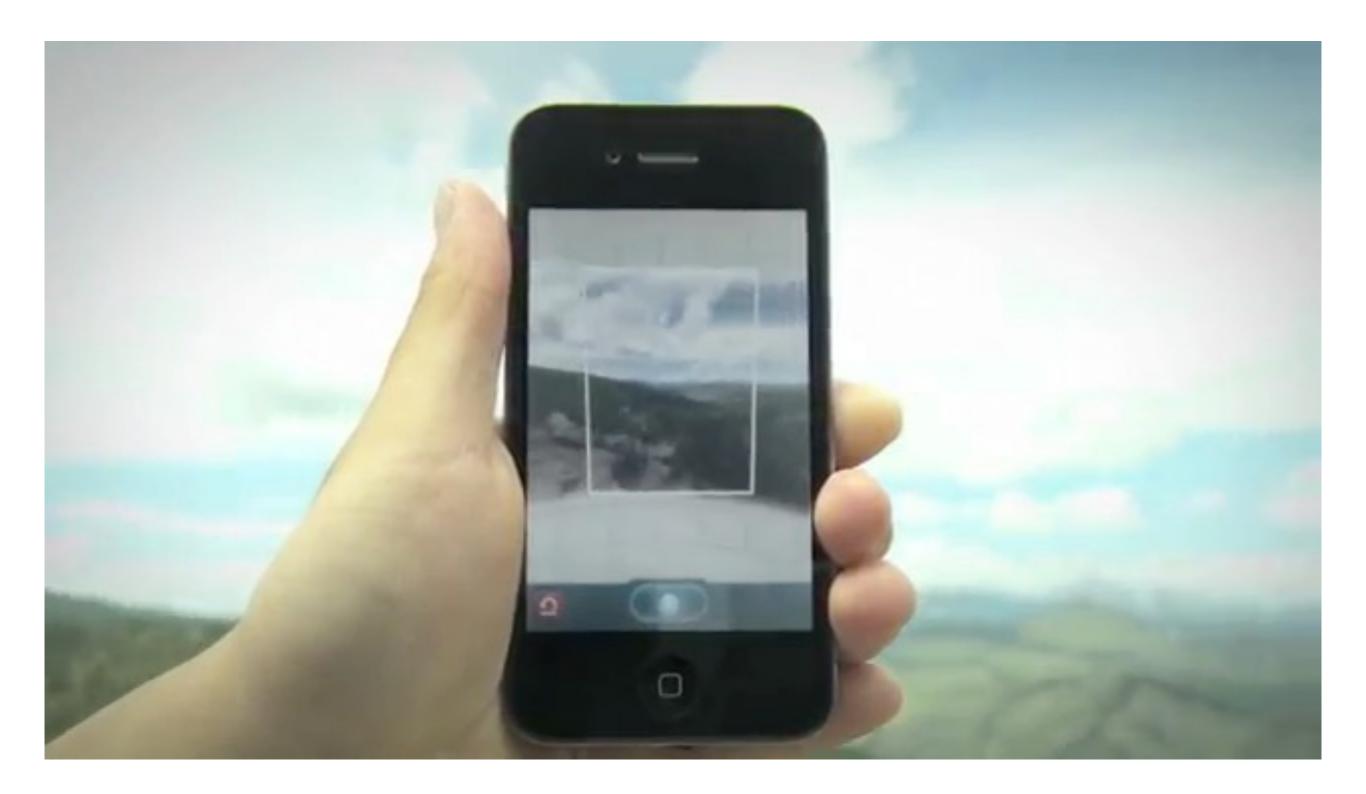


Image stitching



3D Scanning

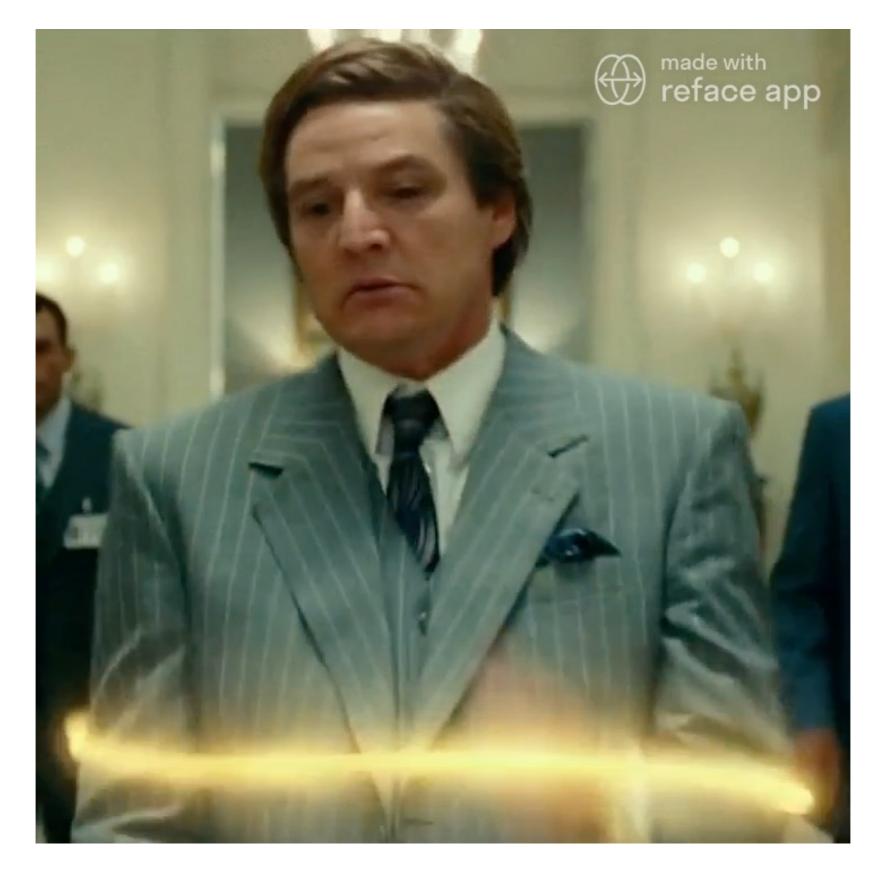
Style Transfer



Deep Fake

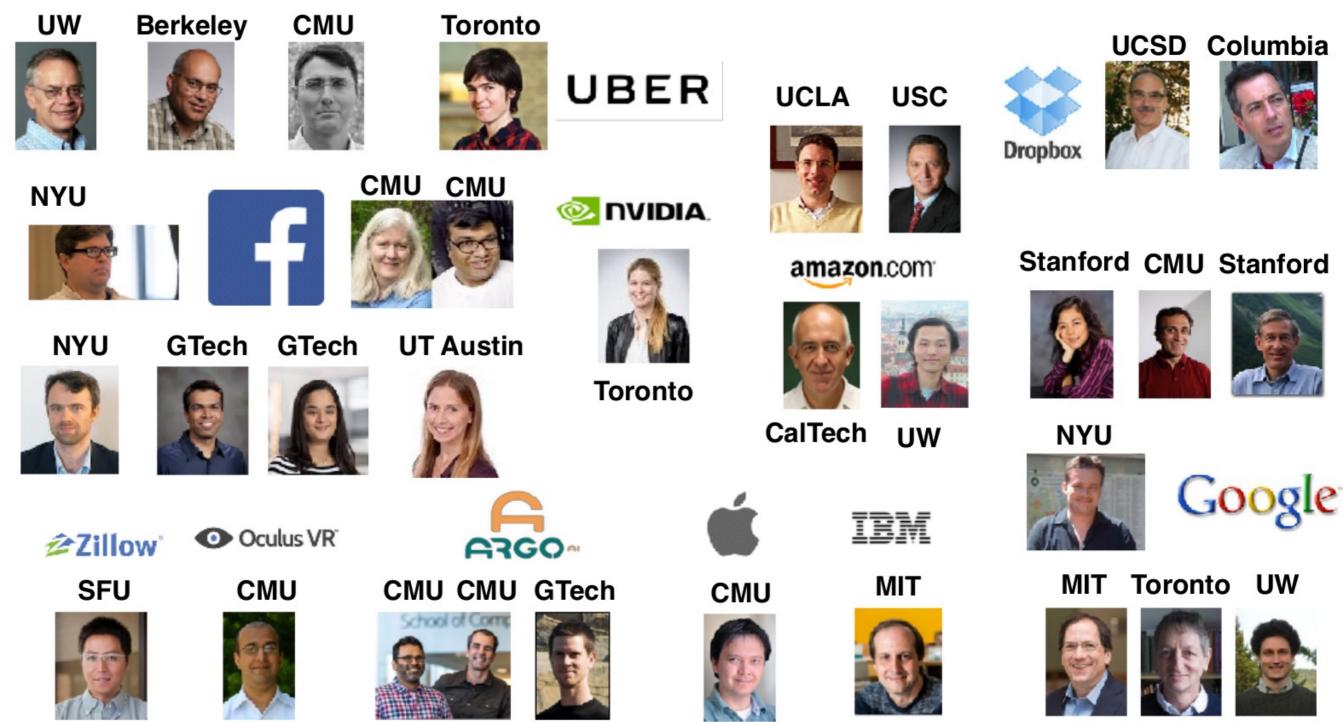


Deep Fake



It's a good time to do computer vision

Industry aggressively hiring CV faculty from universities



Platinum Donors facebook amazon Microsoft Google **NVIDIA** Tencent 腾讯 (intel) Nervana A MOMENTA Gold Donors HISCENE O