Summary of Giannarakis Thesis

# Introduction

Introduction to ASML, not of great importance, large complex machines with time series where causality detection is very useful.

# Theoretical Background

Information theory: Shannon entropy, Mutual Information, Transfer entropy (very similar wording as the book, but shorter / more concise, less details.

Transfer entropy and Granger causality.

Time series, stationarity, examples, etc.

Estimations of density, estimations of parameters using OLS, MLE, likelihood ratio test.

# Entropy Estimators

Estimating entropy:

* Plug-in estimators, correction, also for continuous case.
* Digamma estimator, K-L estimator.

Mutual Information estimator:

* Using entropy estimators,
* Using KSG estimator (SotA).

Transfer Entropy estimators:

* KSG estimator for the MI terms.
* Plug-in estimators.

Non-stationarity:

* Data transformations (differencing / log transforms) to make series stationary.
* Symbolic Transfer Entropy.
* Having multiple realisations of a time-series.
* When increments are stationary, there are some other ways to estimate entropy.

Significance testing:

* Test whether e.g. TE is significantly different from 0.

# Random Walk

AR(1) system, compensated TE (for instantaneous causation).

Non-stationary for a = 1.

When drift is added, TE remains the same.

Transfer entropy with lag = 1 analysed. Analysis of cTE as a function of t, variances, ratio, and b.

Performance of estimator is analyzed, which was good.

# Data

Lorenz system, (Generalized) Hénon map, ASML data.

# Benchmark Framework

# Results

# Conclusion