csafe
Center for Statistics and Applications in Forensic Evidence

IOWA STATE UNIVERSITY | 195 DURHAM CENTER
613 MORRILL ROAD | AMES, IOWA 50011
FORENSICSTATS.ORG

Self-Study: Introduction to Statistics for Forensic Science Practitioners

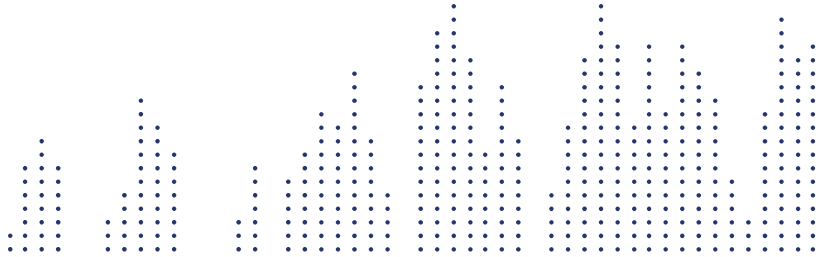
Course Description

Introduction to Statistics for Forensic Science Practitioners is a continuing education course for forensic science practitioners provided by the Center for Statistics and Applications in Forensic Evidence. This course addresses the core concepts related to probability, statistics, and their application to today's forensics issues. You will learn how statistical principles apply the evaluation of evidence, including the assessment of the probative value of the evidence and the range of conclusions that can be derived from forensic analyses.

The emphasis of the course is not on performing statistical analysis but on understanding why statistical ideas must guide the collection, visualization, exploration, analyses, and interpretation of evidence. The instructors will also discuss what can and cannot be concluded from various statistical analyses and how to present results that are supported by statistical findings.

Learning Objectives

1. Understand the differences between populations and samples and methods to make inferences from the sample to the population, and the consequent need for well-designed experiments and surveys.
2. Be able to critically assess the designs used in published scientific papers and their impact on the findings presented by investigators. Students will be asked to evaluate designs, including strengths and weaknesses.
3. Be able to read the course and similar texts to update their knowledge as their need for additional statistical knowledge evolves. Students should be able to identify situations where additional professional statistical help is called for.
4. Be able to calculate minimum sample sizes for basic experimental designs and surveys, and other basic statistics.



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Instructors

Lead Instructor
Alicia Carriquiry, Iowa State University
Distinguished Professor and President's Chair, Iowa State University | Director of CSAFE

Instructional Assistant
Joe Zemmels, Iowa State University

Other Contributors
Naomi Kaplan-Damary, The Hebrew University of Jerusalem
Kiegan Rice, Iowa State University

Course Structure

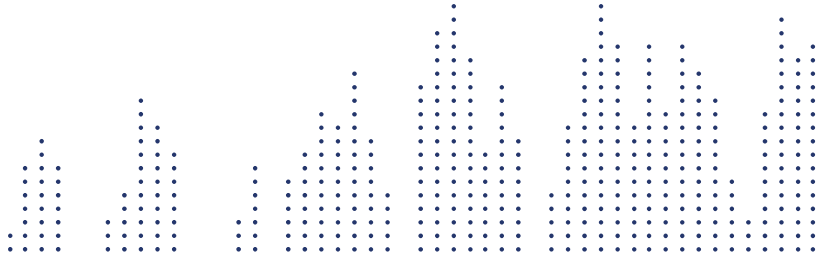
The course is divided into nine sections covering various aspects of probability and statistics and how they apply to forensics. Refer to the course outline below for topics covered in each section. Lectures are provided as recorded videos. Each of the nine sections has between 2-5 lecture videos that are each 45-60 minutes in length. Ungraded quizzes and labs accompany each section to check your understanding and supplement your learning. The final exam will assess your understanding of the course content.

Provided Materials

All course materials are accessible on the course website.
The materials include:
Lecture videos and accompanying slides
Quizzes and solution keys
Excel labs, accompanying .xlsx data files, and solution keys
Enrichment materials (where applicable)

Assessment

Each section has an associated quiz, lab, or both. These are low-stakes assessments intended to check your understanding. They will not be graded, but solution keys are provided.
You may send questions via email to csafelearning@iastate.edu.
The cumulative final exam is the only graded assessment. Those who do not pass the final exam will have an opportunity to study and retake the exam within three (3) weeks of the initial exam period. Certificates will be provided to those who pass the exam.



Quizzes

Apply lecture material to forensics-oriented and other problems. Minimal computation is required.

Focus is on:

1. Understanding how statistics can be used and/or misused.
2. Identifying patterns that can be mathematically or statistically described.
3. Realizing that not all statistical "solutions" are ideal. Solutions are provided on the course website.

Labs

Apply more computationally intensive concepts (formulas, graphing, etc.) using Microsoft Excel.

Focus is on:

1. Developing proficiency with computational tools in Excel.
2. Creating and interpreting various data summaries (numerical, graphical, etc.)
3. Making lecture concepts concrete by using real data. Solutions to conceptual questions & Excel exercises are provided on the course website as two separate files.

