Topics covered

- 1. Correlation and regression (2.5 hrs.):
  - Correlation: Pearson, Spearman
  - Linear Regression: Multiple linear regression, stepwise regression; ridge regression & lasso (Chap.8)

- 2. Principal component analysis (PCA) and rotated PCA (7.5 hrs.)

- 3. Canonical correlation analysis (CCA) (2 hrs.)

- 4. Time series: Fourier spectral analysis, windows, filters, and singular spectrum analysis (4 hrs.).

- **5. Classification and clustering** (3.5 hrs.)
  - Classification: k-nearest neighbour, logistic regression (Bayes' Theorem)
  - Clustering: K-means clustering, hierarchical clustering, self-organizing map

- **6. Feed-forward Neural Network (NN) models**: (5.5 hrs.)
  - multi-layer perceptrons (MLP),
  - MLP classifier,
  - radial basis functions (RBF),
  - conditional density networks (CDN); mixture models

- **7. Nonlinear optimization methods**: Deterministic vs stochastic approaches (2 hrs.)
  - Gradient descent methods
  - Evolutionary computation

- 8. Learning and generalization: (4.5 hrs.)
  - variance & bias errors,
  - regularization, cross-validation, (Bayesian NN),
  - ensemble methods (bootstrapping, boosting),
  - effects of time averaging,
  - regularization of linear models (ridge regression and lasso)

- 9. Tree-based methods: classification and regression trees (CART), random forests (1.5 hrs).

- 10. Forecast verification (1.5 hrs)

- 11. Nonlinear principal component analysis (1 hr)

- 12. Kernel methods (1 hr) [optional material]