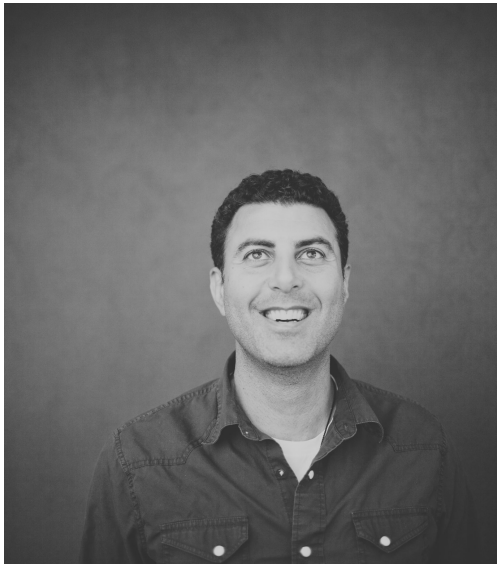
Lecture 1:

# Introduction


Computer Graphics and Imaging

UC Berkeley CS184

# Welcome to CS184!



## Prof. Tarek Elaydi

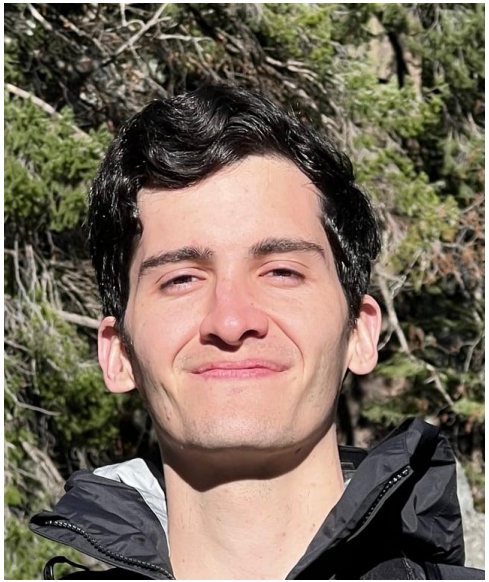
- Currently **Principle Technical Artist** at IO Interactive
- **20 year career** in Feature Film and AAA Games
- **Master's degree**: computer graphics and computer vision
- **Research interests**: Material appearance, human perception, scientific visualization, color science
- **Fun Fact**: Won an Oscar for Best VFX for **Life of Pi**

# Welcome to the Staff of CS184!

https://cs184.eecs.berkeley.edu/su25/staff/

Sriram Srivatsan
Head TA

C.K. Wolfe
GSI



Alejandro Escontrela
GSI

# Welcome to the Staff of CS184!

https://cs184.eecs.berkeley.edu/su25/staff/

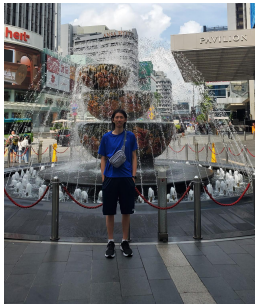
TAs

Sanika Bharvikar

Natalie Wei

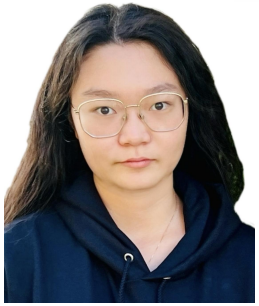
Kevin Tseng

Brandon Lai



Tutors

Curtis Hu



Karina Jin

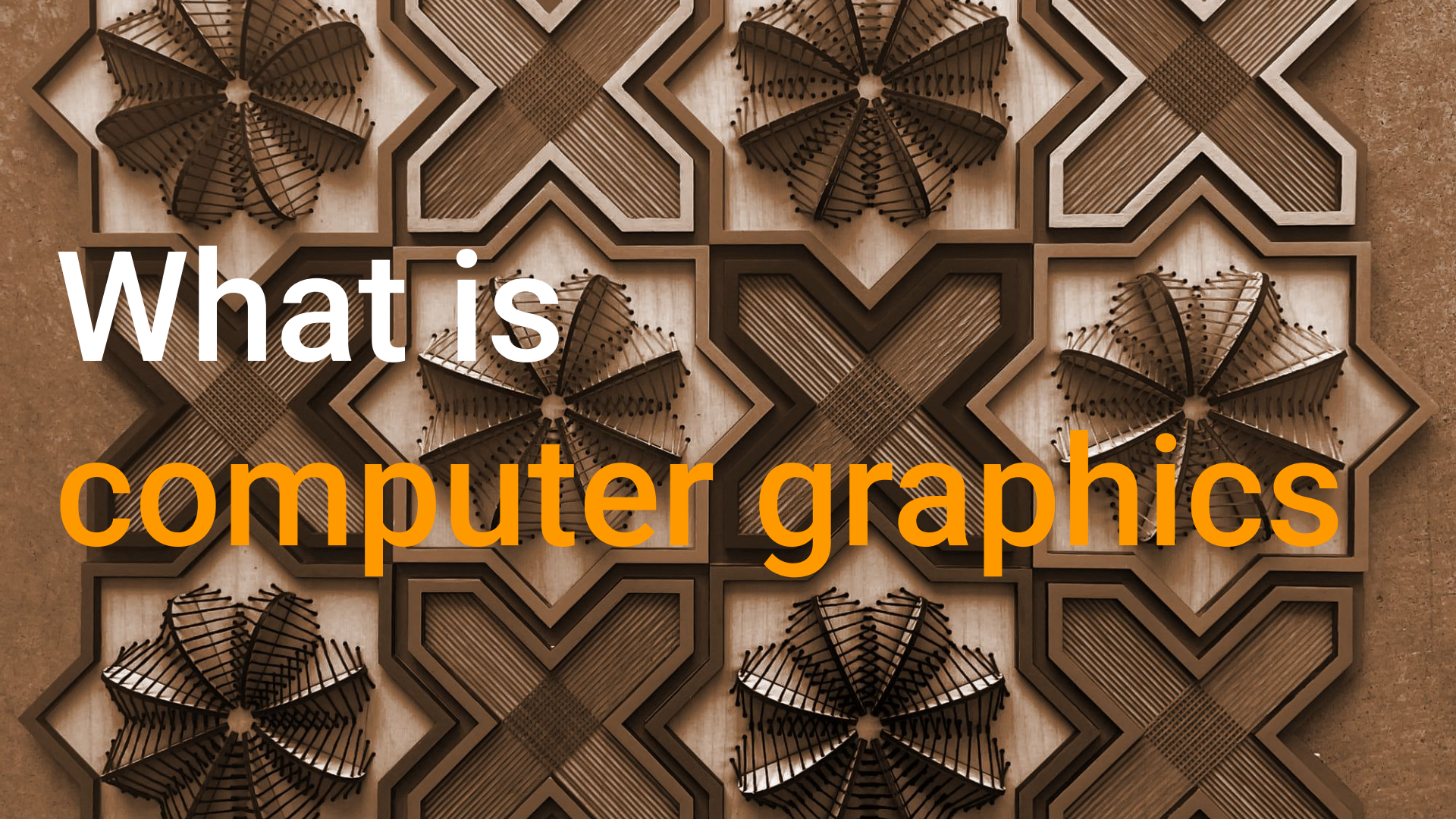
Minjune Kim

# Welcome to CS184!

https://cs184.eecs.berkeley.edu/su25

**Introduction outline:**

- What is Computer Graphics?
- Applications of Computer Graphics
- Course Overview
- Course Logistics

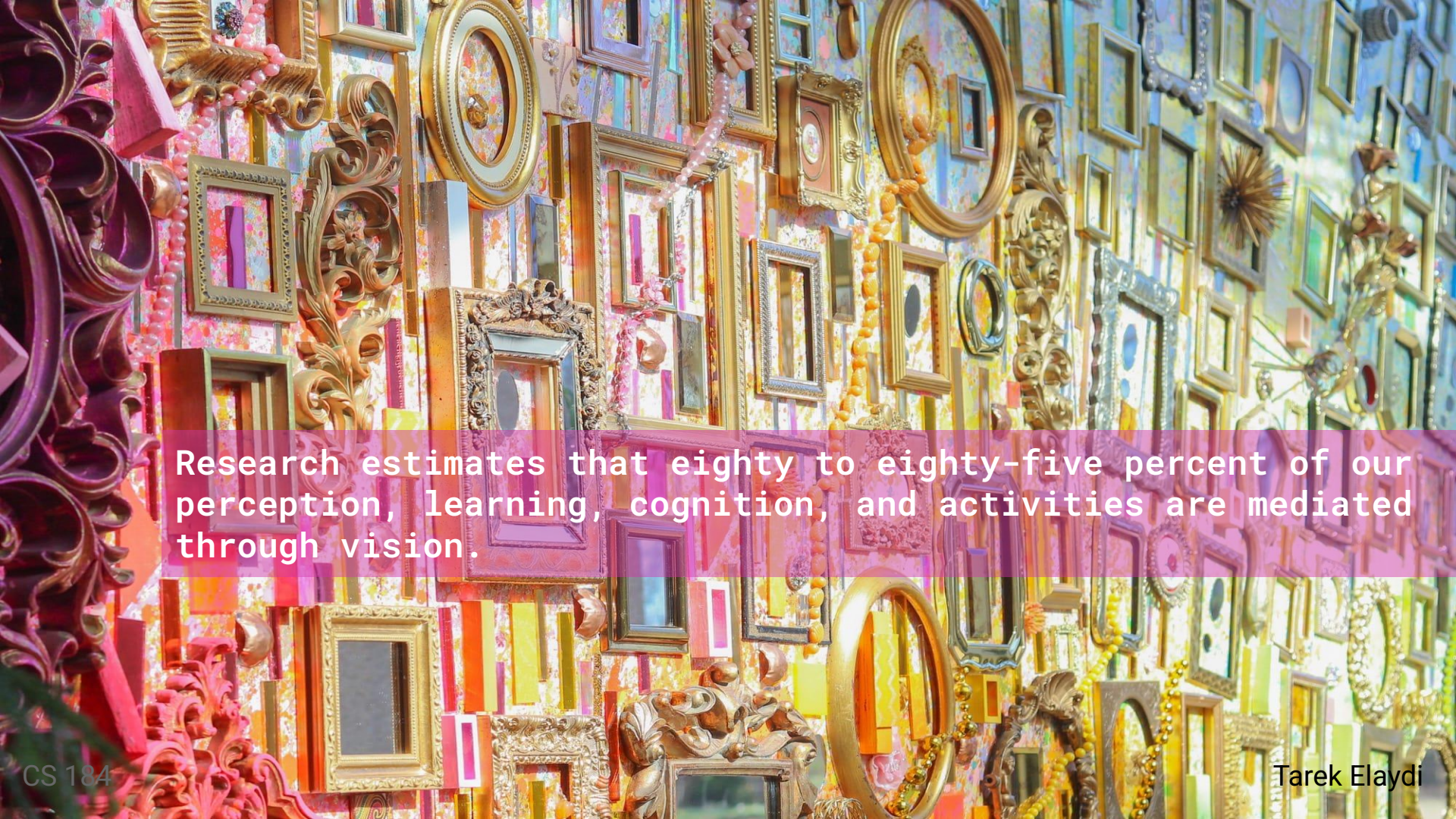

What is
computer graphics

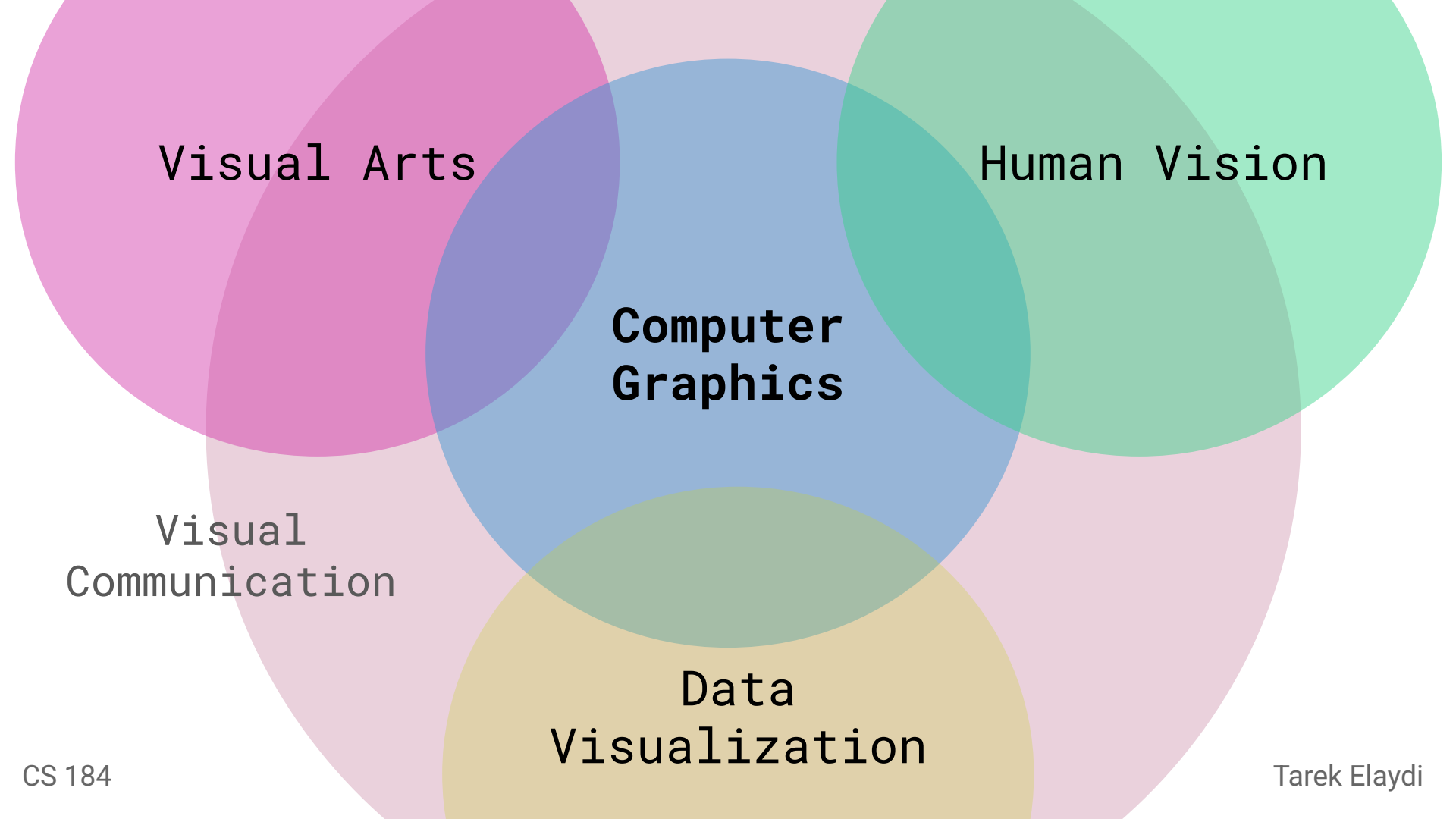
**com·put·er graph·ics** /kəmˈpyo͞odər ˈgrafiks/ n.
The use of computers to synthesize and process visual information.

