Chapter 1:An Introduction to Business Statistics and Analytics

STAT 2601 – Business Statistics

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Learning Objectives

- Understand the difference between population and sample.
- Distinguish between parameters and statistics.
- Recognize different types of data and how they're collected.
- Classify variables as qualitative or quantitative.
- Identify levels of measurement.
- Differentiate between descriptive and inferential statistics.

Why Statistics in Business?

Real-World Example

A local Ottawa coffee shop wants to know:

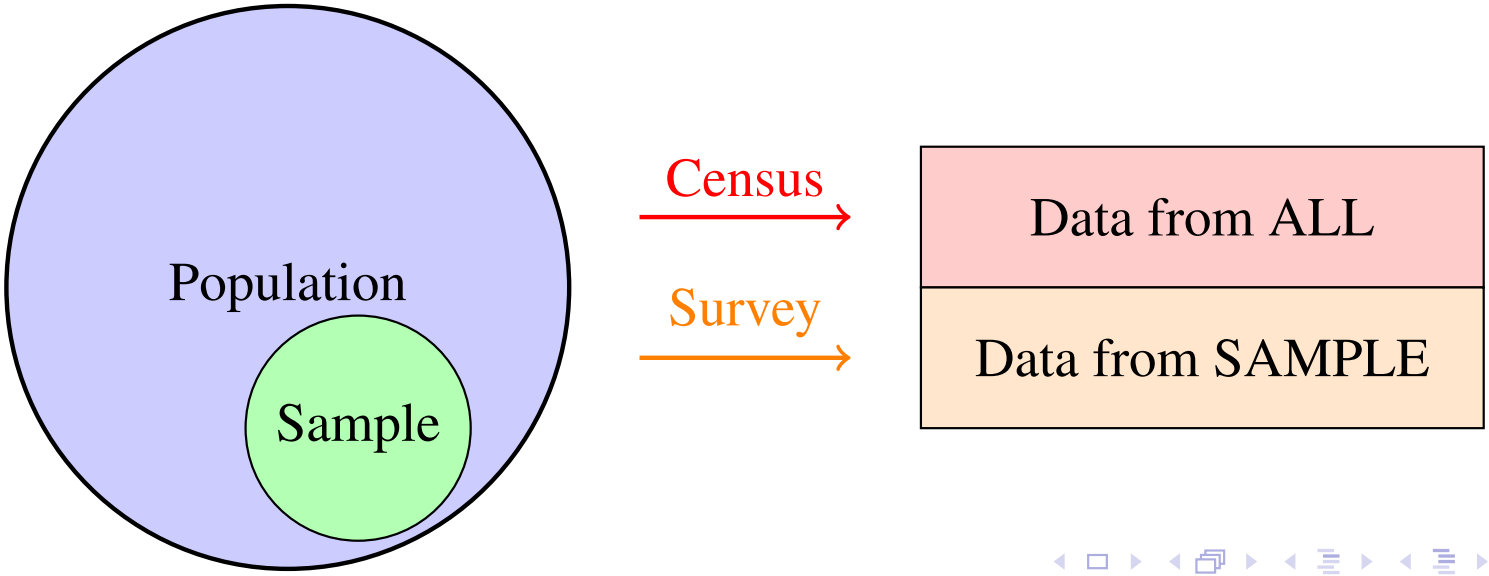
- What percentage of customers prefer oat milk over dairy?
- What's the average daily revenue?
- Which new pastry should they add to the menu?

Statistics helps answer these questions using data!