Mighty Ai Robot CVTE 视源股份 😚 MALONG 码隆 🕋 Sighthound **BOSCH** A MTSUBBH U Simple nuTonomy Face⁺⁺ 비 小川 meitu MMTLAB COGNEX 💐 ARGO AI Snap Inc. Silver Donors TATATANG Kitware UBER ATG Diskep Research O Pinterest VionVision TOYOTA SIEMENS ... AIMATTER & XILINX lealthineers Bronze Donors MathWorks 🕜 matterport 🔨 Mapillary Lunit omron Deringer SPORTLOG CloudSight" Horizon Robotic vip.com Panasonic SEGWAY AXON ROGOTICS DAITUOT A 3dMD Zillow DAiCure gumgum" (Synaptics' S NIO object/ideo Ingenerity for life NetP®sa Yandex 👤 playground 🕝 CrowdFlower Startup Donors MORPX AUTOMATA Wrnch inilabs Autox EATURE FEATURE ANANTAK TS spotscale deepcognal 😭 Shopagon speechacean 🥂 水滴科技 🏭 MLJKH Non-Profit Donors S CHOUS EYENUK 7 NEXT A MARKABLE SANCE OFTICE

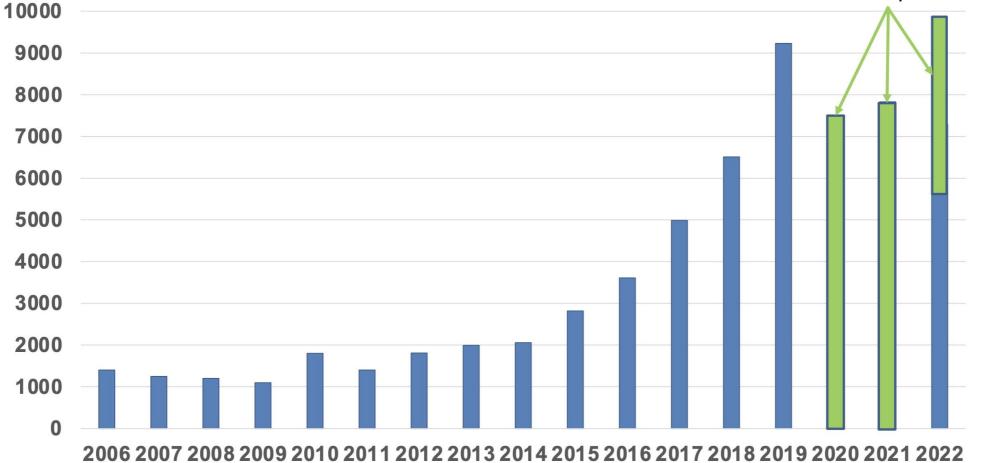
Industry aggressively hiring CV graduates, or even students!