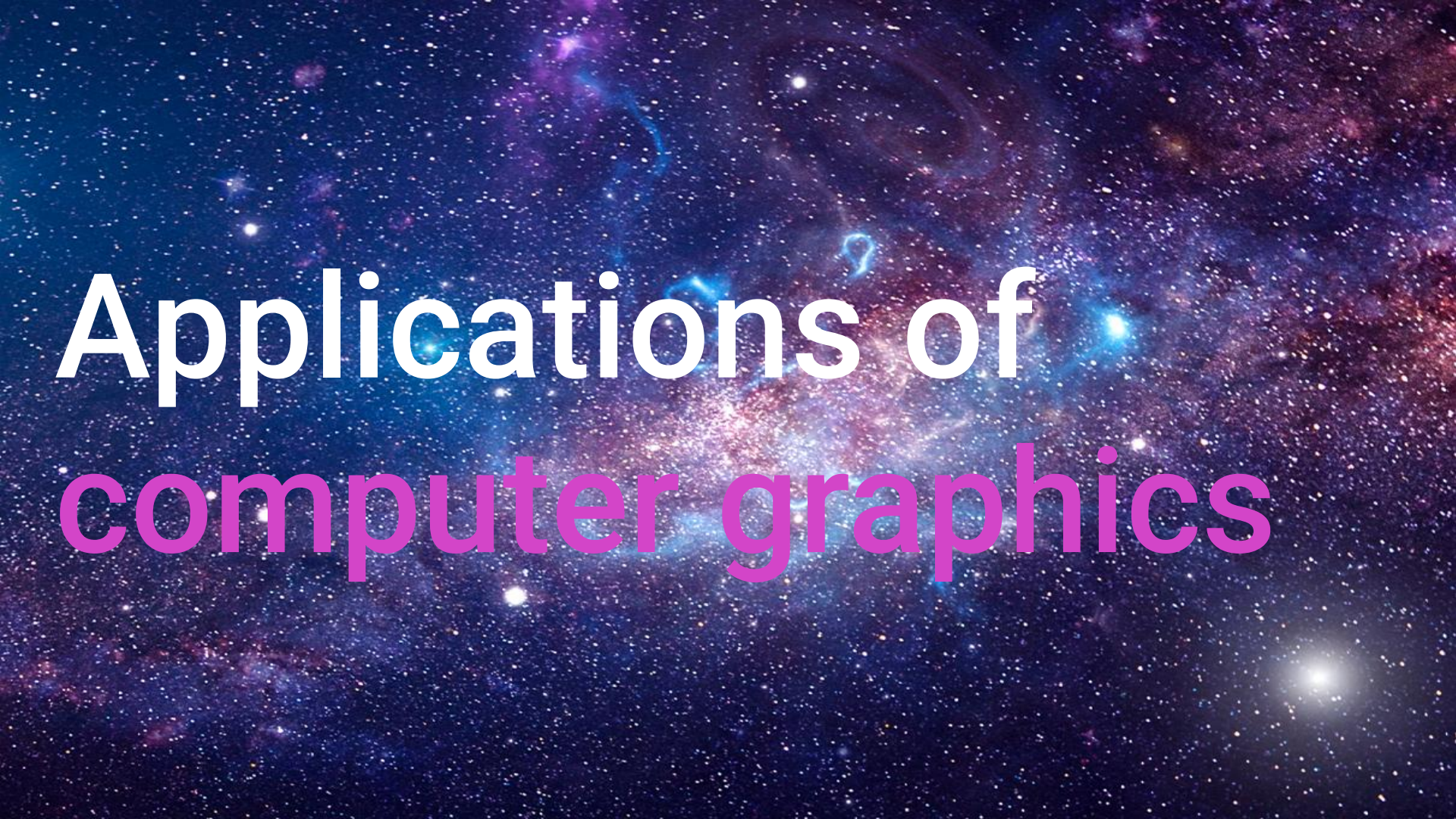
# Vision is our dominant sense



Tarek Elaydi


Research estimates that eighty to eighty-five percent of our perception, learning, cognition, and activities are mediated through vision.


Visual Arts
Human Vision
Computer Graphics
Visual Communication
Data Visualization

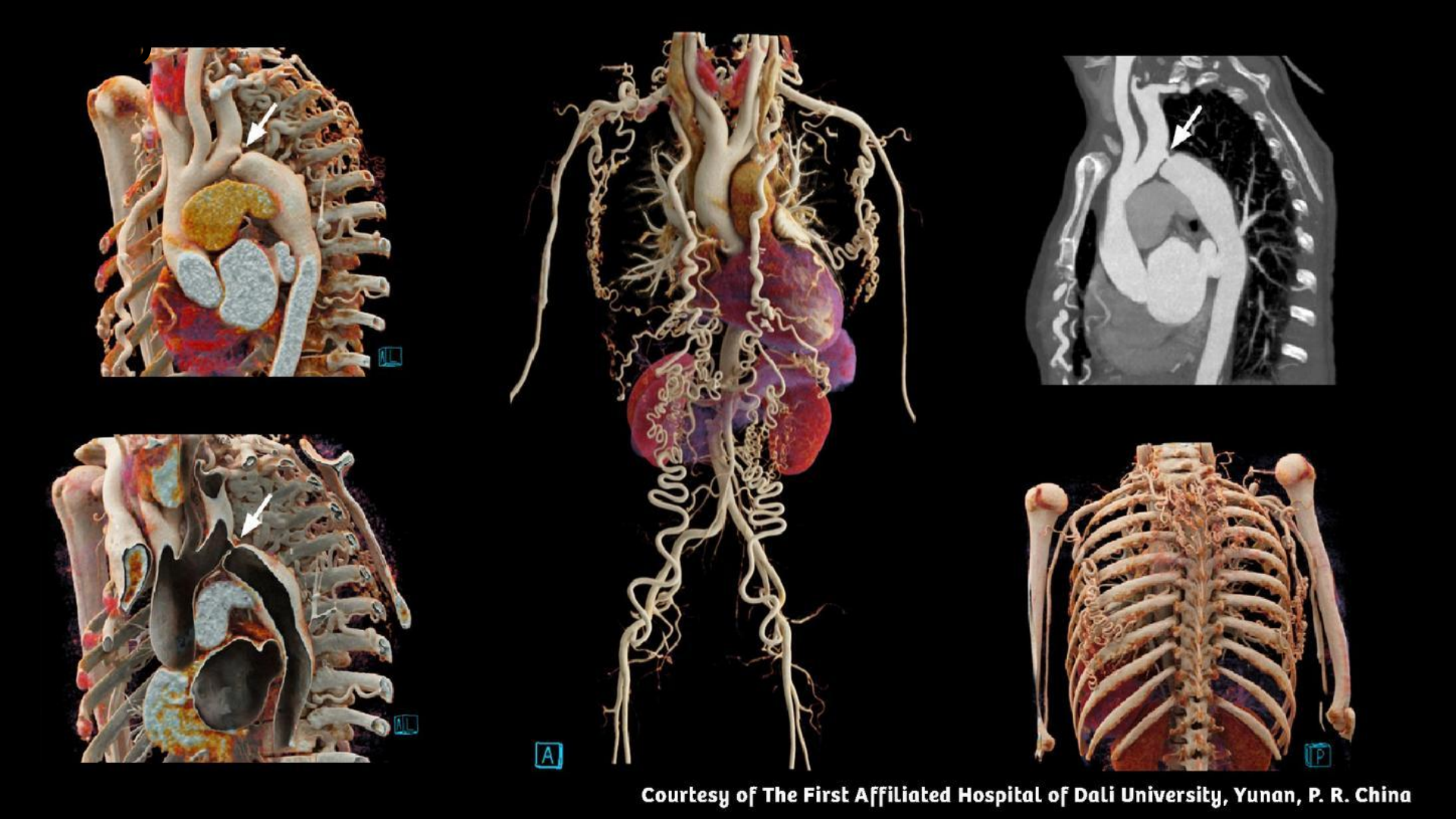

Applications of
computer graphics

# Medical Imaging

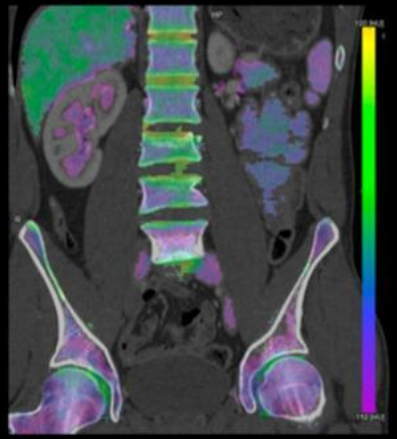


Tarek Elaydi

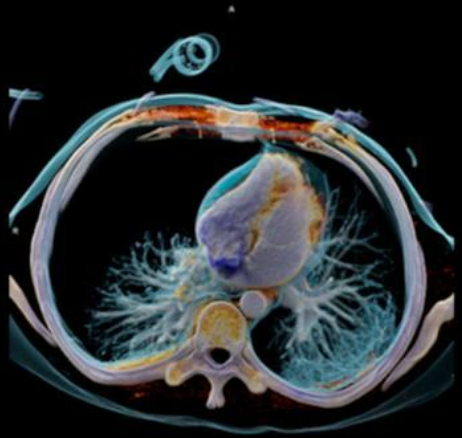

Q-3D
AP 18 post
AP 26 post
AP 10 post
AP 6 post
AP 14 post
AP -2 ant
AP -6 ant
Sc 6
TIR/M
SI 15
SI 14
SI 12
SI 11
Sc 5
TSE/M
SI 10
SI 7
5 cm




