

Computer Vision: Overview

Siheng Chen 陈思衡

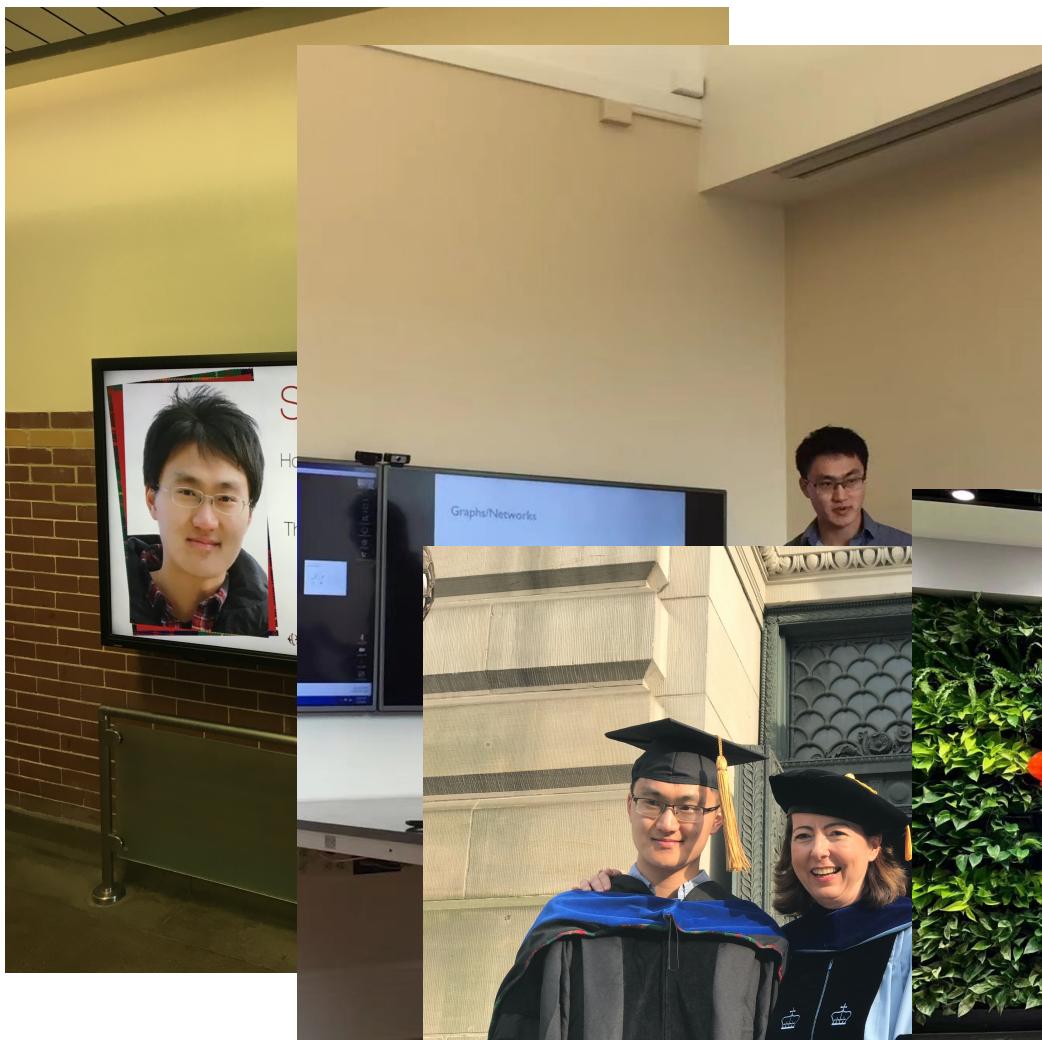
Welcome to ECE4880J

A bit about me

Introduction to computer vision

Course overview

A bit about me



A bit about me



Graph data science
2011- 2016



Autonomous driving
2017- 2019



Autonomous driving
2019- 2020



Group Intelligence
2020- Present



A bit about me

Multi-Agent Graph Intelligence Crew (MAGIC)



Collaboration



Interaction



Graph data science

A bit about me

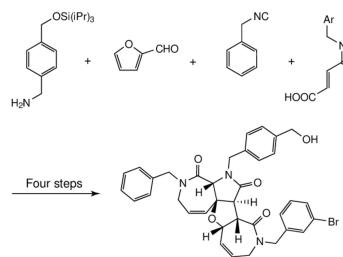
Graph data science



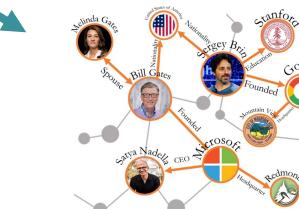
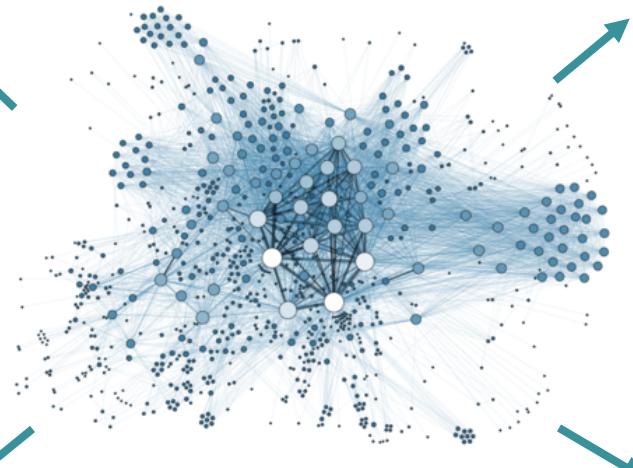
brain network



