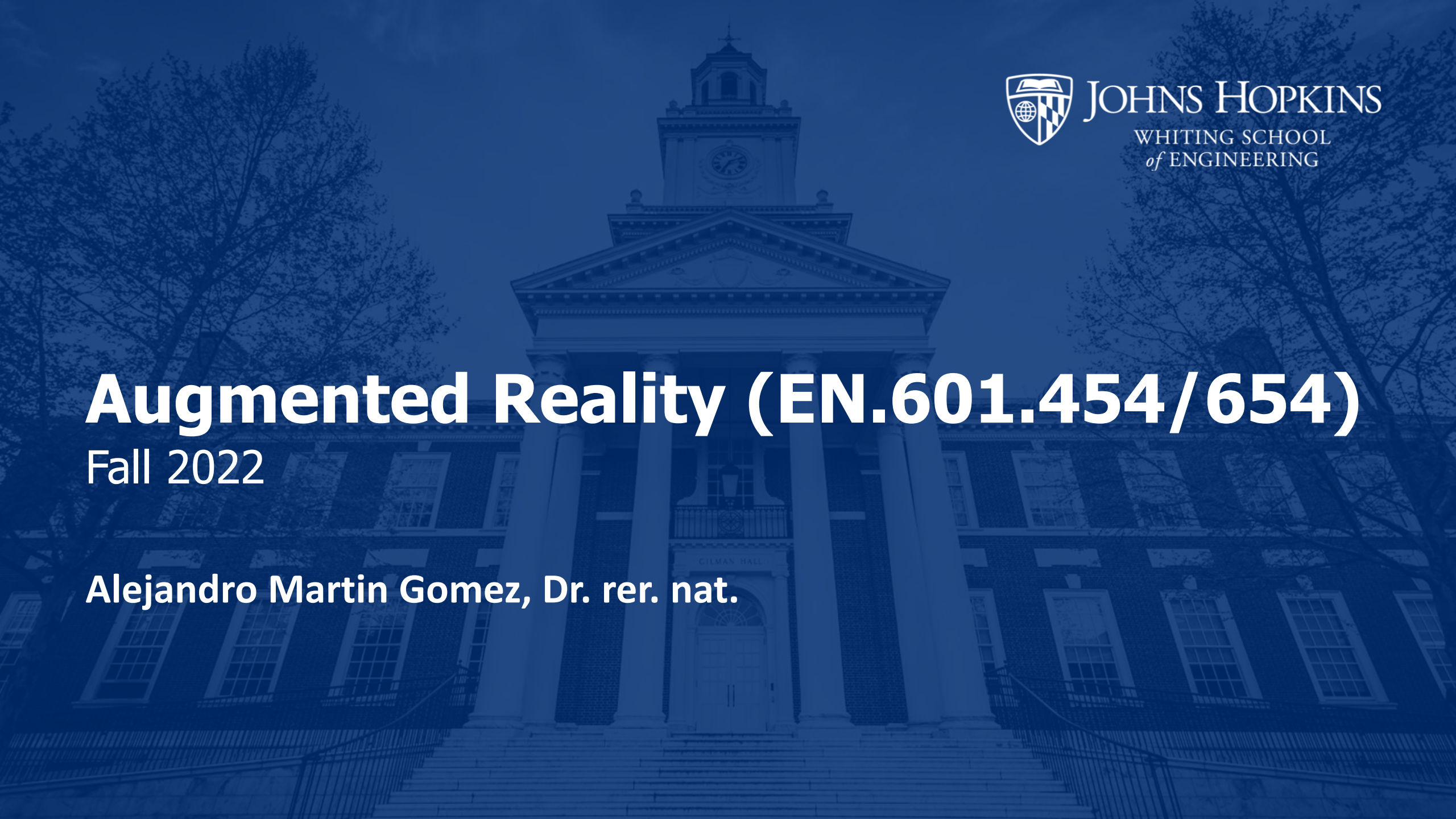

Augmented Reality (EN.601.454/654)

Fall 2022

Alejandro Martin Gomez, Dr. rer. nat.

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General Description

General Description

- Instructor: Alejandro Martin Gomez
- Student Level: Undergraduate/Graduate (Applications)
- Prerequisites: Linear Algebra, Intermediate Programing, Data Structures
- Textbooks:
  - Schmalstieg, Dieter, and Tobias Höllerer. *Augmented reality: principles and practice*. Addison-Wesley Professional, 2016.
  - Hartley, Richard, and Andrew Zisserman. *Multiple view geometry in computer vision*. Cambridge university press, 2003.
    - Both books are available using our library resource

General Description

- Course Description:

This course presents an introduction to augmented reality technologies, with an emphasis on designing and developing interactive augmented and virtual reality experiences. The course will cover the history of the area, interaction techniques, and specific application areas. The course also discusses the main issues of calibration, tracking, sonification, advance visualization and display technologies.

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Objectives

Objectives

- By the end of this course, you will be able to identify and understand the basic components of an augmented reality application.

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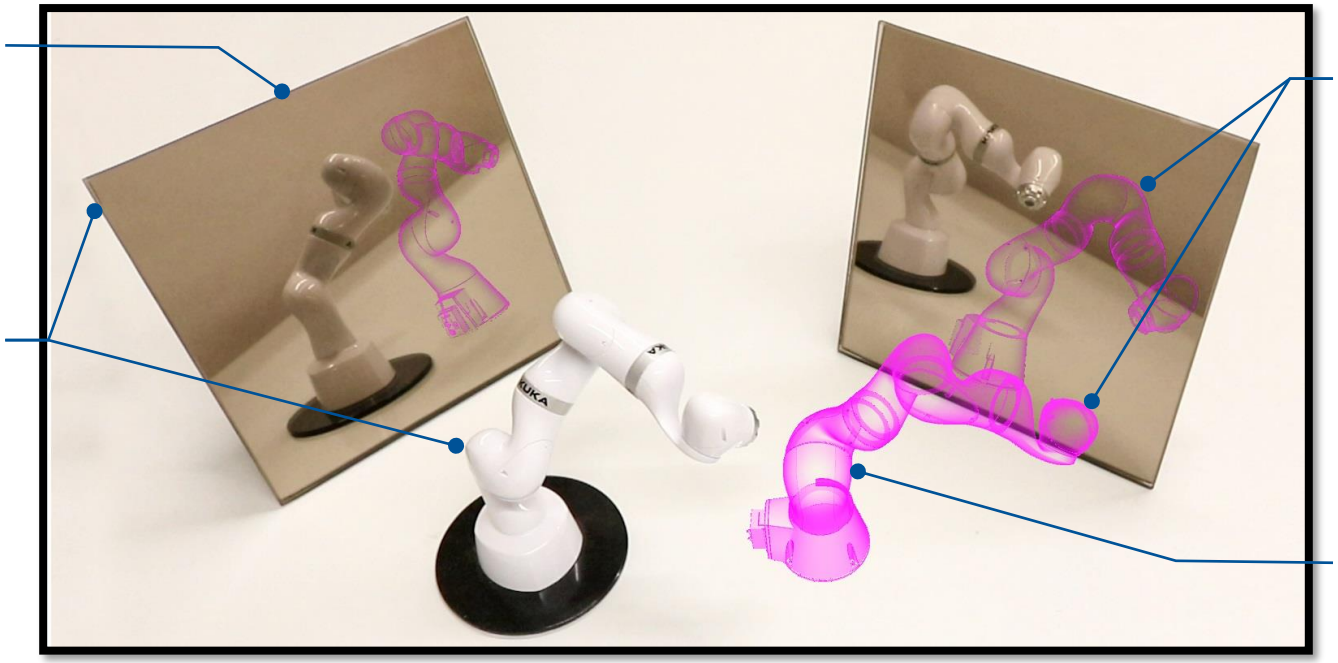

Objectives

- By the end of this course, you will be equipped with the necessary tools to design and implement your own augmented reality applications.