Courtesy of The First Affiliated Hospital of Dali University, Yunan, P. R. China



ALH



# Computer Aided Design

## (and manufacturing)



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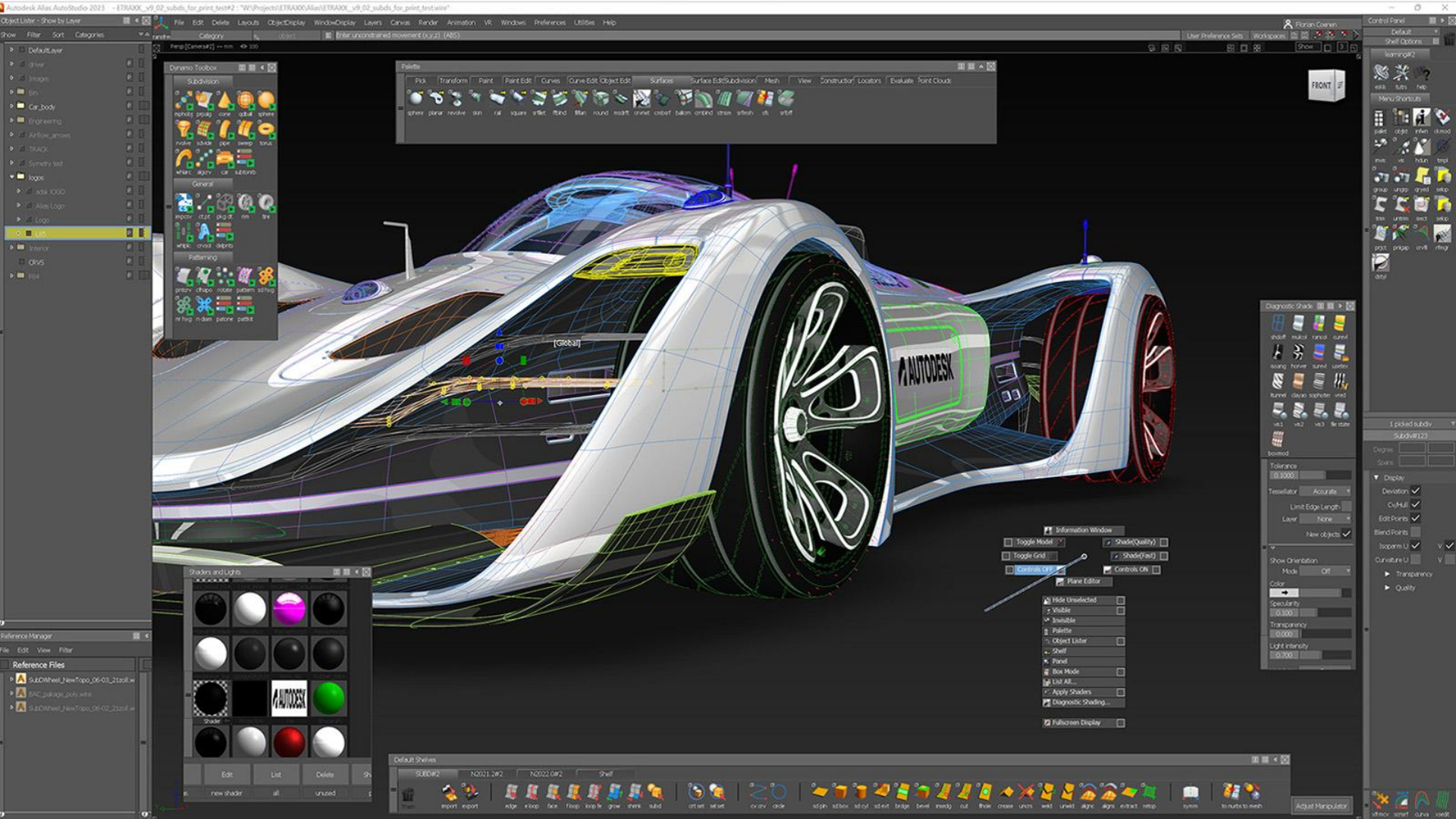
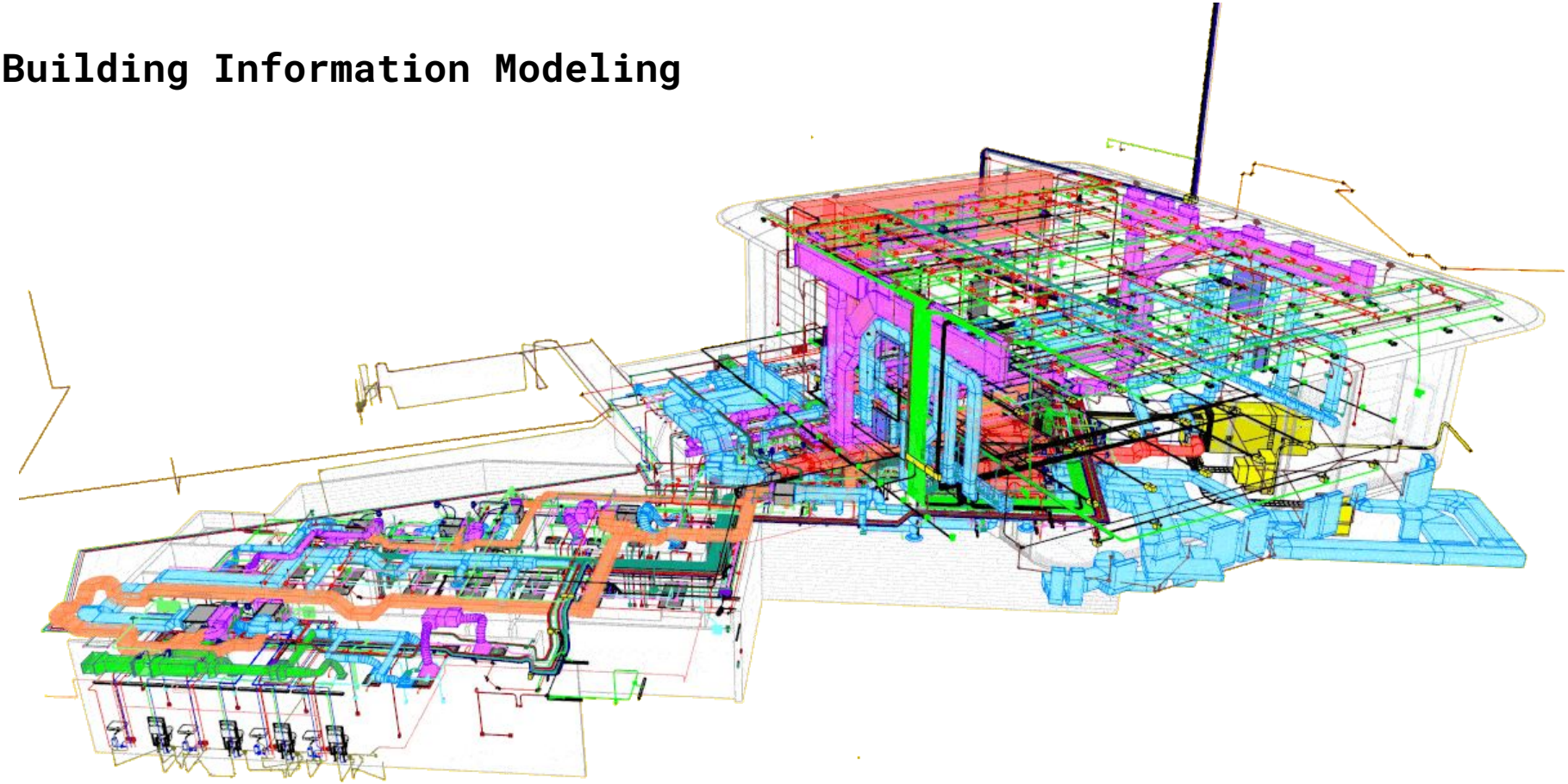
# Tianrui Xie's Morph Wireless Mouse



AUTODESK
FRONT
Dynamo Toolbox
Palette
Shaders and Lights
Reference Manager
Default Shelves
Diagnostic Shade
Information Window