traffic network



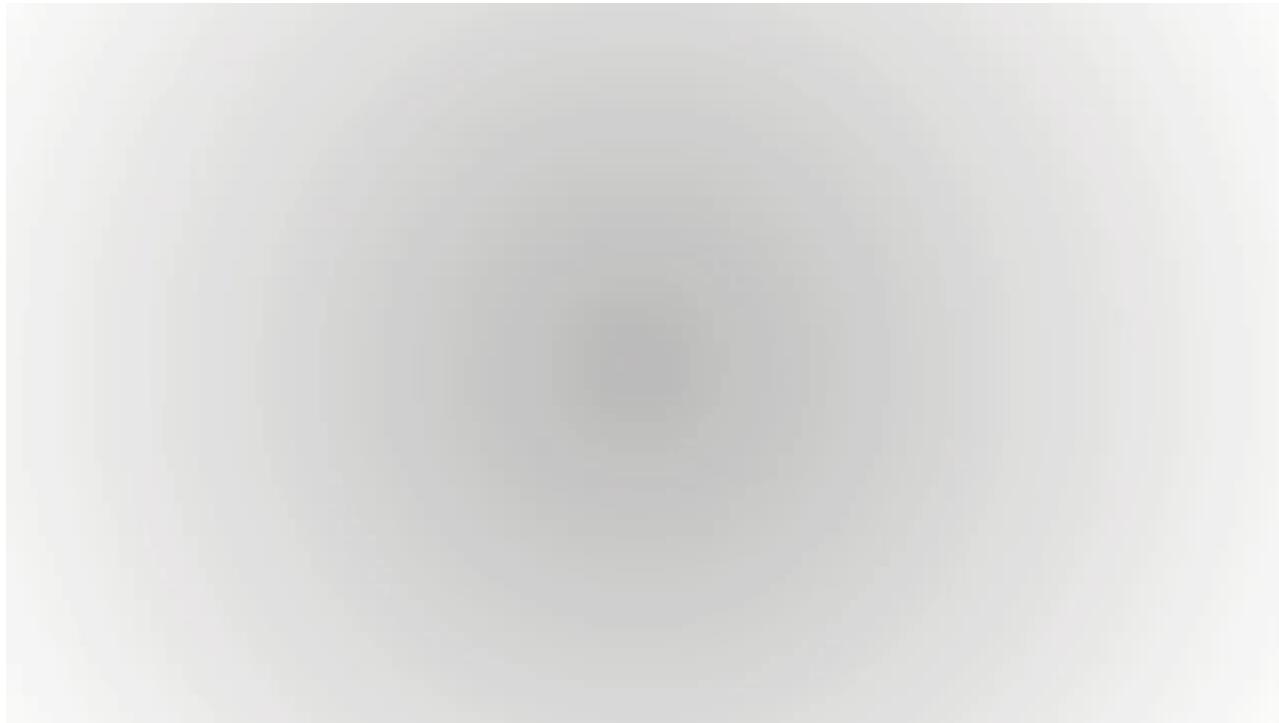
Molecules



Knowledge graph

A bit about me

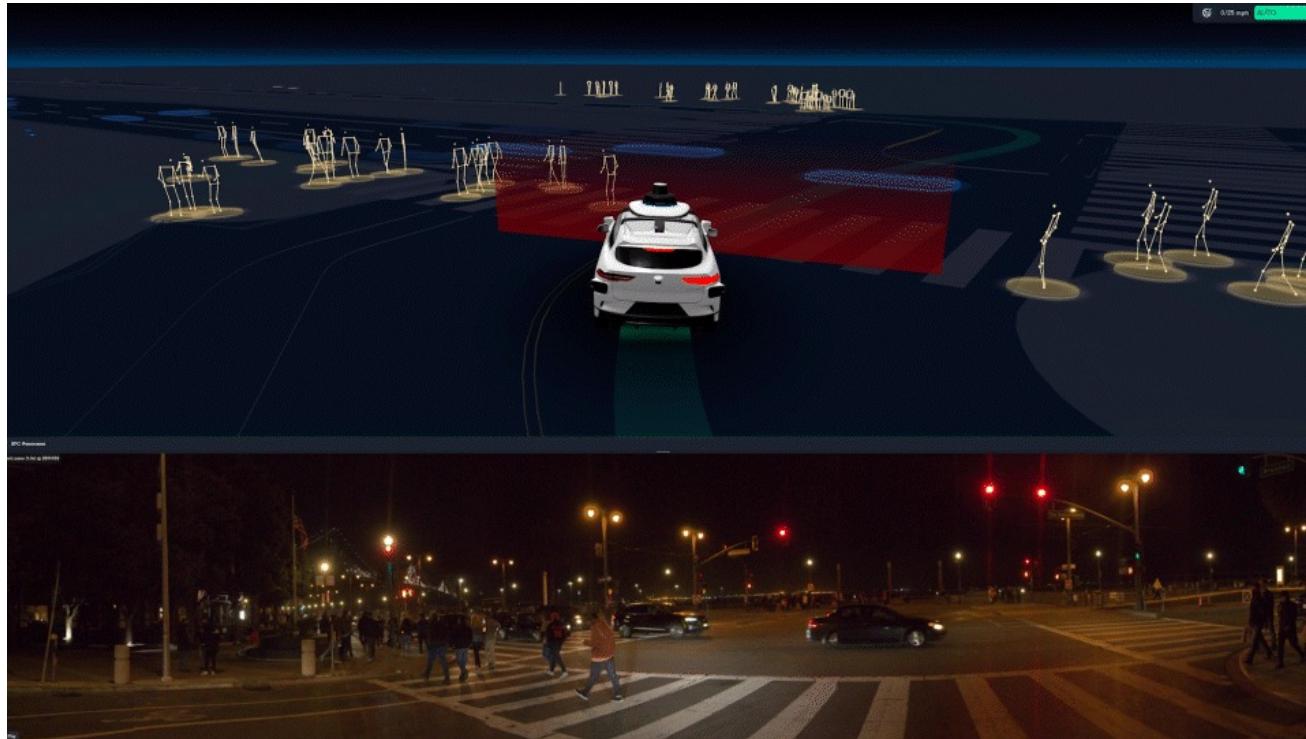
Graph data science **for computer vision**



3D scene graph construction for scene understanding

A bit about me

Graph data science **for computer vision**



3D skeleton graph based human behavior understanding for autonomous driving

A bit about me

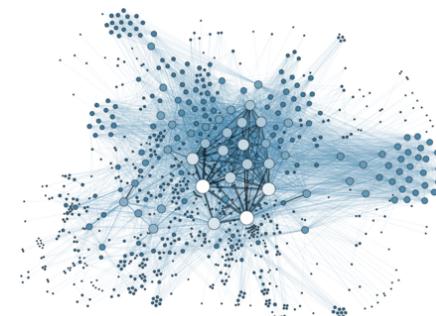
Multi-Agent Graph Intelligence Crew (MAGIC)



Collaboration



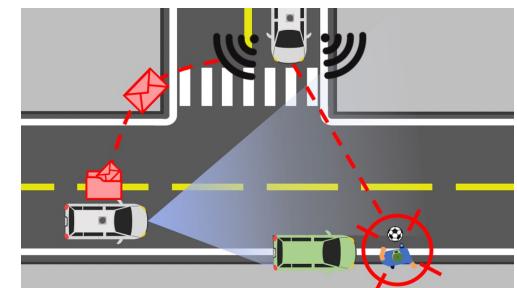
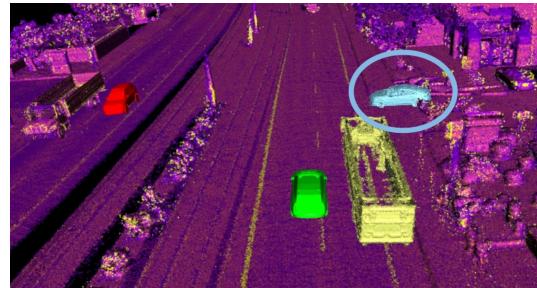
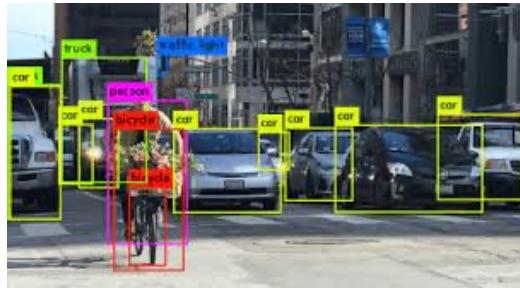
Interaction



