

Course: Graphs and Matrices

This short course about the spectral properties of graphs is designed to help students grasp the fundamental ideas behind graph eigenvalues and eigenvectors and how they are used in things like spectral community detection and the economic complexity index. It is made accessible to understand, especially for physics students, and will be taught using a blackboard.

Questo breve corso sulle proprietà spettrali dei grafi è pensato per introdurre agli studenti i concetti fondamentali di autovalori e autovettori dei grafi e come vengono utilizzati nella rilevazione spettrale delle comunità e l'indice di complessità economica. È pensato per essere facile da capire, specialmente per gli studenti di fisica, e verrà presentato a lavagna.

Duration: 4 hours

Syllabus:

- Graph matrices zoo
 - Directed graphs
 - Adjacency
 - Perron-Frobenius
 - Kleinberg hubs and authorities
 - Cospectral theorem
 - Non-negative eigenvalues
 - Undirected graphs
 - Adjacency matrix Eigenvalue boundaries
 - Laplacian
 - Non-negative eigenvalues
 - Zeroth order perturbation correction
 - Community detection
 - Minimum cut
 - Eigenvalue range
 - Springs and oscillations
 - Normal Matrix
 - Transition matrix (right stochastic)
 - Connection to the normal matrix
 - Eigenvector orthogonality through the degree metric tensor
 - Left stochastic matrix
 - Cospectral theorem
 - Connection to the right stochastic matrix
 - Page-rank
- Bipartite graphs
 - Eigenvalues with opposite sign
 - Economic Complexity Index

Course: Advanced Agent-Based Modeling: Railway Dynamics

This brief course aims to enlighten students about the challenges associated with agent-based modeling by exploring a challenging, concrete example.

Questo breve corso offre una panoramica sulle sfide legate alla modellizzazione ad agenti per mezzo della discussione di un esempio concreto e complesso.

Duration: 1 hour

Syllabus

- Why ABM?
- The double language problem
- Railway dynamics
 - Macro- and microscopic simulations
 - Train services
 - Rolling stocks, Infrastructure, Personnel
 - Freight and passengers
 - Numbering
 - Join and split
 - Infrastructure
 - Stations
 - Platforms
 - Sidings
 - Blocks
- Data
 - Wrangling and validation
 - Infrastructure
 - RINF (European Register of Infrastructure)
 - OpenRailwayMap
 - Actual timetables
 - Train services
 - Scheduled Timetables
 - Reassignments
 - Delays
 - Actual timetables
 - Delay cascades
- Simulation
 - Delay sampling vs delay generation
 - Delay reducing strategies
 - Rerouting
 - Canceling
 - Priority change
 - Extra rolling stock
 - Buffering