# Building Information Modeling



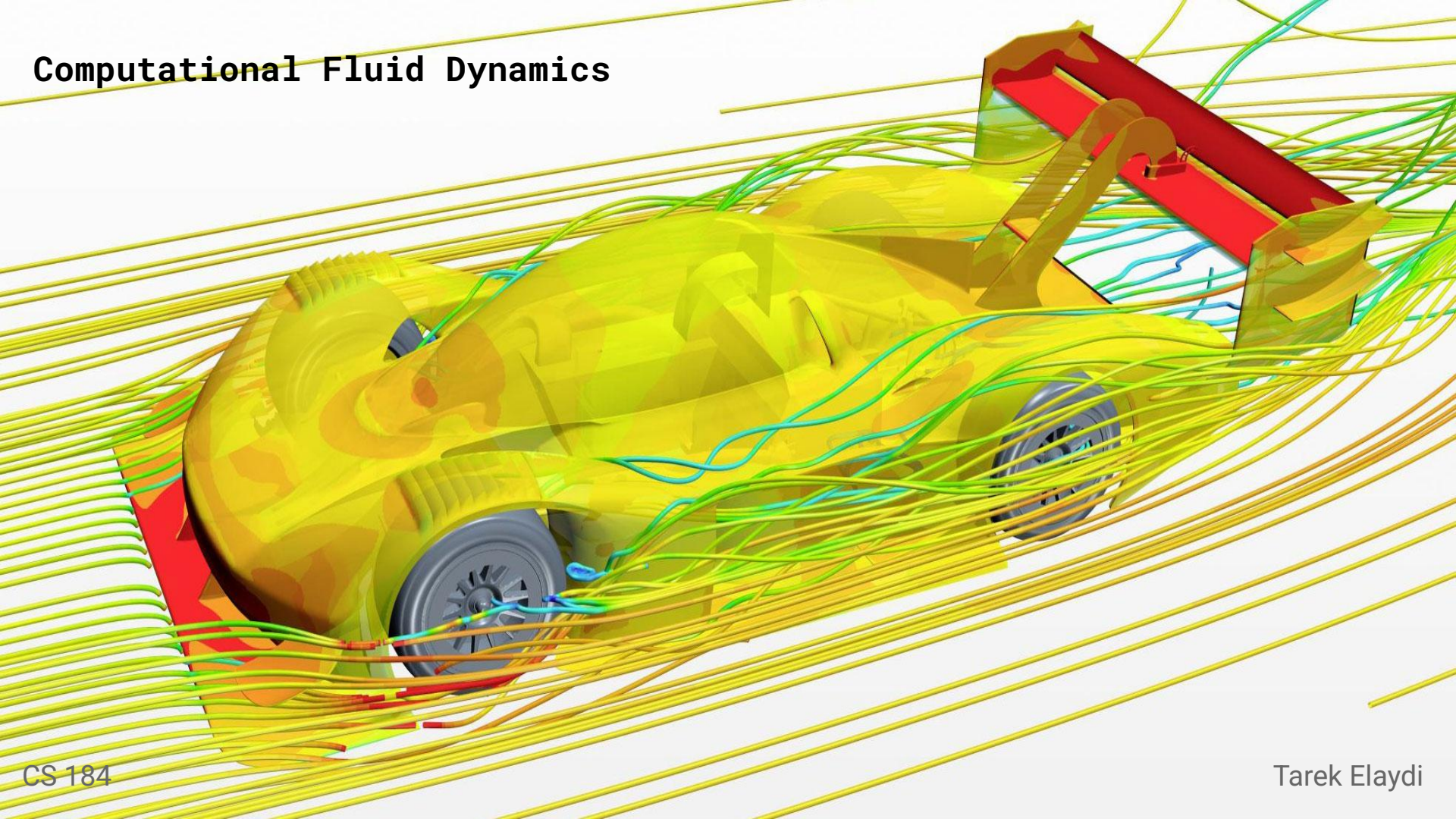

TAKHINI ARENA

# Numerical Simulation



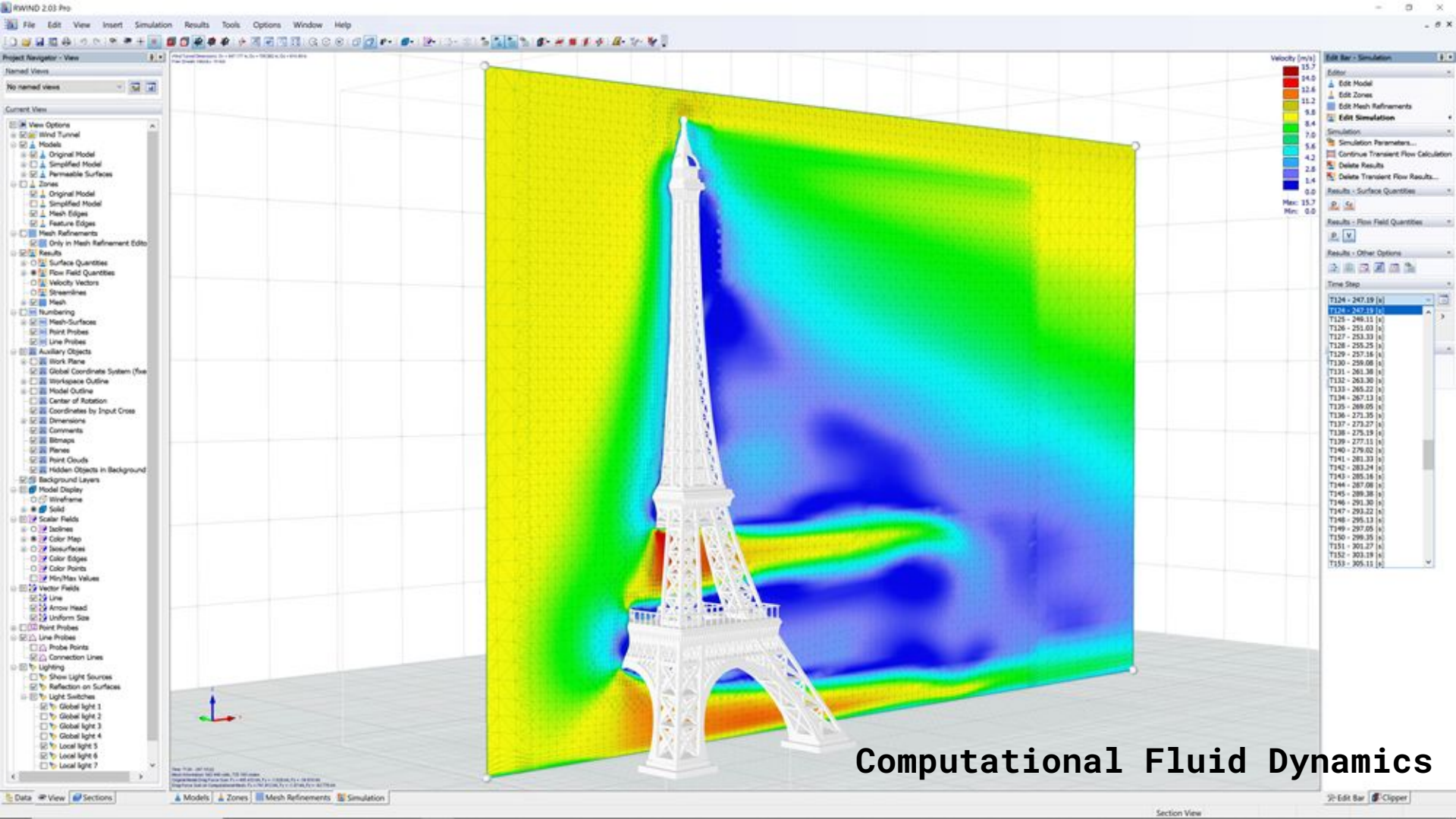
Tarek Elaydi

# Computational Fluid Dynamics





Tarek Elaydi




# Computational Fluid Dynamics

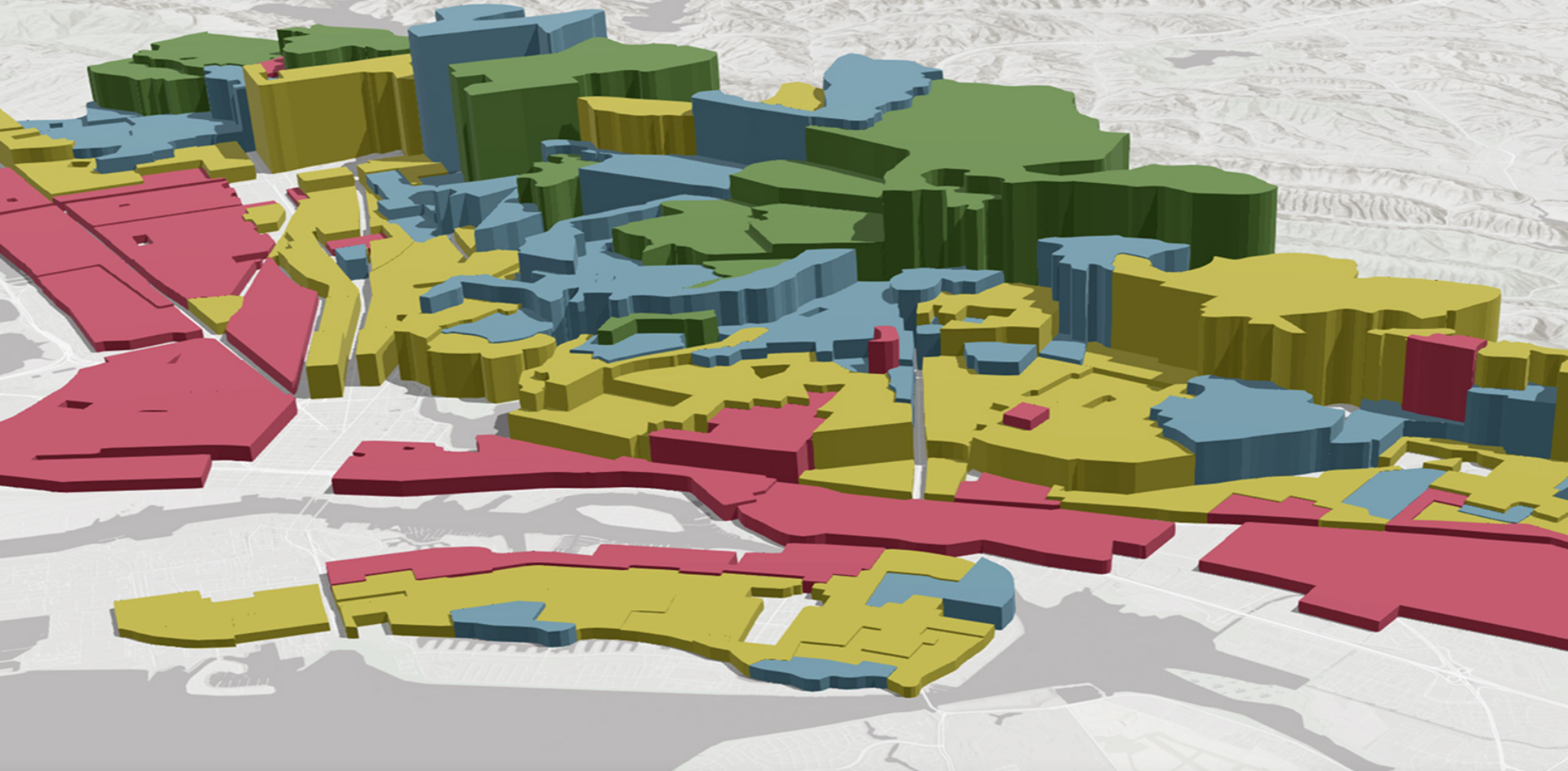
# Data Visualization



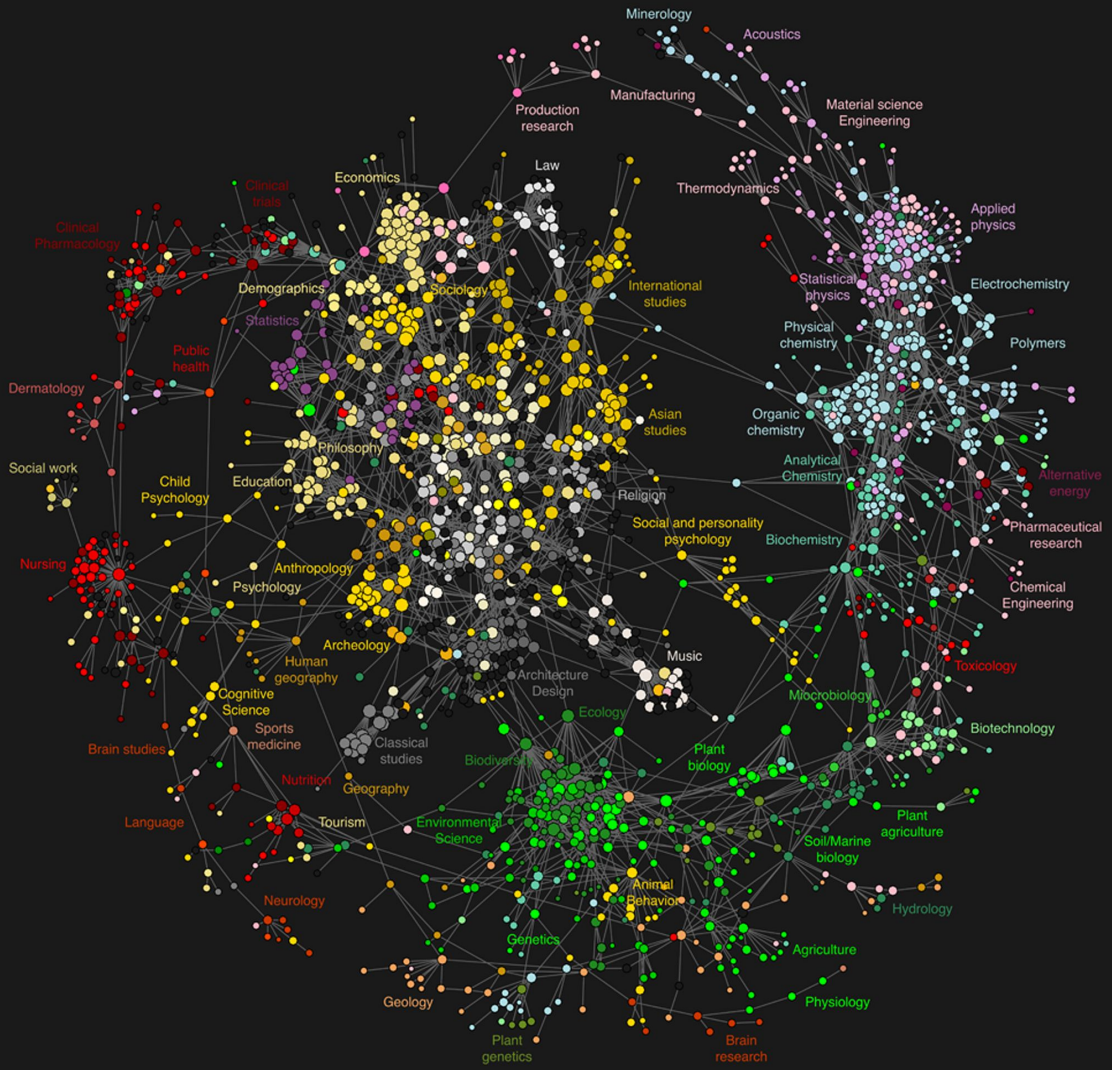
Tarek Elaydi


80%
75%
50%
25%
A
B
C
ONE
TWO
THREE
FOUR
JAN
FEB
MAR
APR
MAY
JUN
JUL

# Graphical Information Systems



# Map of Science



# Digital Photography

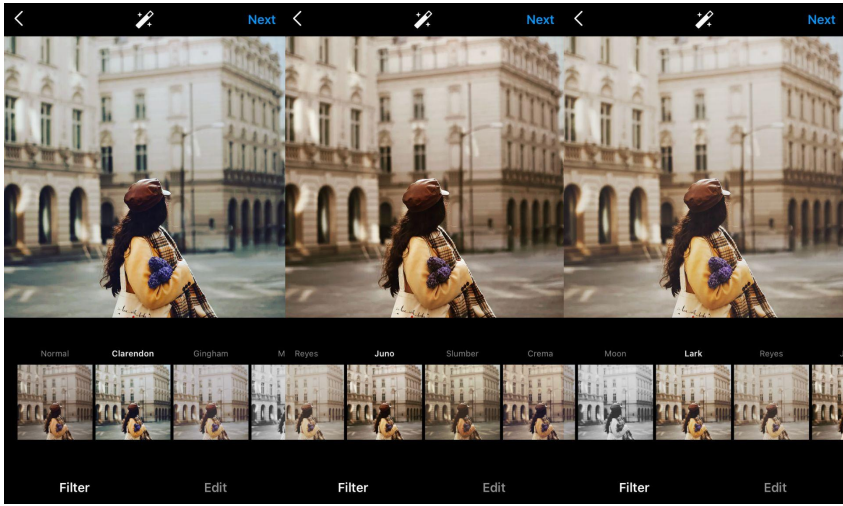


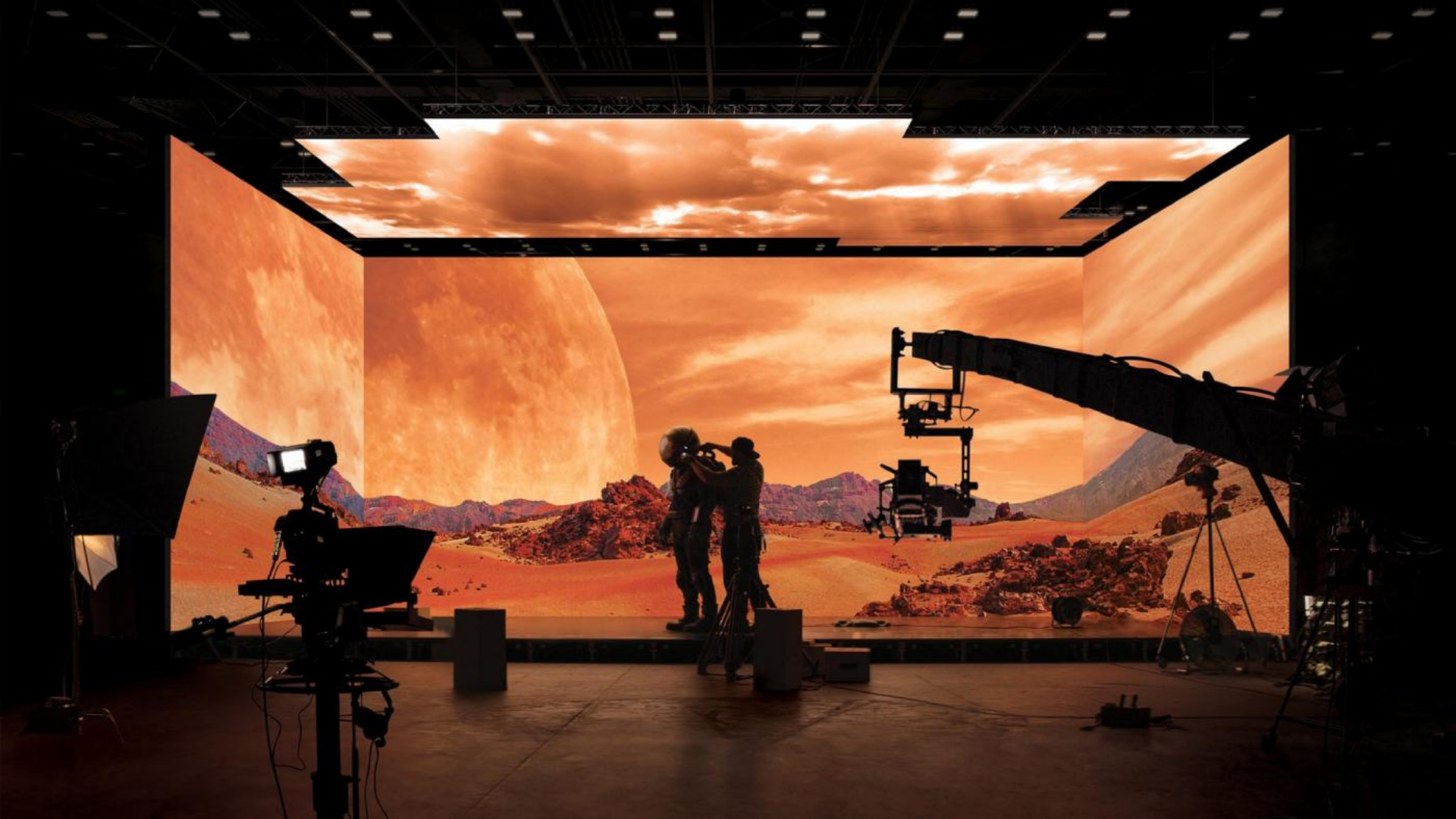
Tarek Elaydi


BEFORE


BEFORE


AFTER


Next
Next
Next
Normal
Clarendon
Gingham
Reyes
Juno
Slumber
Crema
Moon
Lark
Reyes
Filter
Edit
Filter
Edit
Filter
Edit