Graph data science

A bit about me

Multi-agent collaboration



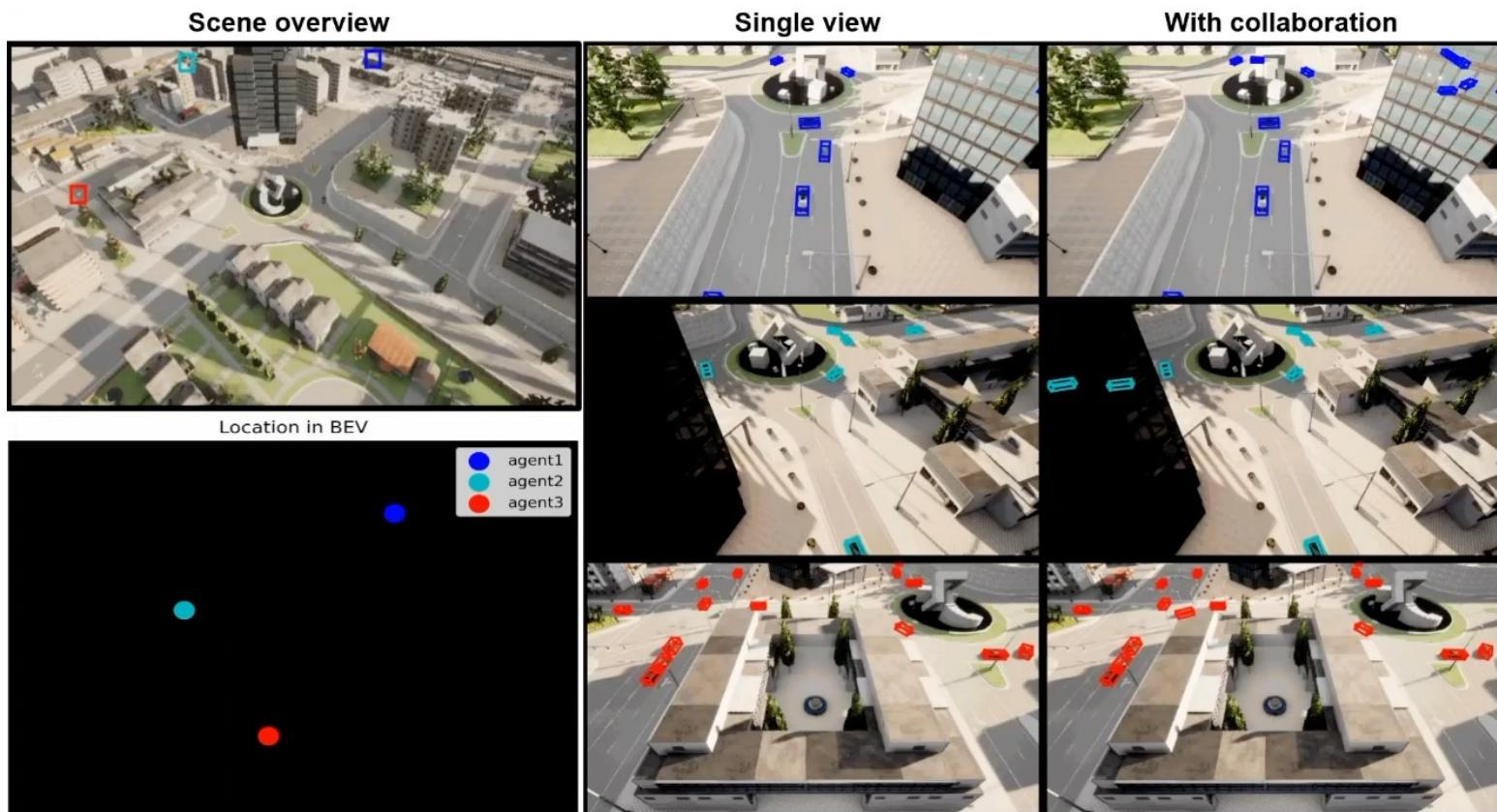
Occlusion?

Collaboration!

Which agent should send what perceptual information to which agent at what time?

A bit about me

Multi-agent collaboration



A bit about me

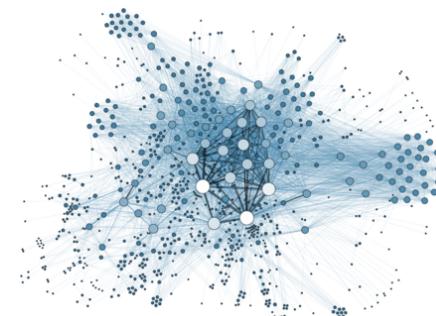
Multi-Agent Graph Intelligence Crew (MAGIC)



