Introduction to Modern Data Science (24h)

Course Outline

This course introduces students to the modern data science ecosystem, combining scientific computing, data engineering, machine learning, and software engineering best practices. Students learn how to build reproducible data science projects using contemporary Python tools while developing the practical skills required to acquire, process, analyze, visualize, and model real-world data.

The course covers the complete data science workflow, from environment setup and collaborative development to exploratory data analysis, statistical inference, machine learning, REST APIs, containerization, and the fundamentals of MLOps. Emphasis is placed on reproducibility, scalability, and industry-standard tools widely used in professional data science.

1. Computing Environment and Python Fundamentals Overview of Linux, Windows, and macOS

File systems, paths, and permissions Essential shell commands and scripting Python refresher: scripts, modules, and packages Command-line workflows for data science

2. Modern Python Tooling The modern Python ecosystem Virtual environments and dependency management with uv Code quality using ruff (linting and formatting) Development with Visual Studio Code AI-assisted programming and productivity tools Reproducible Python environments

3. Data Manipulation and Processing Working with tabular data using NumPy and Pandas Data formats: CSV, Parquet, and Apache Arrow Data cleaning and preprocessing Filtering, joins, aggregations, and missing values Performance considerations Introduction to scalable data processing with Polars, DuckDB, Dask, and Spark

4. Exploratory Data Analysis and Statistical Thinking Principles of exploratory data analysis (EDA) Descriptive statistics and data summarization Statistical inference with SciPy Data visualization using Matplotlib and Seaborn Interactive dashboards with Plotly and Streamlit Communicating insights through visualizations

5. Version Control and Project Organization Git fundamentals GitHub and collaborative development workflows Branching, merging, and pull requests Organizing reproducible data science projects Notebooks versus Python scripts Literate programming with Marimo

6. Building Data Applications Consuming REST APIs with requests Designing REST APIs with FastAPI Introduction to containerization with Docker (or Podman) Building portable and reproducible applications Deploying simple data services

7. Introduction to Machine Learning and Artificial IntelligenceThe machine learning workflow Supervised and unsupervised learning Feature engineering and model evaluation Introduction to deep learning Large Language Models (LLMs) Generative AI, prompt engineering, and AI agents

8. MLOps and Production Machine Learning From notebooks to production Model serving: batch and

real-time inference Experiment tracking with MLflow CI/CD for machine learning projects Introduction to cloud-native ML workflows Model monitoring, drift detection, and retraining strategie

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