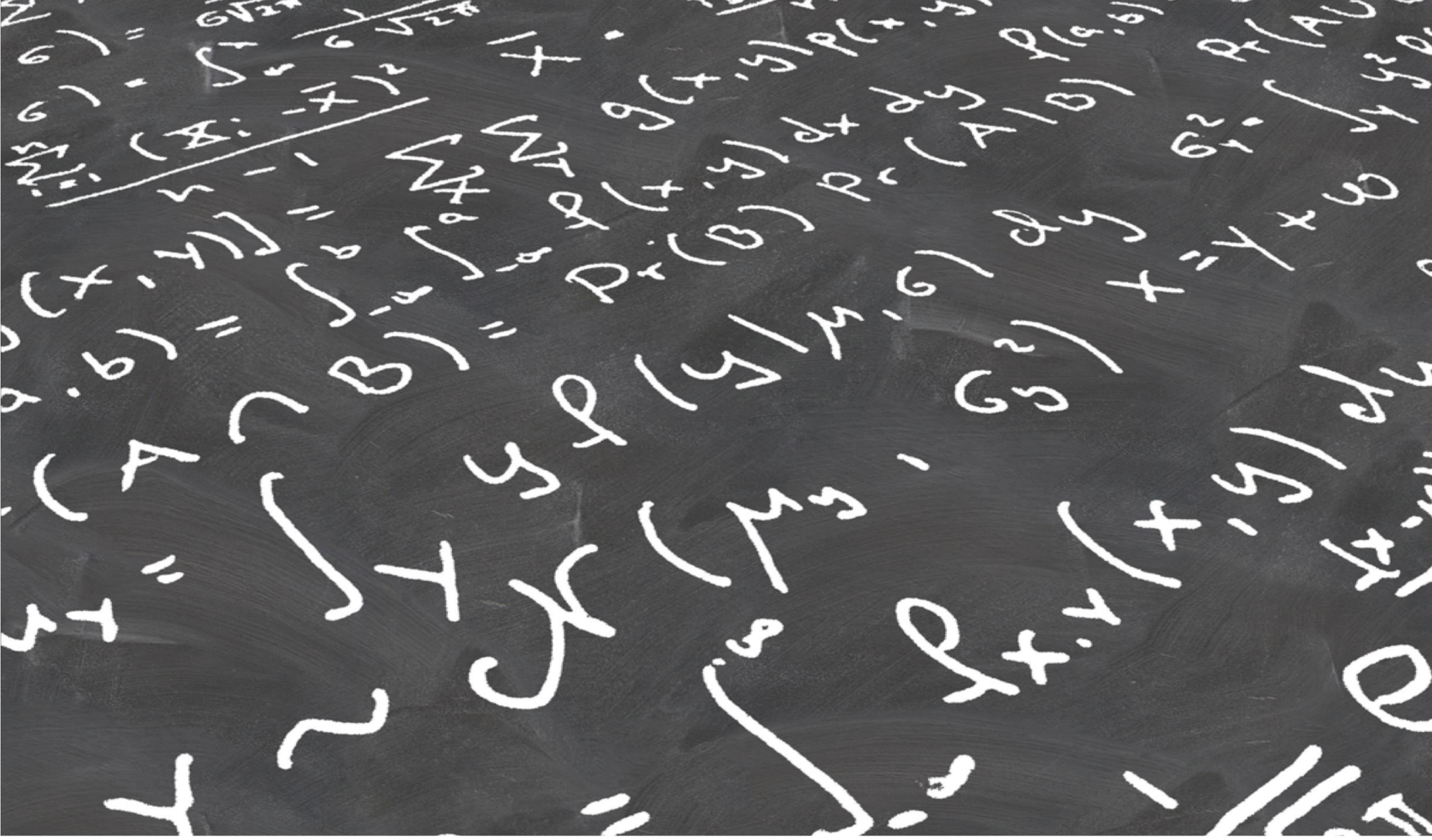
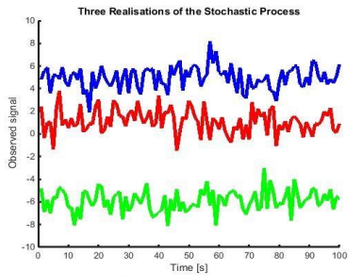


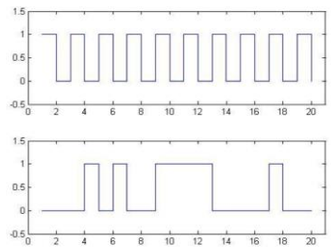
Introduction to Stochastic Modelling and Processes (SMP)

Gunvor Elisabeth Kirkelund
Lars Mandrup

Why Stochastic Modelling and Processes?