(strong dominant industrial presence at conferences for recruitment)

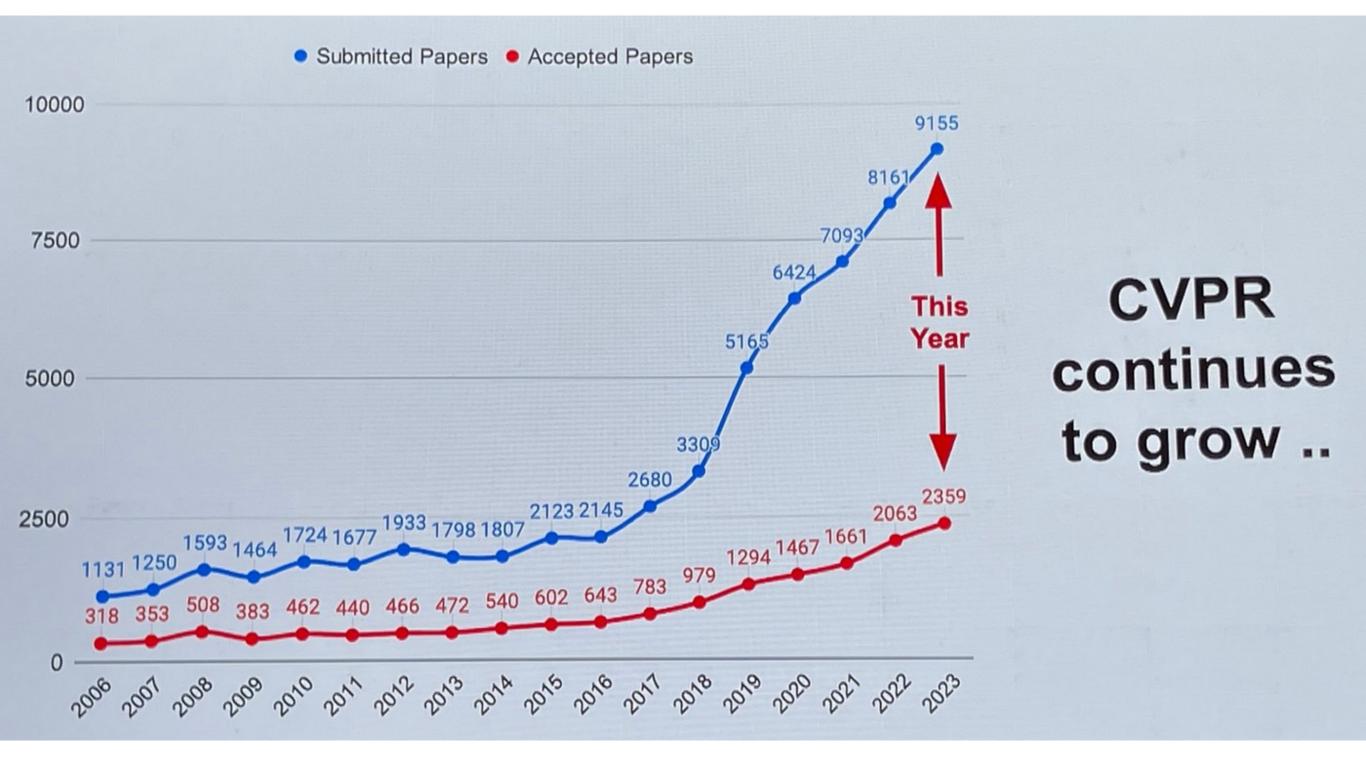
Stats for CVPR (Computer Vision and Pattern Recognition)

CVPR Attendance Trend (as of June 20, 2022)

Remote/Virtual attendees



Stats for CVPR (Computer Vision and Pattern Recognition)