Objectives

- By the end of this course, you will be equipped with the necessary tools to design and implement your own augmented reality applications.

Speed 2x

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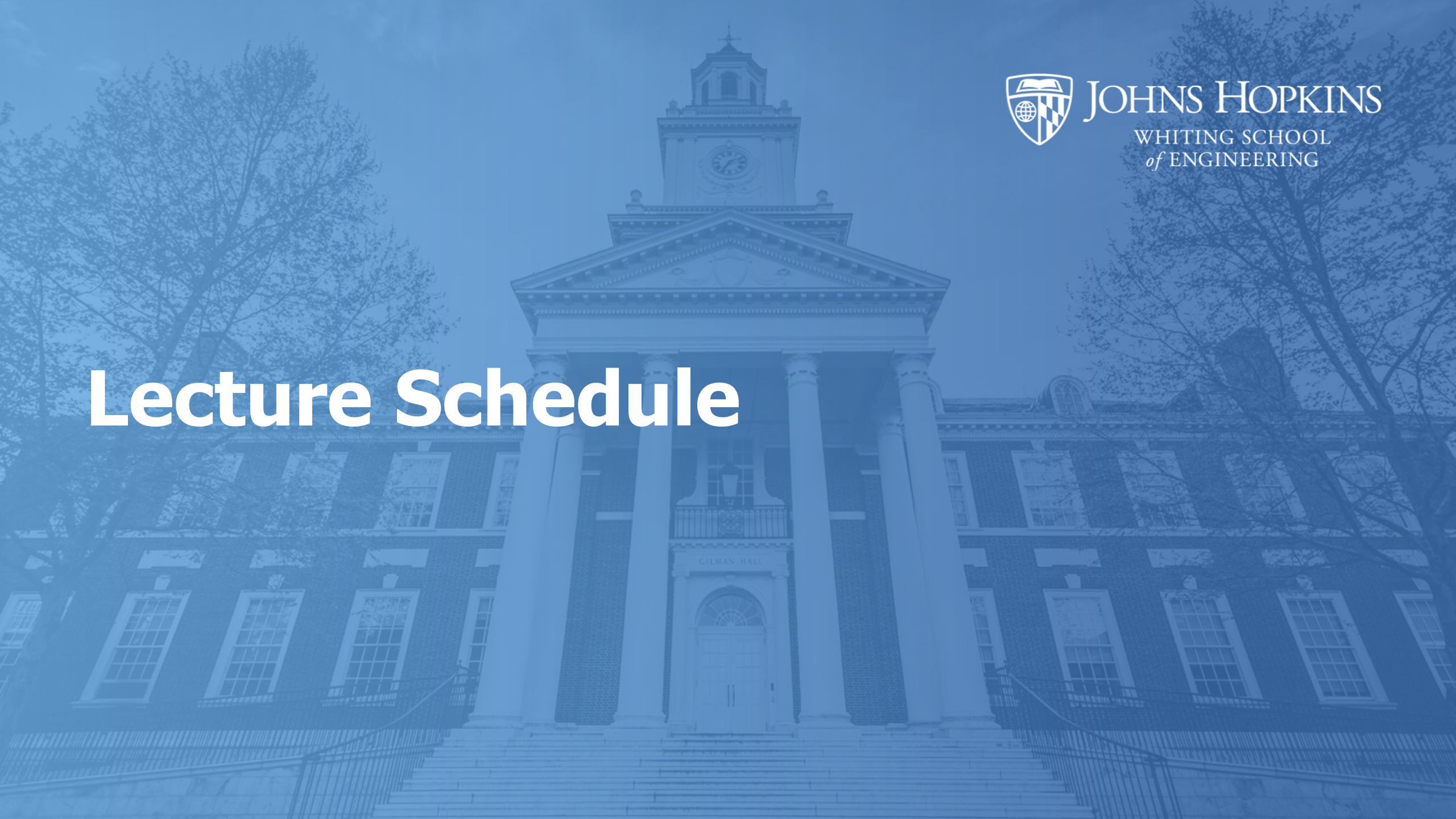
Logistics

Logistics

- Lecture: 2 sessions of 1 hour and 15 minutes each
  - Time: Tuesdays and Thursdays from 15:00 to 16:15
  - Location: Maryland 310
  - Website: TBD (Most probably, we will use a GitHub Page)

- Office Hours: 2 hours per week
  - Lead Teaching Assistant: Irene Kim will reach out to you with further details



