Statistical Tools for Decision Making

Rosario Barone

Tor Vergata University of Rome

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- Statistics provides tools to analyze data, quantify uncertainty, and make informed decisions.

Understanding Uncertainty

- Uncertainty arises due to incomplete information or randomness.
- Making decisions without considering uncertainty can lead to poor outcomes.
- Statistics helps us quantify and manage uncertainty.

Data-driven Decision Making

- Statistics empowers decision making by analyzing data.
- Data provides insights into patterns, trends, and correlations.
- With data analysis, decisions are based on evidence rather than intuition alone.

What is Statistics?

Statistics is the science of collecting, organizing, analyzing, interpreting, and presenting data.

It provides methods for making sense of data in order to make informed decisions and draw meaningful conclusions.

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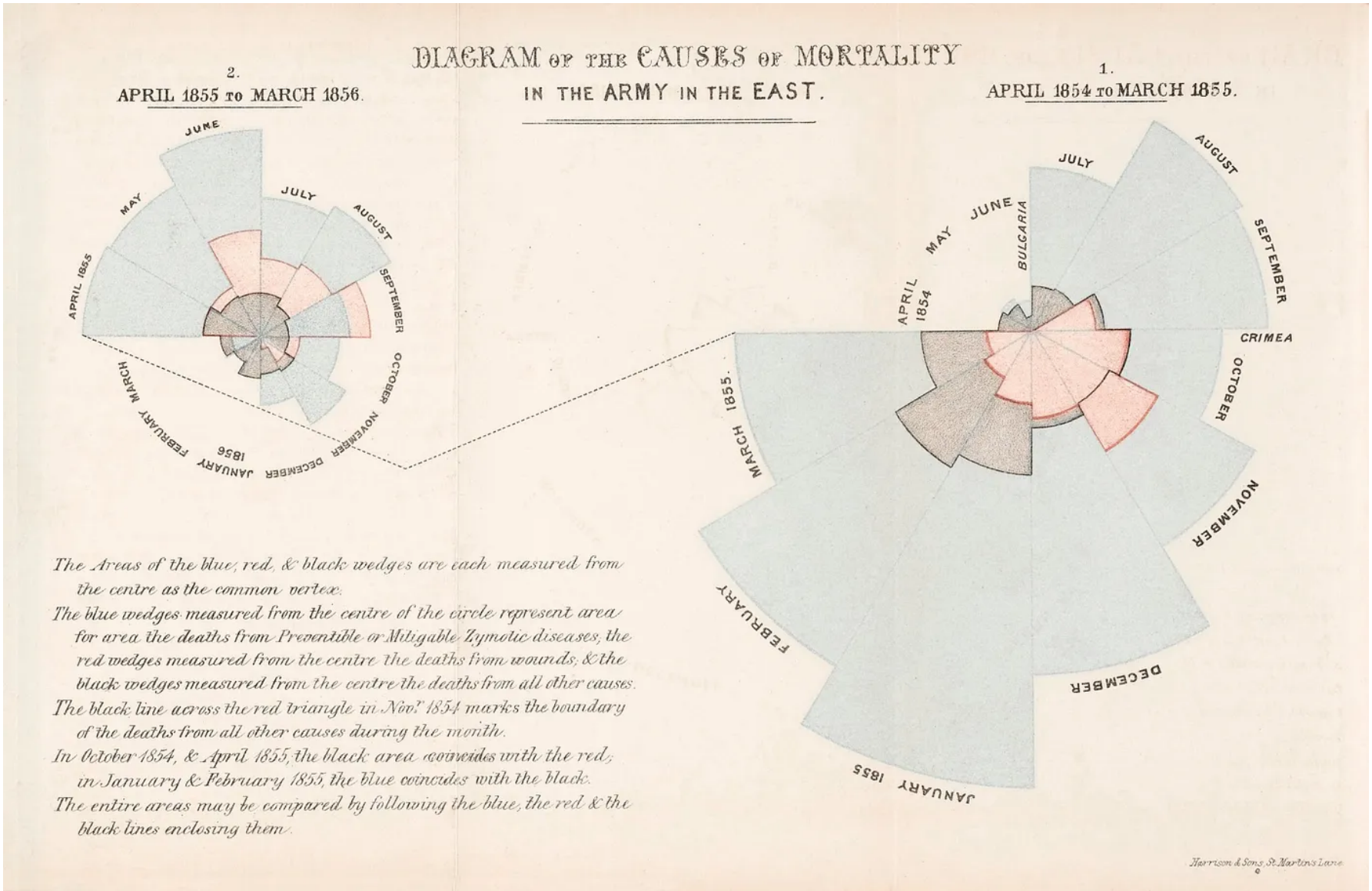
- **Descriptive Statistics:** Methods to summarize and describe data.
- **Inferential Statistics:** Methods to make predictions or inferences about a population based on sample data.