- All scientific and engineering work contain some element of randomness
  - How can I get anything out of this noisy signal?
  - How much can I conclude from my measurements?
  - How many tests / size of population do I have to do to validide my system/method/model?
- Stochastic processes is a way to handle and modelling the randomness
- Mandatory if you want to take a master degree





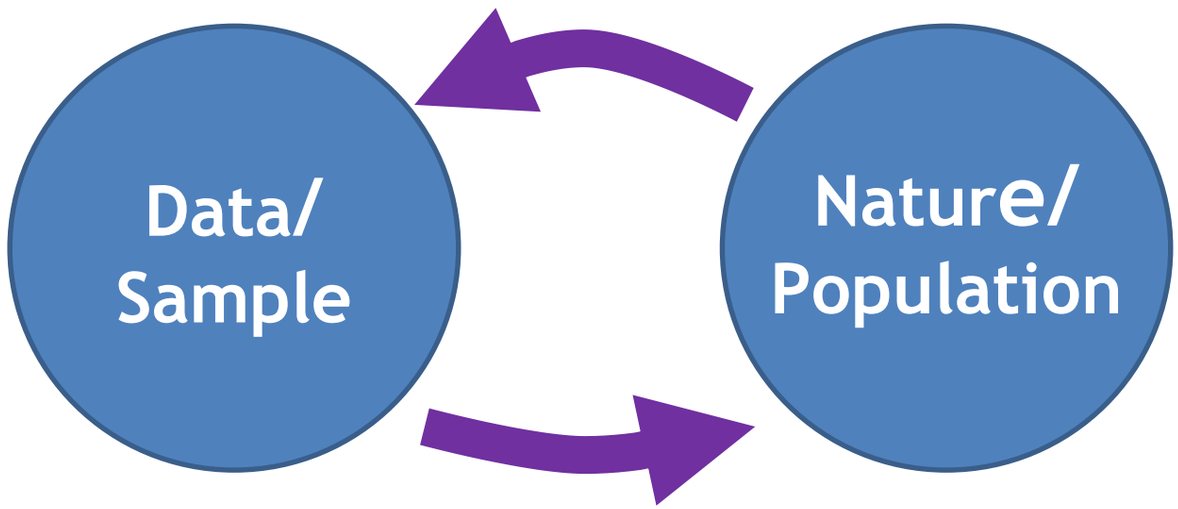
Content of the Course

Probabilistics

- Probability theory ← Without time variable
- Stochastic Processes ← With time variable
- Statistics

- Probability theory tells us what is in the sample given nature.