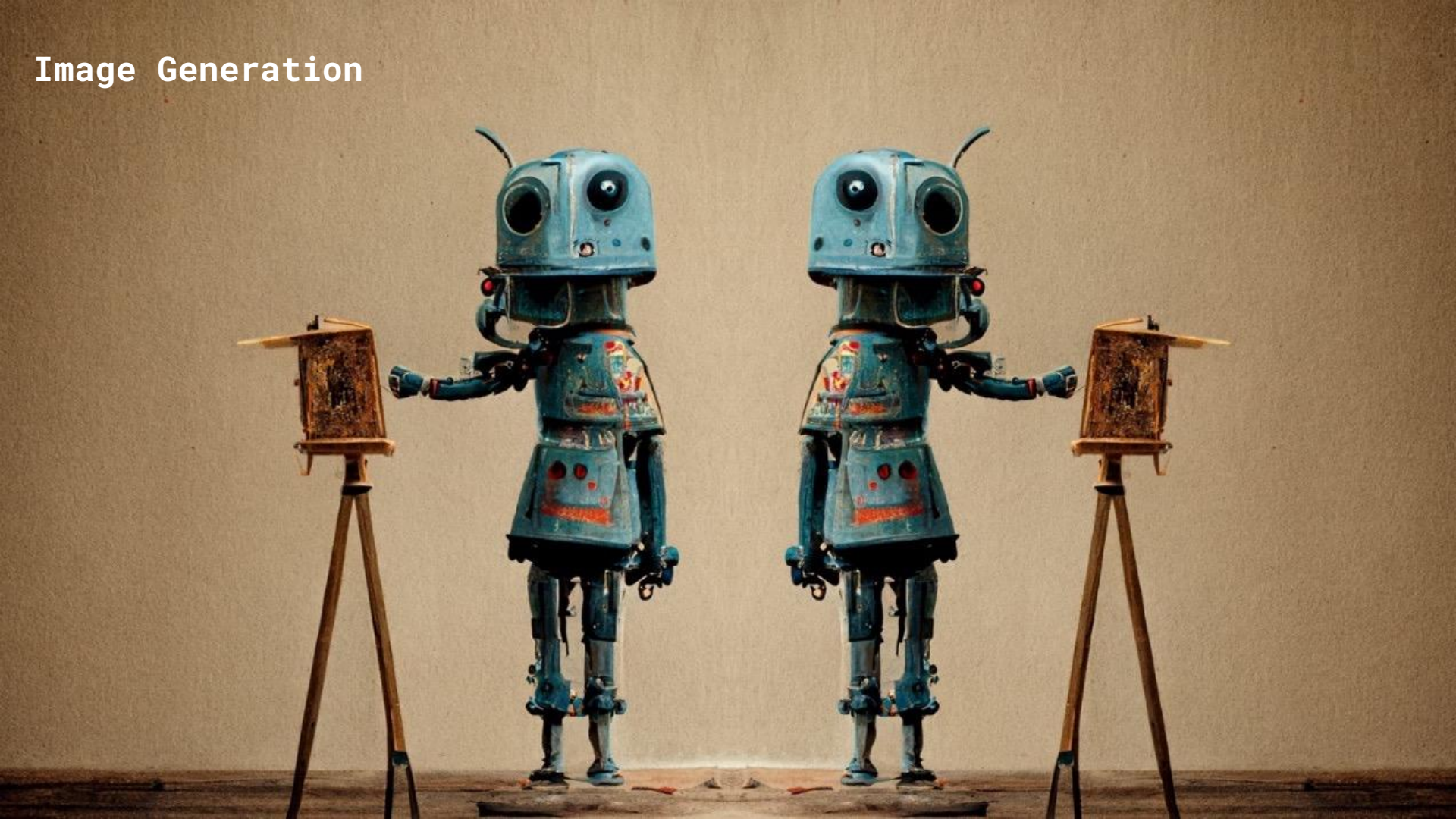


# Generative AI



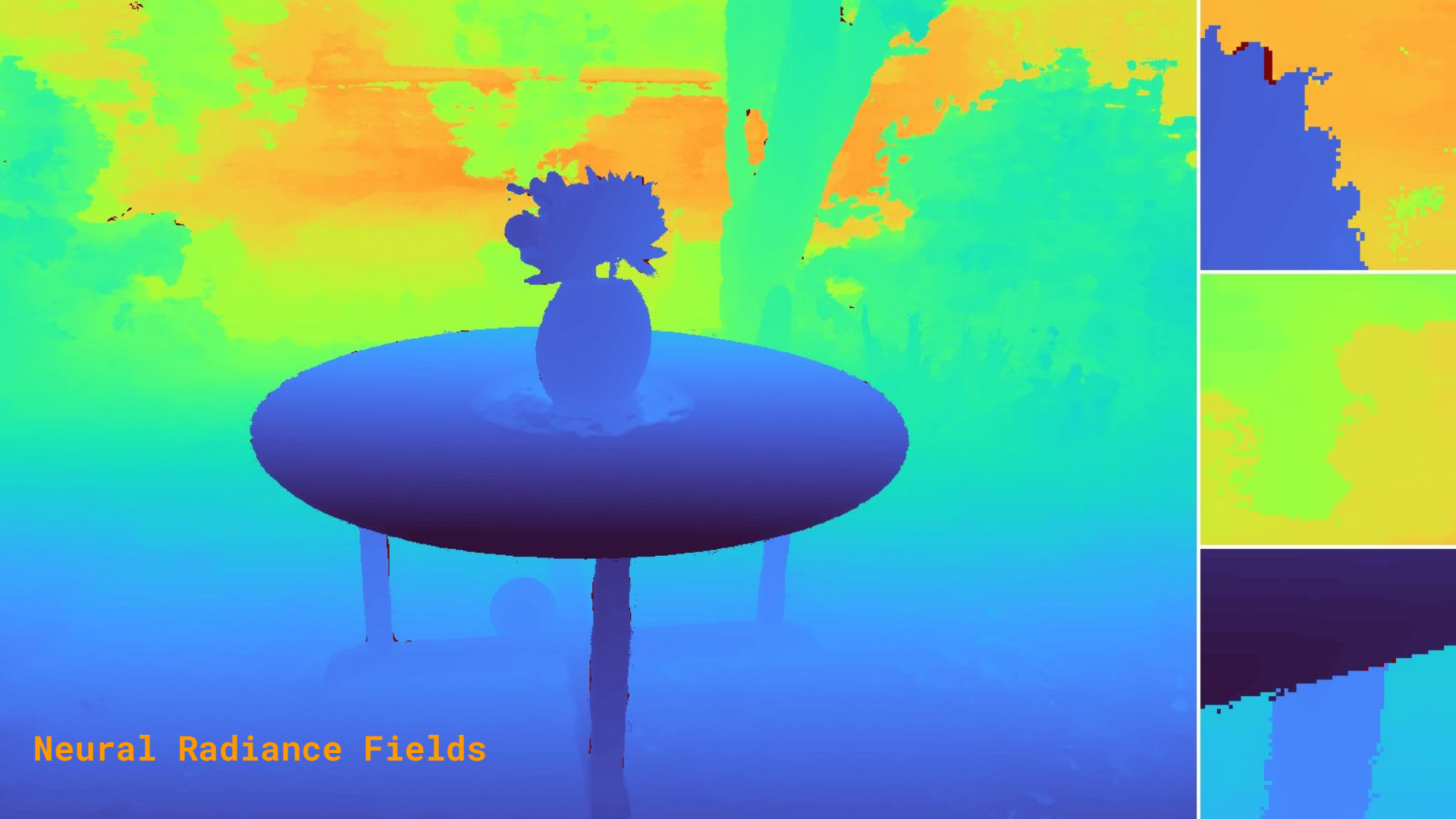
Tarek Elaydi

# Image Generation



# 3D Model Generation

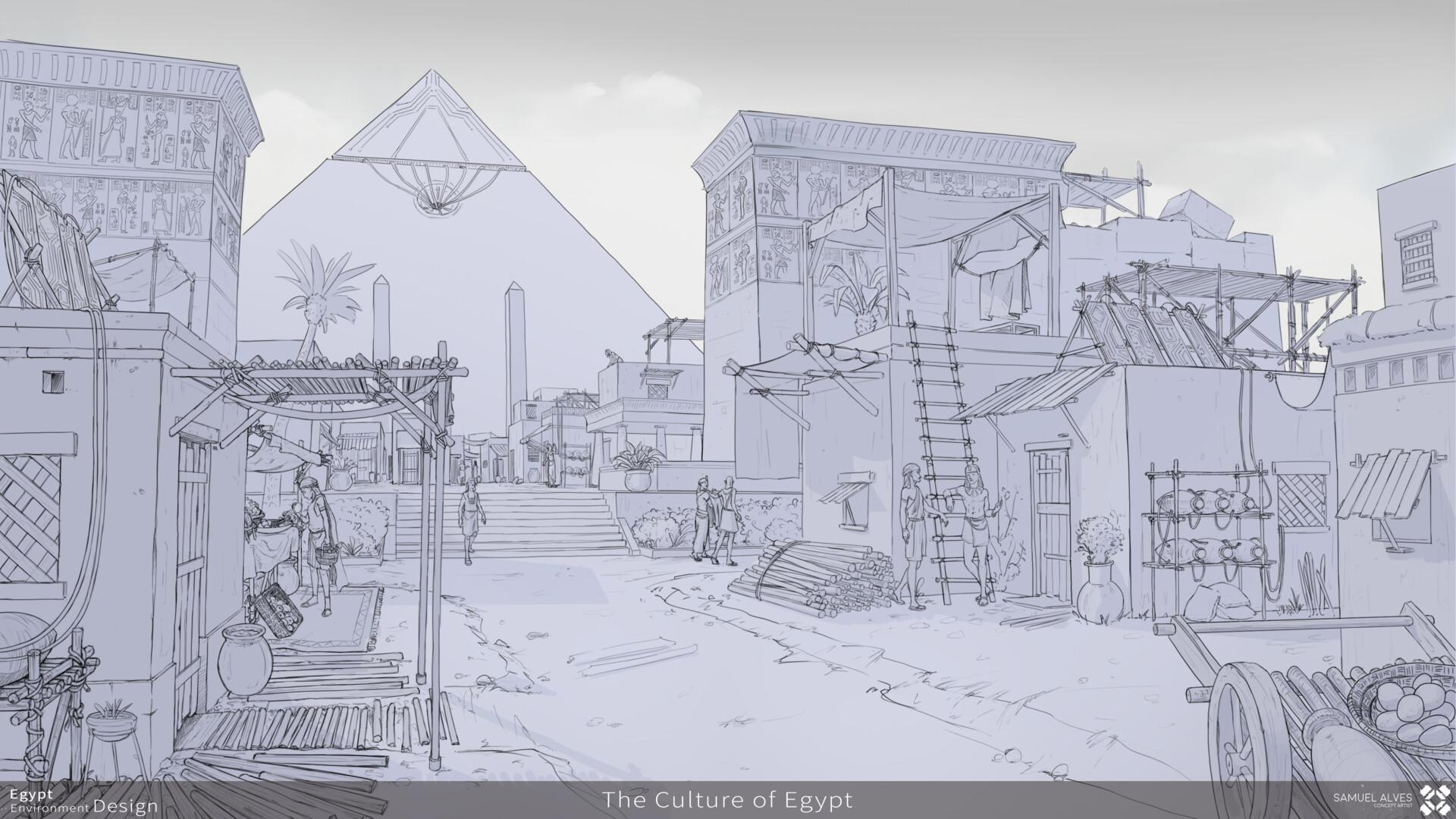

Rendering
Scene Generation: Neural Radiance Fields


Neural Radiance Fields

# Computer Games



Tarek Elaydi



Egypt
Environment Design

The Culture of Egypt

SAMUEL ALVES
CONCEPT ARTIST


SAMUEL ALVES
CONCEPT ARTIST

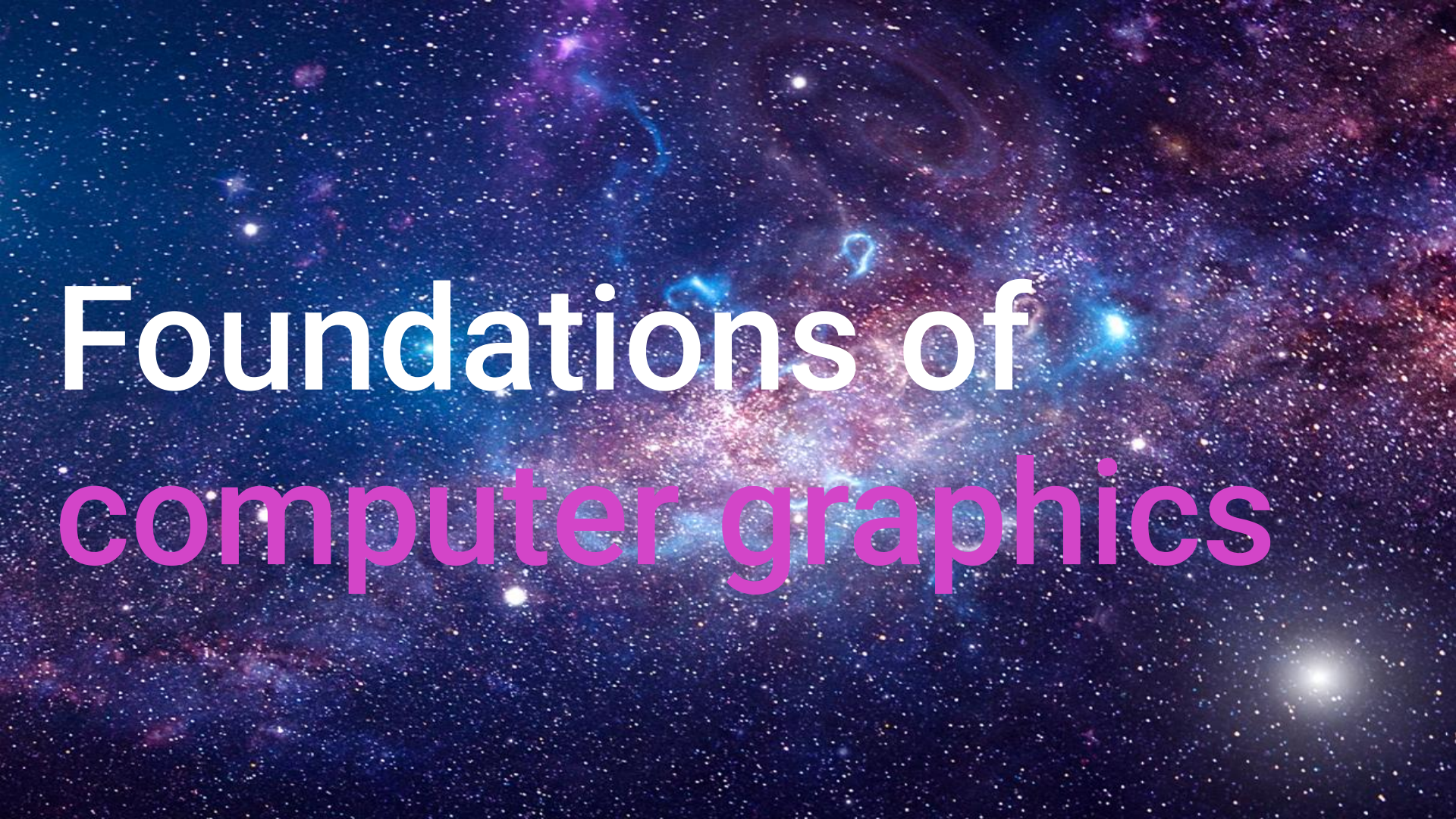

FOOTBALL FOR HOPE
FOOTBALL FOR HOPE
FOOTBALL FOR HOPE
FOOTBALL FOR HOPE
FOOTBALL FOR HOPE
FOOTBALL FOR HOPE
de rossi
6
ROBBEN
11
KUYT
9
5

