

CSC 320

Introduction to Visual Computing

Week 1 – Jan. 9th, 2019

CSC320: Introduction to Visual Computing

- Instructors: Yani Ioannou, Yawen Ma
- Course Website: <http://www.cs.toronto.edu/~csc320h>
 - Course information sheet
 - Lecture Slides
- Piazza: <http://piazza.com/utoronto.ca/winter2019/csc320>
 - Announcements
 - Instructor/TA contact: post private question to “instructors”
 - Course/Assignment Peer Discussion Groups
- MarkUs
 - Assignment upload/grading

What we will cover today

- Course Intro & Admin
 - What is “visual computing” (disciplines, objectives)
 - Is this course for me?
 - Admin stuff
- The Basics of Image Formation
 - Cameras/Optics
 - Photography Basics (focus, DoF, aperture, shutter speed, ISO)
 - Sensor Basics (Mosaicing, Colour, Noise)

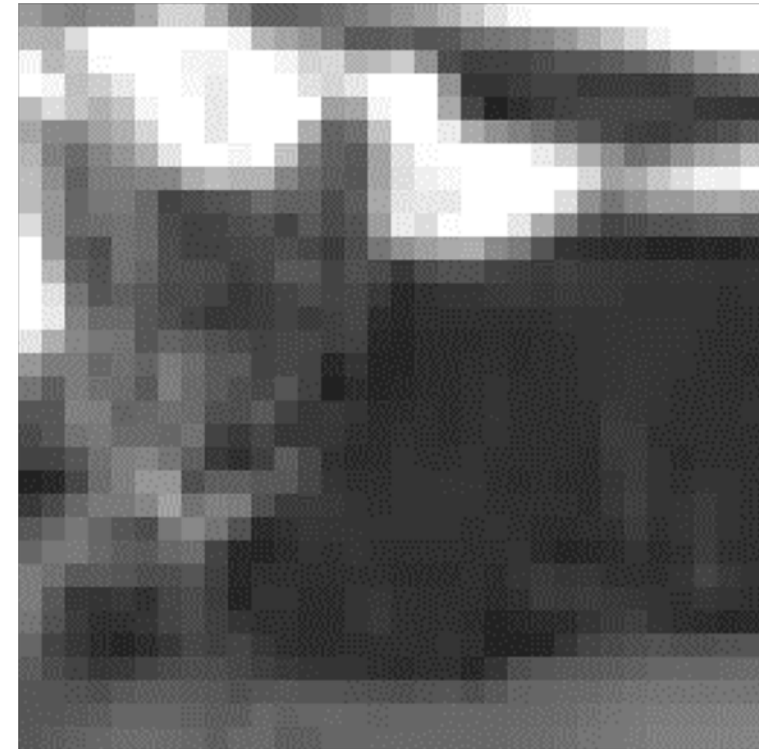
What is Visual Computing?

Topic 0: Course Introduction

What is Visual Computing?

- Understand how pixels in digital images and the real world relate

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CIFAR10 Training Image
(Single Channel)

Vision is Difficult!

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
PROJECT MAC

Artificial Intelligence Group
Vision Memo. No. 100.

July 7, 1966

THE SUMMER VISION PROJECT

Seymour Papert

The summer vision project is an attempt to use our summer workers
effectively in the construction of a significant part of a visual system.

The particular task was chosen partly because it can be segmented into

<http://www.lyndonhill.com/opinion-cvlegends.html>

Visual Computing Disciplines

- Computer vision
- Computer graphics
- Image processing
- Visualization
- Virtual and augmented reality
- Video processing

(also includes aspects of pattern recognition, human computer interaction, machine learning and digital libraries ...)