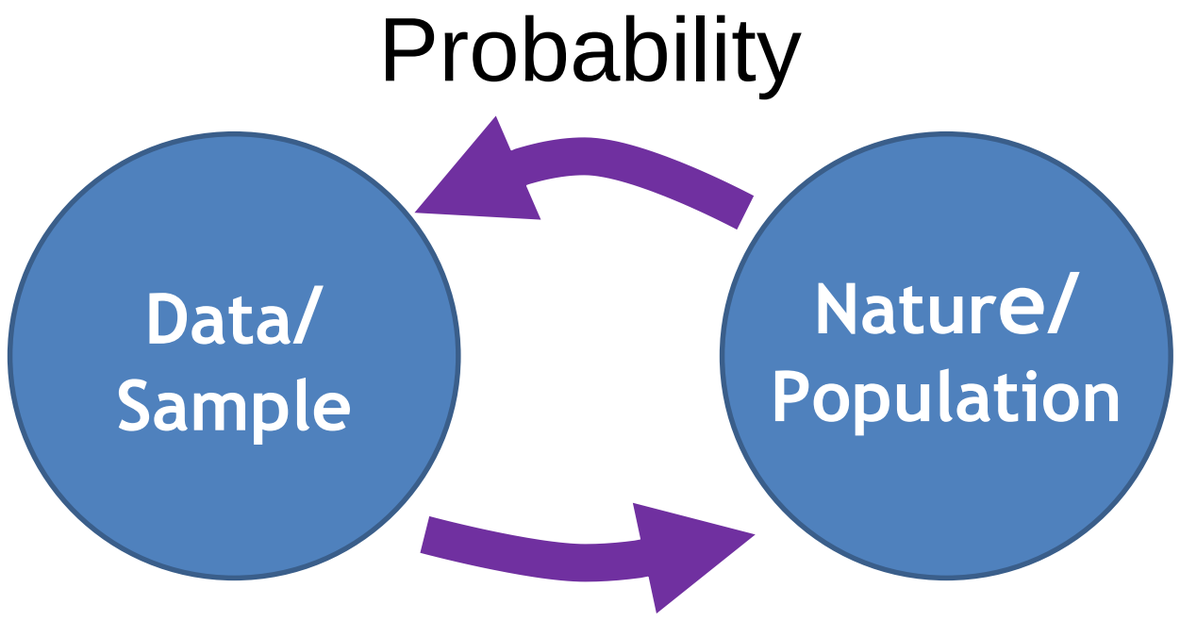
Given a regular dice probability theory can tell me how many times I will get a 6, when I roll the dice 100 times.



- Statistics tells us about nature given the sample.

Rolling an unknown dice 100 times, I 12 times get a 6.
Statistics tell me the nature of the dice (is it regular or not).

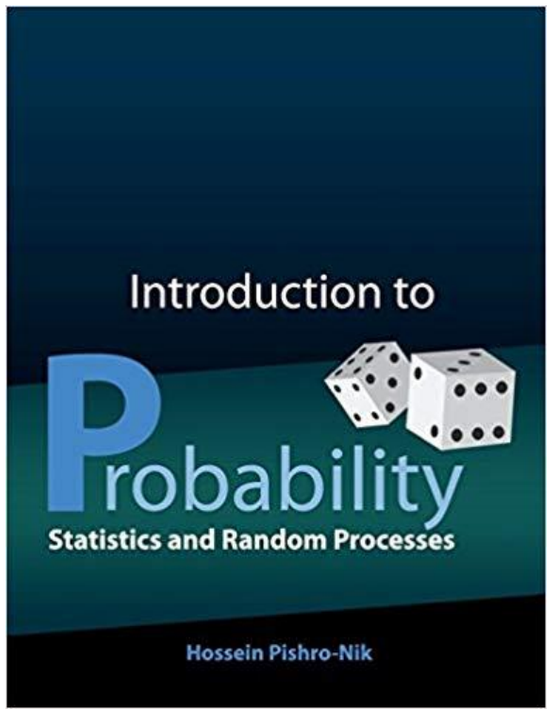
Topics

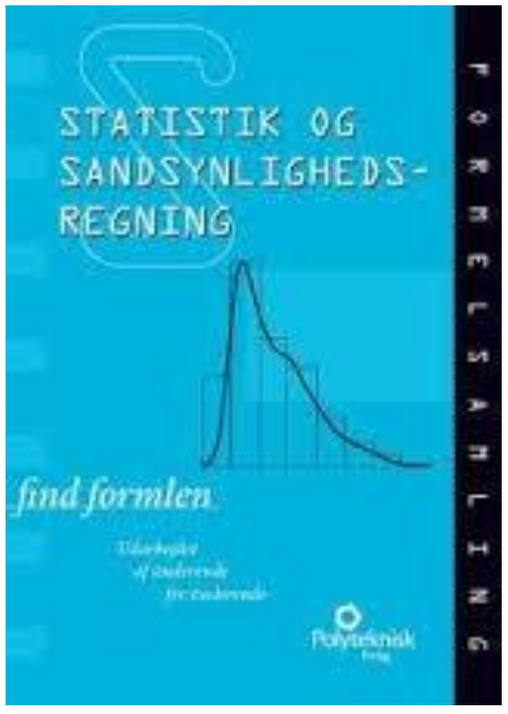


- Probability Theory and Stochastic Processes
  - Basic probability theory
  - Probability distributions
  - Stochastic (random) processes
- Statistics
  - Statistical tests
  - Model estimation
  - Linear regression

