Visión por computador para las geociencias

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

2024-08-08

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

Special guest:

- **Ronny Hänsch**
  ⇒ Researcher at DLR (German Aerospace Center) & Professor at TU-Berlin (Germany)
  ⇒ Computer Scientist, research focus on Computer Vision and Machine Learning applied to Remote Sensing

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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.

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: Thursdays 09:00-13:00 ?
- Key dates:
  - 2024-08-05 = start of semester
  - 2024-08-08 = first meeting (today)
  - 2024-11-22 = end of semester
  - 2024-12-06 = end of exam period
- Evaluation:
  3 partial exams, final grade = mean of the 2 best ones
- Experience with Python? With Jupyter notebooks? Personal Computer?
- Why are slides in English? Will some lectures be in English?

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