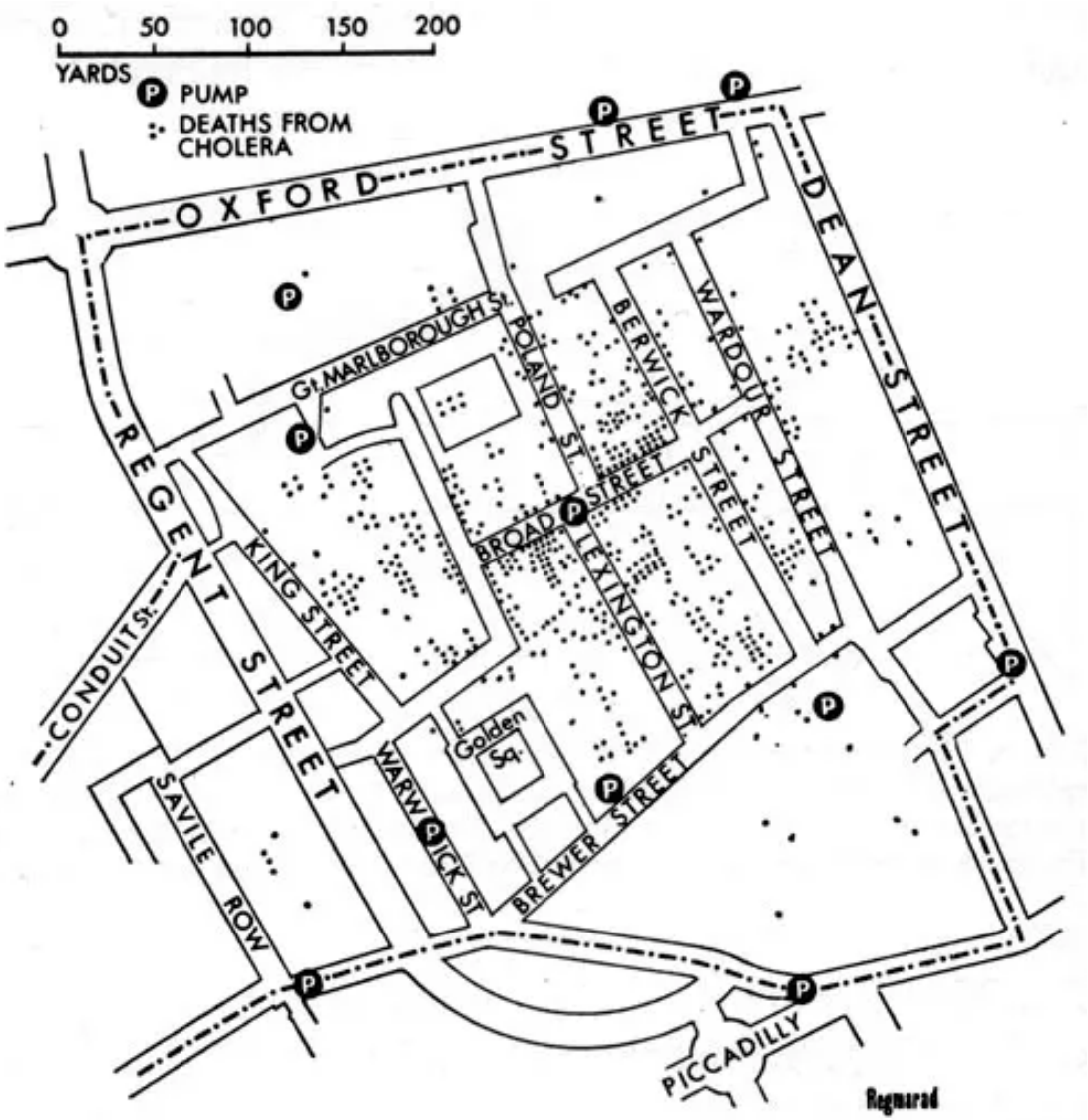
Step by step

1. **Problem Formulation:** Clearly define the research question or problem.
2. **Data Collection:** Gather relevant data using appropriate methods.
3. **Data Cleaning:** Preprocess the data to handle errors, outliers, and missing values.
4. **Data Analysis:** Apply descriptive and inferential statistics to the data.
5. **Interpretation:** Draw conclusions and make inferences based on analysis.
6. **Presentation:** Communicate findings through visualizations and reports.
7. **Decision Making:** Use results to inform decisions and actions.