Curriculum

- “Introduction to Probability, Statistics and Random Processes”, Hossein Pisho-Nik – free ebook: https://www.probabilitycourse.com/
- “*Statistik og Sandsynlighedsregning - find formlen*”, Polyteknisk Forlag
- Supplerende noter





Course Format

Classroom lectures

- One 4 hours lesson each week in 14 weeks

Exam

- 3 hours written exam

Teachers:

- Lars Mandrup, room 306E, lma@ece.au.dk
- Gunvor Elisabeth Kirkegaard, room 300E, gek@ece.au.dk

Lecture Format

Classroom lectures

- The course will consist of 4 hour classroom lessons each week.

- In the first 2 hours we will give introductions to each topic

- In the second 2 hours you will work in groups to solve different types of Group Assignment problems related to the curriculum.

- As the time during these 4 hour sessions are very limited we expect you to have read the curriculum and solved the introductory assignments before the lecture. Solutions will be provided to all introductory assignments.

What we expect before you begin the course

- Can understand and do basic mathematics (integrate, differentiate, basic functions, …)
- Have a basic knowledge of Matlab
- And have installed Matlab

After the course: Words and Concepts to Know

Probability density function
Binomial coefficient
Cross-covariance
Convolution
Deterministic
Rayleigh Distribution
Deterministic
Intersection
Type I Error
SSS
pdf
Temporal cross-correlation
Cross-correlation
Correlation
Markov chain
Probability Mass Function
i.i.d.
Temporal mean
Continuous random variable
Randomly Sampled Data
Temporal variance
Marginal
Correlation coefficient
Stochastic Processes
Unordered
Mutually Exclusive/Disjoint
Ensemple variance
Uniform distribution
Replacement
Sampling
Non-deterministic
Ergodicity
Sample point
Specificity
Stationarity
Gaussian distribution
Sample space
Central Limit Theorem
Experiment/Trial
cdf
Complement/not
Joint pmf
WSS
Likelihood
Covariance
Simultanious pmf
Independent and Identically Distributed
Event
Relative frequency
Realization
Independence
Union
Correlation coefficient
Normal distribution
Sensitivity
Combinatorics
Bivariate Normal Distribution
Transformation of stochastic variables
Binomial distribution
Joint events
Empty set/Null set
Binomial Mass Function
Standard deviation
Total probability
Strict Sense Stationary
Ordered Set
Conditional probability
Mean
Simultaneous density function
Variance
Bayes Rule
pmf
Ensemple mean
Autocovariance
Type II Error
Autocorrelation Coefficient
Joint density function
Power Spectral Density
Non-deterministic
Stochastic
Posterior
Autocorrelation
Wide Sense Stationary
Bernoulli Trial
Prior
Expectation
Subset
Cumulative Distribution Function
psd
Marginal probability density function

After the course: Words and Concepts to Know

Descriptive statistics
Statistic
Bernoulli Trial
Estimator
Biased/Unbiased
Linear Regression
Heavy
Random Sample Consensus
Left-tailed
Chi-Square Distribution
Paired test
Central Limit Theorem
Population
Null hypothesis
Linear Model
Quantiles
Test catalog
Slope parameter
Sample Correlation Coefficient
Sample variance
Normal approximation
Intercept parameter
Significance Level
Regression Intercept
Inferential statistics
Q-Q plot
Statistical model
Alternative hypothesis
Two-sided t-score
Average rate
Extrapolation
χ_k^2
Confidence Level
Outliers
Test statistics
True mean
Sample mean
Predicted data
Maximum-likelihood
Model Fitting
Slope parameter
Binominal Distribution
Right-tailed
Pooled variance
Students t-distribution
Unpaired test
Residual
Empirical Variance
Comparing two population means
Standard Normal Distribution
Poisson Distribution
Residual plot
z-statistic
Reject
p-value
Inliers
Sample
Chi-Square Test
Two-tailed
Hypothesis test
One-sided
Degrees of freedom
Confidence Interval
Measured data
RANSAC
Sample Size
Critical values
Coefficient of Determinaton
Fail to reject