2Image and video synthesis and generation8893Humans: Face, body, pose, gesture, movement8114Transfer, meta, low-shot, continual, or long-tail learning6885Recognition: Categorization, detection, retrieval6736Vision, language, and reasoning6317Low-level vision5538Segmentation, grouping and shape analysis5249Deep learning architectures and techniques48510Multi-modal learning490113D from single images4312Medical and biological vision, cell microscopy42013Video: Action and event understanding37314Autonomous driving39515Self-supervised or unsupervised representation learning34916Datasets and evaluation24417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision52220Computational imaging22621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision if graphics15524Robotics14425Transparency, fairness, accountability, privacy, ethics in vision12526Explainable computer vision10127Embodied vision: Active agents, simulation8028Document analysis and understanding7229 <t< th=""><th>1</th><th>3D from multi-view and sensors</th><th>1,090</th><th>246</th></t<>	1	3D from multi-view and sensors	1,090	246
3Humans: Face, body, pose, gesture, movement8134Transfer, meta, low-shot, continual, or long-tail learning6885Recognition: Categorization, detection, retrieval6736Vision, language, and reasoning6317Low-level vision5538Segmentation, grouping and shape analysis5249Deep learning architectures and techniques48510Multi-modal learning450113D from single images4312Medical and biological vision, cell microscopy42013Video: Action and event understanding35314Autonomous driving35915Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision35220Computational imaging22521Vision + graphics14522Vision applications and systems17123Vision + graphics14524Robotics14625Transparency, fairness, accountability, privacy, ethics in vision12726Explainable computer vision12727Machine learning (other than deep learning)6529Machine learning (other than deep learning)6529Machine learning (other than deep learning)6530Physics-based vis	2	Image and video synthesis and generation	889	185
4Transfer, meta, low-shot, continual, or long-tail learning6885Recognition: Categorization, detection, retrieval6736Vision, language, and reasoning6317Low-level vision5538Segmentation, grouping and shape analysis5249Deep learning architectures and techniques48510Multi-modal learning450113D from single images43112Medical and biological vision, cell microscopy42013Video: Action and event understanding37314Autonomous driving35915Self-supervised or unsupervised representation learning34417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision25220Computational imaging22521Vision + graphics15524Robotics1425Transparency, fairness, accountability, privacy, ethics in vision12726Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others5133Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3	3		813	166
6Vision, language, and reasoning6317Low-level vision5538Segmentation, grouping and shape analysis5249Deep learning architectures and techniques48510Multi-modal learning450113D from single images43112Medical and biological vision, cell microscopy42013Video: Action and event understanding37314Autonomous driving35915Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27619Efficient and scalable vision28220Computational imaging22821Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics14524Robotics14425Transparency, fairness, accountability, privacy, ethics in vision12726Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photo	4		688	153
7Low-level vision5538Segmentation, grouping and shape analysis5249Deep learning architectures and techniques48510Multi-modal learning450113D from single images4312Medical and biological vision, cell microscopy4203Video: Action and event understanding3734Autonomous driving3595Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision28220Computational imaging22821Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics14824Robotics14425Transparency, fairness, accountability, privacy, ethics in vision12726Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Compute	5	Recognition: Categorization, detection, retrieval	673	139
8Segmentation, grouping and shape analysis5249Deep learning architectures and techniques48510Multi-modal learning450113D from single images43112Medical and biological vision, cell microscopy42013Video: Action and event understanding37314Autonomous driving35915Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27219Efficient and scalable vision28220Computational imaging22621Video: Low-level analysis, motion, and tracking21522Vision + graphics15524Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10127Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	6	Vision, language, and reasoning	631	1 18
9Deep learning architectures and techniques48510Multi-modal learning450113D from single images43112Medical and biological vision, cell microscopy42013Video: Action and event understanding37314Autonomous driving35915Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27219Efficient and scalable vision28220Computational imaging28221Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics15524Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12226Explainable computer vision10127Embodied vision: Active agents, simulation8029Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4133Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	7	Low-level vision	553	1 26
10Multi-modal learning450113D from single images43112Medical and biological vision, cell microscopy42013Video: Action and event understanding37314Autonomous driving35915Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision25220Computational imaging22621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics15524Robotics14225Transparency, fairness, accountability, privacy, ethics in vision12226Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	8	Segmentation, grouping and shape analysis	524	<mark>1</mark> 13
113D from single images43112Medical and biological vision, cell microscopy42013Video: Action and event understanding37314Autonomous driving35915Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision28220Computational imaging26621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics15824Robotics14425Transparency, fairness, accountability, privacy, ethics in vision12226Explainable computer vision12227Biometrics10728Document analysis and understanding7229Machine learning (other than deep learning)6630Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	9	Deep learning architectures and techniques	485	92
12Medical and biological vision, cell microscopy42013Video: Action and event understanding37314Autonomous driving35915Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision25220Computational imaging22621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics14824Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12526Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	10	Multi-modal learning	450	89
13Video: Action and event understanding37314Autonomous driving35915Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision28220Computational imaging22621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics14125Transparency, fairness, accountability, privacy, ethics in vision12526Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	11	3D from single images	431	91
14Autonomous driving33915Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision28220Computational imaging28621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics15524Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3335Computer vision theory33	12	Medical and biological vision, cell microscopy	420	53
15Self-supervised or unsupervised representation learning34916Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision22220Computational imaging28621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics15524Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	13	Video: Action and event understanding	373	83
16Datasets and evaluation34417Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision25220Computational imaging22621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	14	Autonomous driving	359	69
17Scene analysis and understanding27618Adversarial attack and defense27419Efficient and scalable vision22220Computational imaging22621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	15	Self-supervised or unsupervised representation learning	349	71
18Adversarial attack and defense27419Efficient and scalable vision25220Computational imaging22621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics15524Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	16	Datasets and evaluation	344	54
19Efficient and scalable vision25220Computational imaging22621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics15524Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	17	Scene analysis and understanding	276	54
20Computational imaging22621Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics15524Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	18	Adversarial attack and defense	274	61
21Video: Low-level analysis, motion, and tracking21522Vision applications and systems17123Vision + graphics15524Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	19	Efficient and scalable vision	252	48
22Vision applications and systems17123Vision + graphics15524Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	20	Computational imaging	226	53
23Vision + graphics15524Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	21	Video: Low-level analysis, motion, and tracking	2 <mark>15</mark>	46
24Robotics14125Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	22	Vision applications and systems	171	35
25Transparency, fairness, accountability, privacy, ethics in vision12926Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	23	Vision + graphics	155	32
26Explainable computer vision10727Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	24	Robotics	141	23
27Embodied vision: Active agents, simulation8028Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	25	Transparency, fairness, accountability, privacy, ethics in vision	129	30
28Document analysis and understanding7229Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4133Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	26	Explainable computer vision	107	24
29Machine learning (other than deep learning)6530Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	27	Embodied vision: Active agents, simulation	80	14
30Physics-based vision and shape-from-X5531Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	28	Document analysis and understanding	72	12
31Biometrics5132Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	29	Machine learning (other than deep learning)	65	14
32Others4733Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	30	Physics-based vision and shape-from-X	55	12
33Optimization methods (other than deep learning)4634Photogrammetry and remote sensing3835Computer vision theory33	31	Biometrics	51	11
34Photogrammetry and remote sensing3835Computer vision theory33	32	Others	47	12
35 Computer vision theory 33	33	Optimization methods (other than deep learning)	46	12
	34	Photogrammetry and remote sensing	38	8
36 Computer vision for social good 25	35	Computer vision theory	33	5
	36	Computer vision for social good	25	5