Collaboration



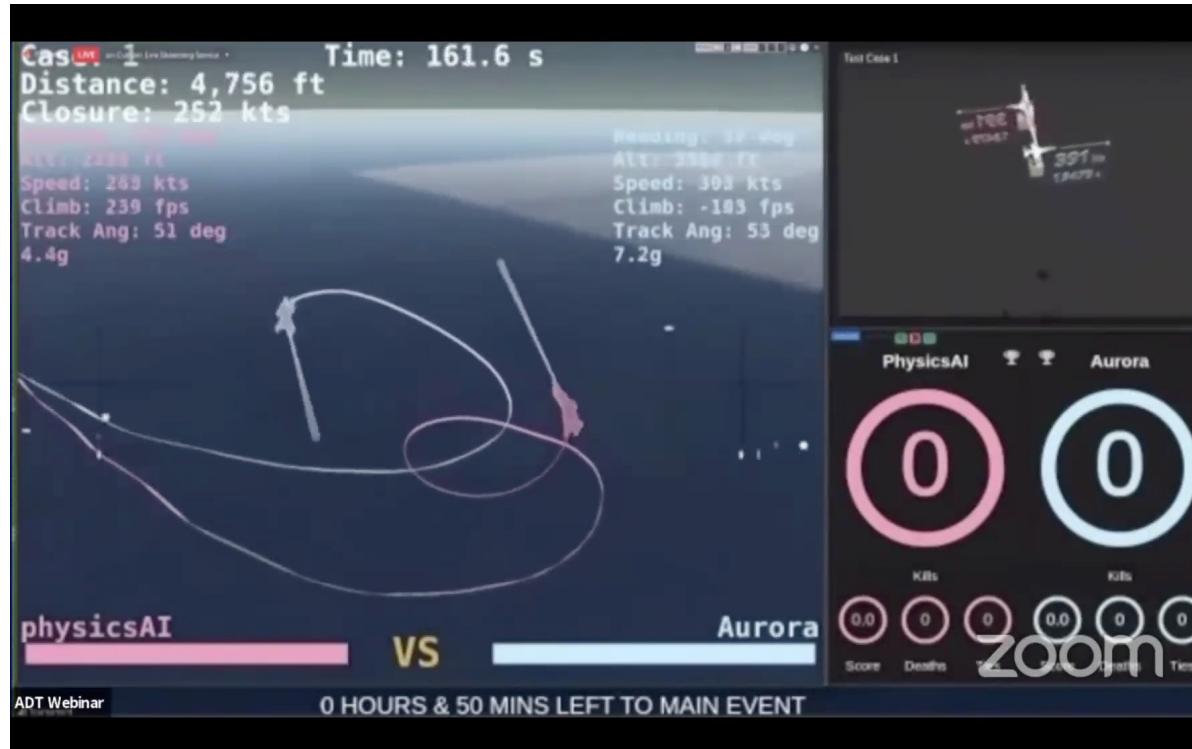
Interaction



Graph data science

A bit about me

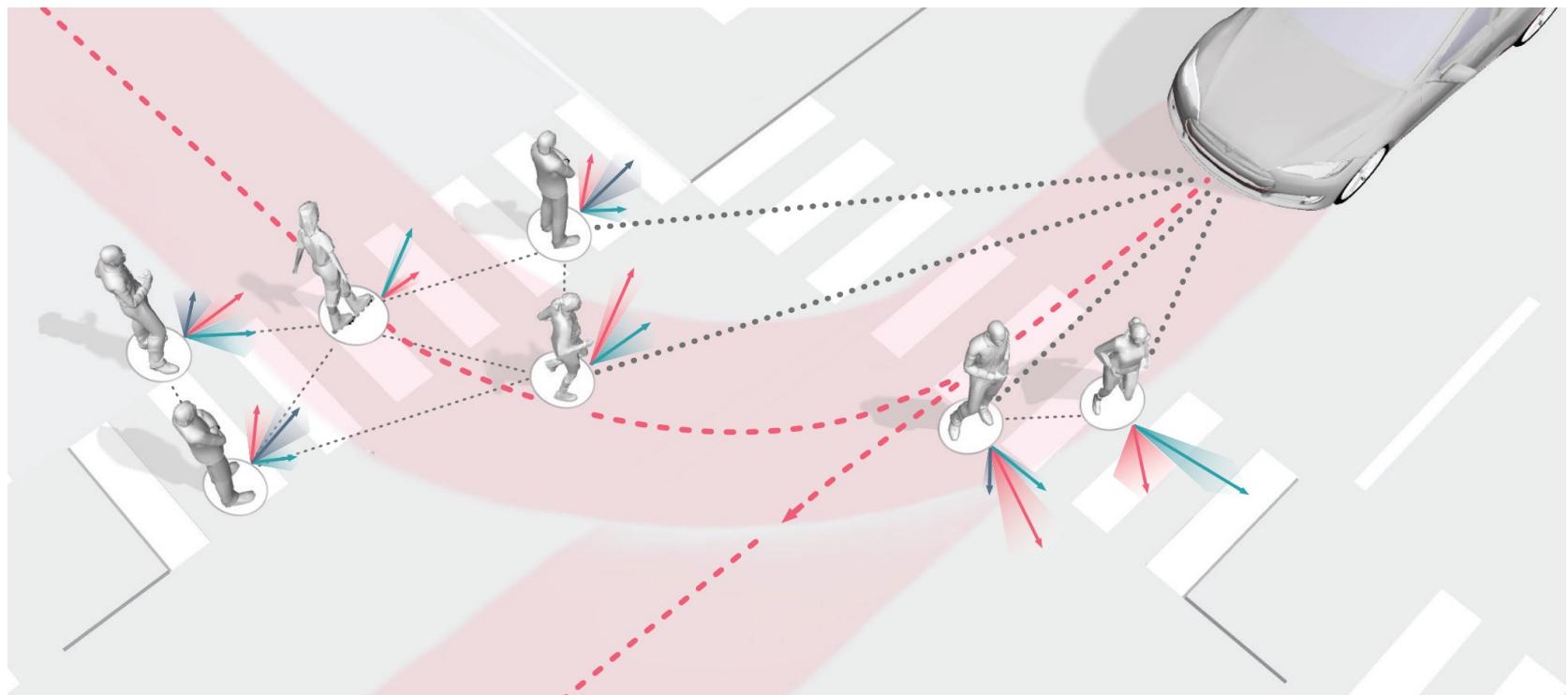
Multi-agent interaction



AlphaDogFight

A bit about me

Multi-agent interaction



A bit about me

Multi-Agent Graph Intelligence Crew (MAGIC)



交大-协作图智能



图计算，让群体协作更智能

居住地 现居上海交通大学电子信息与电气工程学院

所在行业 高新科技

个人简介 上海交通大学未来媒体网络协同创新中心的多体协作图智能研究，由陈思衡教授组织和指导，致力于研究基于图计算的交互建模和协作策略优化。Multi-Agent Graph Intelligence Crew (MAGIC)，让群体协作更加智能！

Welcome to ECE4880J

A bit about me

Introduction to computer vision

Course overview

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A bit about me

Introduction to computer vision

Course overview

What a person sees



What a computer sees

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

Applications of computer vision



Face recognition

Applications of computer vision



Face recognition

Applications of computer vision



GLOBAL
AUTONOMOUS
VEHICLE
MARKET

OPPORTUNITIES AND FORECASTS,
2019-2026

Global Autonomous Vehicle Market is expected to reach **\$557 billion** by 2026.

Growing at a **CAGR of 39.5%** (2019-2026)