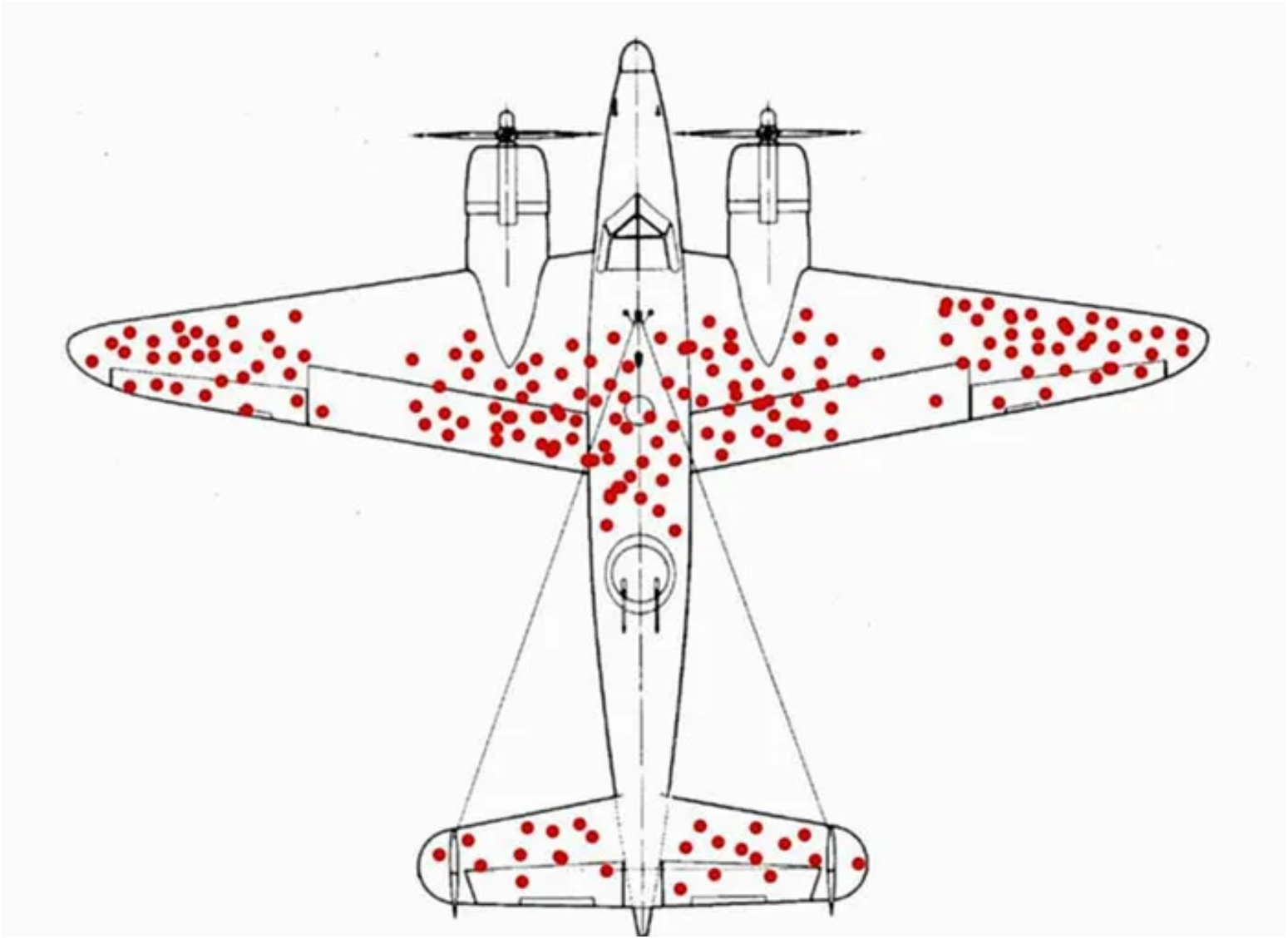
Stats in history: Florence Nightingale



Stats in history: John Snow



Stats in history: Abraham Wald



- **Statistical Methodology**
  - Refers to the theoretical and mathematical framework of statistics.
  - Focuses on the development of statistical techniques and tools.
  - Provides the foundation for analyzing and interpreting data.
  - Is concerned with the "how" and "why" of statistical techniques.
- **Applications of Statistics**
  - Involve the practical use of statistical methods to solve real-world problems.
  - Apply statistical techniques to specific domains and data sets.
  - Examples include economics, healthcare, finance, quality control, and more.
  - Focus on the "what" and "where" of using statistical tools.
  - Address specific questions or challenges within different fields.

Applications: Economics

- Analyzing GDP growth rates to assess economic health.
- Studying inflation rates to predict future price trends.
- Evaluating the impact of minimum wage changes on employment.
- ...

Applications: Finance

- Calculating portfolio returns and risk measures to make investment decisions.
- Analyzing stock price movements to identify trading opportunities.
- Assessing credit risk using credit scoring models.
- ...

Applications: Healthcare

- Conducting clinical trials to test new drugs.
- Analyzing patient data to identify disease trends.
- Calculating mortality rates to evaluate public health interventions.
- Evaluating pandemic diffusion with spatio-temporal models.
- ...

Applications: Education

- Assessing teaching methods' impact on student test scores.
- Analyzing standardized test results for educational improvement.
- Studying graduation rates to evaluate institutions.
- ...

Applications: Marketing

- Conducting market research surveys to understand consumer preferences.
- Analyzing sales data to identify the most popular products.
- Using A/B testing to optimize website design and content for higher conversion rates.
- ...

Applications: Environmental Science

- Tracking climate data to identify long-term trends in temperature and precipitation.