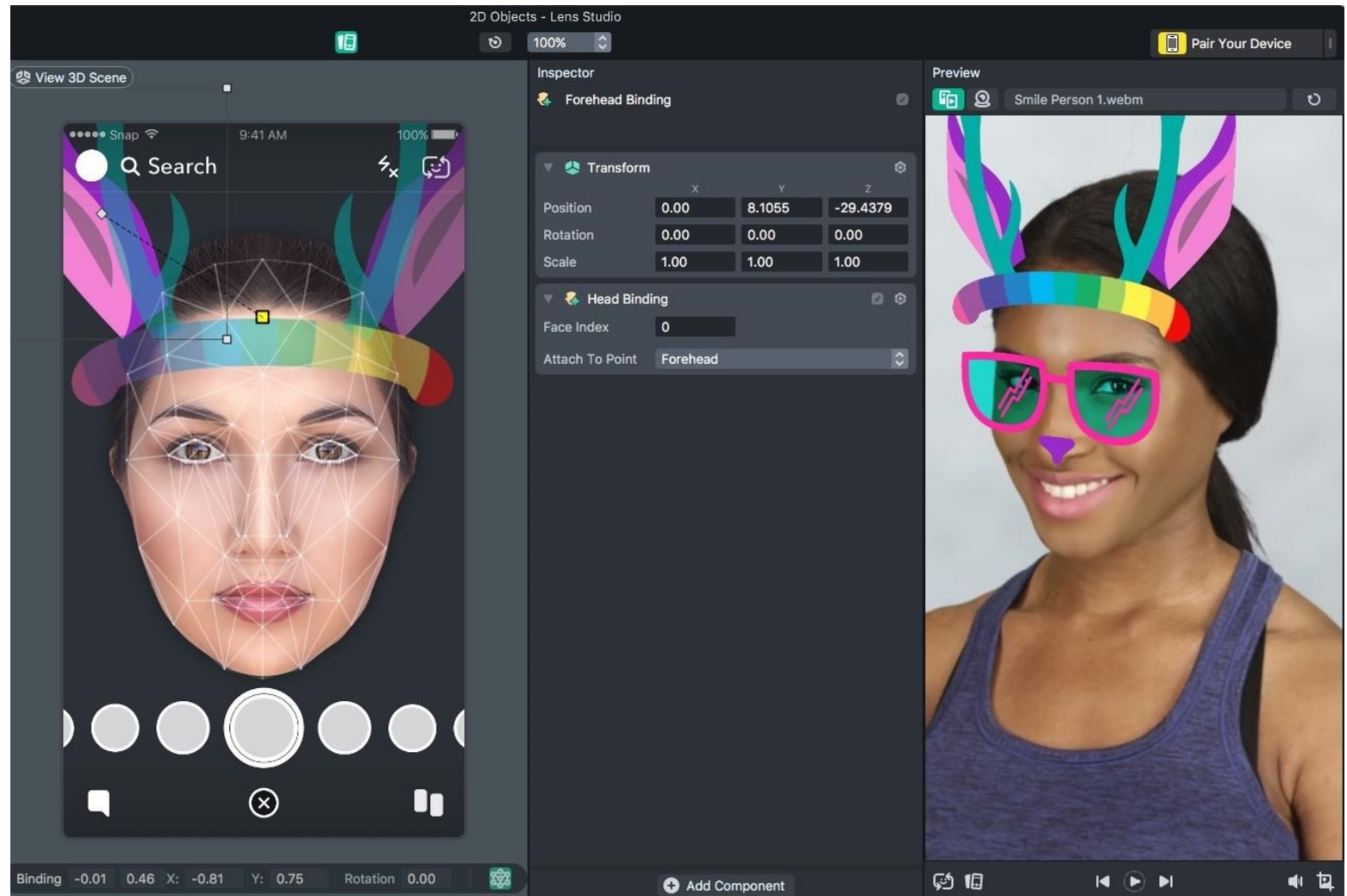
Visual Computing: Computer Vision

pixels → model of real world

Allows us to automate image understanding

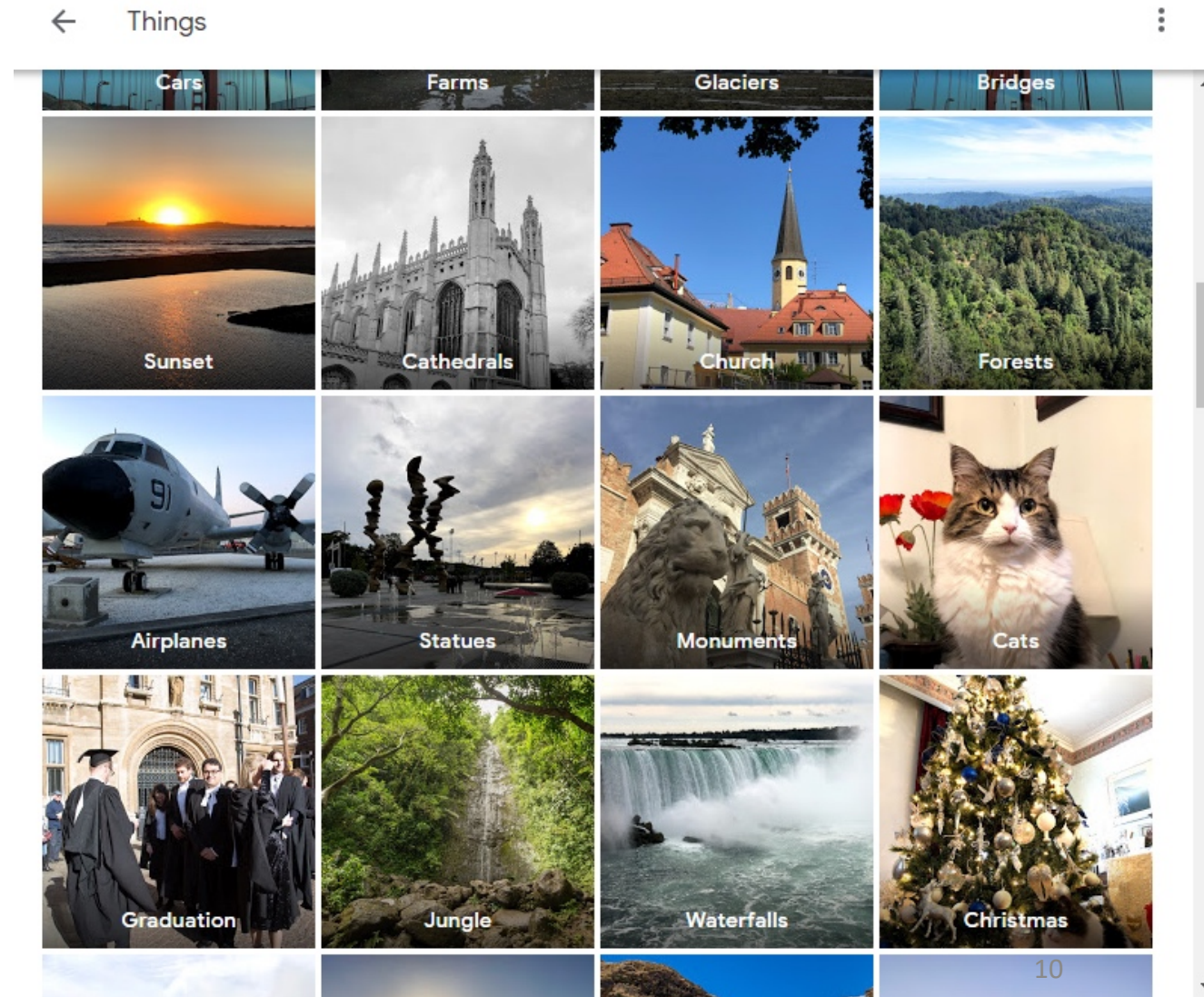
Computer Vision: Face Recognition

- Snapchat Lenses:
 - Facial landmark detection
- Apple FaceID:
 - 3D image
- Some phones:
 - 2D video



Computer Vision: Object/Scene Recognition

- Automatic image tagging (i.e. with Google Photos)



Visual Computing: Computer Graphics

model of real world → pixels

Allows us to experience things we might not in the real world

Realistic Video Games

- Going from a world model to almost photo-realistic real-time graphics
- Real-time raytracing



Virtual Reality

- Oculus Rift, HTC Vive, Playstation VR, ...
- Augmented Reality = computer vision + computer graphics



Objectives of Visual Computing

1. Realistic Image Synthesis
2. Capturing Reality
3. Manipulating Photos & Videos
4. Photo & Video Interpretation

Who are these people?