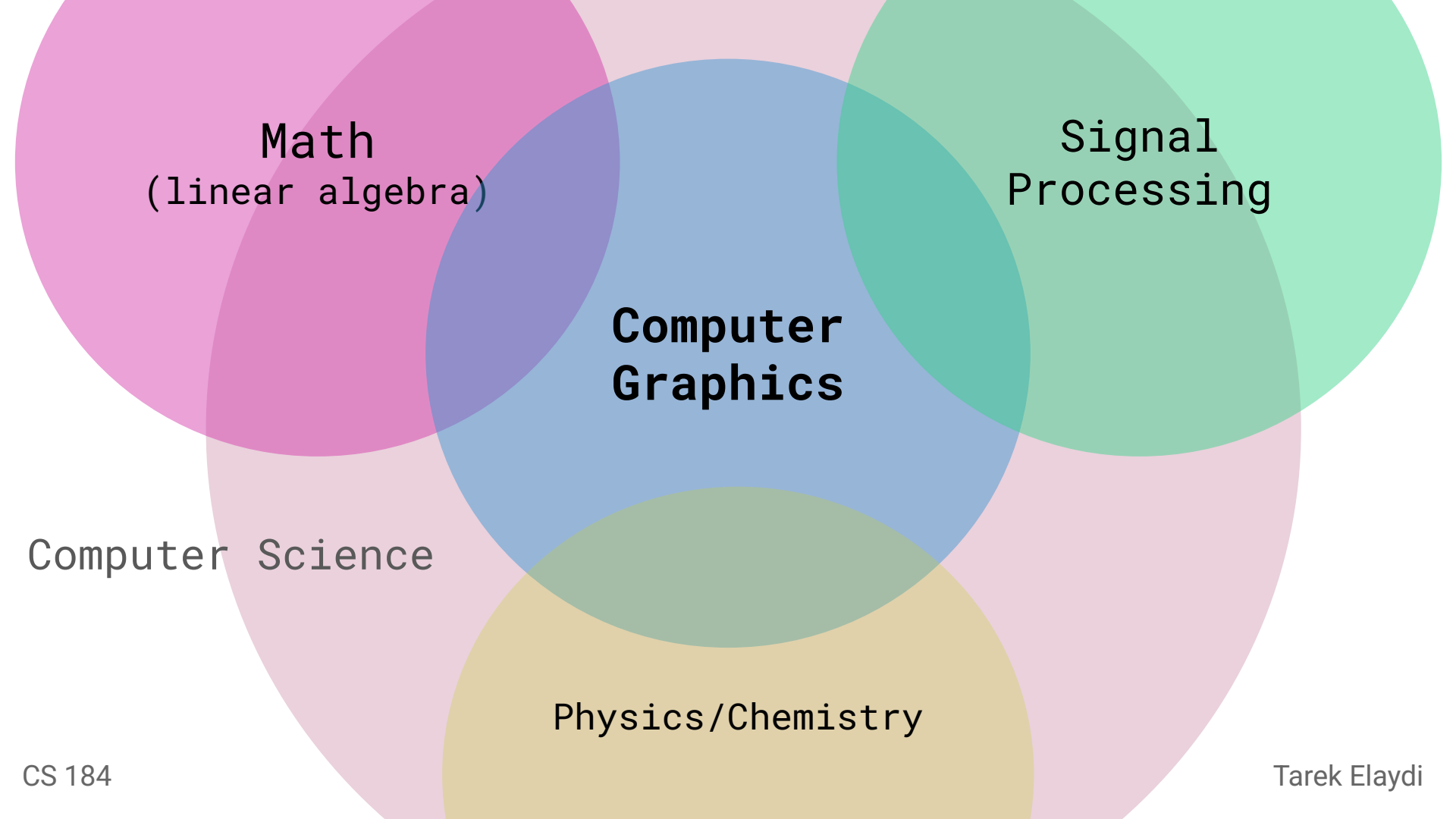
# Animation and VFX



Tarek Elaydi

Alita Battle Angel


Foundations of
computer graphics


Math
(linear algebra)
Signal
Processing
Computer
Graphics
Computer Science
Physics/Chemistry

# Foundations of Graphics and Imaging

**These applications require sophisticated theory and systems Science and Mathematics**

- **Physics of light, color, optics, …**
- **Math of curves, surfaces, geometry, perspective,...**
- **Displays, GPUs, input devices, …**
- **Cameras, lenses, sensors,...**
- **Perception: color, stereo, motion, image quality, …**
- **Art and design: composition, form, lighting, ...**

# Course Goals

Overview of core ideas in graphics and imaging

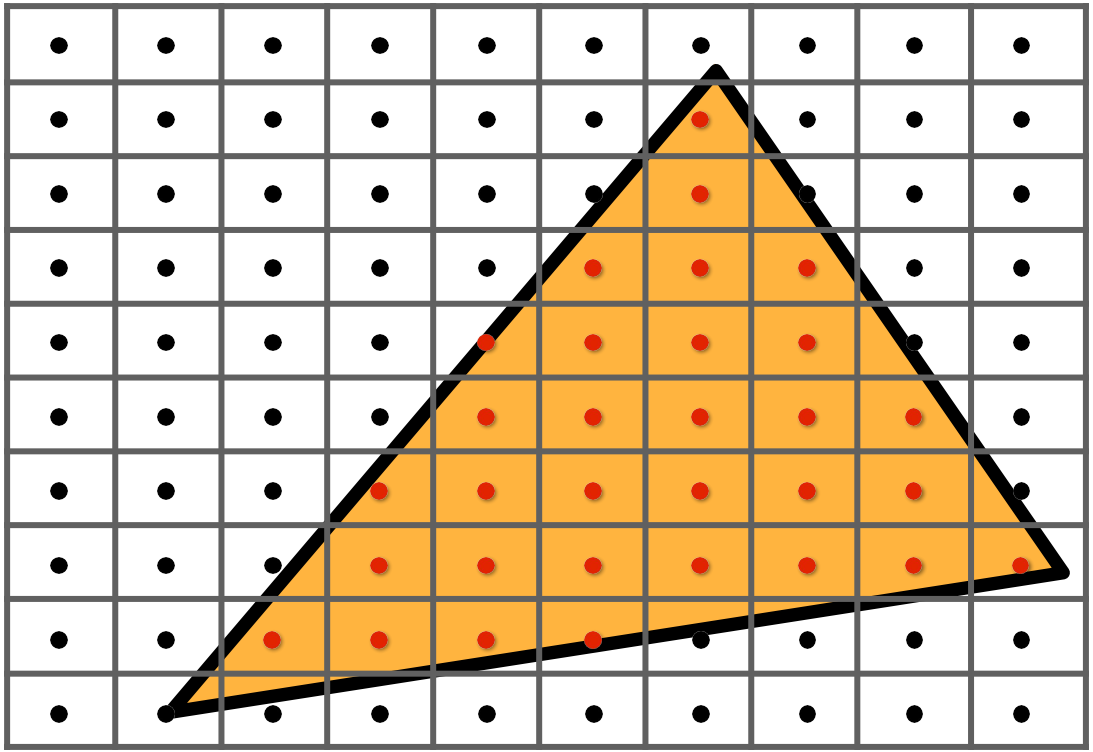
- Modeling the world, image synthesis
- 3D graphics: geometry, rendering, animation
- Image capture, manipulation and display

Acquire core concepts and skills

- Representations (geometry, images, transforms, …)
- Algorithms (sampling, subdivision, ray-tracing, …)
- Technology (GPUs, displays, cameras, …)

# Course Topics

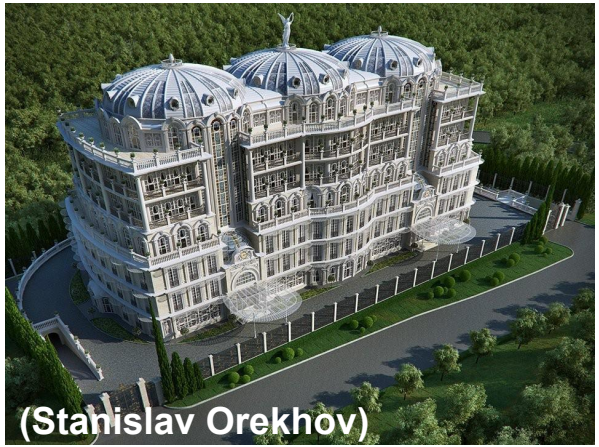
# Drawing Digital Images (Rasterization)

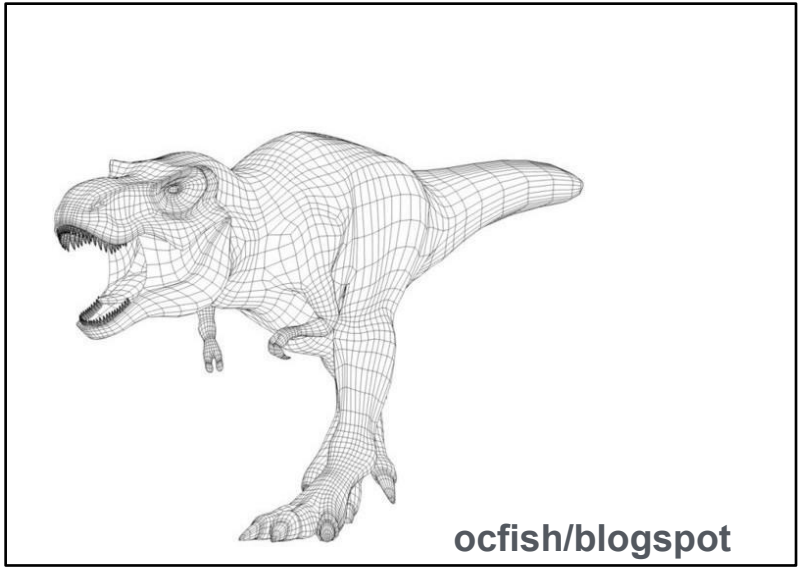


# Filtering and Sampling

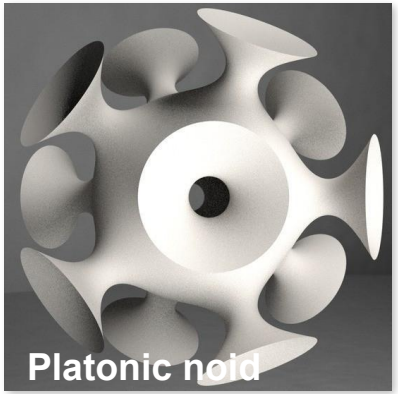
**No Jaggies**

# Modeling Geometry


(Stanislav Orekhov)


ocfish/blogspot


[Kaldor 2008]