- Analyzing pollution levels in different regions to assess environmental impact.
- Studying wildlife populations to make conservation recommendations.
- ...

Applications: Social Sciences

- Conducting surveys to understand public opinion on political issues.
- Analyzing crime statistics to identify patterns and develop crime prevention strategies.
- Studying income distribution to assess economic inequality.
- ...

Applications: Quality Control

- Monitoring manufacturing processes to ensure product quality.
- Using statistical process control charts to detect deviations from established standards.
- Analyzing customer feedback to identify areas for improvement.
- ...

Applications: Sports

- Analyzing player performance statistics to make team decisions.
- Studying sports performance data to identify areas for improvement in training.
- Calculating odds and probabilities for sports betting.
- ...

Applications: Public Policy

- Analyzing census data to allocate government resources effectively.
- Evaluating the impact of policy changes, such as tax reforms or social programs.
- Studying crime statistics to inform law enforcement strategies.
- ...

Outline of the course

1. **Descriptive statistics**: types of data; graphical representations; means; variability, contingency; correlation; simple linear regression.
2. **Introduction to the statistical software R**: syntax, functions and graphical procedures.
3. **Probability**: introduction to the probability theory and elementary probability rules; random variables; common families of distributions; sampling distributions.
4. **Statistical inference**: point estimation; confidence intervals; hypothesis testing; multiple linear regression. Applications in R.

Assessment

- **Midterm exam**: (written) consisting of theoretical questions and exercises.

- **Final exam**: (oral) theoretical questions, (oral) discussion of statistical exercises, implementations of functions and interpretation of some outputs in R. The final exam of non-attending students will be covering all the topics of the course.