

What's Next in Graphics

Logistics

- Course Reviews
 - in Canvas, students will see a pop-up notification on their Canvas dashboard page any time they log into Canvas during the evaluation period.
 - direct link: <http://course-evaluations.stanford.edu>.
 - in Axess > My Academics > Course and Section Evaluations > Link to the evaluation system near the top of the page
- Final Showcase
 - Saturday (Aug. 16) from 8:30-11:00AM
 - BE ON TIME
 - There will be various awards presented
 - Remember to prepare a ONE MINUTE presentation!
 - Let us know IN ADVANCE if you will not be present (and record your 1 minute!)
- Final Project Rendering
 - Render now

Upcoming Classes

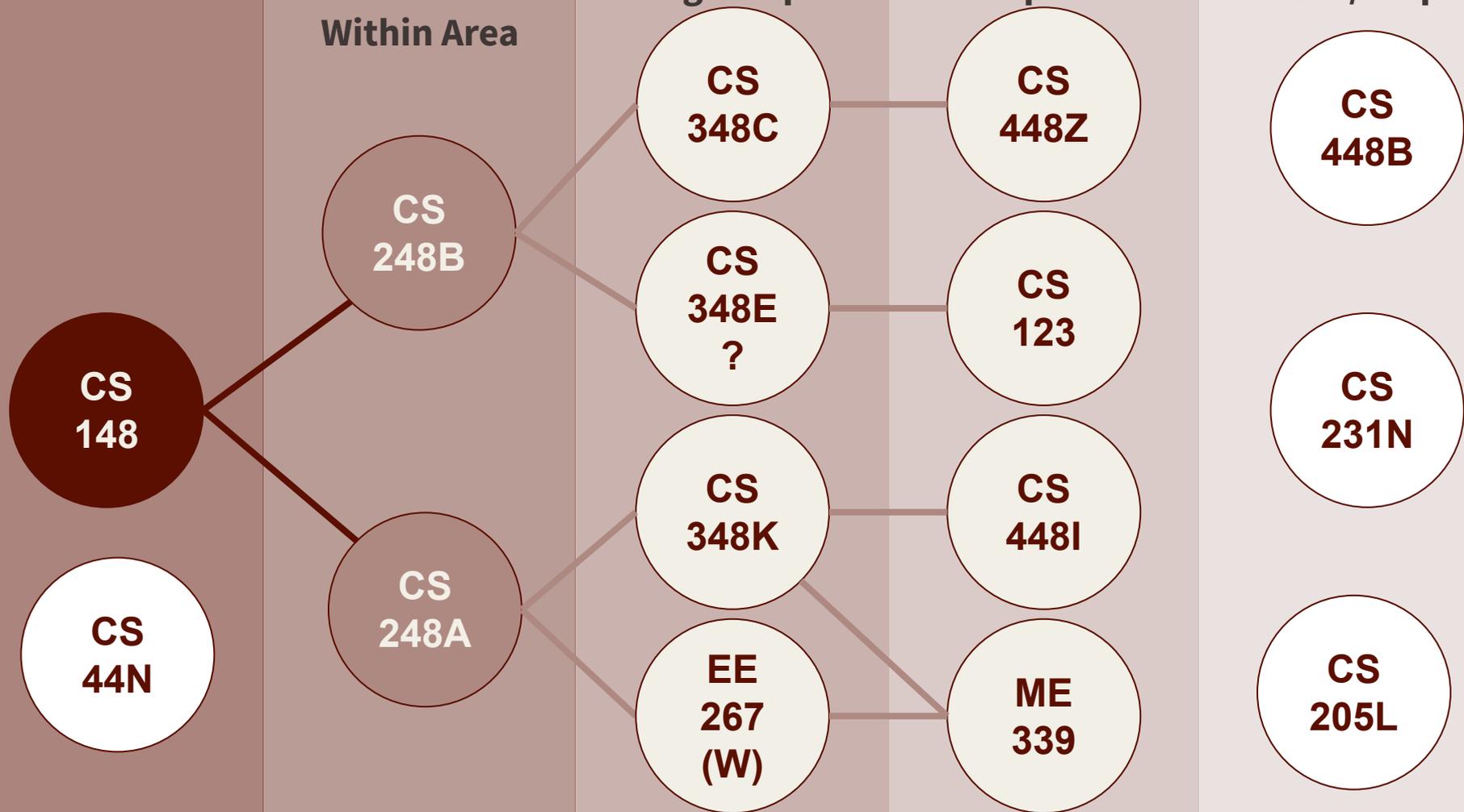
Overview

Overview Within Area

Single Topic

Deep Dive

Related/Helpful



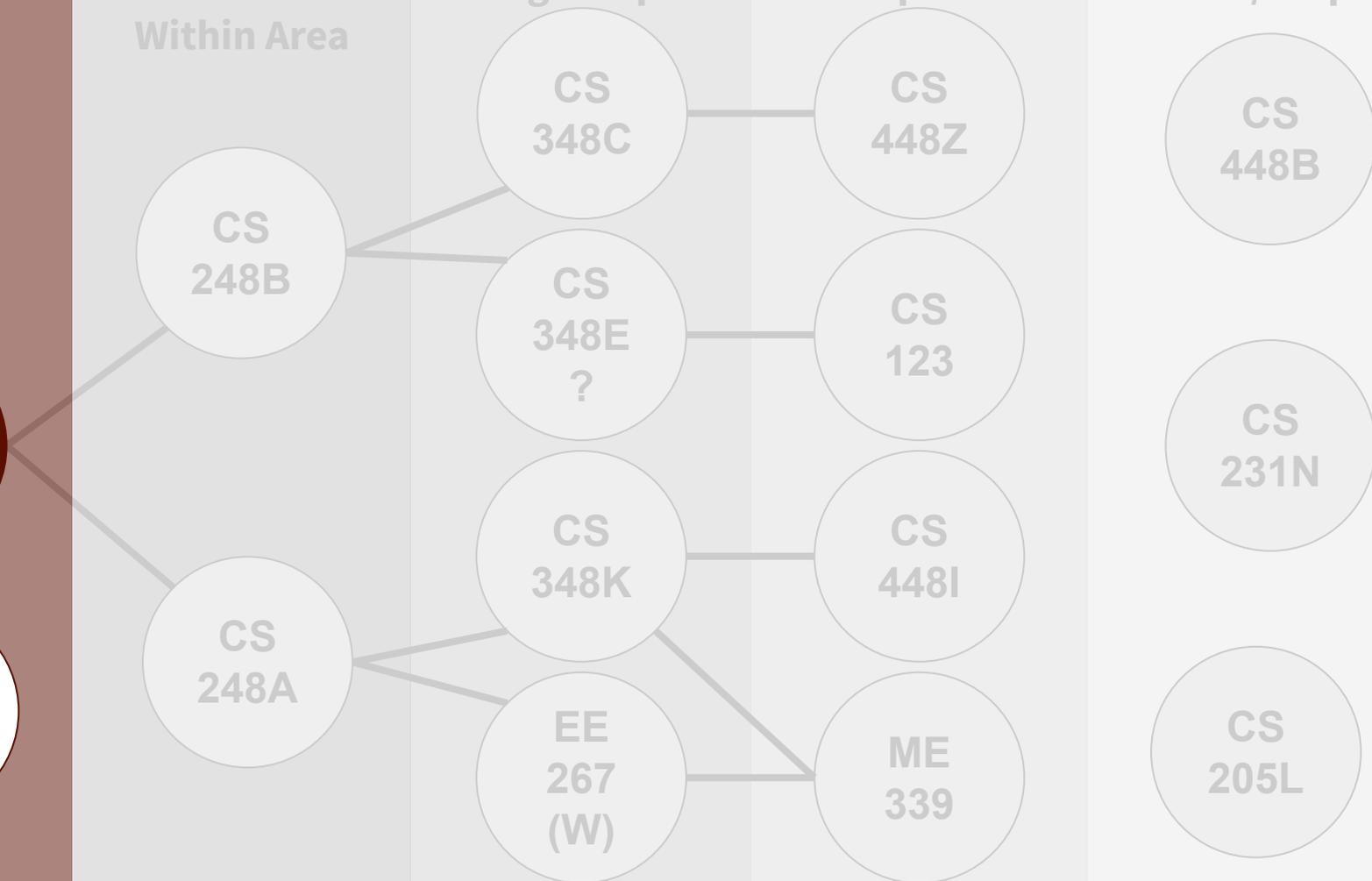
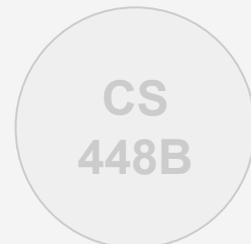
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CS 44N: Great Ideas in Computer Graphics