Autonomous driving

Applications of computer vision

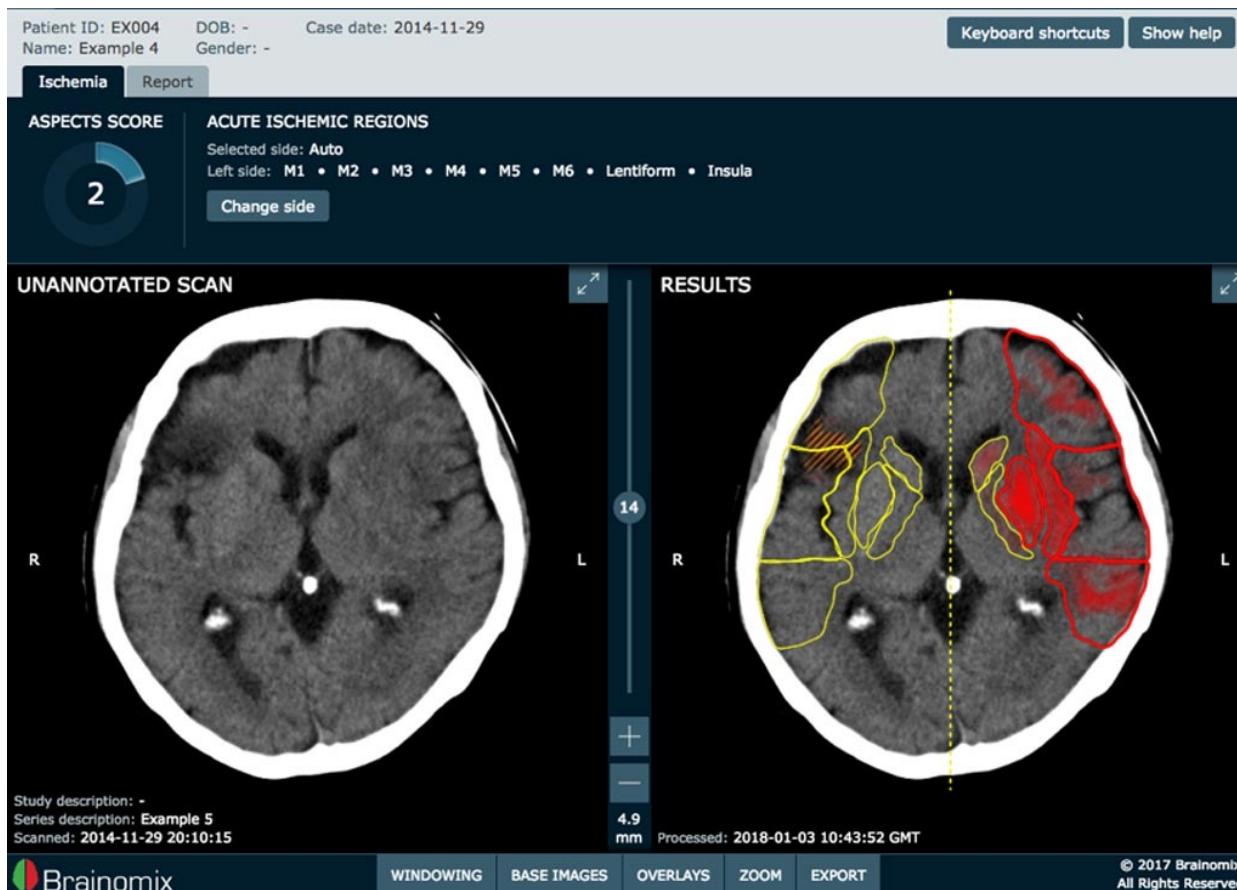
Applications of computer vision

Applications of computer vision



Metaverse

Applications of computer vision

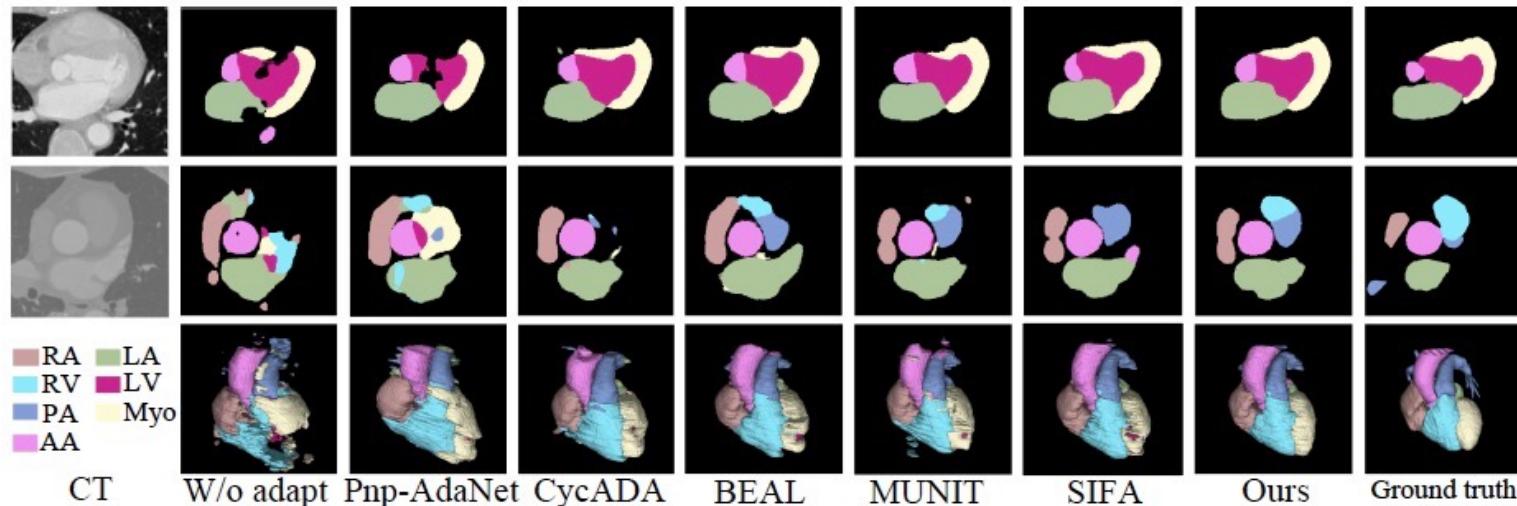


Biomedical image analysis

Applications of computer vision



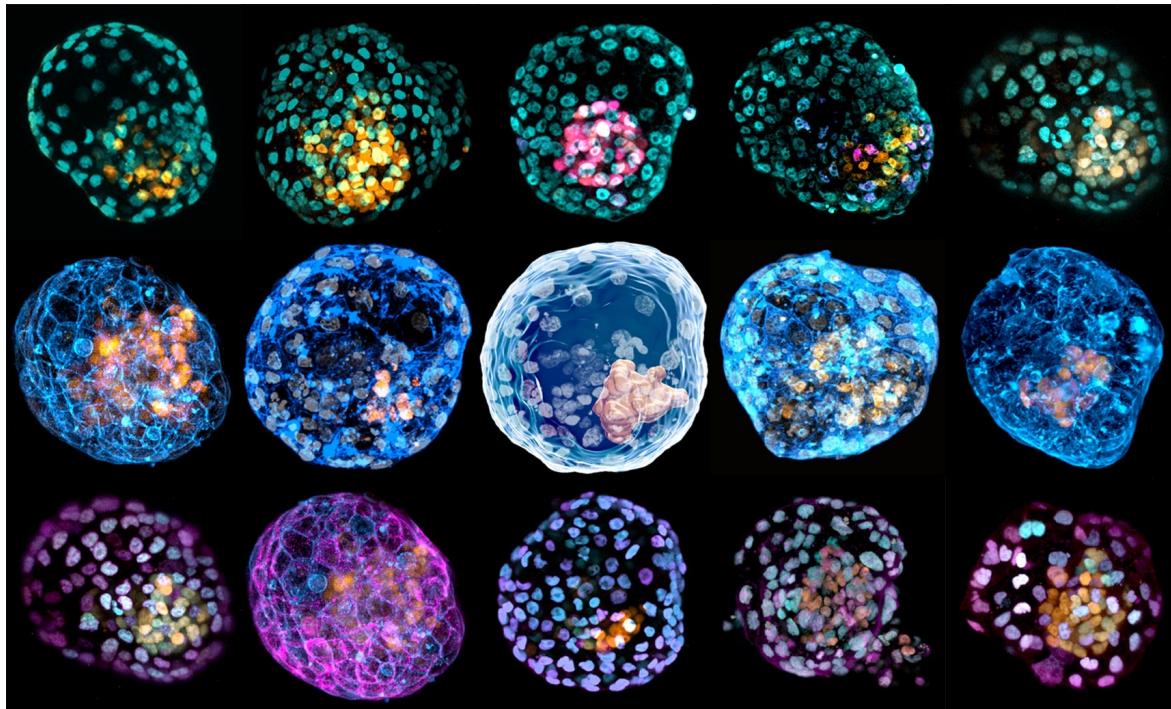
Approximately, 17.5 million people die from heart disease each year in the world, accounting for 30% of all deaths



Biomedical image analysis

Applications of computer vision

Applications of computer vision



Computer vision in cell biology

The third and perhaps most exciting contribution that computer vision systems can make to cell biological research is to **give access to image-based information that is inaccessible by eye**

Applications of computer vision



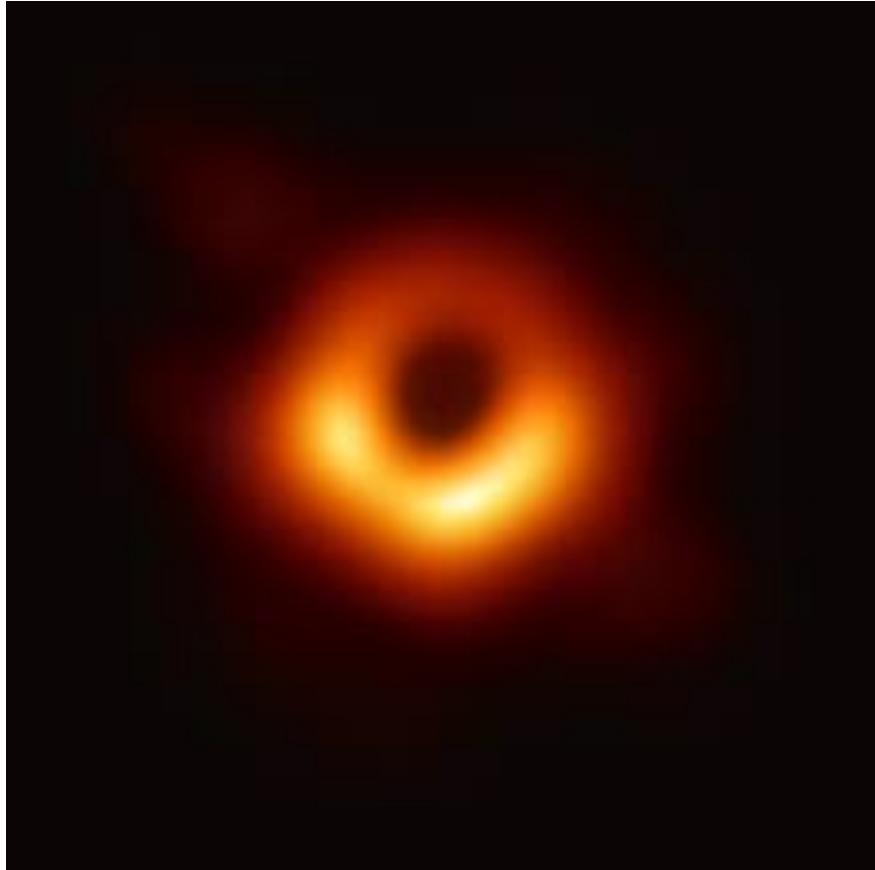
Massachusetts Institute of Technology



Revealing Invisible Changes In The World

Created for the NSF International Science & Engineering
Visualization Challenge 2012

Applications of computer vision



Katie Bouman

*Computational imaging for VLBI image reconstruction
CVPR 2016
cited by 52 times so far*

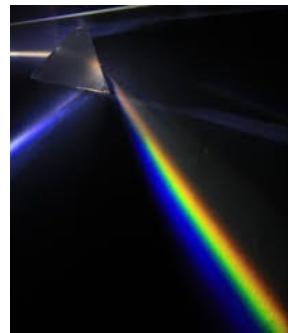
the first picture of a black hole in April of 2019