Platonic noid

# Modeling Material Properties

# Modeling Lighting

**Monster’s Inc., 2001**

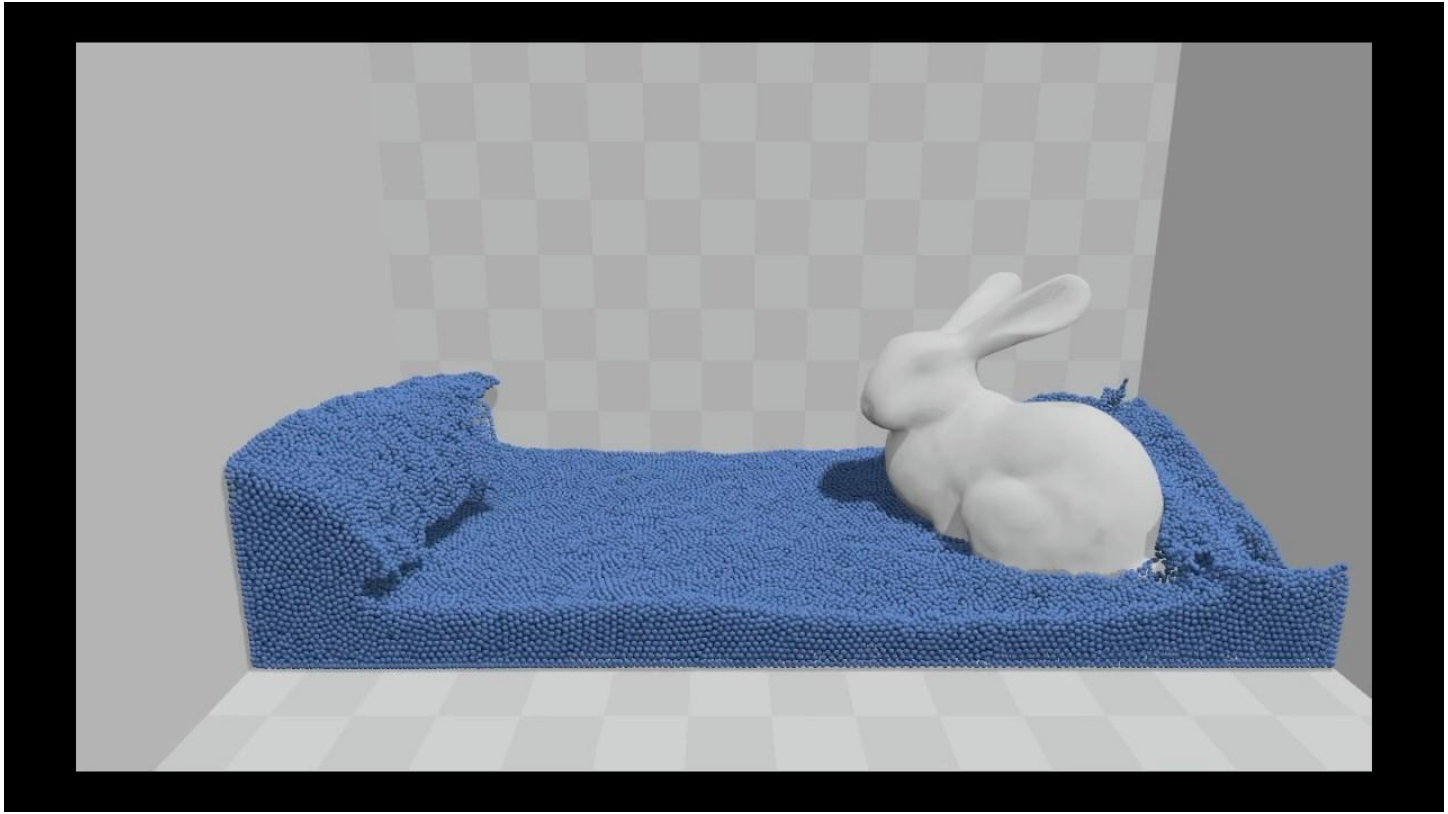
# Light Transport and Image Synthesis

Photograph (CCD) vs. computer rendering

# How Do Cameras and Lenses Work?

Glenn Derene, Popular Mechanics

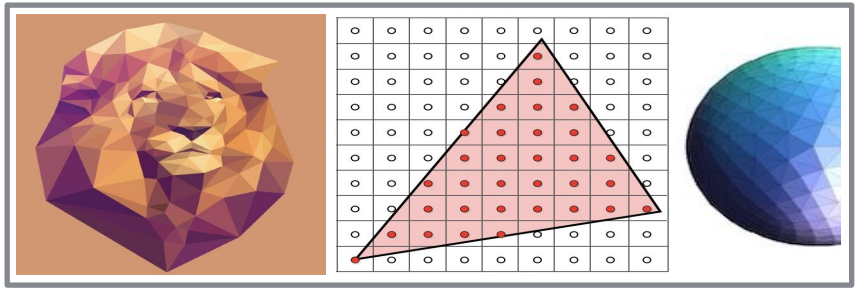
# Animation and Physical Simulation



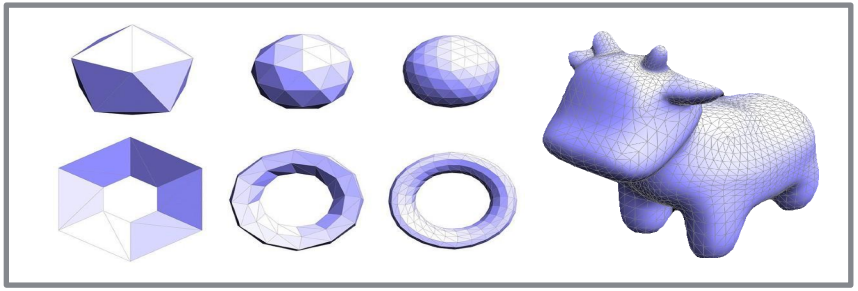
Position Based Fluids, Macklin and Müller

# Hands-on Learning

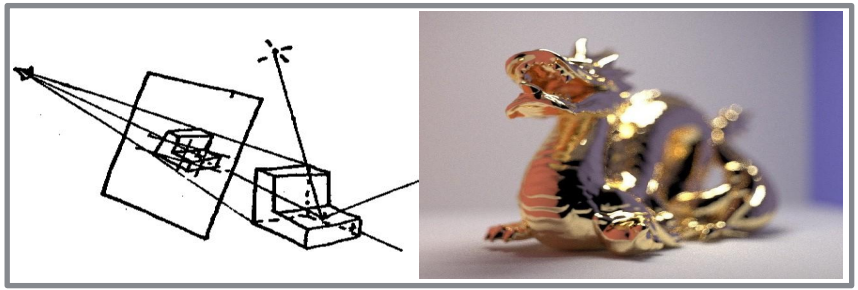
# Course Assignments



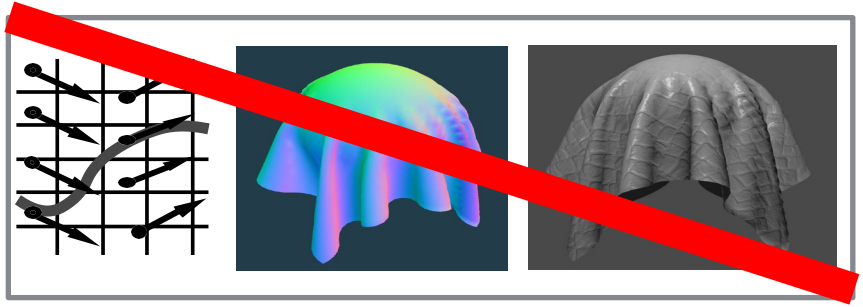
1. Digital Drawing (2 weeks)



2. Geometry (2 weeks)

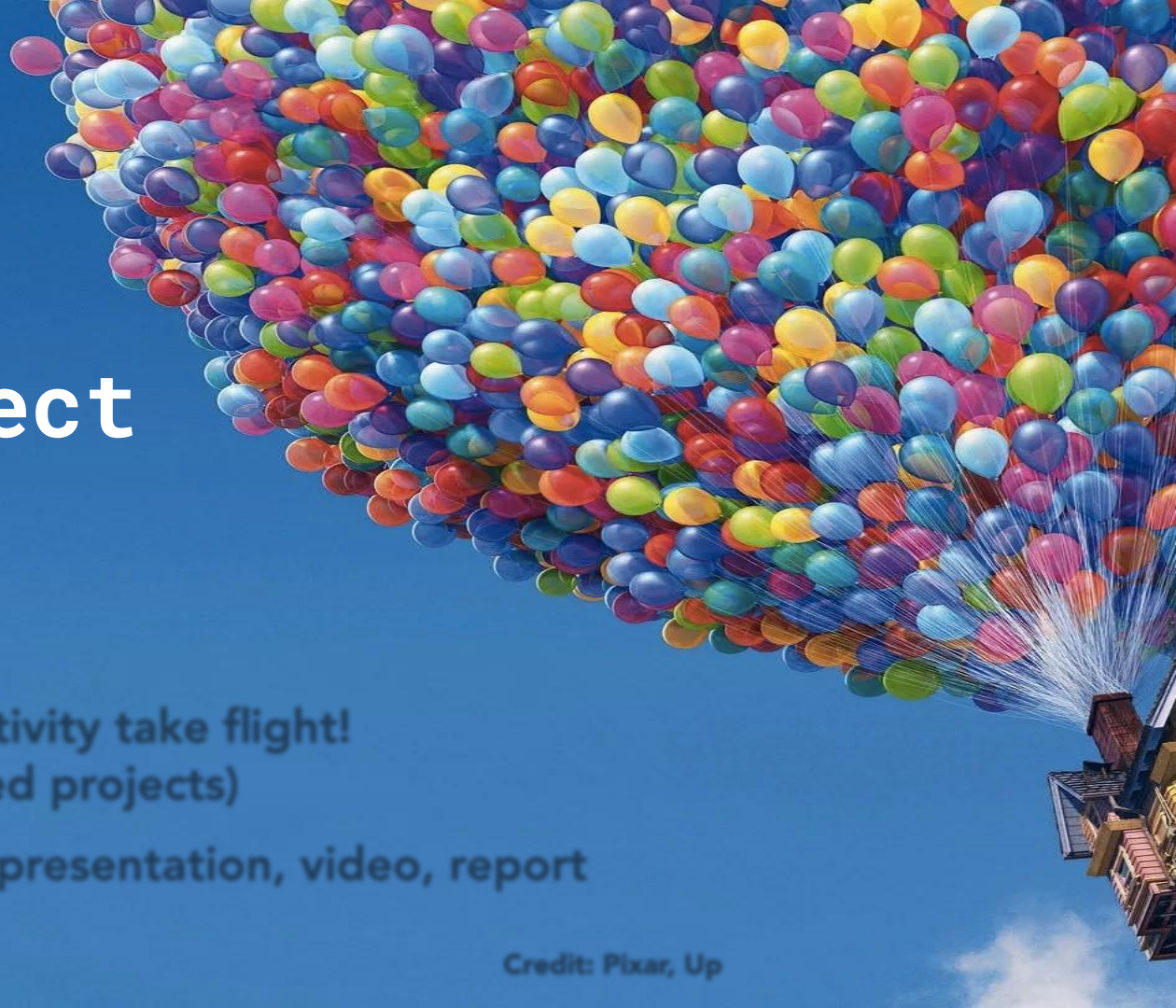


3. Ray-Tracing (2 weeks)



4. Animation (2 weeks)

# Final Project

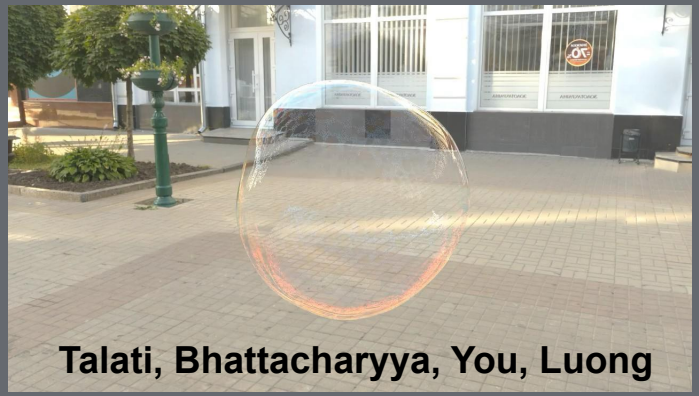


Project Competition

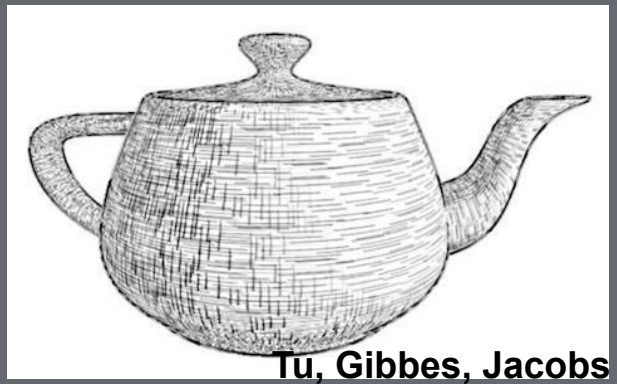
- 4 weeks, let your creativity take flight!
  (we will have suggested projects)
- Proposal; checkpoint; presentation, video, report

Credit: Pixar, Up

# Final Project - Examples


Talati, Bhattacharyya, You, Luong

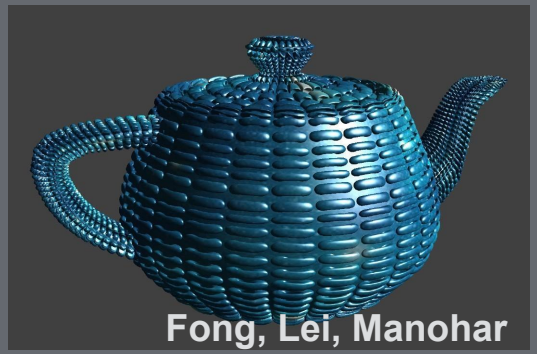

Ni, Wu, Yu, Zhou


Tu, Gibbes, Jacobs

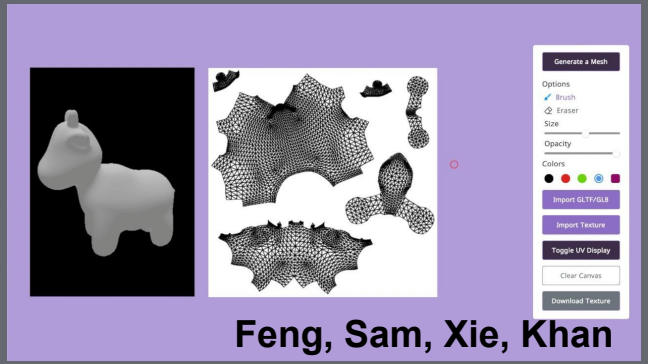

Doriwala, Kamat, Lim, Feguson

More examples and project reports on prior year course websites: cs184.eecs.berkeley.edu

# Final Project - Examples






More examples and project reports on prior year course websites: cs184.eecs.berkeley.edu

