



## SPLIT SUMMER SCHOOL 2023

### COURSE: AI TECHNIQUES: DATA CLUSTERING AND SIGNAL PROCESSING IN JULIA

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Web page: <https://www.unist.hr/en/education/split-summer-school/about-split-summer-school>

#### Content

The course is aimed at students with little or no Julia knowledge seeking to learn how to use Julia with emphasis on AI techniques for data clustering and signal processing. Julia is the most recent programming language for high-performance computing. It is fast, easy to use, and open source. Julia has amazing ecosystems for data science, machine learning, scientific computing, parallel computing, and visualization. The lectures will be presented using Pluto notebooks. We will cover AI techniques for data clustering: k-means algorithm, spectral bipartitioning of graphs, spectral k-partitioning, partitioning of bipartite graphs, and clustering of textual collections. We will also cover some methods used in signal processing: low rank plus sparse splitting, spectral signal decomposition, and compressive sensing. The course is hands-on, and students will have an opportunity to solve problems of their choice.

#### Prerequisites

The participants should be familiar with programming, linear algebra including eigenvalues and eigenvectors, and graphs. Familiarity with signals and linear programming is a plus. Installation of Julia and Pluto notebooks is advised. Installation instructions can be found at <https://github.com/ivanslapnicar/Julia-Course>.

#### Learning Outcomes

The participants will be able to:

- use Julia and Pluto notebooks,
- recognize applications where K-means algorithm can be efficiently used and use it,
- apply graph spectral bipartitioning and recursive bipartitioning to data clustering problems,
- apply graph spectral k-partitioning to data clustering problems,
- apply spectral partitioning of bipartite graphs to data clustering problems,
- cluster collections of texts in any language using spectral clustering of bipartite graphs
- recognize problems that can be decomposed into low-rank and sparse parts, and perform the decomposition
- decompose a signal into mono-components using Hankel matrices
- understand compressive sensing method



Program structure:

- 5-day course
- Students will make their final presentations
- Lecture notebooks are publicly available

### Important dates:

Course dates: September 12-16, 2023  
 Deadline for application: July 1, 2023  
 Payment due by: July 1, 2023  
 Confirmation of the course: July 10, 2023

**Price of the course** - on-site: 300 € (tax included)  
 on-line: 50 € (tax included)

**Bed & breakfast:** 189 € (tax included) – contact person: Marina Kero [marina.kero@scst.hr](mailto:marina.kero@scst.hr)

### Schedule

Day 1

- **Introduction to Julia** (3h)
- Individual work/exercise (1h)

Day 2

- **Data clustering:** K-means clustering and the package Clustering.jl. Spectral graph bipartitioning. (3h)
- Individual work/exercise (1h)

Day 3

- **Data clustering:** Spectral graph k-partitioning. Spectral partitioning of bipartite graphs. Clustering of textual data and the packages TextAnalysis.jl and Languages.jl (3h)
- Individual work/exercise (1h)

Day 4

- **Signal processing:** Low rank + sparse splitting. Signal decomposition using spectral methods. Compressed sensing. (3h)
- Individual work/exercise (1h)

Day 5

- **Students' final projects and presentations** (4h)

Lecturer:

Professor Ivan Slapničar

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