Computer vision



Low-level vision

Edit an image



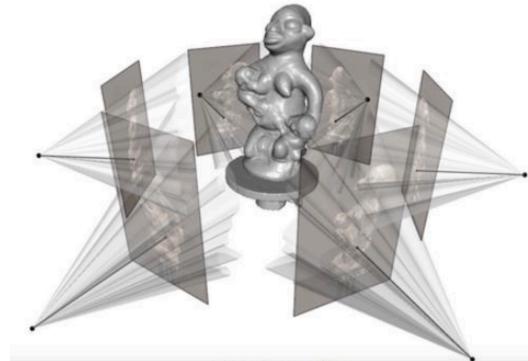
Physics-based vision

Understand physics that governs how an image was formed



Learning-based vision

Understand an image



Geometry-based vision

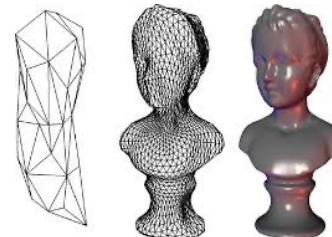
3D reconstruction and calibration

Computer vision

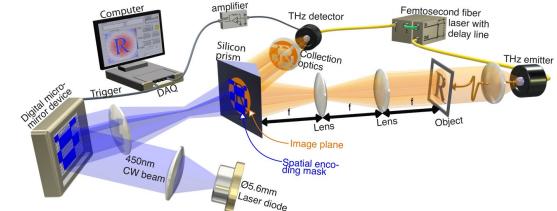
Neuroscience



Compute graphics



Computer imaging



Machine learning

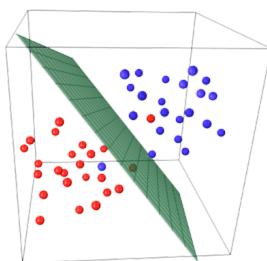


Image processing

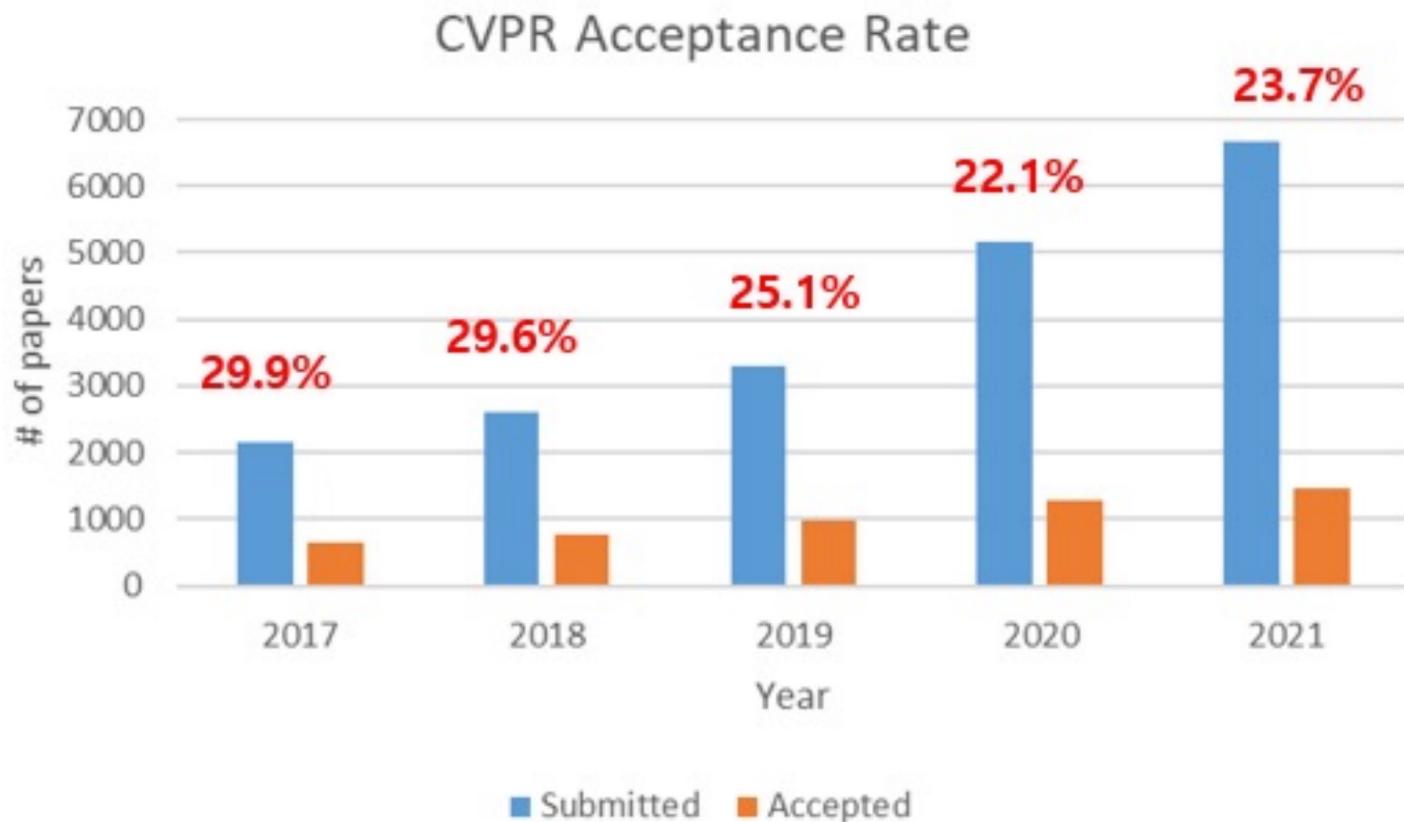


Robotics

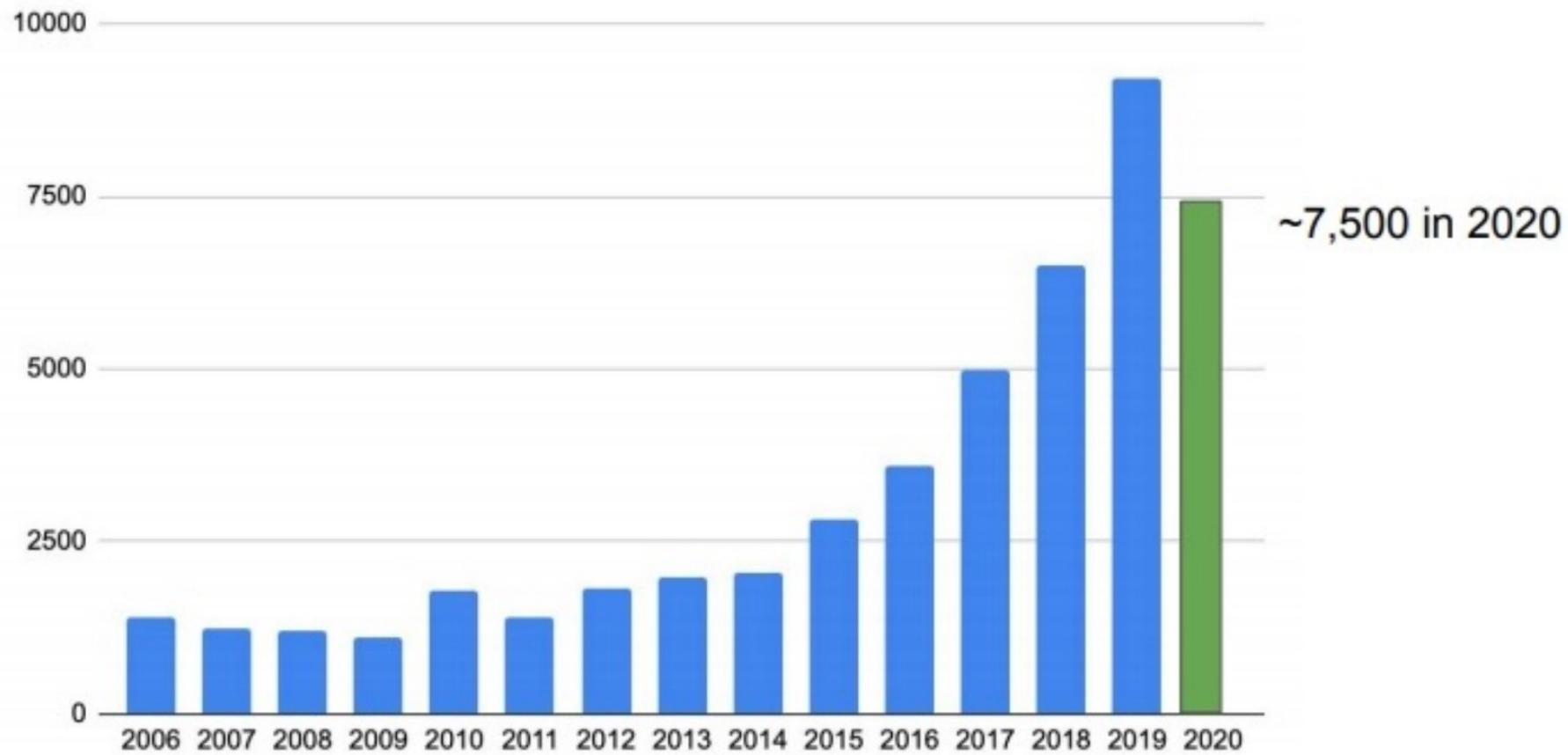


It's a **great** time to do
computer vision

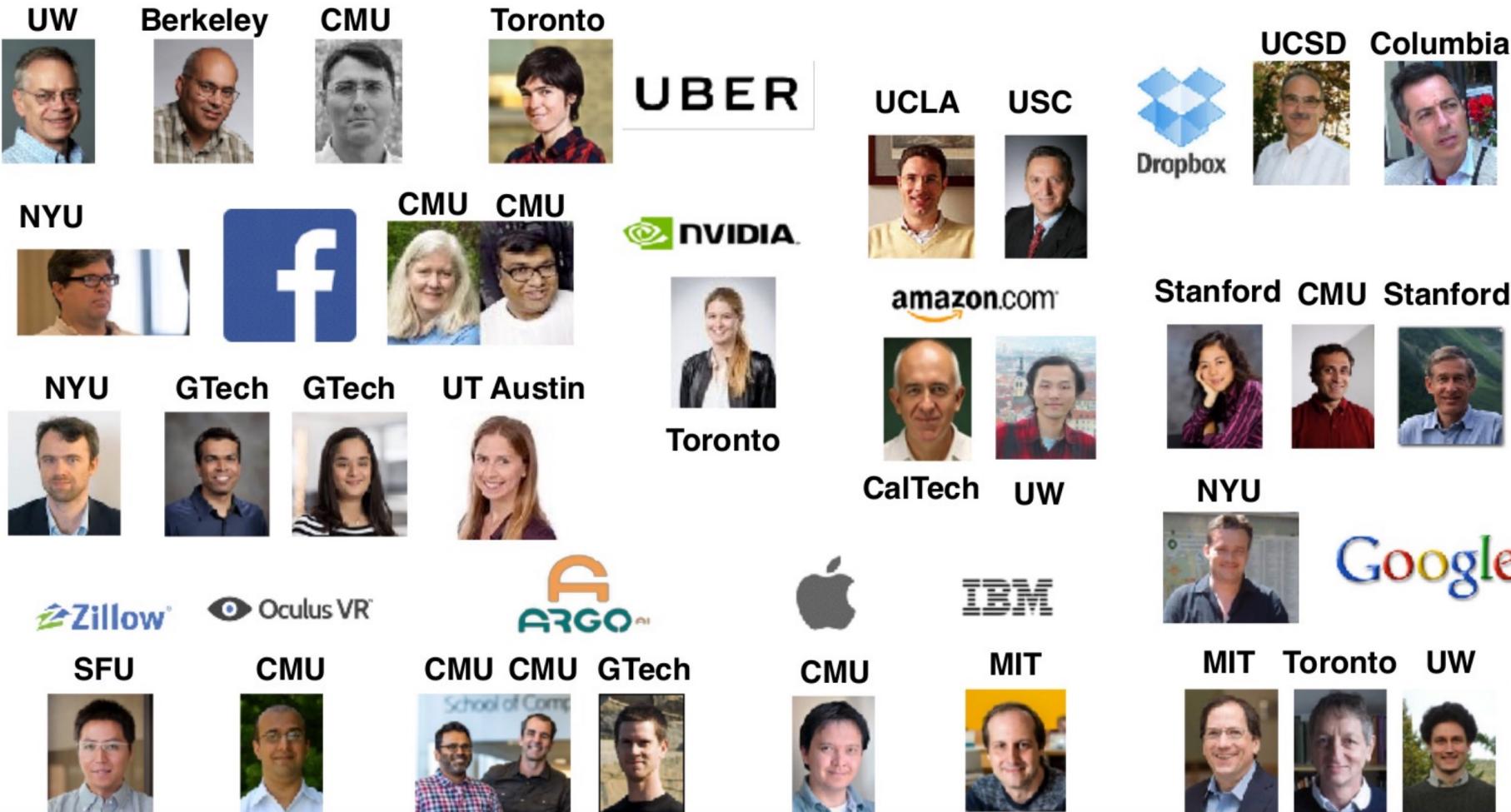
Stats for Computer Vision and Pattern Recognition (CVPR)



Stats for Computer Vision and Pattern Recognition (CVPR)



Industry aggressively hiring CV faculty from universities



**Industry aggressively hiring
CV graduates as well!**

Welcome to ECE4880J

A bit about me

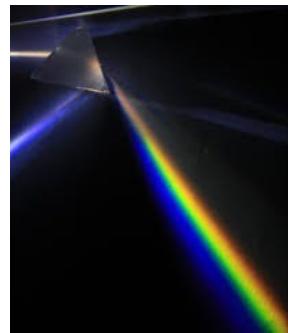
Introduction to computer vision

Course overview

Course overview



Low-level vision
Edit an image

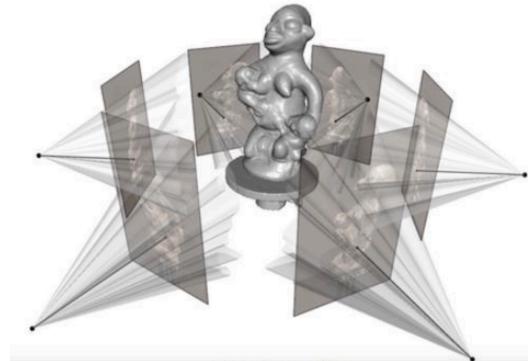


Physics-based vision

Understand physics that governs how an image was formed



Learning-based vision
Understand an image



Geometry-based vision
3D reconstruction and calibration

Course overview