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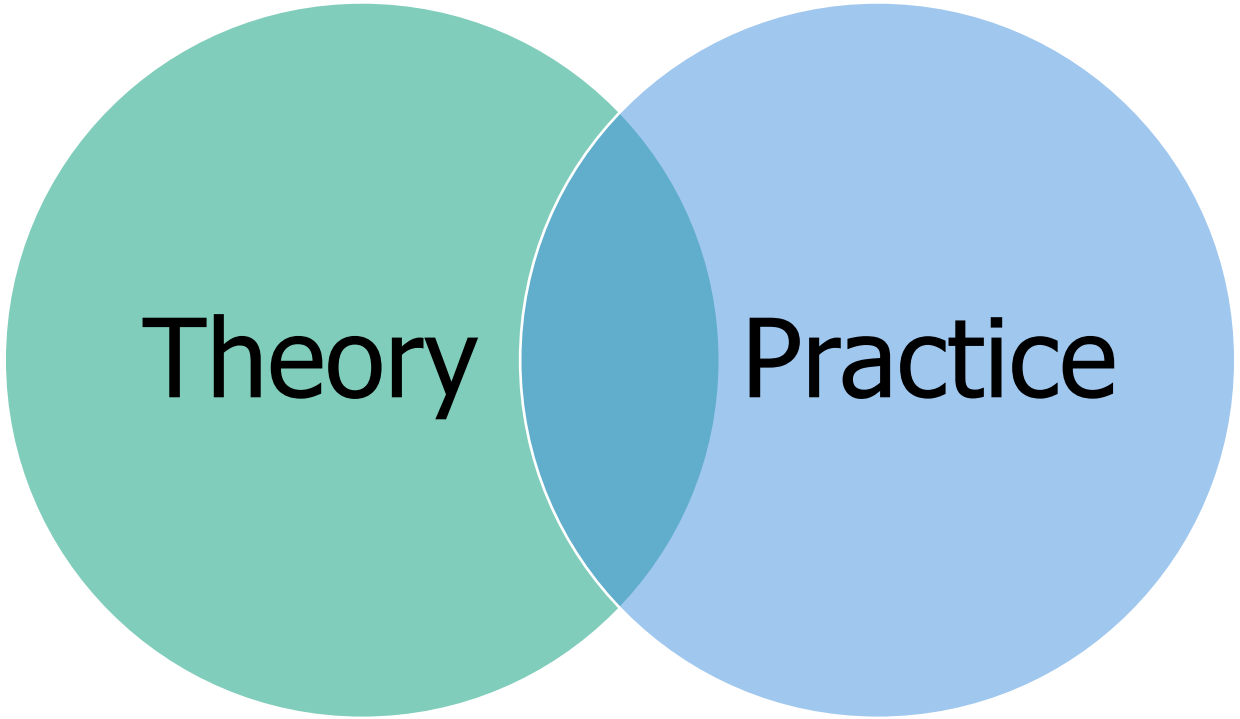
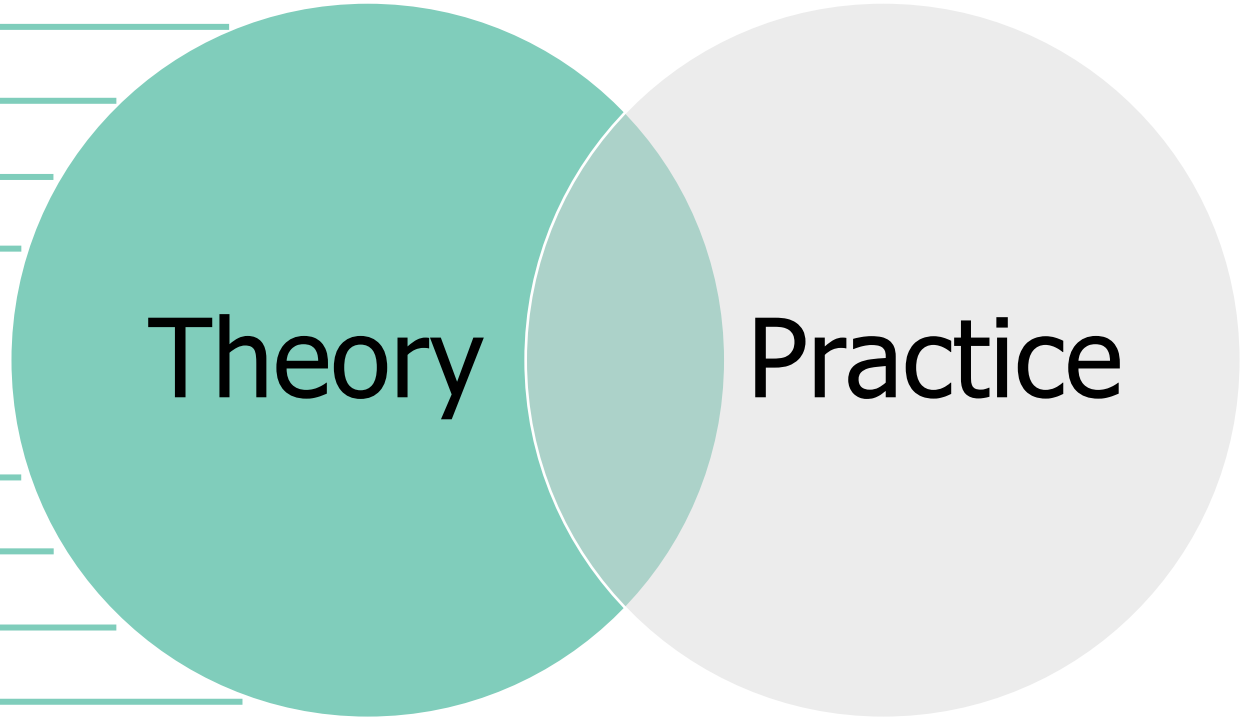
Lecture Schedule

Lecture Schedule

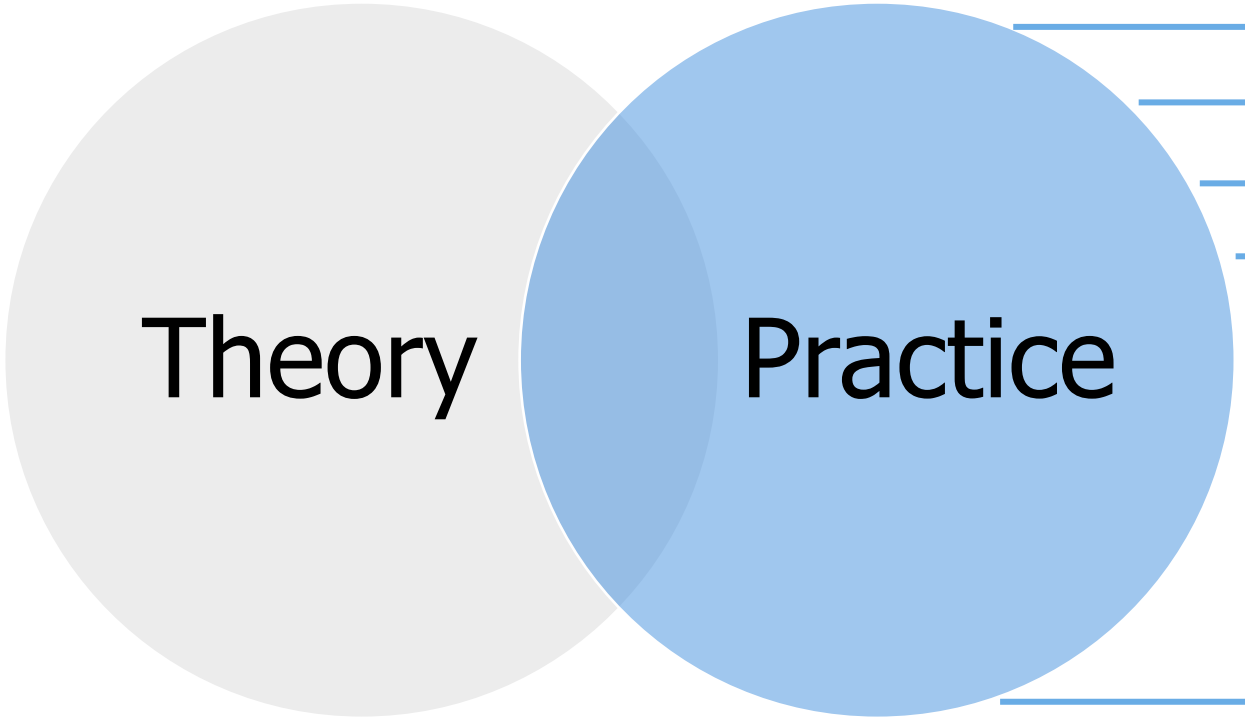


Lecture Schedule

Introduction to Augmented Reality
Transformation, Parameter Estimation
Camera Models and Calibration
Visual System and Perception
Rendering
Head Mounted Displays
Input Devices
Sonification
User-Centered Design
Medical AR