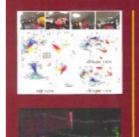
Computer vision at CMU

Dedicated courses for each subject we cover in this class:

- Physics-based Methods in Vision
- Geometry-based Methods in Computer Vision
- Computational Photography
- Visual Learning and Recognition
- Statistical Techniques in Robotics
- Sensors and sensing

... plus an entire department's worth of ML courses.

Master in **Computer Vision** at CMU



















Carnegie Mellon

Master of Science - Computer Vision



August 2016 - December 2017 (16-month program)

Computer vision is the study of acquiring and interpreting visual imagery. As computer vision shifts from research to development, there is a critical need for developers with expertise in this field.

GOALS

 Offer a comprehensive set of courses Facilitate hands-on research and development projects Expose students to current and emerging state-of-the-art Computer Vision applications Prepare students for careers in Computer Vision

COURSES

Intoduction to Computer Vision Introduction to Machine Learning Mathematical Fundamentals for Robotics Visual Learning and Recognition Geometry-based Methods in Computer Vision

Electives (choose 2)

Human Communication and Multimodal Machine Learning The Visual World as seen by Neurons and Machines **Comprehensive Sensing and Sparse Optimization** Large Scale Learning using Images and Text **Big Data approaches in Computer Vision** Human Motion Modeling and Analysis Statistical Techniques in Robotics Physics-based Methods in Vision **Probabilistic Graphical Models** Statistical Machine Learning **Convex Optimization** Vision Sensors Project and Seminar Courses

> Application Materials Résumé • General GRE

Statement of Purpose (1 to 2 pages)