Image processing (7 lectures)

- Filtering, edge detection, line detection, feature descriptor, ...

Course overview

Image processing (7 lectures)

Machine learning and neural networks (8 lectures)

- PCA, K-means, logistic regression, CNN, RNN, ...

Course overview

Image processing (7 lectures)

Machine learning and neural networks (8 lectures)

Fundamental computer vision tasks (7 lectures)

- Image classification, object detection, semantic segmentation, ...

Course overview

Image processing (7 lectures)

Machine learning and neural networks (8 lectures)

Fundamental computer vision tasks (7 lectures)

Latest computer vision research topics (5 lectures)

- Generative models, self-supervised learning, scene understanding, ...

Course overview

Image processing (7 lectures)

Machine learning and neural networks (8 lectures)

Fundamental computer vision tasks (7 lectures)

Latest computer vision research topics (5 lectures)

Computer vision for autonomous driving (3 lectures)

- 3D object detection, trajectory prediction, end-to-end system, ...

Course overview

Stanford: <http://cs231n.stanford.edu/>

CMU: <http://16385.courses.cs.cmu.edu/spring2022/>

Michigan: <https://web.eecs.umich.edu/~justincj/teaching/eecs498/FA2020/schedule.html>

Coursera: <https://www.coursera.org/specializations/deep-learning>

Why do you need to take this course?