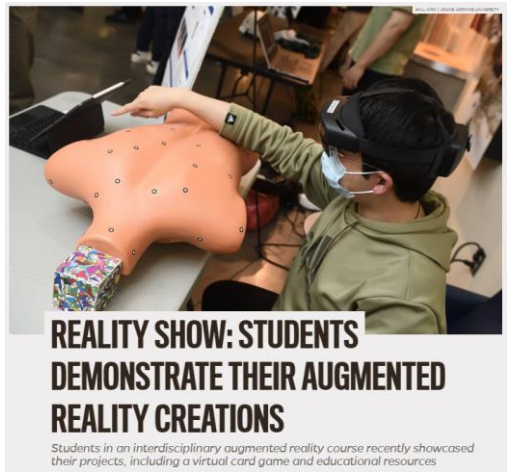


Lecture Schedule



- Introduction to Augmented Reality
- Camera Models and Calibration
- Visual System and Perception
- Rendering
- Head Mounted Displays
- Project

https://hub.jhu.edu/2022/05/19/augmented-reality-class-demonstrations/



Lecture Schedule

#	Date	Topic	Assignment		Remarks
			Release	Due	
1	08/30 (Tue)	Course Logistics			
2	09/01 (Thu)	Introduction to Augmented Reality			
3	09/06 (Tue)	Transformations	1		Roll-a-ball
4	09/08 (Thu)	Parameter Estimation (Part 1)			
5	09/13 (Tue)	Parameter Estimation (Part 2)	2		Transformations, Parameter Estimation
6	09/15 (Thu)	Camera Models and Projection Matrices		1	
7	09/20 (Tue)	Camera Calibration	3		Camera Models and Camera Calibration
8	09/22 (Thu)	Hands-on Session 1 (Marker Tracking)	4		Marker Tracking
9	09/27 (Tue)	Visual System and Perception		2	
10	09/29 (Thu)	Hands-on Session 2 (Rendering)	5		Rendering, Visual Perception
11	10/04 (Tue)	Head-mounted Displays		3	
12	10/06 (Thu)	Hands-on Session 3 (HoloLens)			
13	10/11 (Tue)	Input Devices		4	
14	10/13 (Thu)	Other AR Modalities (Sonification)			
15	10/18 (Tue)	User-Centered Design (Guest Lecture)		5	
16	10/20 (Thu)	Medical Augmented Reality			
17	10/25 (Tue)	Mid-Term Exams			Mid-Term Exams

Lecture Schedule

#	Date	Topic	Assignment		Remarks
			Release	Due	
18	10/27 (Thu)	Projects Introduction			
19	11/01 (Tue)	Project Development			
20	11/03 (Thu)	Project Development			
21	11/08 (Tue)	Kick off Presentation			
22	11/10 (Thu)	Project Development			
23	11/15 (Tue)	Project Development			
24	11/17 (Thu)	Project Development			
25	11/22 (Tue)	Project Development			Thanksgiving!
26	11/24 (Thu)	Project Development			Thanksgiving!
27	11/29 (Tue)	Project Development			
28	12/01 (Thu)	Project Development			
29	12/06 (Tue)	Project Development			
30	12/08 (Thu)	Project Development			Poster/Report Submission Deadline
31	12/13 (Tue)	Demo Preparation			
32	12/15 (Thu)	Final Presentation and Demo			Final Exam (Demo Day)

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Assessment

Assessment

- Assignments (40%)
- Quizzes (5%)
- Midterm exam (15%)
- Final project (40%)

Grade Breakdown

- Assignments (40%) -> (5 x 8%, with bonus, capped at 40%)
  - Introduction to augmented reality (8%)
  - Transformations and Parameter Estimation (8%)
  - Camera Models and Camera Calibration (8%)
  - Marker Tracking (8%)
  - Visual Perception and Rendering (8%)








Grade Breakdown

- Quizzes - Exit Ticket (5%)
  - Contain topics discussed in the lectures (weekly / biweekly)

- Midterm exam (15%)
  - October 25th , 2022

Grade Breakdown

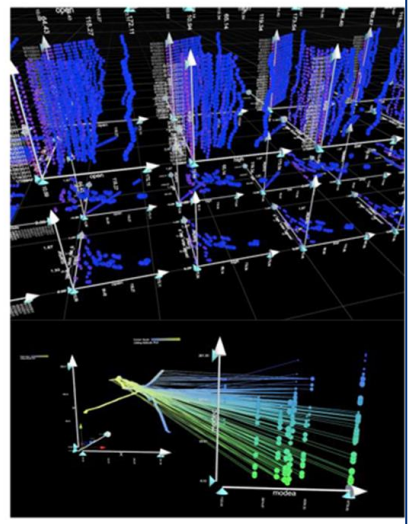
- Final project (40%)
  - 5% Kickoff presentation ➔ November 8th, 2022
  - 20% Implementation ➔ October 27th, 2022 - December 8th, 2022
  - 15% Poster and Demo ➔ December 15th, 2022
    - Two pages report IEEE Conference Paper Format (10%)
    - Poster for presentation (5%)

Final Projects, Examples

- Augmented Reality
  - Spring 2021
  - Prof. Nassir Navab
- Teaching / Education

Immersive Visual Analytics of Data Analysis in Mixed Reality

- **Background:**
  - During user studies of VR/AR systems, data with complex relationships are acquired.
  - This project aims to create a platform for the visualization of such data in a MR environment.
- **Objective:**
  - Build a Visual Analysis Pipeline for Unity.
  - We have data available that can be provided to generate the visualizations.
- **Suggested Features to Use:**
  - Immersive Analytics Toolkit (github.com/MaximeCordeil/IATK)
  - Smarthpones/Tablets and RGB cameras.