A hands-on interactive and fun exploration of great ideas from computer graphics. Motivated by graphics concepts, mathematical foundations and computer algorithms, students will explore an eccentric selection of "great ideas" through short weekly programming projects. Project topics will be selected from a diverse array of computer graphics concepts and historical elements.



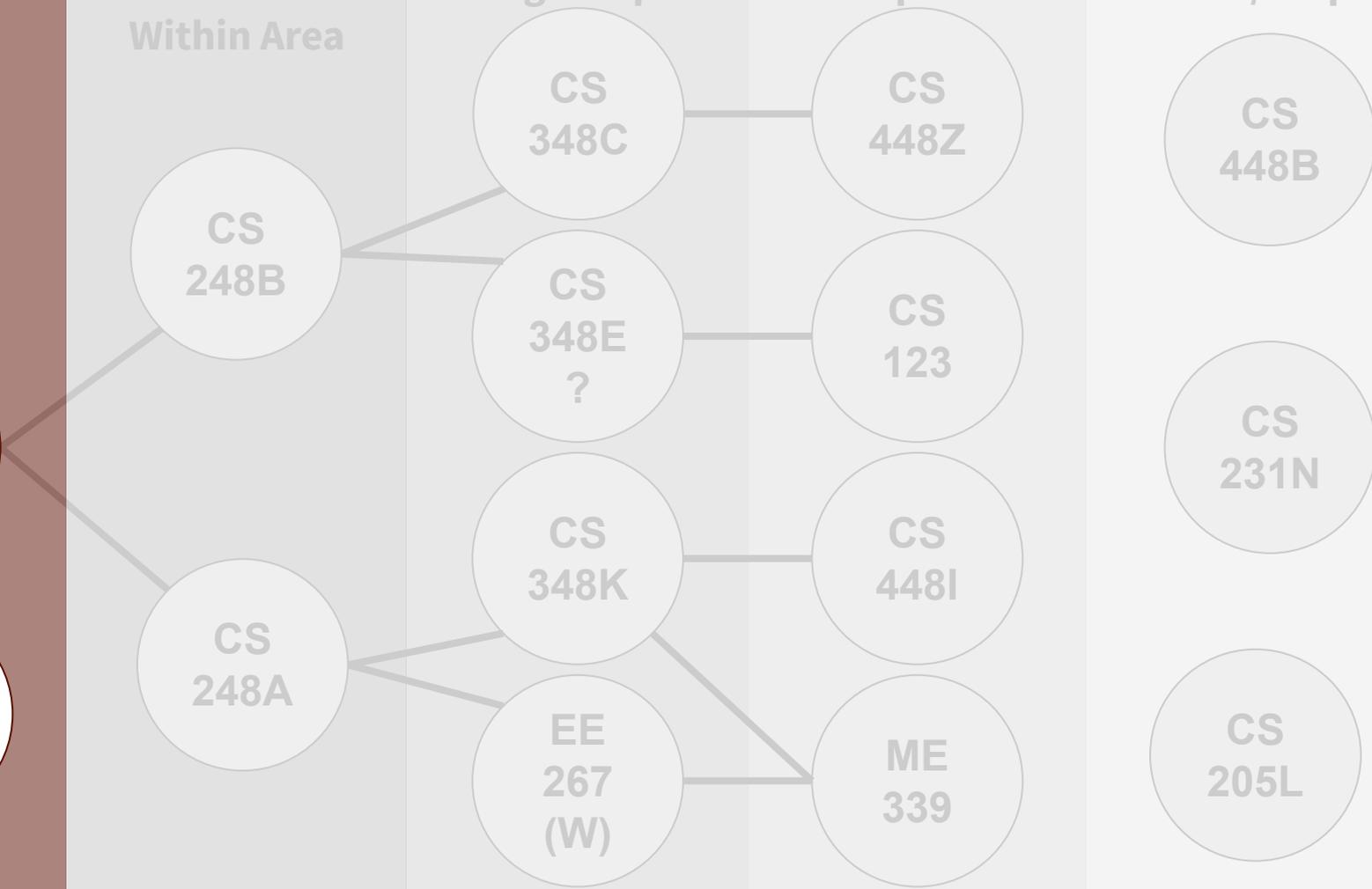
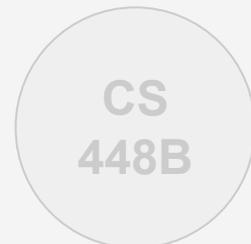
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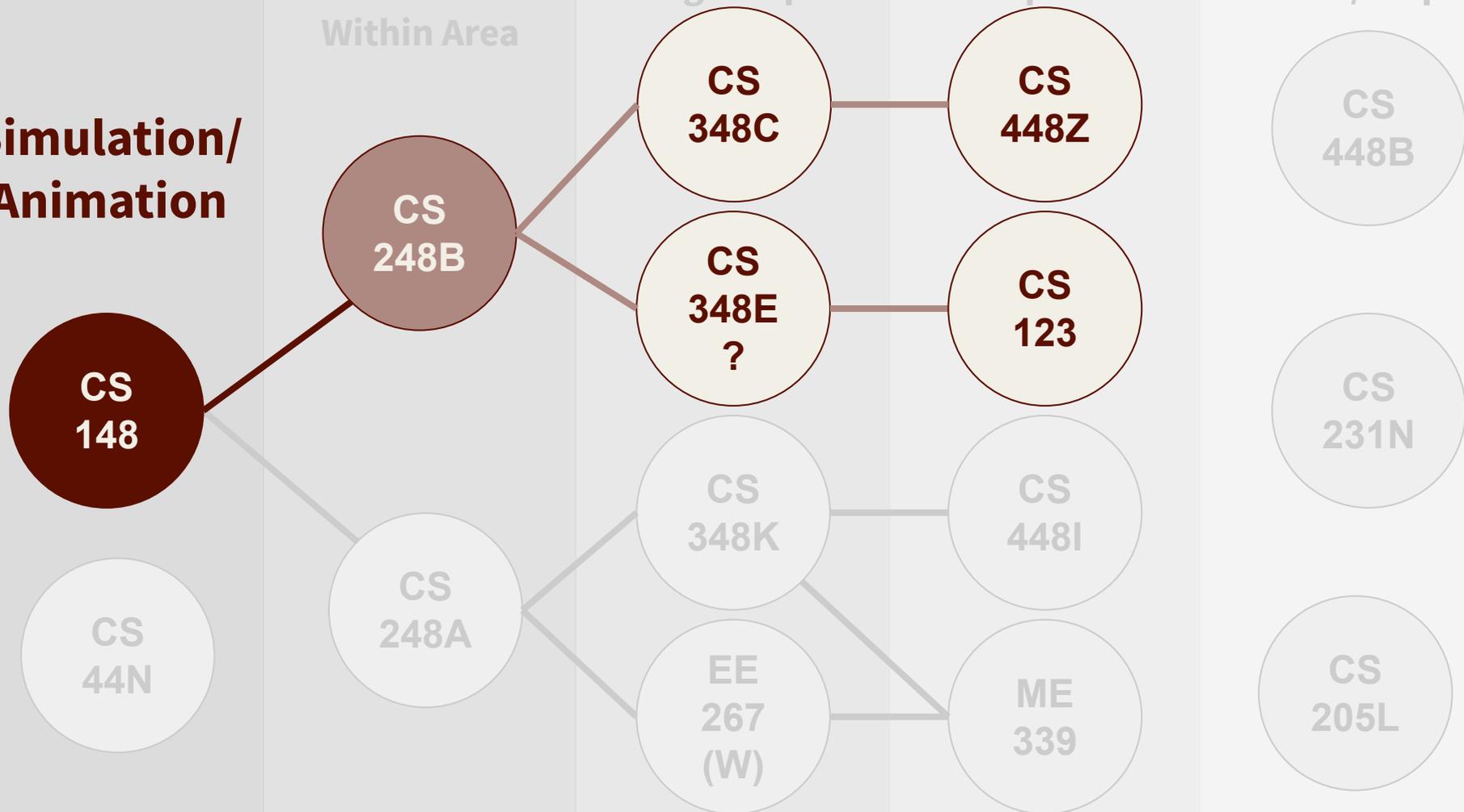
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Single Topic