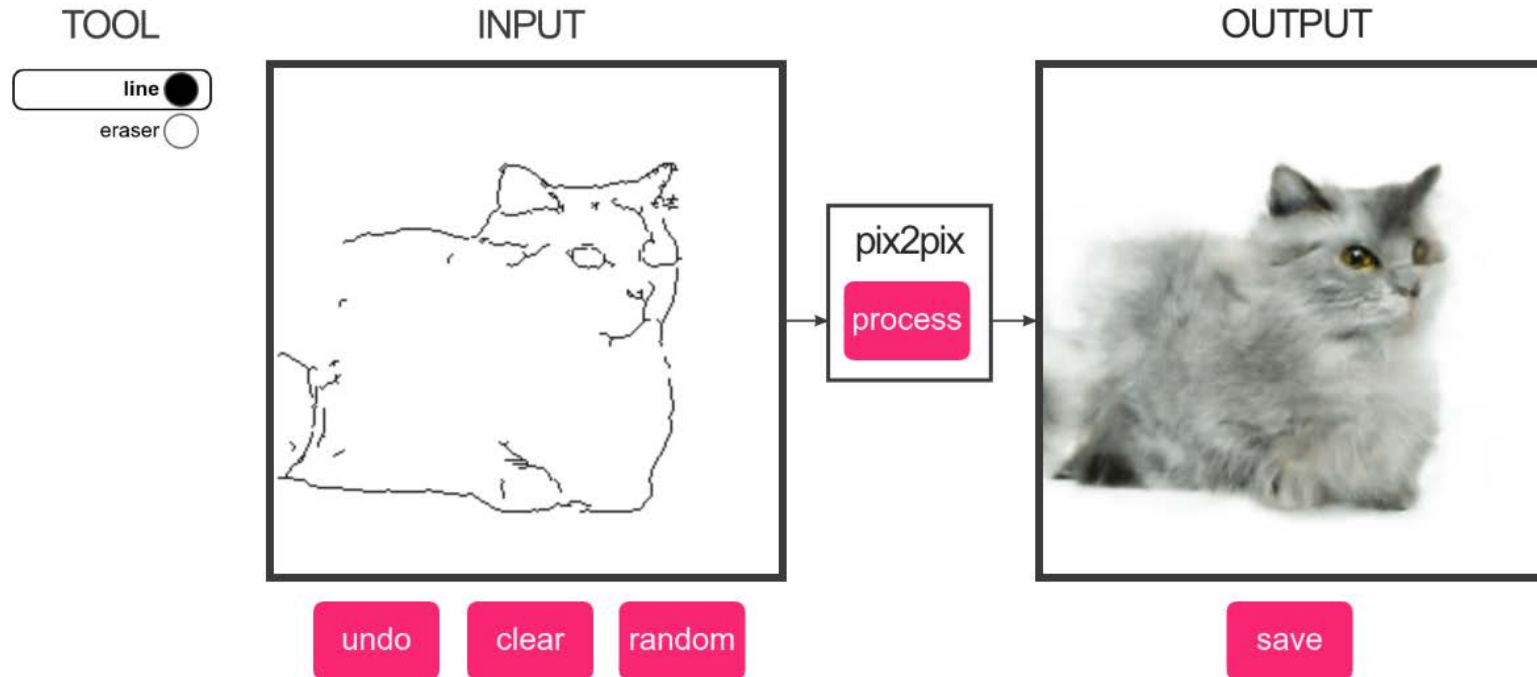
1. Realistic Image Synthesis: State of the Art



A Style-Based Generator Architecture for Generative Adversarial Networks, Karras et al. Dec. 2018, arXiv:1812.04948