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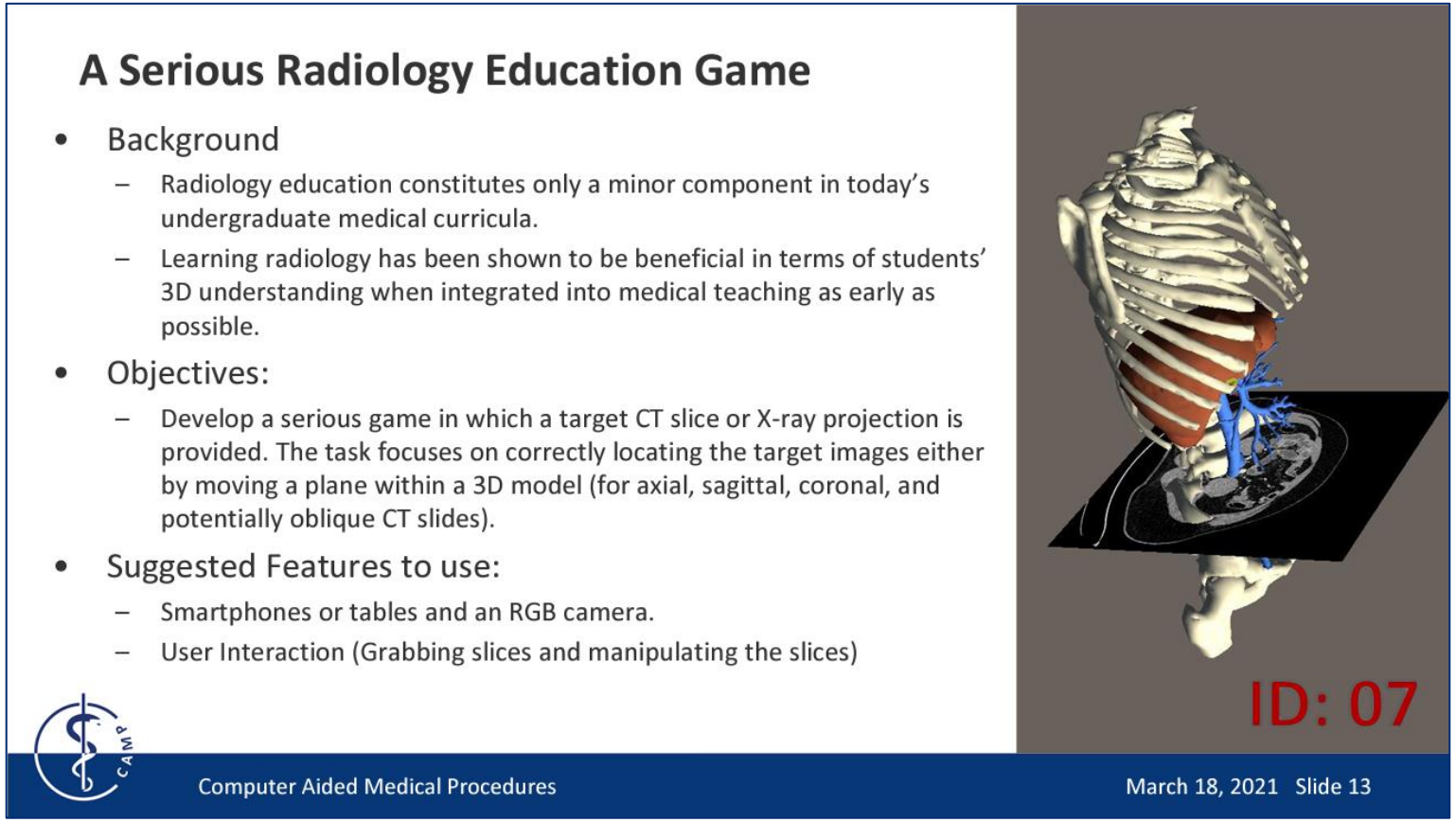
Computer Aided Medical Procedures March 18, 2021 Slide 10

Final Projects, Examples

- Augmented Reality
  - Spring 2021
  - Prof. Nassir Navab
- Medical Applications

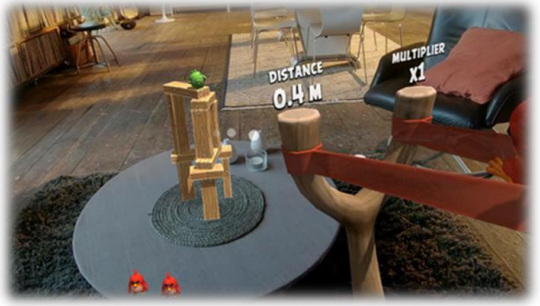


Final Projects, Examples

- Augmented Reality
  - Spring 2021
  - Prof. Nassir Navab
- Gamming

AR Angry Bird

- Objective:
  - Develop an AR “angry bird” like game
  - Find a flat surface in the environment and generate a base for bad piggy
  - Use a slingshot (with marker) to launch the birds and destroy their base
- Suggested Feature to Use:
  - Marker Tracking
  - Spatial mapping
- Milestones:
  - Make your own trackable slingshot
  - Find flat surface in environment and generate the base
  - More types of birds with different special power



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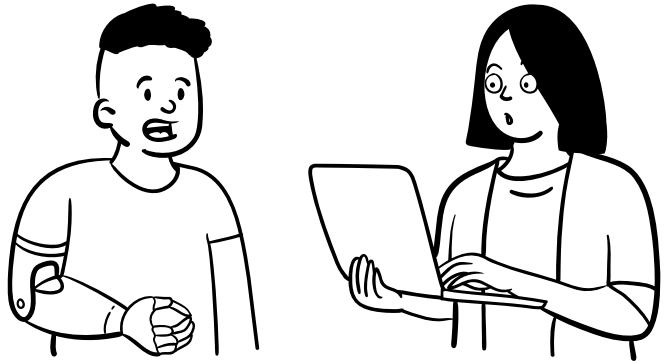
Computer Aided Medical Procedures March 18, 2021 Slide 15

Late Submissions

- Mark all deadlines in your calendar (assignments, mid-term exam, poster, and demos)
- Late submission are NOT accepted!!!
- Late submission results in 0 scores.