Deep Dive

Related/Helpful

**Simulation/
Animation**



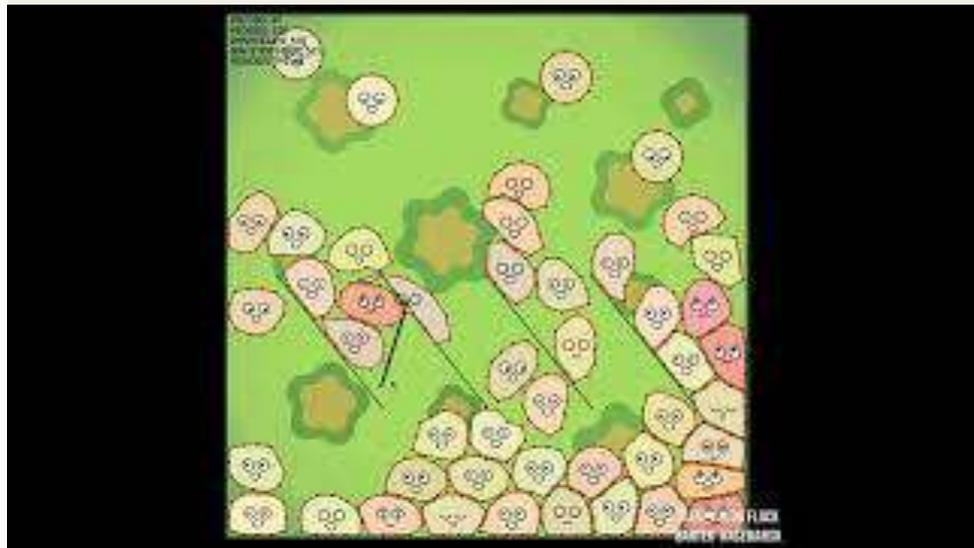
CS 248B: Fundamentals of Computer Graphics: Animation and Simulation

- Learn more about simulation and motion
- Focus on sound and motion
- Rigid body and soft body interactions
- Particle systems
- IK bones (rigging)



CS 248B: Fundamentals of Computer Graphics: Animation and Simulation

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CS 348C: Computer Graphics: Animation and Simulation

- Simulation and Animation, but focused on particle systems
- Taught in Houdini
- Particle systems, procedural geometry, dynamics, and sound
- Final project



CS 348C: Computer Graphics: Animation and Simulation

- Simulation and Animation, but focused on particle systems
- Taught in Houdini
- Particle systems, procedural geometry, dynamics, and sound
- Final Project

FINAL PROJECTS

CS 448Z: Physically Based Animation and Sound

- Modeling sound waves and radiation
- Sound propagation and acoustic transfer
- Fracture
- Fire
- Cloth



CS 348E: Character Animation: Modeling, Simulation, and Control of Human Motion

- Simulation and Animation, but focused on the human body
- Forward and Inverse Kinematics
- Study of hands
- Using motion to predict future actions



CS 123: A Hands-On Introduction to Building AI-Enabled Robots

- Build your own quadruped robot
- Program the Robot
- Requires only basic linear algebra and python
- Only 20 slots