 Undergraduate/Graduate (as applicable) Transcripts Only online applications will be accepted. Early application deadline: December 3, 2015 Final application deadline: December 15, 2015

FOR INDUSTRY SPONSORSHIPS PLEASE CONTACT JULIE GOLDSTEIN (JGOLDS@CS.CMU.EDU), 412-268-4017

Carnegie Mellon University

ms-cv@ri.cmu.edu

www.ri.cmu.edu/MSCV

MSCV Project I MSCV Project II

Srinivasa Narasimhan **MSCV Program Director**



Martial Hebert MSCV Spiritual Guru



J. Andrew (Drew) Bagnell



Fernando De la Torre Frade



Abhinav Gupta



Kris M. Kitani



Simon Lucey

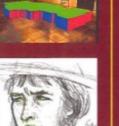


Deva Kannan Ramanan



5000 Forbes Avenue, Pittsburgh, PA 15232 Yaser Ajmal Sheikh









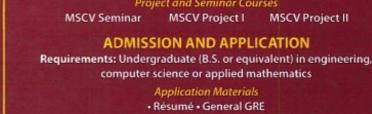


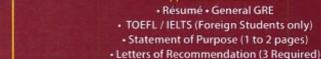












Course logistics

Website



http://16385.courses.cs.cmu.edu/

(includes links to Canvas and Piazza)

Assignments Canvas

https://canvas.cmu.edu/courses/37379

Discussion & Notes plaza

https://piazza.com/class/lluyey2bprp44v

Image processing:

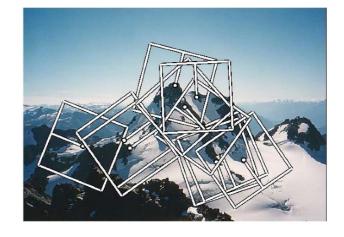
- Basics of filtering.
- Image pyramids.
- Gradients and lines.
- Hough transforms.

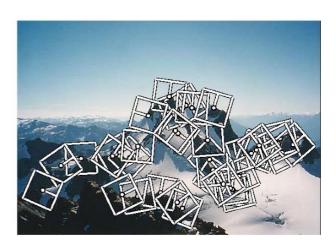


Feature detection and correspondences:

- Corner detection.
- SIFT et al.
- Feature descriptors.
- RANSAC.

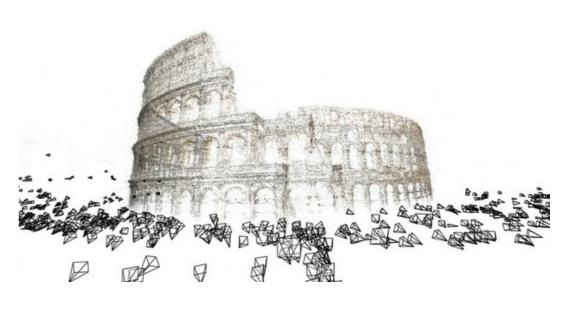






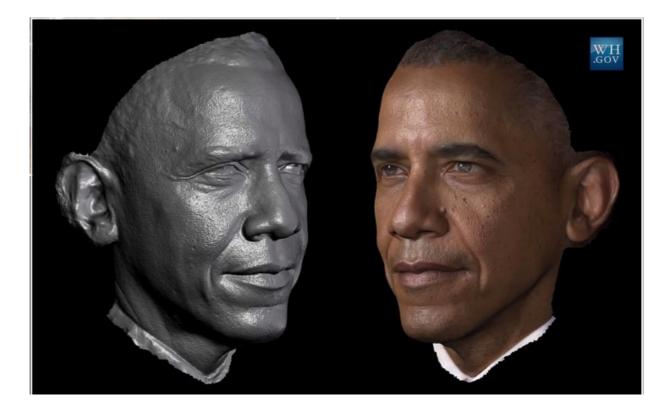
Transformations and geometry:

- Homographies and image alignment.
- Camera models.
- Fundamental matrix.
- Epipolar geometry and stereo.
- Structure from motion.