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Communication Channels

Grading and Communication Channels

- Canvas

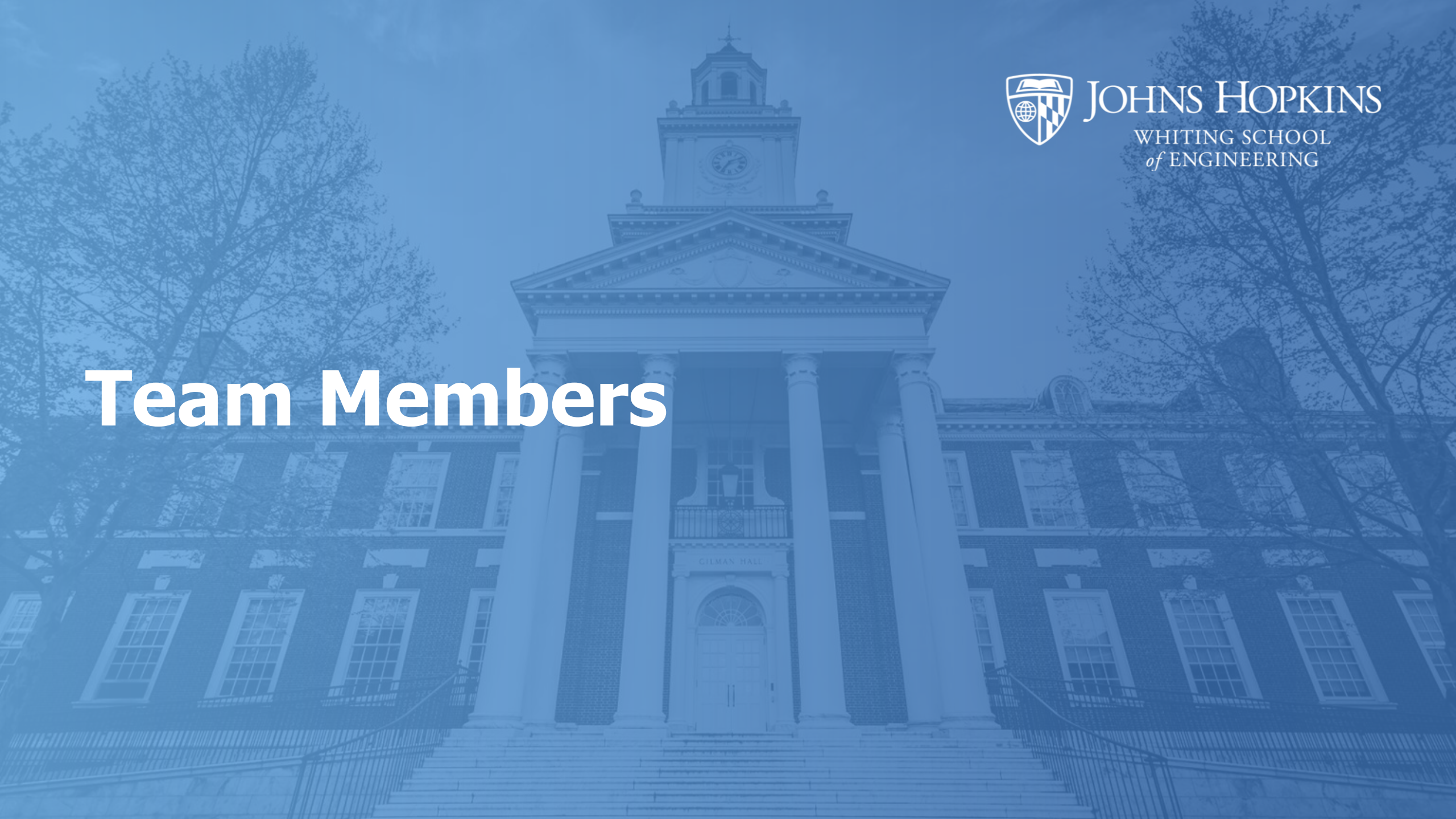
Grading and Communication Channels

- Canvas

- Gradescope

- Discord

- GitHub Pages



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Team Members

Team Members

Irene Kim

Teaching Assistant

dkim214@jhu.edu

Yihao Liu

Senior Class Assistant

yliu333@jhu.edu

Alejandro Martin Gomez

Instructor

alejandro.martin@jhu.edu

An Chi Chen

Class Assistant

achen134@jhu.edu

Muhammad Hadi

Class Assistant

mhadi2@jhu.edu

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Other Related Topics

Research and Final Projects

- If you are interested in conducting research and want to publish your project, please reach out to your mentors once the projects start (strongly encouraged).

- Projects from last semester has been now accepted to the Augmented Environments for Computer Assisted Interventions workshop and will be published at the Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization journal.

Towards Reducing Visual Workload in Surgical Navigation: Proof-of-concept of an Augmented Reality Haptic Guidance System

Gesiren Zhang[a,b], Jan Bartels[a], Alejandro Martin-Gomez[a,c], Mehran Armand[a,b,c,d]

[a]Biomechanical- and Image-Guided Surgical Systems (BIGSS) Lab, Laboratory for Computational Sensing and Robotics, Johns Hopkins University, Baltimore, MD, USA
[b]Department of Mechanical Engineering, Johns Hopkins University, Baltimore, MD, USA
[c]Department of Computer Science, Johns Hopkins University, Baltimore, MD, USA
[d]Department of Orthopaedic Surgery, Johns Hopkins University, Baltimore, MD, USA

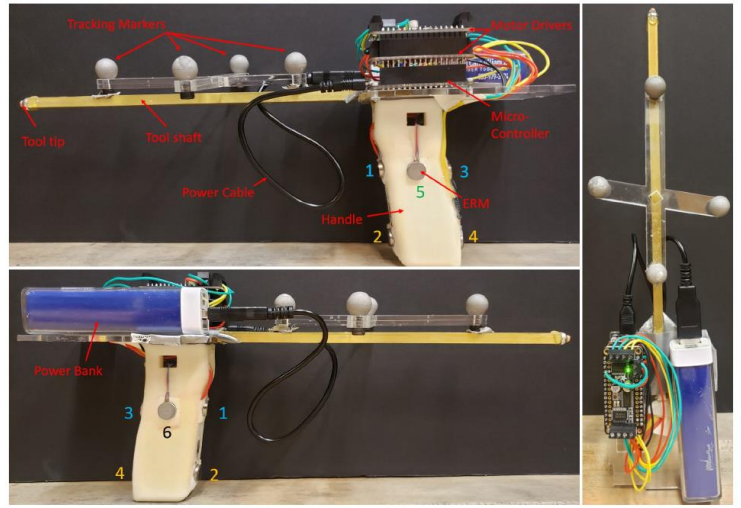

Figure 1.: The custom mock surgical tool consisted of 6 ERMs on the handle; tool shaft and tip; a set of tracking markers; motor drivers and controller; and a power bank connected to the controller via a power cable.

Waitlist

- If you are on the waitlist and need to access the materials before being able to register for the class, please contact Irene Kim, (our leading TA)
- The course was originally designed for 30 students.
- The capacity has been increased it to the maximum number of spaces available at Maryland 310