Overview

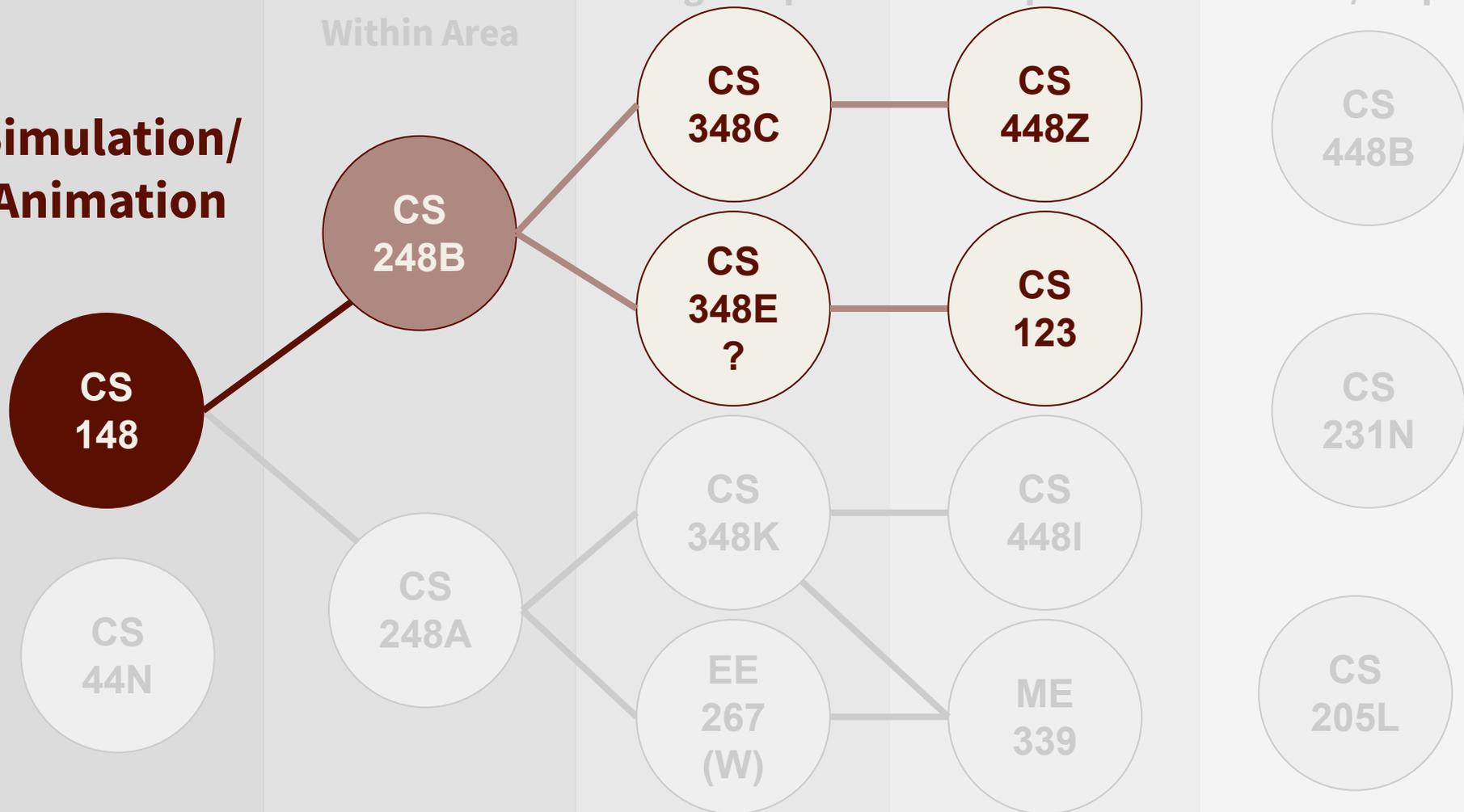
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Animation**



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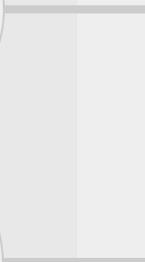
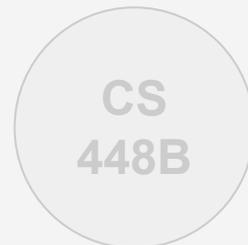
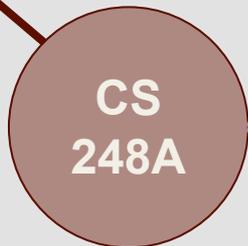
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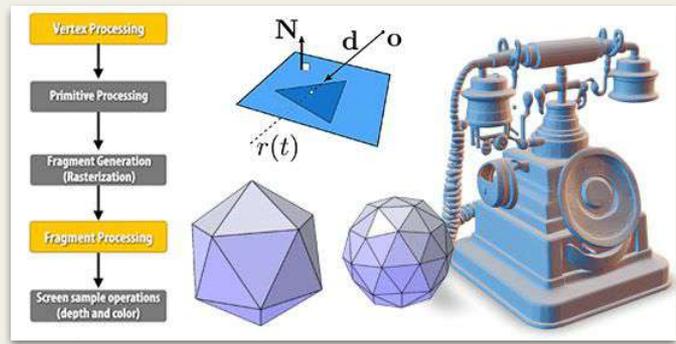
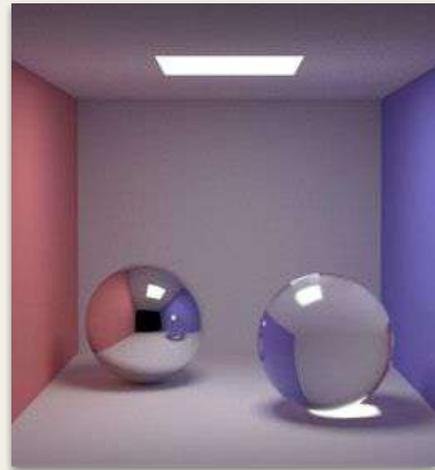
Related/Helpful

**Rendering/
Efficiency/
Hardware**



CS 248A: Computer Graphics: Rendering, Geometry, and Image Manipulation

- What is an image and how does it get shown on the screen?
- GPU pipeline
- Transformations
- A bit of interaction
- Final Project



CS 348K: Visual Computing Systems

- Digital camera processing
- Neural network hardware
- Video compression
- NERFS
- GPU accelerated ray tracing

```
Func blur_3x3(Func input) {  
    Func blur_x, blur_y;  
    Var x, y, xi, yi;  
  
    // The algorithm - no storage or order  
    blur_x(x, y) = (input(x-1, y) + input(x+1, y) + input(x, y-1) + input(x, y+1) + input(x, y)) / 5;  
    blur_y(x, y) = (blur_x(x, y-1) + blur_x(x, y+1) + blur_x(x, y)) / 3;  
  
    // The schedule - defines order, locali  
    blur_y.tile(x, y, xi, yi, 256, 32)  
        .vectorize(xi, 8).parallel(y);  
    blur_x.compute_at(blur_y, x).vectorize(x, 8).parallel(y);  
  
    return blur_y;  
}
```



CS 448I: Computational Imaging

- Human Perception and Digital Cameras
- Using ML to solve inverse problems (denoising, etc.)
- Light field imaging
- Wave optics



Analysis of Modern Reconstruction for Image Reconstruction
 EE 367 - Computational Imaging
 Stephen Zhu

Motivation

Ill-posed inverse problem: given a noisy, blurred, incomplete, etc. image, how can we recover the original image?

The method used in this project relies on diffusion models and varying sampling algorithms to attempt reconstruction. Peak Signal to Noise Ratio (PSNR) and Learned Perceptual Image Patch Similarity (LPIPS) are the main metrics for determining success.

Challenges & Limitations

- Hallucinates high-frequency details
- Struggled on non-human subjects

References

1. Wang, et al. "Score-Based Generative Models for Denoising Diffusion Equations." *ICML*, 2021.
 2. Dhariwal, et al. "Diffusion Models Beat GANs on High-Resolution Image Synthesis." *ICML*, 2022.
 3. Saito, et al. "Score-Based Generative Models for Denoising Diffusion Equations." *ICML*, 2021.
 4. Saito, et al. "Score-Based Generative Models for Denoising Diffusion Equations." *ICML*, 2021.
 5. Saito, et al. "Score-Based Generative Models for Denoising Diffusion Equations." *ICML*, 2021.