# Course Logistics

# Prerequisites

**Math**

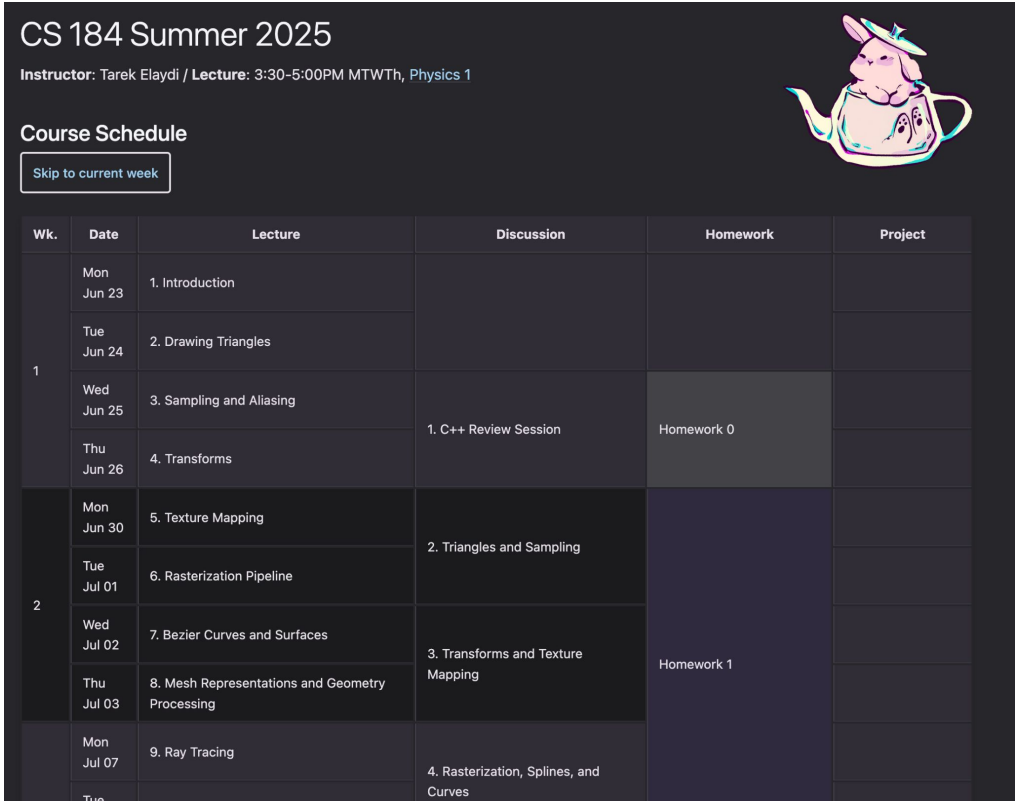
- **Vectors, matrices, basic linear algebra**
- **Helpful: exposure to stats, signal processing, Fourier transform**

**Programming**

- **Data structures (CS61B)**
- **Fluency with development environment, debugging, etc.**
- **Fluency with C and C++ (CS61C's first quarter)**

# Course Website

- [cs184.eecs.berkeley.edu/](cs184.eecs.berkeley.edu/)
- **Big shout-out to Ashley Chiu for bringing this inclusive template from CS161 to graphics**
- **Schedule and policies up on website calendar now**
- **We will NOT use bCourses/Canvas except to host recordings**



CS 184 Summer 2025

**Instructor**: Tarek Elaydi / **Lecture**: 3:30-5:00PM MTWTh, Physics 1

Course Schedule

Skip to current week

| Wk. | Date | Lecture | Discussion | Homework | Project |
|---|---|---|---|---|---|
| 1 | Mon Jun 23 | 1. Introduction | | | |
| | Tue Jun 24 | 2. Drawing Triangles | | | |
| | Wed Jun 25 | 3. Sampling and Aliasing | 1. C++ Review Session | Homework 0 | |
| | Thu Jun 26 | 4. Transforms | | | |
| 2 | Mon Jun 30 | 5. Texture Mapping | 2. Triangles and Sampling | Homework 1 | |
| | Tue Jul 01 | 6. Rasterization Pipeline | | | |
| | Wed Jul 02 | 7. Bezier Curves and Surfaces | 3. Transforms and Texture Mapping | | |
| | Thu Jul 03 | 8. Mesh Representations and Geometry Processing | | | |
| | Mon Jul 07 | 9. Ray Tracing | 4. Rasterization, Splines, and Curves | | |

# Shoutouts

## Past Head TAs!

- Jennifer Zhao
- Ashley Chiu

# Course Schedule - Important Dates

## See course website for all dates and more info.

## Exams

- **Monday, July 14th 3:30 PM-5:00 PM**
- **Thursday, August 7th 3:30 PM-5:00 PM**
  - **Send an email to the course email (cs184-su25@berkeley.edu) to staff this week if you have an exceptional circumstance that requires you to miss an exam**

## Final Project

- **TBD!**

# Ed

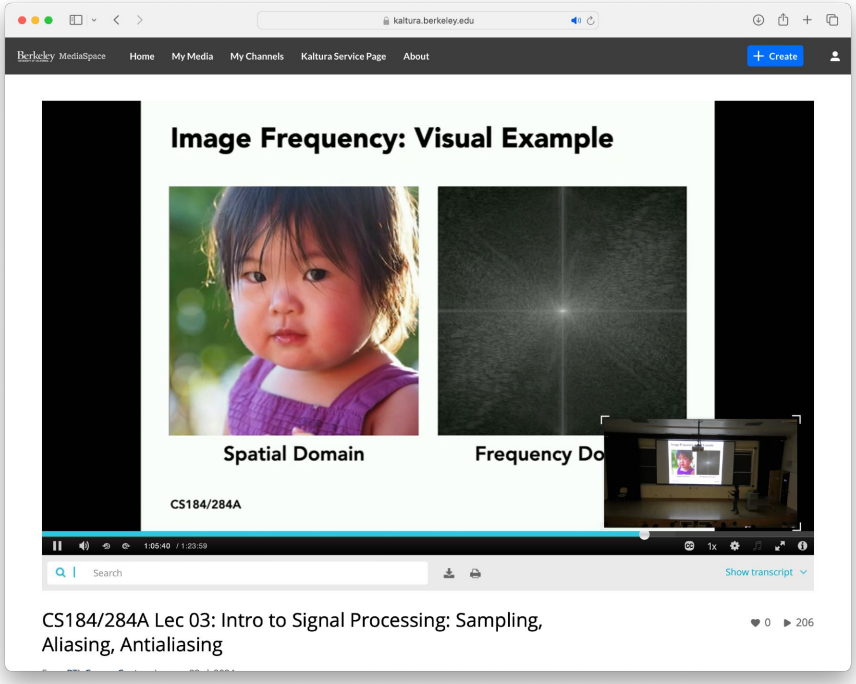
**edstem.org, course Ed link on course website**

- **You should be added already (if not, please sign up)!**
- **Please use Ed instead of email for logistics and general communication / discussion**
- **Conceptual questions and intellectual discussions will be hosted on lecture-specific threads (connected to class participation points)**

# Lecture Will Be Recorded

**Videos will be linked on the course website shortly after lecture**

- could take a few hours to a few days based on kaltura



# Discussion Section

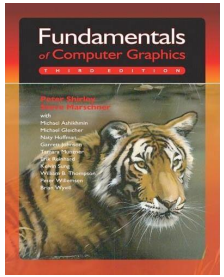
**Sections start this week, and TAs will give a primer on C++ and building class projects**

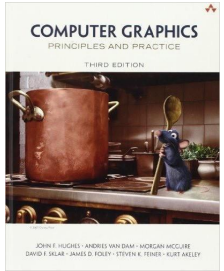
# Resources

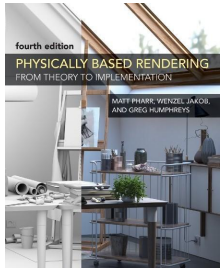
**Lectures will be primary source**

**Textbook reference material (optional):**

- **Fundamentals of Computer Graphics by P. Shirley, S. Marschner, et al.**
- **Computer Graphics: Principles and Practice (3rd Edition) by Hughes, van Dam, et al.**
- **Physically Based Rendering, Fourth Edition: From Theory to Implementation by Pharr, Jakob and Humphreys**



# Learning, Grading, Collaboration & Culture

**Goals:**

- **Enable you to increase focus on learning rather than assessment**
- **Encourage your learning through collaboration**
- **Entrust you with and support you in maintaining academic integrity Main**
- **Ideas (details on course website policies page — please review):**
- **The class is not graded on a curve.**
- **Collaboration in pairs is encouraged on homework assignments.**
- **Final project in teams of four.**
- **Two in-person exams. Details**
- **Please read the Policies page on the course website; ask questions on Ed.**

# Course Deliverables and Assessment

## Your course grade is computed using a point system with a total of 100 points.

- Three homework assignments, worth 12 points each
- Two exams, worth 15 points each
- Final project, worth 30 points
- Participation, worth 4 points

**Lots of extra credit!**

Each letter grade for the course corresponds to a range of scores:

| Grade | Points |
|---|---|
| A | >= 94 |
| A- | >= 90 |
| B- to B+ | >= 80 |
| C- to C+ | >= 70 |
| D- to D+ | >= 60 |

# Late Days Policy

**You have 2 late days per assignment**

- **Extend a homework assignment deadline (not the final project) by 24 hours using one late day.**
- **If you do not have remaining late days, 1 course point penalty per day (out of 12 total course points)**
- **Late days are meant to be used for personal schedule conflicts, illness, submission issues and other unforeseen circumstances.**
- **For exceptional circumstances, contact staff through the staff email (cs184-su25@berkeley.edu)**

# Participation Policy

**Every week, starting week 2, you are eligible for up to 2 participation credits.**

- **1 credit for attending lecture**
- **1 credits for attending discussion, and**
- **0.5 credit for making one well thought-out response on any question on any designated Ed lecture thread**

**Note that you must earn participation credits week-to-week and cannot “make up” participation at the end of the semester**

# Policy on Use of Generative-AI Tools

**You are welcome to use AI tools for minor coding and debugging. But a few rules/comments:**

- **Must describe use and what you learned**
- **Exams are in-person, closed-book. Likely will have coding questions**
- **Current AI tools are not perfect, so supervise your tools closely**
- **Minimal-effort use of AI tools may result in no partial credit**
- **We encourage you to explore AI tools in a way that augments rather than reduces your learning in class**

# What We Are Looking For In Lecture Ed Posts

## Challenge classmates with a question

- For example, make up a question you think might be on an exam

## Provide a link to an alternative explanation

- “This site has a really good animation of pre-filtering to avoid aliasing”

## Mention real-world examples

- For example, describe what default interpolation functions are used in iOS.

## Constructively respond to another student’s question

- “@nojaggies, are you sure that is correct?  I thought that Tarek said…”

# Class Philosophy

**We want to build an active, engaged class community.**

**Come to class, participate in lecture, discussion, office hour parties, homework parties.**

**Practice cooperative, supportive learning.**

**Contribute on the website.**

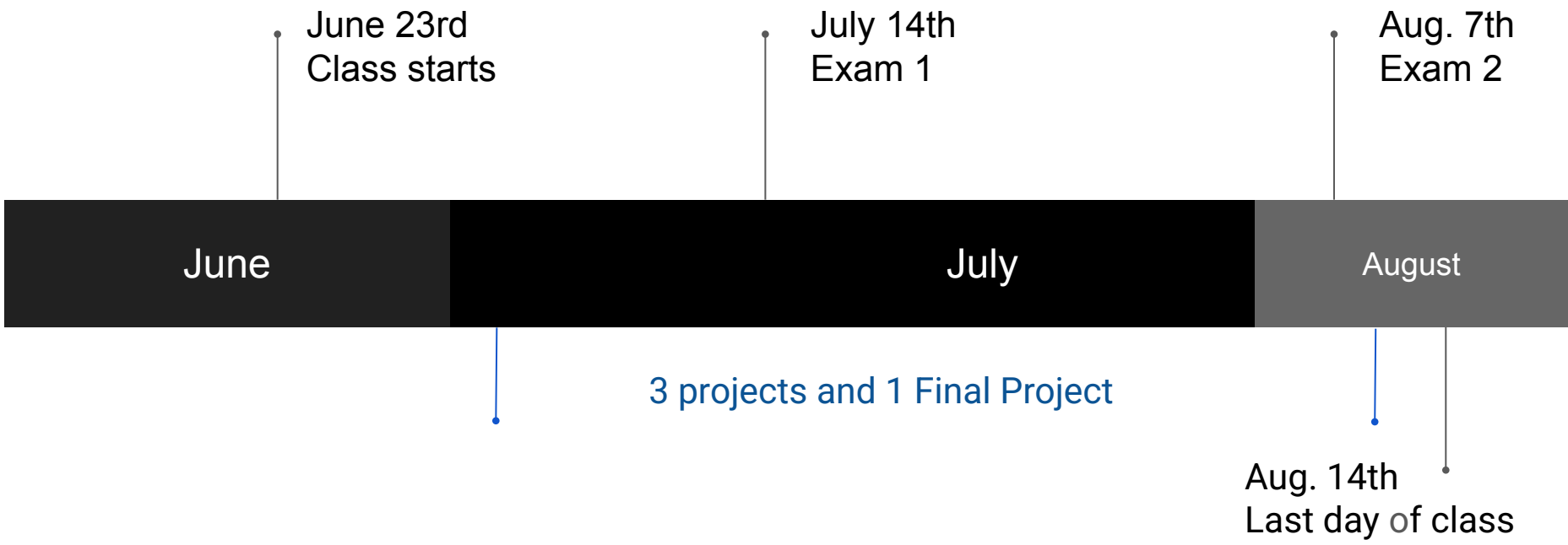
**Uphold academic honor individually and collectively.**

# Inclusive Classroom

**We are committed to creating a learning environment welcoming and supportive of all students. Towards this goal, we call on our class community to:**

- **Respect, welcome and learn from each other as individuals with unique backgrounds, perspectives and identities.**
- **Collaboration and team learning are encouraged, and will be supported through class staff and resources.**
- **Homework assignments and final project are a great way to meet new people and make friends; work on building trust and leveraging each other's unique strengths.**
- **If you feel that your learning is negatively affected by your experiences outside of class (e.g. family matters, current events), please don't hesitate to come and talk with the instructor and/or staff. We want to support you.**

# Quick overview



# Course Roadmap

## Rasterization Pipeline

### Core Concepts

- Sampling
- Antialiasing
- Transforms

## Geometric Modeling

### Core Concepts

- Splines, Bezier Curves
- Topological Mesh Representations
- Subdivision, Geometry Processing

## Lighting & Materials

### Core Concepts

- Measuring Light
- Unbiased Integral Estimation
- Light Transport & Materials

## Cameras & Imaging

Rasterization Transforms

& Projection Texture

Mapping

Visibility, Shading, Overall Pipeline

Intro to Geometry

Curves and Surfaces

Geometry Processing

Ray-Tracing & Acceleration

Radiometry & Photometry

Monte Carlo Integration

Global Illumination & Path Tracing

Material Modeling

# Questions?

# Acknowledgments

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