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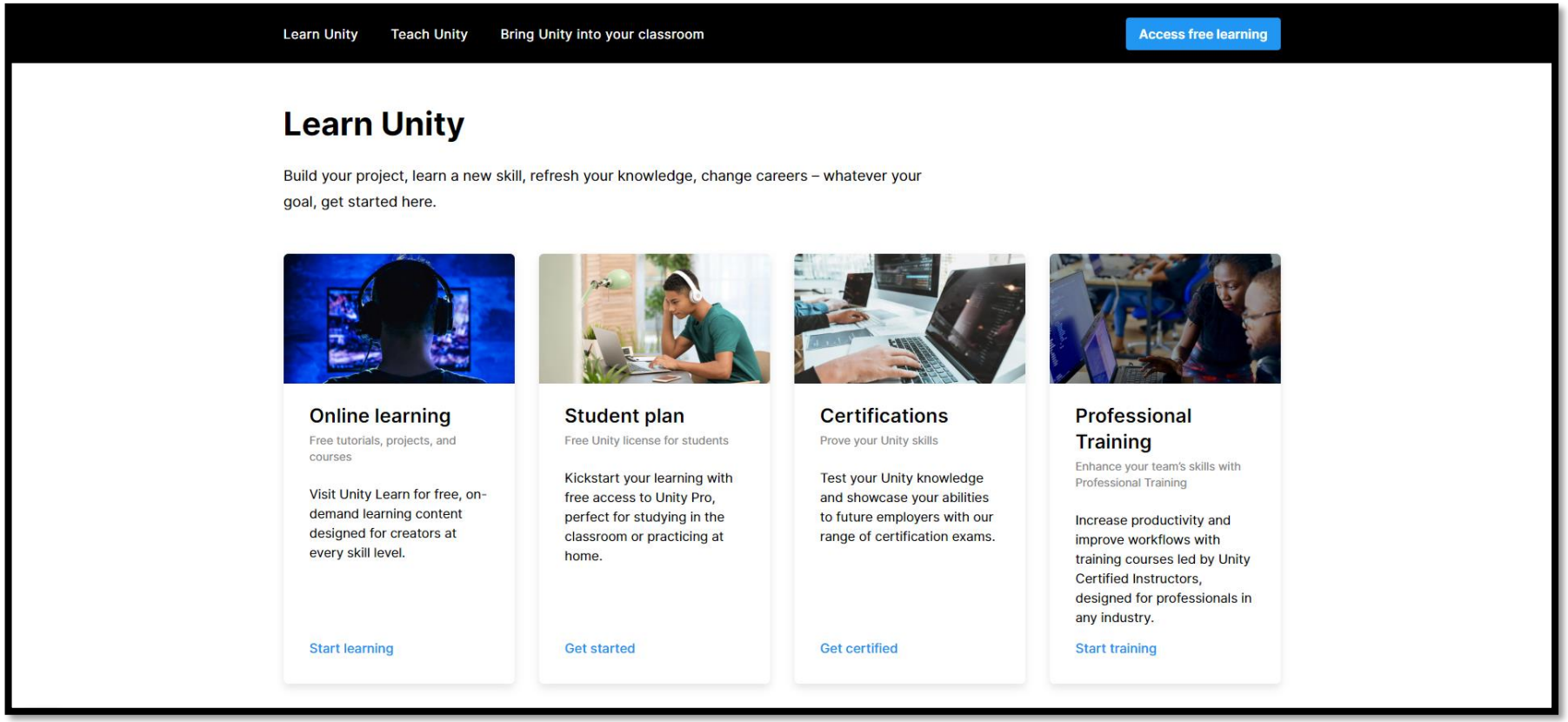
Software