Overview

Score-Distillation Editing (SDEdit)	Score-Based Anisotropic Langevin Dynamics (ScoreALD)	Diffusion Posterior Sampling (DPS)
<ul style="list-style-type: none"> • Partially noisy, then reverse diffusion <ul style="list-style-type: none"> ◦ Used 500 / 1000 noising steps • PSNR = 20 • LPIPS = 0.20 	<ul style="list-style-type: none"> • Utilizes gradient of log likelihood • Anisotropic gradient for better convergence • PSNR = 22 • LPIPS = 0.15 	<ul style="list-style-type: none"> • Takes into account estimate of original image in gradient • No annealing, but normalize gradients • PSNR = 30 • LPIPS = 0.05

Solving Inverse Problems in Imaging with Diffusion Models
 Matthew M. Saito
 Stanford University
 EE 367 Final Project, Winter 2025

Motivation

- Captured images are noisy
- Diffusion models are great at unconditionally generating images
- For inverse problems, need to **condition diffusion process on measurement**
- Conditioning is computationally intractable, requiring heuristics/approximations

Related Work

- Optimization based methods: ADMM & HOS [1]
- Convergence can be slow
- Neural network supervised approaches [2]
- Falls when out of distribution

References

1. Wang, et al. "Score-Based Generative Models for Denoising Diffusion Equations." *ICML*, 2021.
 2. Dhariwal, et al. "Diffusion Models Beat GANs on High-Resolution Image Synthesis." *ICML*, 2022.
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 5. Saito, et al. "Score-Based Generative Models for Denoising Diffusion Equations." *ICML*, 2021.

Methods

SDEdit [3]

$\epsilon_t = \beta_t - \beta_{t-1}$

$\sigma_t = \sqrt{\beta_t - \beta_{t-1}}$

$\epsilon_t = \text{Noise}(\epsilon_t)$

ILVR [4]

$\epsilon_t = \beta_t - \beta_{t-1}$

$\sigma_t = \sqrt{\beta_t - \beta_{t-1}}$

$\epsilon_t = \text{Denoising}(\epsilon_t)$

Example by factor 5

ScoreALD [5]

$\epsilon_t = \beta_t - \beta_{t-1}$

$\sigma_t = \sqrt{\beta_t - \beta_{t-1}}$

$\epsilon_t = \text{Denoising}(\epsilon_t)$

Example by factor 5

DPS [6]

$\epsilon_t = \beta_t - \beta_{t-1}$

$\sigma_t = \sqrt{\beta_t - \beta_{t-1}}$

$\epsilon_t = \text{Denoising}(\epsilon_t)$

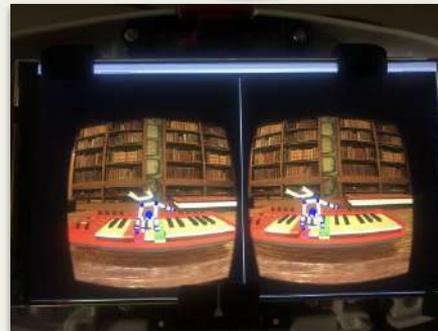
Experimental Results

SDEdit	ILVR	ScoreALD	DPS

EE 267: Virtual Reality



- Hands on electrical engineering class
- Hardware systems used for virtual reality
- Write code and explore software for VR
- Project based class



ME 339: Introduction to Parallel Computing Using MPI, OpenMP and CUDA

- Programming multicore processors, GPUs, and parallel computers
- Multi-threaded programs
- Machine learning



Overview

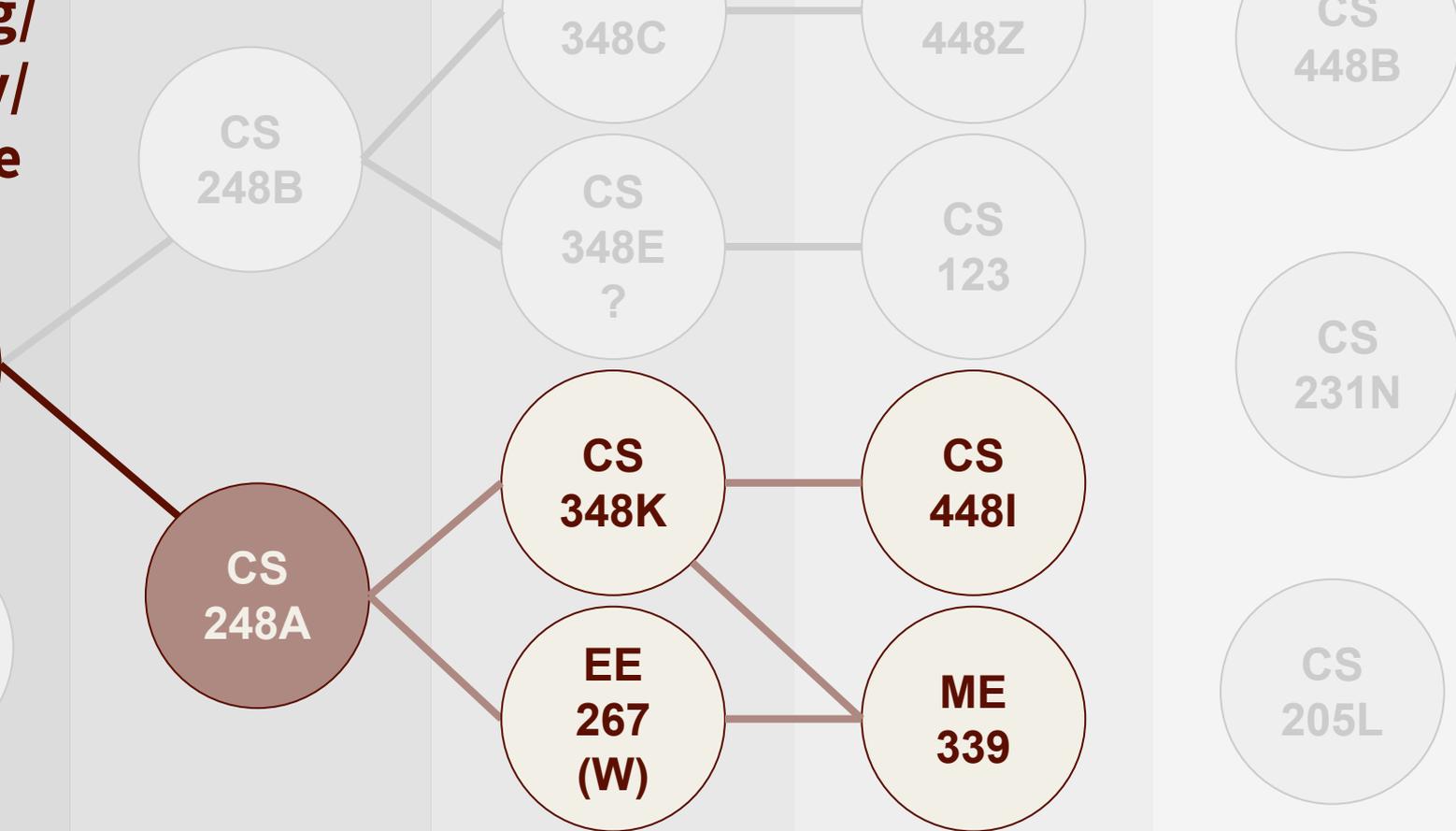
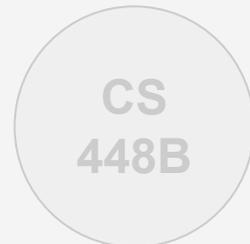
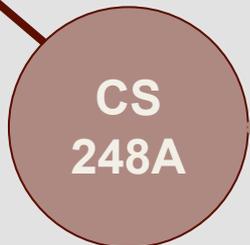
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**Rendering/
Efficiency/
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Related/Helpful

Learning and Vision

CS
148

CS
44N

CS
248B

CS
248A

CS
348C

CS
348E
?