Contact Information

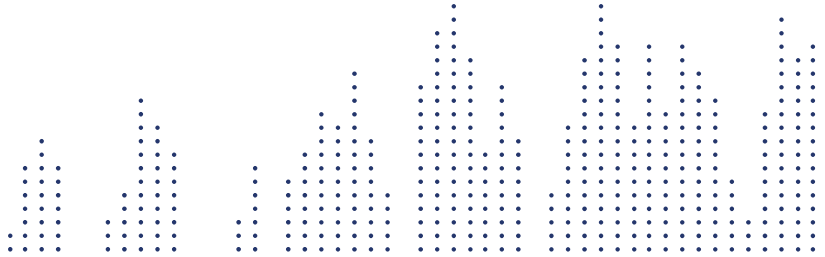
Anthony Greiter, Learning and Development Specialist
Center for Statistics and Applications in Forensic Evidence (CSAFE)
agreiter@iastate.edu
515-294-1561

Software Information

All participants will need access to:

- a computer,
- reliable internet,
- an updated internet browser, and
- Microsoft Excel.

Demonstrations and labs are done using Microsoft Excel; compatibility with another spreadsheet software cannot be guaranteed.



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Course Outline

Section 1: Introduction

Introduces concepts such as the scientific method, statistics as a mathematical science, and the difference between a population and a sample.

a. What is the scientific method?
b. What is statistics?
c. Statistics, forensic practice, and the criminal justice system
d. Populations and samples, deduction and induction, and examples in practice

Section 2: The language of probability

Defines fundamental probability concepts and introduces standard mathematical notation used in probability.

a. Probability: People (CA) v. Collins (1968)
b. What is probability? Some notation and properties
c. Two interpretations of probability
d. Probability and odds
e. Marginal, joint, and conditional probability
f. Independence, the product rule, conditional independence, and State (CT) v. Skipper
g. Bayes' Theorem, the Likelihood Ratio, and prior information

Section 3: Collecting data

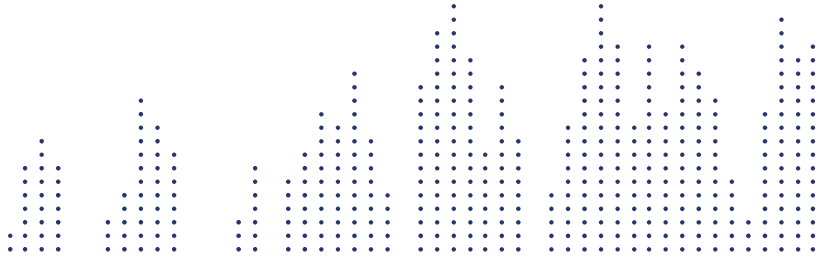
Discusses characteristics of a good sample and sampling design.

a. From probability to inference
b. Collecting data: observational studies, surveys, and experiments
c. Sampling methods: probability versus non-probability sampling
d. Precision, margin of error, and calculation of sample size
e. Experiments and experimental design

Section 4: Types of data

Defines categorical and quantitative data and discusses how they can be visually and numerically summarized.

a. Types of data
b. Visualizing data
c. Summarizing data



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Section 5: Probability models and uncertainty

Introduces concepts related to random variables and defines commonly used probability models.

a. Measurement, variability, and uncertainty
b. Reliability, repeatability, and reproducibility; accuracy and precision
c. Probability distributions, and parameters
d. Probability models for discrete variables
e. Probability models for continuous variables
f. Expectation, variance, covariance, and correlation of variables
g. Propagation of error

Section 6: Inference

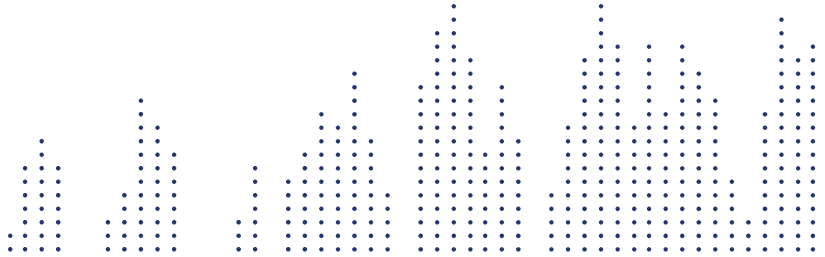
Explores common statistical inference techniques including point and interval estimation and hypothesis testing.

a. Definitions
b. Goals of inference
c. Point estimation, properties of estimators, standard errors, and sampling distributions
d. Interval estimation
e. Hypothesis testing, types of errors, and p-values
f. Difference between two means
g. Equivalence testing
h. Hypothesis testing for proportions
i. Non-parametric tests of hypothesis
j. Discussion of hypothesis testing in the context of forensic practice

Section 7: Regression and analysis of variance

Introduces methods to mathematically describe the relationship between variables including simple linear, multiple linear, and logistic regression.

a. Dependent and independent variables
b. Simple linear regression, least squares estimation, and hypothesis testing for regression coefficients
c. Model diagnostics
d. Beyond simple linear regression
e. Calibration and extrapolation



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Section 8: Analyzing and Interpreting Forensic Evidence

Compares different approaches to analyzing and interpreting forensic evidence including the two-stage approach and the likelihood ratio.

a. Types of evidence and types of forensic questions
b. Logic of forensic examination
c. Expert opinion
d. The two-stage approach
e. Likelihood ratio and Bayes factor

Section 9: Reporting and testimony

Compares and contrasts different approaches to reporting forensic evidence.

a. Likelihood ratio
b. Categorical conclusion
c. Random match probabilities
d. Strength of support statements
e. Source probability statements
f. The prosecutor's fallacy