Visión por computador para las geociencias

a.k.a. Computer Vision for Geosciences (CV4GS)

2026-02-04

Sébastien Valade

Lecturers

Main lecturer:

- **Sébastien Valade** (valade@igeofisica.unam.mx)
  ⇒ Researcher at UNAM (Instituto de Geofísica, Departamento de Vulcanología)
  ⇒ Volcanologist, research focus on Remote Sensing & Geophysics (https://svalade.github.io)

Assistant:

- **Santiago Piñon Juárez** (santiagopinonj@gmail.com)
  ⇒ PhD student at UNAM (Instituto de Geofísica, Departamento de Vulcanología)
  ⇒ Physicist, research topic on remote sensing of volcanic ash plumes from ground and space

Special guest:

- **Sophie Giffard-Roisin**
  ⇒ Researcher at IRD (France)
  ⇒ Computer Scientist, research focus on Computer Vision and Deep Learning techniques for natural hazards (https://sophiegif.github.io/)
  ⇒ will co-supervise the projects

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Lecture goals

- acquire theoretical & practical knowledge to process digital images *(photographs, satellite imagery, microscope imagery, video, etc.)*
- progression from classical computer vision (CV) methods, to advanced artificial intelligence (AI) methods, using the Python programming language
- examples and applications inspired from geoscience problems

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Lecture material

- Programming language: Python
- Programming environment: Jupyter notebooks

Note: although the course is built around Python / Jupyter, you can use the programming language and IDE of your choice.

Overview (previous editions)

- Previous editions (2021, 2024) can be found here:
  ⇒ https://svalade.github.io/cv4gs/
  ⇒ *40% CV, 35% ML, 25% DL*

- This edition intentions:
  ⇒ *less CV, more DL !*
  ⇒ *less lectures, more time for group projects !*

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1. Crash course to Python

- Introduction to the main features of Python
  $\Rightarrow$ *data types, operators, containers, control flow statements, functions/classes, modules/packages*

- Introduction to the programming tools used during the course
  $\Rightarrow$ *Jupyter notebooks*

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2. Digital Image Processing

- Digital image
  $\Rightarrow$ *what is a digital image and how to manipulate it*
- Image Filtering
  $\Rightarrow$ *spatial- and frequency-domain filering, learn to code a spatial filter & use standard image processing libraries*
- Image Morphology & Segmentation
  $\Rightarrow$ *erosion, dilation, opening and closing operators; why segment an image and how to do so*
- Image Homography
  $\Rightarrow$ *image transformation matrices, image stitching & perspective correction*
- Features & Motion Estimation
  $\Rightarrow$ *image features, Digital Image Correlation & Optical Flow*

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3. Machine Learning Methods

- Introduction to the basic concepts of statistical learning
  - supervised / unsupervised learning
  - input / output domain
  - test / training / validation datasets
  - overfitting / underfitting
  - features and performance evaluation
- Machine Learning
  - Dimensionality reduction (PCA)
  - Regression algorithms (linear, polynomial, logistic, softmax)
  - Classification algorithms (kNN, SVM, RF)

  $\Rightarrow$ introduction to Python's Scikit-learn library
- Deep Learning
  - MLP (MultiLayer Perceptron) to CNN (Convolutional Neural Networks)
  - network architectures, transfer learning,

  $\Rightarrow$ introduction to Python's TensorFlow / Keras library

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Points to discuss

- Lectures date/time: Fridays 09:00-13:00 ? Presencial o virtual?
- Key dates:
  - 2026-02-03 = start of semester
  - 2026-02-04 = first meeting (today)
  - 2026-05-29 = end of semester
  - 2026-06-12 = end of exam period
- Evaluation:
  - 1 partial exam
  - 1 group project

  $\Rightarrow$ Calificación total = promedio de los 2

  $\Rightarrow$ 80% de presencia para validar
- Experience with Python? With Jupyter notebooks? Personal Computer?
- Why are slides in English? Will some lectures be in English?

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