Pave your path to be a CV engineer / researcher

- | | | |
|---|--|---|
| <ul style="list-style-type: none">▪ Background knowledge▪ Critical thinking▪ Programming skills▪ Writing skills▪ Hard working | <p>Leading performance
in benchmarks</p> | <p>Publish papers
in top-tier conferences</p> |
|---|--|---|

Course overview

The first one will be released today and due on this Friday

Homework assignments (64%)

- Six assignments ($4\% + 5 * 12\%$)

- generous grading policy
- mainly programming in Python
- might have extra credit

Course project (36%)

- Individual team-up report (4%)
 - Proposal (4%)
 - Progress report (4%)
 - Presentation (10%)
 - Final report (14%)
- competition-oriented project
 - research-oriented project

Extra credits (at most 4%)

- Make contribution to the course design

Course project

Competition-Oriented Project

- For future computer vision engineers
- Emphasize engineering, implementation, good performances

nuScenes detection task

Leaderboard

Method		Metrics													
Date	Name	Modalities		Map data	External data	mAP	mATE (m)	mASE (1-IOU)	mAOE (rad)	mAVE (m/s)	mAAE (1-acc)	NDS	PKL *	FPS (Hz)	Stats
		Any	All	All											
> 2022-01-13	FusionVPE	Camera, Lidar	no	no	0.733	0.235	0.227	0.284	0.243	0.128	0.755	0.529	n/a		
> 2021-05-25	Centerpoint-Fusion	Camera, Lidar, Rad.	no	yes	0.724	0.237	0.227	0.318	0.211	0.133	0.749	0.491	n/a		
> 2021-12-29	PAI3D	Camera, Lidar	no	no	0.714	0.245	0.233	0.308	0.233	0.131	0.742	0.535	n/a		
> 2021-07-30	DAA_AVP	Lidar	no	no	0.697	0.237	0.229	0.376	0.248	0.124	0.727	0.937	n/a		
> 2022-03-24	PDP-e	Camera, Lidar	no	no	0.697	0.245	0.231	0.359	0.244	0.154	0.725	0.556	n/a		
> 2022-02-10	AutoAlignV2	Camera, Lidar	no	no	0.684	0.245	0.233	0.311	0.258	0.133	0.724	0.604	n/a		
> 2021-04-19	CenterPoint-VID	Lidar	no	no	0.674	0.255	0.235	0.339	0.233	0.128	0.718	0.555	n/a		
> 2021-07-15	DCAN	Camera, Lidar	no	no	0.673	0.247	0.241	0.312	0.277	0.122	0.717	0.577	n/a		

Course project

Research-Oriented Project

- For future computer vision researchers
- Emphasize technical novelty and critical thinking
- Potentially worth a paper publication

Course overview

Required background

- Programming fundamentals (Python experience desirable)
- Linear algebra
- Basic probability
- Calculus

Teaching Assistant: Chenxin Xu (徐晨鑫)

Ph.D student at Shanghai Jiao Tong University

- Email: xcxwakaka@sjtu.edu.cn
- Tel: +86 15821805287
- Office hour: SEIEE building, 5-303A, 09:00 – 17:00

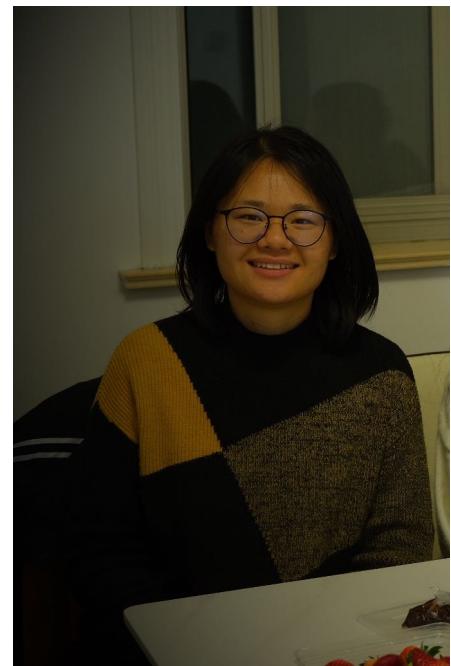


- Research interest: Graph neural network, trajectory prediction
- Hobby: Badminton, Movies, Explore delicious food

Teaching Assistant: Yue Hu (胡悦)

Ph.D student at Shanghai Jiao Tong University

- Email: 18671129361@sjtu.edu.cn (Daily check at 9am)
- Tel: +86 1521135726
- Office hour: SEIEE building, 5-303A, 09:00 -17:00



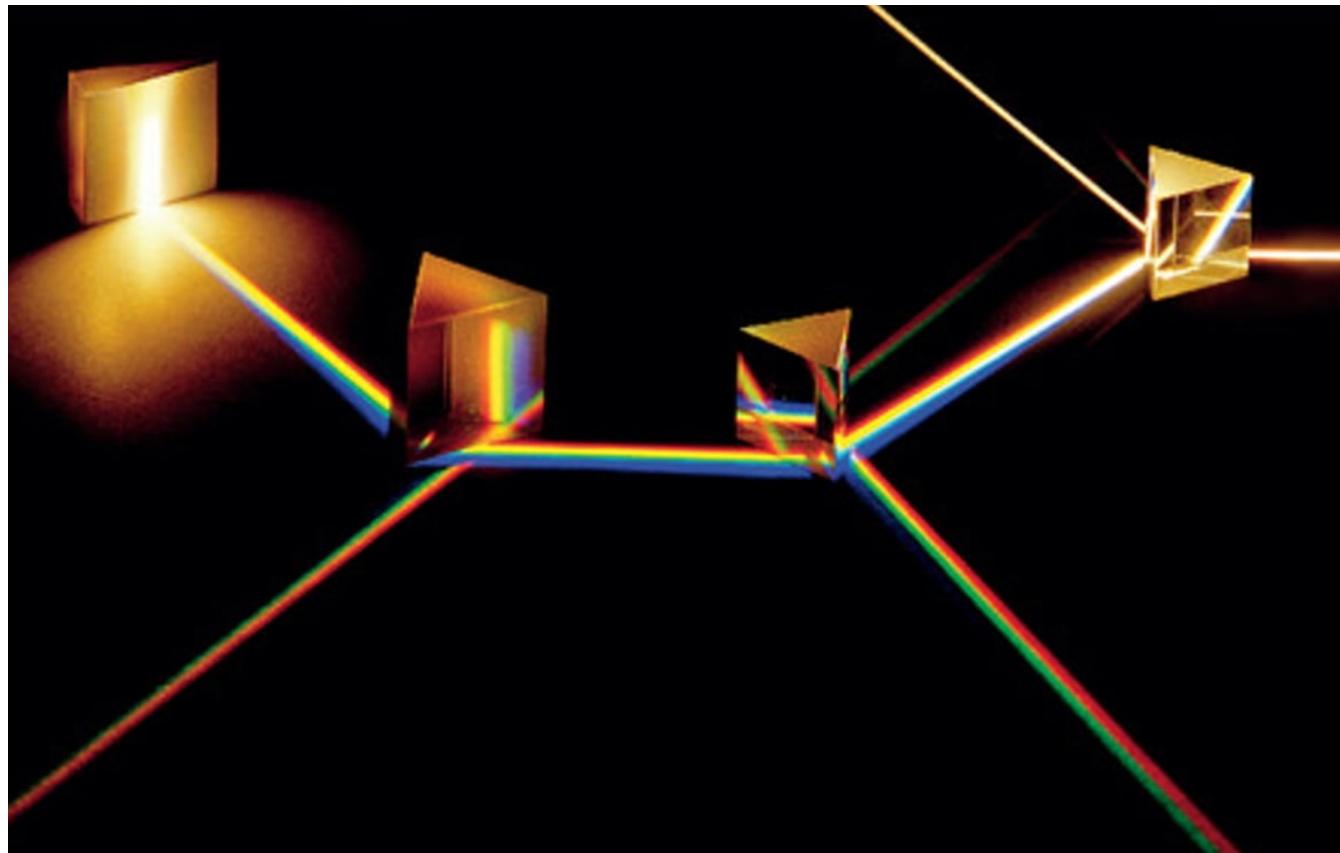
- Research interest: Collaborative perception, 3D object detection, Graph learning
- Hobby: Hiking, sports

Course overview

Principles

- Provide elite education service
- Generous grading policy
- Up-to-date topics
- Encourage to speak up
- Try your best

Next lecture: Maths review



The first one will be released today and due on this Friday

extremely simple! 10 mins work,
But 4 points !

Thank you very much!

sihengc@sjtu.edu.cn