

# Computer Vision and Artificial Intelligence in Python

Summer 2019

## Instructor Information

### Instructor

Islam Akef Ebeid

### Email

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### Office Location & Hours

UTA 5<sup>.558</sup>, 9:00 to 5:00, M-F

## General Information

### Description

Computer vision is a subdomain of the field of Artificial Intelligence that deals with developing algorithms in which the computer can have a semantic understanding of images in a way that is similar to humans. This understanding serves the whole purpose of creating autonomous machines capable of functioning in the world.

In this two-week-long course, we will explore the basics and the latest applications of Artificial Intelligence in general and Computer Vision, in particular, using the Python programming language. Each class will cover a specific topic and will start with an introduction followed by a practical example for the students to implement and have a hands-on experience. The student will be evaluated based on the level of engagement during the in-class assignment. The students and the instructor then will engage in a discussion about the topic and what the students think they have learned.

### Expectations and Goals

By the end of the course, students are expected to have learned the basics of Computer Vision and Artificial Intelligence using Python. They will have solved and used hands-on programming to implement examples and solve problems.

## Course Materials

- Slides

<http://bit.ly/paiseslides>

- Code

<http://bit.ly/paisocode>

- Datasets

<http://bit.ly/paisedata>

• Books:

- Programming Computer Vision with Python by Jan Erik Solem
- Computer Vision: Algorithms and Applications by Richard Szeliski
- Learning OpenCV by Gary Bradski and Adrian Kaehler

<http://bit.ly/paisebook>

## Course Schedule

### Day 1

- Basic Image Handling and Processing
- Image Descriptors

### Day 2:

- Image to Image Mappings
- Camera Models, and Augmented Reality

### Day 3:

- Multiple View Geometry
- Image Clustering

### Day 4:

- Image Search
- Image Classification

### Day 5:

- Image Segmentation
- OpenCV

### Day 6:

- 3D Vision

### Day 7:

- Deep Learning with Computer Vision

## Course Flow

### Day 1:

- Basic Image Handling and Processing:
  - Introduces the necessary tools for working with images and the central Python modules used in the book. This chapter also covers many fundamental examples needed for the remaining chapters.
- Image Descriptors:
  - Explains methods for detecting interest points in images and how to use them to find corresponding points and regions between images.

### Day 2:

- Image to Image Mappings:
  - Describes fundamental transformations between images and methods for computing them. Examples range from image warping to creating panoramas.
- Camera Models, and Augmented Reality:
  - Introduces how to model cameras, generate image projections from 3D space to image features, and estimate the camera viewpoint.

### Day 3:

- Multiple View Geometry:
  - Explains how to work with several images of the same scene, the fundamentals of multiple-view geometry and how to compute 3D reconstructions from images.
- Image Clustering:
  - Introduces several clustering methods and shows how to use them for grouping and organizing images based on similarity or content.

### Day 4:

- Image Search:
  - Shows how to build efficient image retrieval techniques that can store image representations and search for images based on their visual content.
- Image Classification:
  - Describes algorithms for classifying image content and how to use them recognizing objects in images.

### Day 5:

- Image Segmentation:
  - Introduces different techniques for dividing an image into meaningful regions using clustering, user interactions, or image models.
- OpenCV:
  - Shows how to use the Python interface for the commonly used OpenCV computer vision library and how to work with video and camera input.

## Day 6:

- 3D Vision:

- We will understand the basics of depth vision and how a computer can see in a way similar to humans using a Kinect.

## Day 7:

- Deep Learning with Computer Vision:

- We will use PyTorch library to learn how Deep Learning techniques can be leveraged in the computer vision field.

## Evaluation

Grades will be based on:

- Attendance and Participation (20%)
- In class assignments (60%)
- Final exam (20%)

The final grade will be out of 1000 points and the will be scaled according to:

- A- 90-100
- B- 80-90
- C- 70-80
- D- 60-70
- E- 0-60

## University Policies

### Student Rights & Responsibilities:

- You have a right to a learning environment that supports mental and physical wellness.
- You have a right to respect.
- You have a right to be assessed and graded fairly.
- You have a right to freedom of opinion and expression.
- You have a right to privacy and confidentiality.
- You have a right to meaningful and equal participation, to self-organize groups to improve your learning environment.
- You have a right to learn in an environment that is welcoming to all people. No student shall be isolated, excluded or diminished in any way.