Physics-based vision:

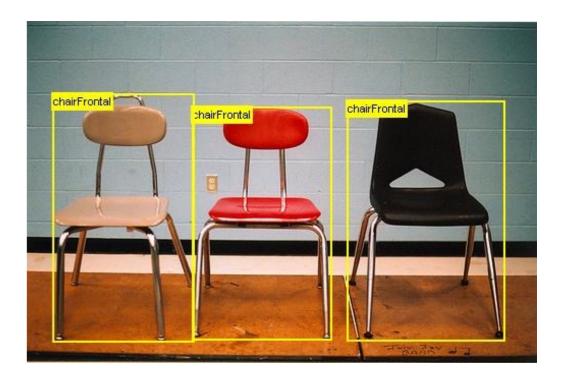
- Reflectance and image formation.
- Radiometry.
- Shape from shading.
- Photometric stereo.



• Color.

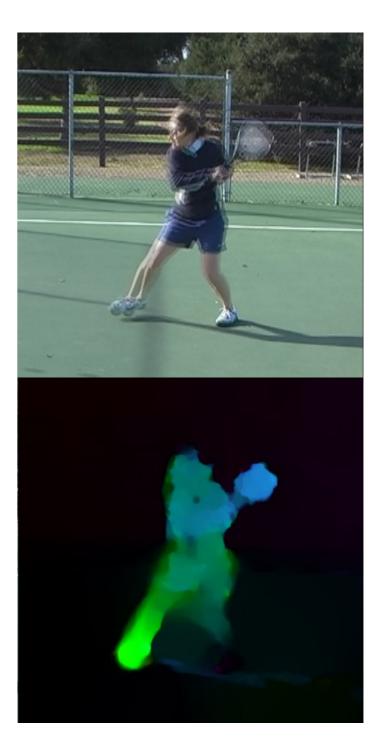
Objects, faces, and learning:

- Basics of probability.
- K-means, KNN, PCA, SVM.
- Bag of words.
- Viola-Jones face detection.
- Perceptron, backpropagation.
- Convolutional neural networks.



Dealing with motion:

- Optical flow (LK, HS).
- Image registration.
- Kalman Filtering.
- Tracking (KLT, Mean-Shift).



Grading

- Six two-week programming assignments: 97%
- Class, Website, and Piazza participation: 3%

Participation:

- Be active! Ask questions.
- Post on Piazza and course website.

Programming Assignments

- a lot of programming <u>in Python</u>
- hours and hours of programming
- days and days of debugging
- generous grading policy
- take advantage of extra credit

Assignment 1 Hough Transform Assignment 2 Homography Assignment 3 Stereo Assignment 4 Bag of Words Assignment 5 Convolutional Neural Nets Assignment 6 Image Alignment

Programming Assignments

- a lot of programming <u>in Python</u>
- hours and hours of programming
- days and days of debugging
- generous grading policy
- take advantage of extra credit

Assignment 1 Hough Transform Assignment 2 Homography Assignment 3 Stereo Assignment 4 Bag of Words Assignment 5 Convolutional Neural Nets Assignment 6 Image Alignment

Seriously.. a lot of programming, so start early!

Leniency

Late days for programming assignments:

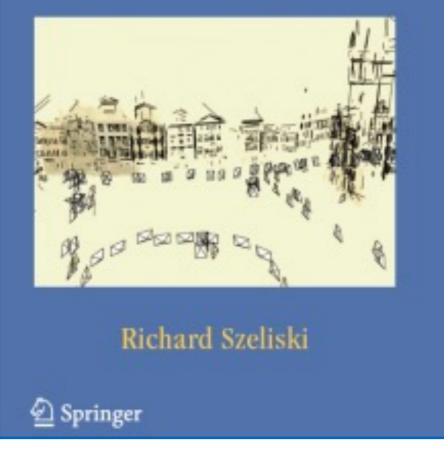
- 10% reduction of points per late day
- 6 free late days <u>total</u>
- use them wisely... save for later (harder) assignments!

Book

TEXTS IN COMPUTER SCIENCE

Computer Vision

Algorithms and Applications



PDF online

http://szeliski.org/Book/

Contact information

- Feel free to email us about administrative questions.
 o please use [16385] in email title!
- Lecture questions should be asked on course website (or in lecture), and assignment/logistic questions should be asked on Piazza.
 - we won't answer technical questions through email.
 - $\circ~$ you can post anonymously if you prefer.
- Office hours will be determined by poll.

feel free to email me about additional office hours.