1. Realistic Image Synthesis: State of the Art

edges2cats



- Try it! <https://affinelayer.com/pixsrv>

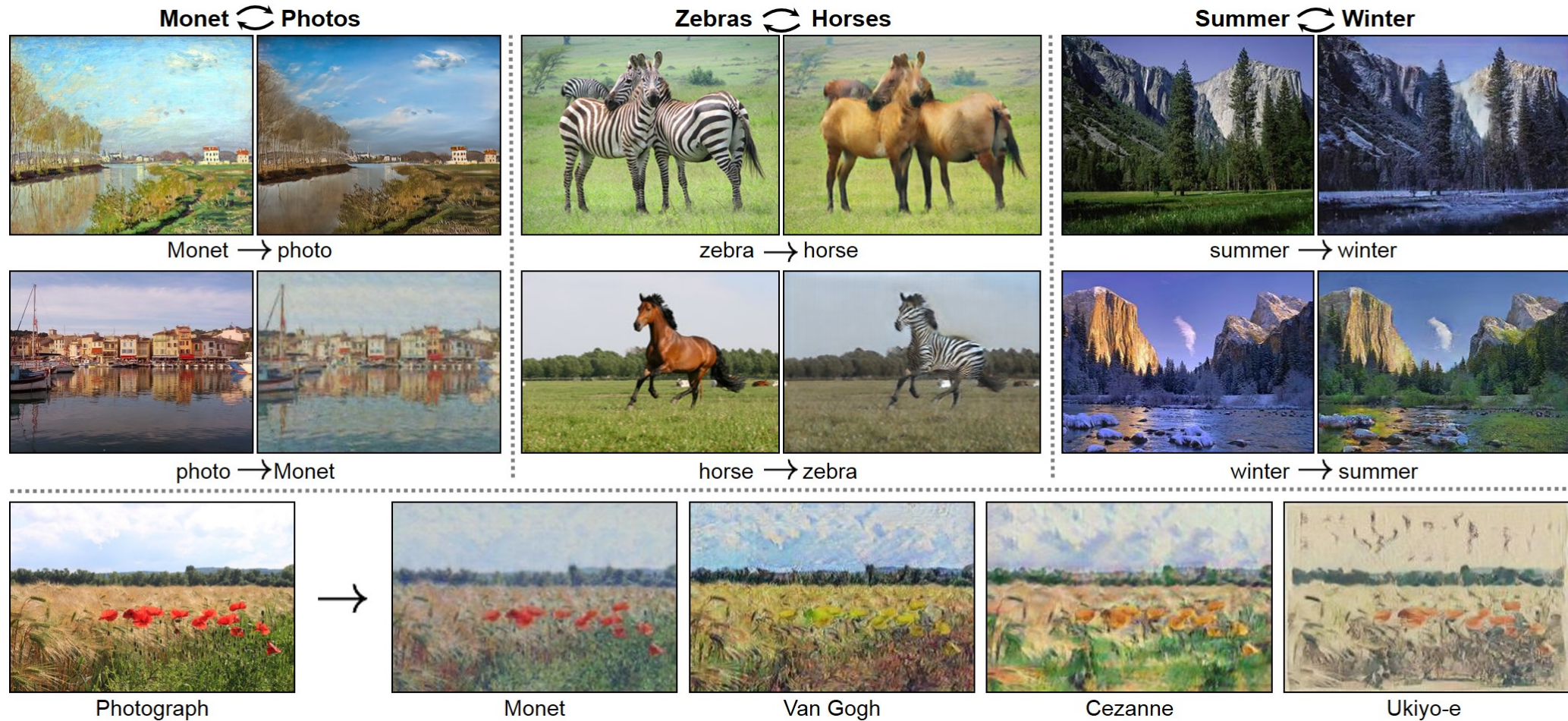
Image-to-Image Translation with Conditional Adversarial Nets, Isola et al. CVPR 2017, arXiv:1611.07004

2. Capturing Reality: Automatic Panoramas



Automatic Panoramic Image Stitching using Invariant Features, Brown et al., CVPR 2007

3. Manipulating Photos: State of the Art



Unpaired Image-to-Image Translation using Cycle-Consistent Adversarial Networks, Zhu, Park et al., ICCV 2017.