### With these rights come responsibilities:

- You are responsible for taking care of yourself, managing your time, and communicating with the teaching team and with others if things start to feel out of control or overwhelming.
- You are responsible for acting in a way that is worthy of respect and always respectful of others.
- Your experience with this course is directly related to the quality of the energy that you bring to it, and your energy shapes the quality of your peers' experiences.
- You are responsible for creating an inclusive environment and for speaking up when someone is excluded.
- You are responsible for holding yourself accountable to these standards, holding each other to these standards and holding the teaching team accountable as well.
- You are responsible for understanding UT's Academic Honesty and the University Honor Code which can be found here: [http://deanofstudents.utexas.edu/sjs/acint\\_student.php](http://deanofstudents.utexas.edu/sjs/acint_student.php)

### Personal Pronoun Use (She / He / They / Ze / Etc.):

Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

### Academic Integrity:

Each student in the course is expected to abide by the University of Texas Honor Code: "As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity." Plagiarism is taken very seriously at UT. Therefore, if you use words or ideas that are not your own (or that you have used in previous class), you must cite your sources. Further, direct quotes must be put in quotation marks. Otherwise you will be guilty of plagiarism and subject to academic disciplinary action, including failure of the course. To learn more, please review this tutorial: [https://uslibraries.usc.edu/tutorials/avoiding-plagiarism/story\\_html5.html](https://uslibraries.usc.edu/tutorials/avoiding-plagiarism/story_html5.html)

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### **Services for Students with Disabilities:**

This class respects and welcomes students of all backgrounds, identities, and abilities. If there are circumstances that make our learning environment and activities difficult, if you have medical information that you need to share with me, or if you need specific arrangements in case the building needs to be evacuated, please let me know. I am committed to creating an effective learning environment for all students, but I can only do so if you discuss your needs with me as early as possible. I promise to maintain the confidentiality of these discussions. If appropriate, also contact Services for Students with Disabilities, 512-471-6259 (voice) or 1-866-329- 3986 (video phone).  
<http://ddce.utexas.edu/disability/about/>

### **Counseling and Mental Health Center:**

Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support.

<http://www.cmhc.utexas.edu/individualcounseling.html>

### **Important Safety Information:**

If you have concerns about the safety or behavior of fellow students, TAs or Professors, call BCAL (the Behavior Concerns Advice Line): 512-232-5050. Your call can be anonymous. If something doesn't feel right - it probably isn't. Trust your instincts and share your concerns. The following recommendations regarding emergency evacuation from the Office of Campus Safety and Security, 512-471-5767,  
<http://www.utexas.edu/safety/>

- Occupants of buildings on The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside.
- Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building.
- Students requiring assistance in evacuation shall inform their instructor in writing during the first week of class.
- In the event of an evacuation, follow the instruction of faculty or class instructors. Do not re-enter a building unless given instructions by the following: Austin Fire Department, The University of Texas at Austin Police Department, or Fire Prevention Services office.
- Link to information regarding emergency evacuation routes and emergency procedures can be found at: [www.utexas.edu/emergency](http://www.utexas.edu/emergency)

## Title IX Reporting:

Title IX is a federal law that protects against sex and gender based discrimination, sexual harassment, sexual assault, sexual misconduct, dating/domestic violence and stalking at federally funded educational institutions. UT Austin is committed to fostering a learning and working environment free from discrimination in all its forms. When sexual misconduct occurs in our community, the university can:

1. Intervene to prevent harmful behavior from continuing or escalating.
2. Provide support and remedies to students and employees who have experienced harm or have become involved in a Title IX investigation.
3. Investigate and discipline violations of the university's relevant policies.

Faculty members and certain staff members are considered "Responsible Employees" or "Mandatory Reporters," which means that they are required to report violations of Title IX to the Title IX Coordinator. I am a Responsible Employee and must report any Title IX related incidents that are disclosed in writing, discussion, or one-on-one. Before talking with me, or with any faculty or staff member about a Title IX related incident, be sure to ask whether they are a responsible employee. If you want to speak with someone for support or remedies without making an official report to the university, email [advocate@austin.utexas.edu](mailto:advocate@austin.utexas.edu) For more information about reporting options and resources, visit [titleix.utexas.edu](http://titleix.utexas.edu) or contact the Title IX Office at [titleix@austin.utexas.edu](mailto:titleix@austin.utexas.edu).

## References

Bradski, G., & Kaehler, A. (2008). *Learning OpenCV: Computer vision with the OpenCV library*. " O'Reilly Media, Inc."

Solem, J. E. (2012). *Programming Computer Vision with Python: Tools and algorithms for analyzing images*. " O'Reilly Media, Inc."

Szeliski, R. (2010). *Computer vision: algorithms and applications*. Springer Science & Business Media.

Subramanian, V. (2018). *Deep Learning with PyTorch: A practical approach to building neural network models using PyTorch*. Packt Publishing Ltd.