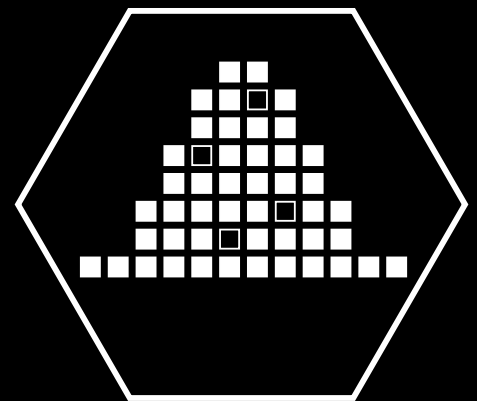# Sampling Fundamentals
Course information sheet 2022-23

Full course, 11 weeks

This course introduces sampling and probability theory with a focus on understanding and application. Using concepts from probability, this course introduces sampling from finite populations and equips learners with an understanding of key fundamentals of sampling including sampling frame, design, error and inference.

Prerequisite Knowledge

Learners should have a basic understanding of mathematics including matrix algebra and calculus. For example, integration and differentiation.

Intended Learning Outcomes
By the end of this course learners will be able to:

- use probability mass functions, probability density functions and cumulative distribution functions in one or more dimensions to compute probabilities and percentiles in particular cases;
- compute moments in one or more dimensions for given distributions and interpret them;
- recognise some of the standard discrete and continuous probability distributions and use them to obtain probabilities, percentiles and moments;
- use the joint distribution of a random vector to derive marginal or conditional distributions;
- determine whether two or more random vectors are independent;
- explain and apply key concepts in large sample theory.
- explain the difference between strategies for sampling in a probabilistic context and discuss advantages and disadvantages of these strategies in a context;
- estimate parameters and their uncertainty in a finite population.

Syllabus

Week 1
- Define sample spaces and sets
- The multiplications principle, permutations and combinations
- Definition and axioms of probability

Week 2
- Conditional probability
- Independence
- Bayes Theorem

Week 3
- Discrete random variables
- Probability mass functions and cumulative distribution functions
- Expectation and variance of discrete random variables
- The Bernoulli, Binomial and Poisson distributions

Week 4
- Bivariate discrete random variables
- The multinomial distribution

Week 5
- Continuous random variables
- Probability density functions
- Expectation and variance of continuous random variables
- Median, percentiles and quantiles

Mid-term week break

Week 6
- The normal distribution
- The uniform and exponential distributions
- Other continuous distributions

Week 7
- Joint bivariate probability density functions
- Marginal distributions
- Conditional distributions
- Independence of random variables

Week 8 (sample material)
- The multivariate normal distribution
- Large sample theory

Week 9
- Introduction to sampling
- Non-probability sampling
- Convenience, quote and systematic sampling

Week 10
- Probability sampling
- Random number generating
- Sampling with and without replacement
- Inference for population characteristics
- Sample size calculations

Week 11
- Stratified sampling
- cluster sampling
- two-stage sampling

"Examples were really good, relevant and easily applied to everyday real world problems"

Online Learning
- Weekly live sessions with tutor(s)
- Weekly learning material (reading material, videos, exercises with model answers)
- Bookable one-to-one sessions with tutor(s)

Textbooks
Tijms, H (2012) Understanding Probability, Cambridge University Press

Dobrow, R (2013) Probability with Applications and R, Wiley

Assessment
(for credit only)

This will typically be made up of 6 pieces of assessment, including online quizze and online class tests.

Software
To take our courses please use an up-to-date version of a standard browser (such as Google Chrome, Firefox, Safari, Internet Explorer or Microsoft Edge) and a PDF reader (such as Acrobat Reader). Learning material will be distributed through Moodle. We encourage all learners to install R and RStudio and we provide detailed installation instructions, but learners can also use free cloud-based services (RStudio Cloud). Learners need to install Zoom for participating in video conferencing sessions. We recommend the use of a head set for video conferencing sessions.

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