CS
348K

EE
267
(W)

CS
448Z

CS
123

CS
448I

ME
339

CS
448B

**CS
231N**

**CS
205L**

CS 205L: Continuous Mathematical Methods with an Emphasis on Machine Learning



- Learn about the mathematical foundation of Machine Learning
- Basis in Linear Algebra
- Programming and paper assignments

Adjacency Matrix

	1	2	3	4	5	6
1	0	0	0	1	1	1
2	0	0	0	1	1	0
3	0	1	0	0	0	1
4	1	1	0	0	0	0
5	1	1	0	0	0	0
6	1	0	1	0	0	0

The graph diagram shows six nodes labeled 1 through 6, each with a small portrait. Node 1 is a woman with blonde hair, node 2 is a woman with dark hair, node 3 is a woman with blonde hair, node 4 is a man with dark hair, node 5 is a man with dark hair, and node 6 is a man with dark hair. Edges connect nodes (1,4), (1,5), (1,6), (2,4), (2,5), (3,6), (4,1), (4,2), (5,1), (5,2), and (6,3).

Overview

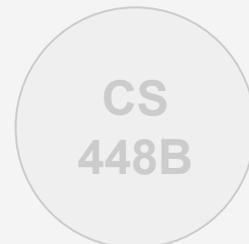
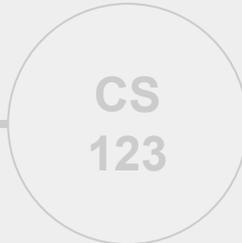
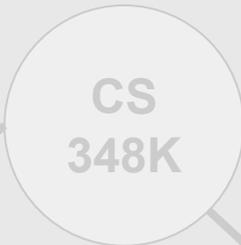
Overview
Within Area

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Deep Dive

Related/Helpful

Learning and Vision



Overview

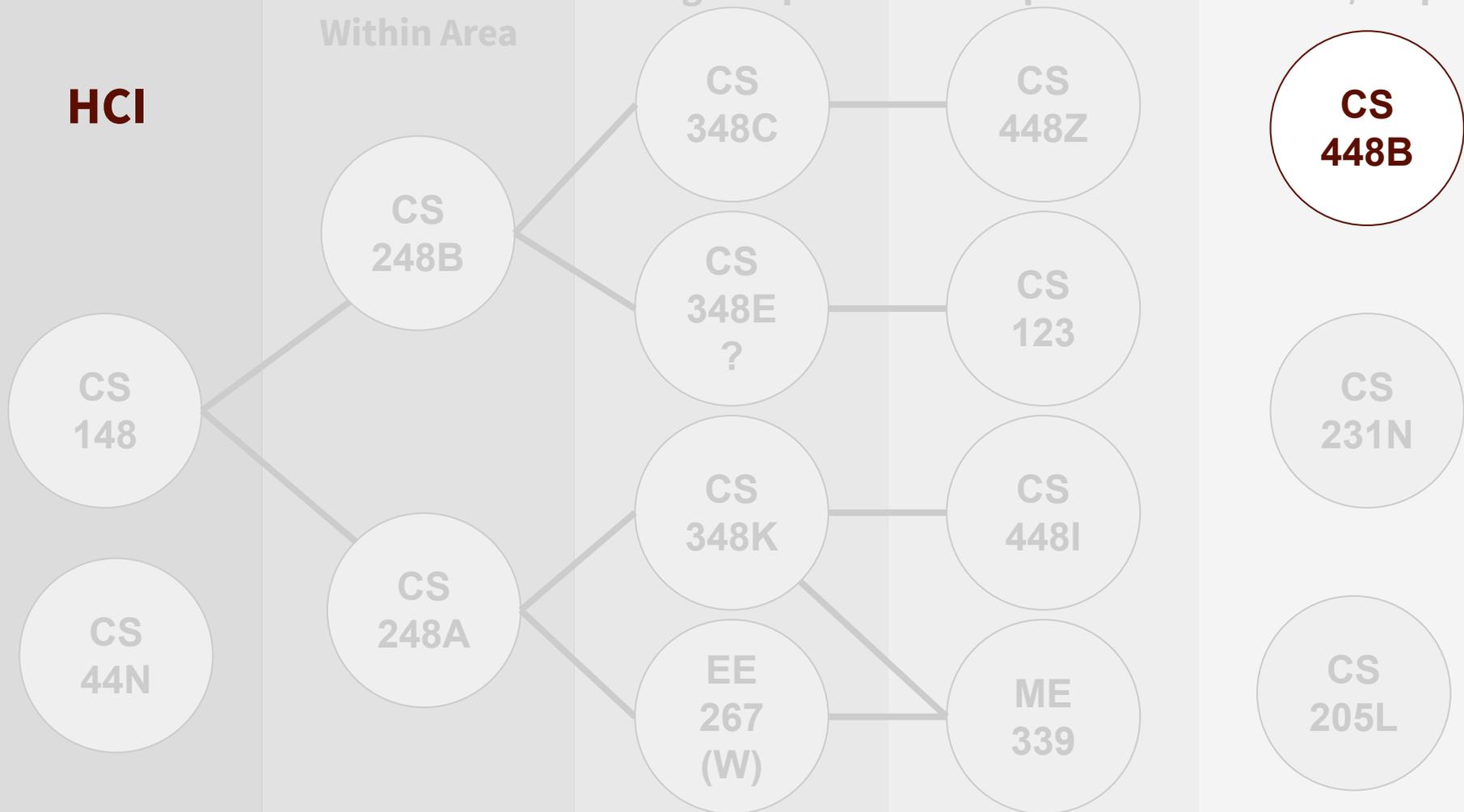
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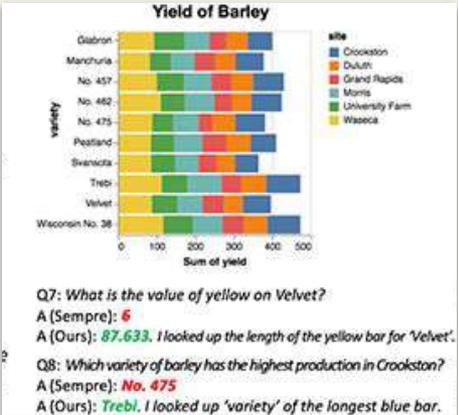
Deep Dive