4. Photo & Video Interpretation: State of the Art

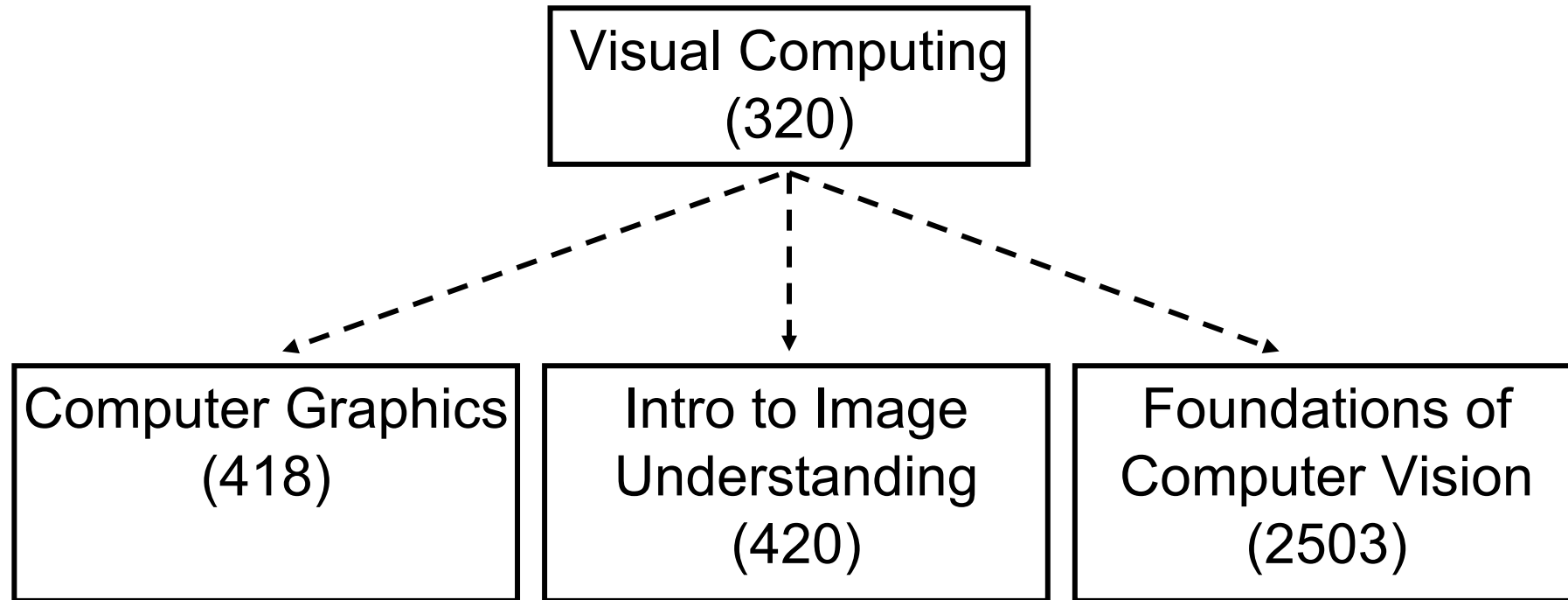


DensePose: Dense Human Pose Estimation In The Wild, Güler et al. arXiv:1802.00434

What do we need to know?

- Be comfortable with
 - Linear algebra
 - Elementary calculus
 - Quite a bit of coding!
- Basic tools for assignments:
 - Python2
 - Numpy
 - OpenCV
 - All are portable and free/open source

Where does this course fit in?



- CSC320 is not a pre-requisite for these courses
- Math foundations are the same, and will help to understand the foundations of these topics

Course Topics

- Imaging essentials (≈ 3 weeks)

Understanding cameras, pixel intensity & color

- Image representation & transformation

Image \Leftrightarrow 2D array of pixels

Image \Leftrightarrow continuous 2D function (≈ 4 weeks)

Image \Leftrightarrow n-dimensional vector (≈ 2.5 weeks)

Hierarchical image representations (≈ 2 weeks)

Image matching & transformation (≈ 2 weeks)

Reading Research Papers

- Will be assigning research papers as reading
- This is an important skill to learn for both research and industry!
- No one way to do it, everyone has their own style: can only learn by doing it

Grading

- 50%: 4 assignments handed out Monday or Wednesday
due at noon on the due date (13.4%, 13.4%, 13.4%, 9.8%)
 - 50%: 1 in-class test (20%) + 1 final exam (30%)
 - Check website for schedule, dates & more details/policy on late assignments and academic integrity
-
- First assignment: **out today**, due 3 weeks later
 - Start soon! This assignment cannot be done last minute easily.

Tutorials

- Math refreshers, OpenCV & programming tutorials
- Attendance **STRONGLY** encouraged since lectures/office hours will not be covering basic math, programming or assignment details
- Wednesday 20:00 - 21:00, Friday 14:00-15:00

Next

Topic 1: The Camera