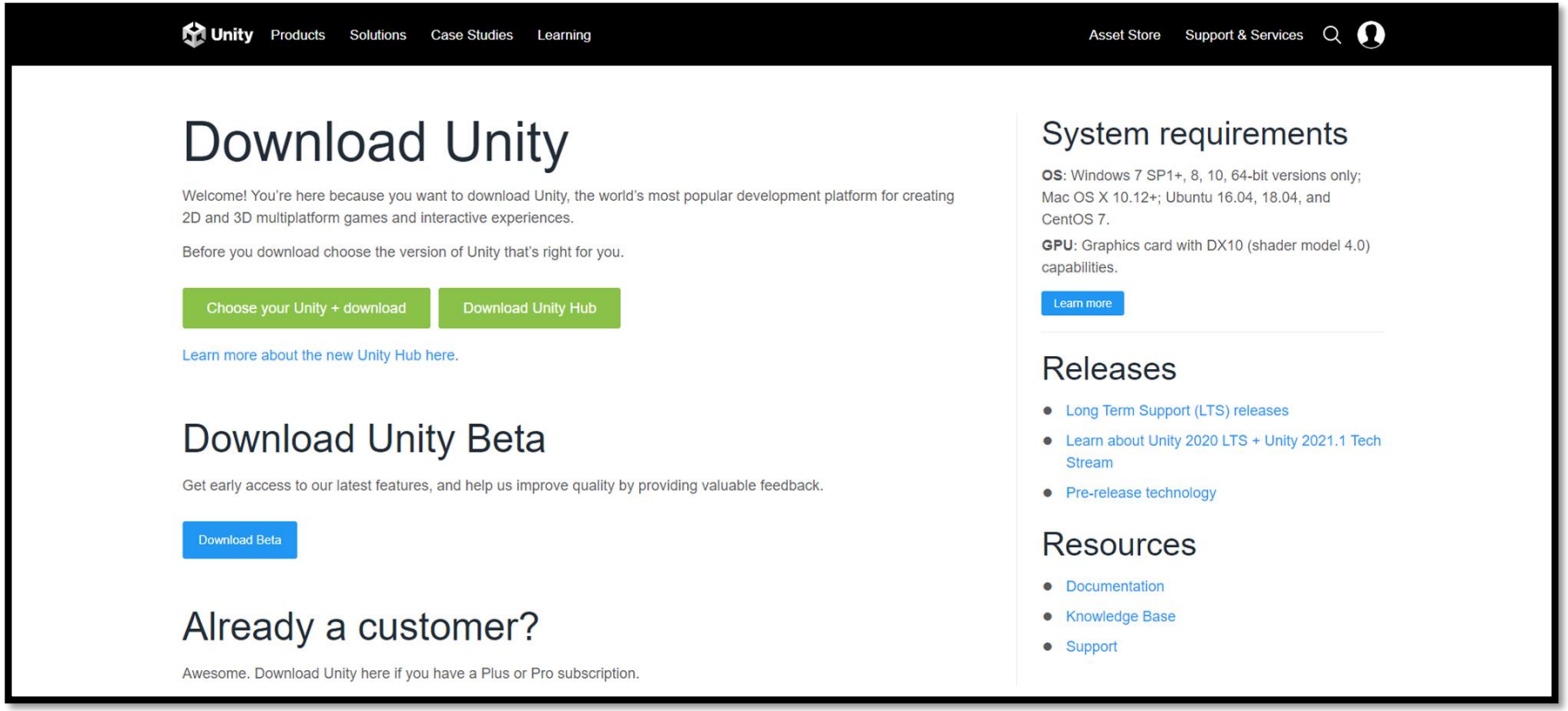
Unity 3D



https://unity.com/learn

https://learn.unity.com/

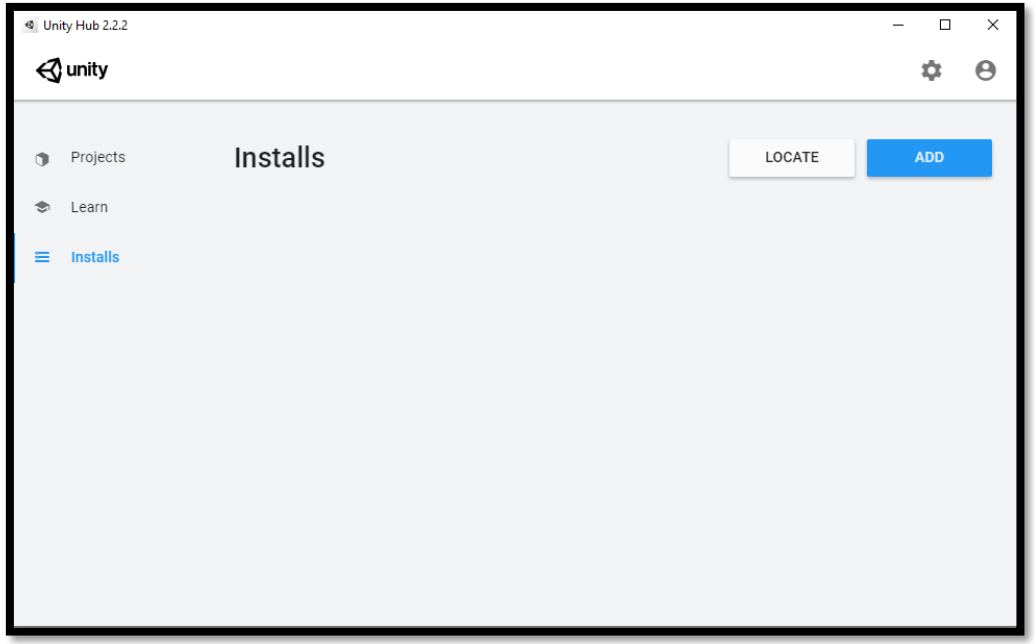
Install Unity HUB

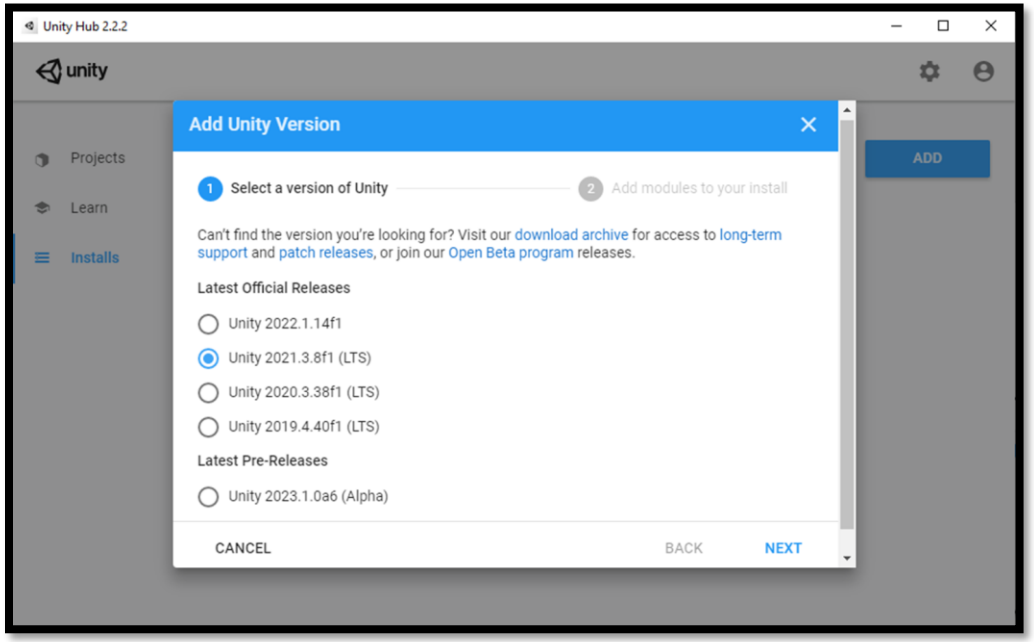


https://unity3d.com/get-unity/download

Install Unity 2021.3.8f1 (LTS)

- This will be important for all our exercises and hands-on sessions





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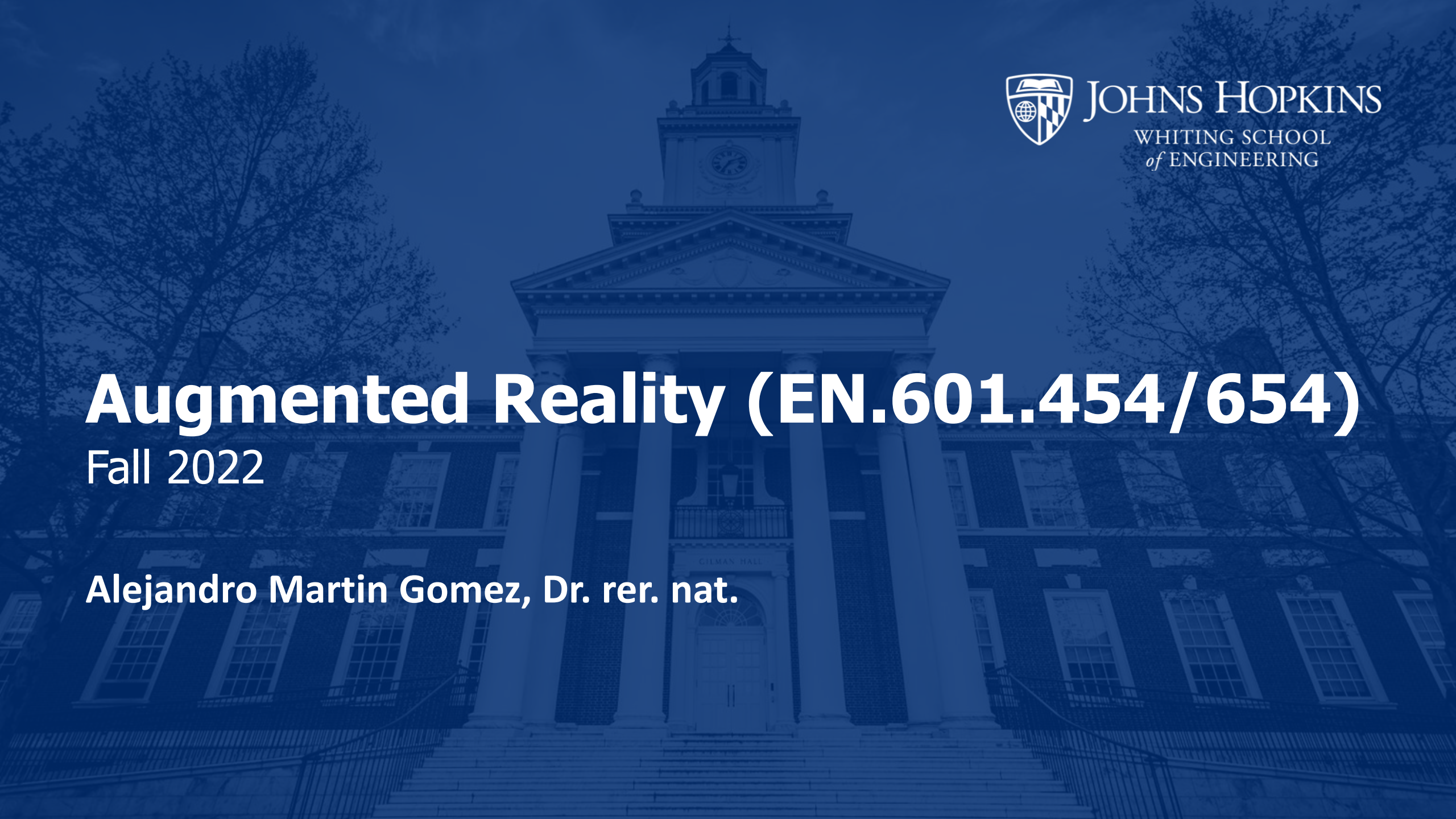
Questions?



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