Related/Helpful

HCI



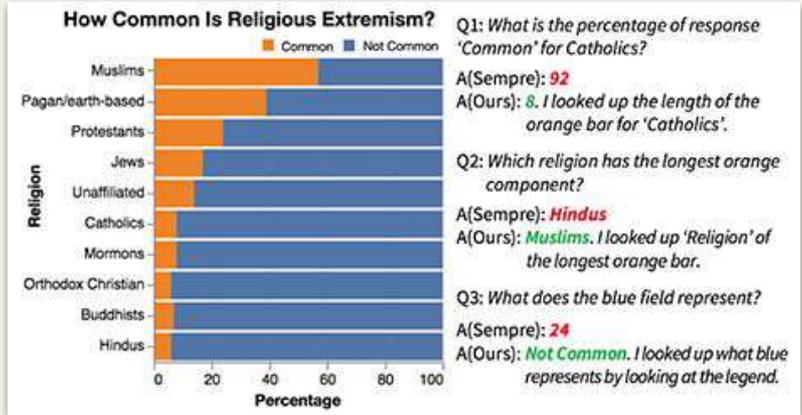
CS 448B: Data Visualization



● Think about Computer Graphics from a comprehension perspective

● Learn how to use and optimize visualization tools

● Discuss data visualization theory



**MI 260: Creative Visualization
Studio**

**BIOE 281: Biomechanics of
Movement (ME 281)**

**ARTSTUDI 167M: Animated By
Origins: Africa and The
Americas (AFRICAAM 167)**

**BIOE 485: Modeling and
Simulation of Human
Movement (ME 485)**

**AMSTUD 129: Animation and
the Animated Film (FILMEDIA
129, 329, 429)**

**PSYCH 230: Computational
Models of Human Creative
Expression**

Questions?

If You're Interested in Industry

- Make a demo reel
- Meet people in the field
 - Volunteer for SIGGRAPH!
 - Look for and go to events
- Take project based classes
- Save your work!

Cutting Edge Graphics

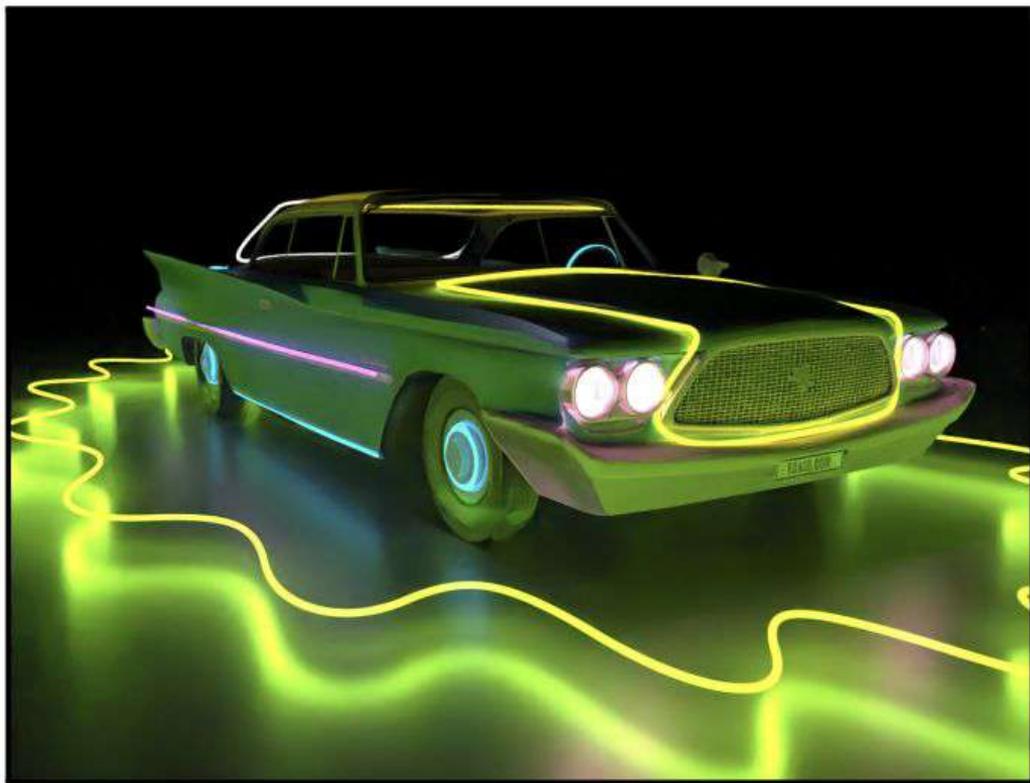


SIGGRAPH 2025

Vancouver+ 10-14 August

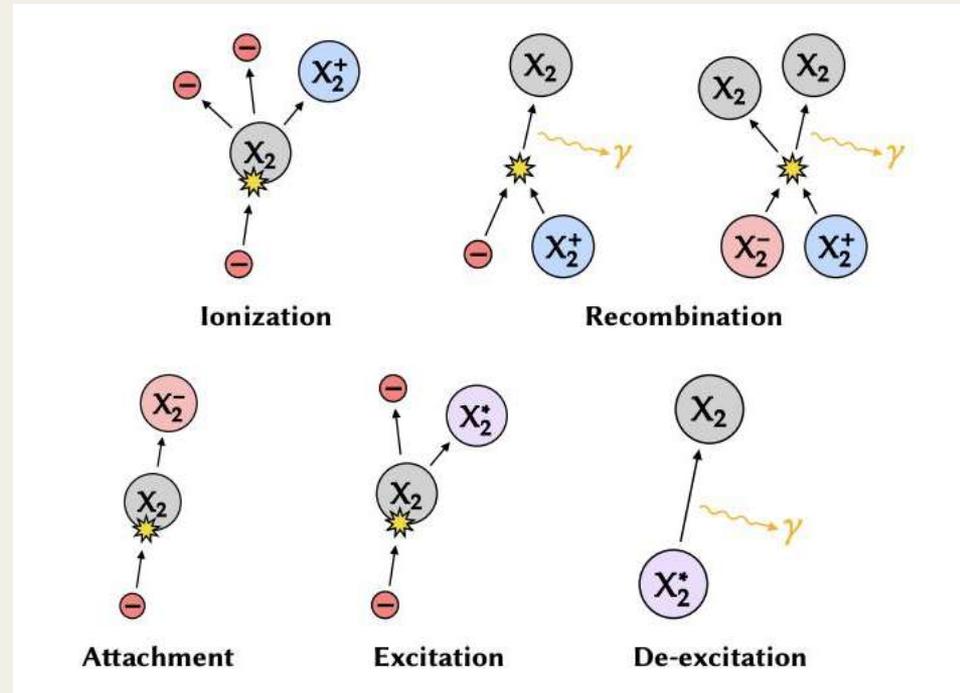
The Premier Conference & Exhibition on
Computer Graphics & Interactive Techniques
Technical Papers Trailer

Modeling and Rendering Glow Discharge



Modeling and Rendering Glow Discharge

Symbol(s)	Meaning
x	Arbitrary point in space, \mathbb{R}^3
ω	Outgoing radiance direction, \mathbb{S}^2
$L_o(x, \omega)$	Outgoing radiance from x along ω
$L_e(\omega, \omega)$	Emission at x along ω
E, \tilde{E}	Electron number density, logarithm
P, \tilde{P}	Positive ion number density, logarithm
N, \tilde{N}	Negative ion number density, logarithm
$\vec{v}_E, \vec{v}_P, \vec{v}_N$	Drift velocity of electrons and ions
\mathcal{D}	Diffusion coefficient
α	Ionization coefficient
β	Recombination coefficient
η	Attachment coefficient
ρ	Ion scale coefficient
$\vec{\mu}$	Homogenized drift velocity, \mathbb{R}^3
λ	Wavelength of light



Crazy Fast Physics: Augmented Vertex Block Descent (AVBD)



Crazy Fast Physics: Augmented Vertex Block Descent (AVBD)

1. Numerical stability
2. Parallel computing

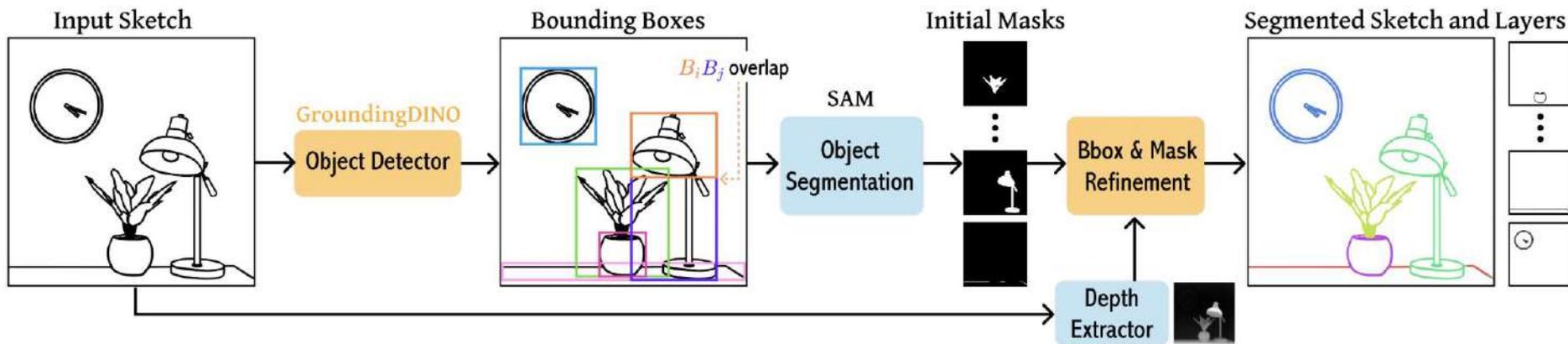
$$\mathbf{x}^{t+\Delta t} = \operatorname{argmin}_{\mathbf{x}} \frac{1}{2 \Delta t^2} \|\mathbf{x} - \mathbf{y}\|_M^2 + E(\mathbf{x}) ,$$

Instance Segmentation of Scene Sketches Using Natural Image Priors



Instance Segmentation of Scene Sketches Using Natural Image Priors

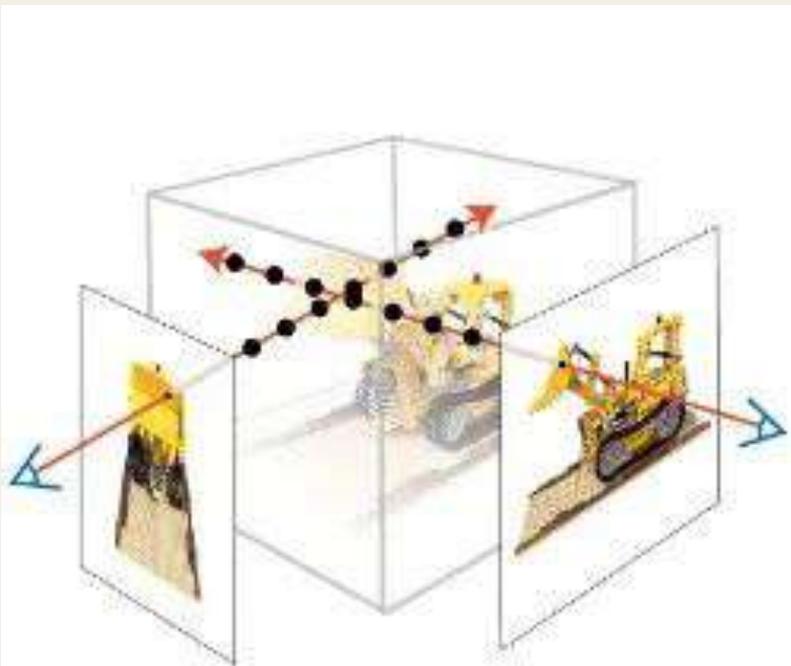
Overall pipeline



Instance Segmentation of Scene Sketches Using Natural Image Priors



DreamPrinting: Volumetric Printing Primitives for High-Fidelity 3D Printing



Neural Radiance Field



A 3D Scene is worth 1000 Splats

DreamPrinting: Volumetric Printing Primitives for High-Fidelity 3D Printing



DreamPrinting 3D Collections

DreamPrinting: Volumetric Printing Primitives for High-Fidelity 3D Printing



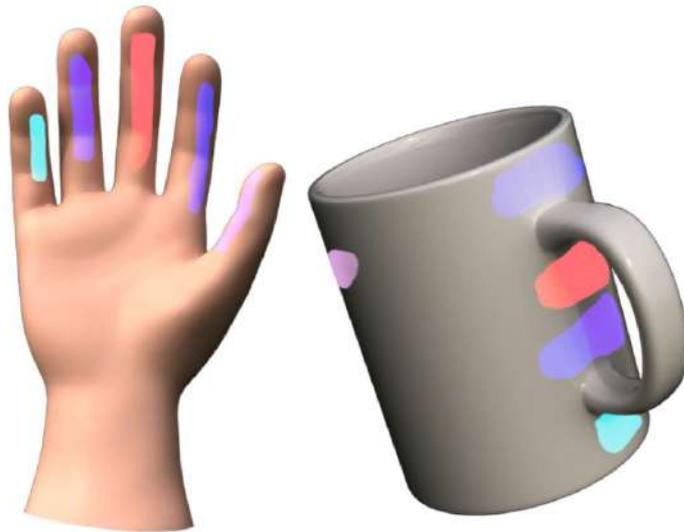
Parasitic Finger



Artist Tools and Human Anatomy



input



Contact Edit



final pose

Contact Edit

Specific Use Cases



A Method for Animating Children's Drawings of the Human Figure

Refining Existing Problems



**Fluid-solid
Coupling in
Kinetic
Two-phase
Flow
Simulation**

Refining Existing Problems



**As-continuous-as-possible
Extrusion-based Fabrication
of Surface Models**

Research in Film and Gaming



**Across
the
Spider-
verse**

Questions?