Population, Sample, Survey, and Census

Key Definitions

- **Experimental Unit:** The smallest entity to which a treatment is applied or from which an observation is made
- **Population:** The complete set of all possible experimental units that you wish to investigate or generalize your findings to
- **Sample:** Subset of the population
- **Survey:** Method of collecting data from a sample
- **Census:** Data collection from the entire population



Population vs Sample: Detailed Comparison

Population

- **Complete set** of all items/individuals
- **Parameter:** Numerical characteristic
- Usually **large** and costly to study
- Often **unknown** in practice
- **Fixed** value for parameters

Sample

- **Subset** of the population
- **Statistic:** Numerical characteristic
- **Smaller** and more manageable
- Used to make **inferences**
- **Varies** between different samples

Carleton University Example

- **Population:** All 25,000 Carleton students
- **Sample:** 500 students randomly selected for a survey
- **Parameter:** True average GPA of all students
- **Statistic = Estimator:** Average GPA of the 500 surveyed students

Survey vs Census: When to Use Which?

Survey (Sample)	Census (Population)
• **Smaller scale**	• **Larger scale**
• **Lower cost**	• **Higher cost**
• **Faster** results	• **Time-consuming**
• **Practical** for large populations	• **Complete** information
• **Sampling error** possible	• **No sampling error**

Real-World Examples

- **Survey:** Polling 1,000 Canadians before federal election
- **Census:** Statistics Canada Census every 5 years
- **Survey:** Customer satisfaction survey at Loblaws
- **Census:** Carleton University counting all registered students each semester

Practical Examples

Example 1: Tim Hortons Customer Preferences

- **Population:** All Tim Hortons customers in Ontario
- **Survey:** Online questionnaire sent to 5,000 randomly selected customers
- **Sample:** The 2,000 customers who responded
- **Census Alternative:** Would require surveying millions of customers - impractical!
- **Result:** 65% of sample prefers local Ontario donuts $\rightarrow$ infer about population

Example 2: Carleton University Budget Planning

- **Population:** All Carleton University employees
- **Census:** Collecting salary data from every single employee
- **Reason for Census:** Required for accurate budget planning, payroll, and reporting
- **Survey Alternative:** Would not provide complete financial picture

Why Use Samples Instead of Census?

Advantages of Sampling

1. **Cost Effective**
2. **Time Efficient**
3. **Practicality**
4. **Accuracy Possible**
5. **Destructive Testing**

When Census is Necessary

1. **Legal Requirements**
2. **Small Populations**
3. **Critical Decisions**
4. **Complete Data Needed**
5. **High Precision Required**

Business Decision Scenario

Problem: Giant Tiger wants to introduce a new product line
Sampling Approach:

- Survey 200 customers in 5 Ottawa stores
- Cost: \$5,000, Time: 2 weeks
- Accuracy: $\pm 5\%$ margin of error

Census Approach:

- Survey all customers (at least 1,000,000)
- Cost: Too much (at least \$1,000,000, Time: 6 months)
- Accuracy: Complete but impractical

Practice: Identify Population, Sample, Survey, Census

Scenario 1: Ottawa Restaurant Chain

"The WORKS" wants to know customer satisfaction. They give feedback cards to every customer for one week.

- Population: _____
- Sample: _____
- Method: Survey or Census? _____

Scenario 2: Statistics Canada

Every 5 years, Statistics Canada collects data from every household in Canada.

- Population: _____
- Method: Survey or Census? _____
- Why census? _____

Scenario 3: Carleton Course Evaluation

At the end of STAT 2601, 100 out of 200 students complete course evaluations.

- Population: _____
- Sample: _____
- Parameter of interest: _____

Summary of Key Concepts

For Business Decisions

- Most business research uses **samples**
- Well-designed surveys provide reliable data
- Census is rare but sometimes necessary
- Always consider cost vs. accuracy trade-off

Statistical Relationships

- **Survey** $\rightarrow$ collects data from **sample**
- **Sample** $\rightarrow$ represents **population**
- **Statistic** $\rightarrow$ estimates **parameter**
- **Census** $\rightarrow$ measures **population** directly

Note: The **experimental unit** is the individual person, object, or item that is independently and randomly assigned to a specific treatment in a statistical study.

Parameter vs Statistic

Parameter

Numerical measure describing a **population characteristic**

- Usually unknown
- Fixed value
- Denoted by Greek letters: μ, σ, σ^2, p

Example: The true average GPA of all Carleton business students (population)

Statistic = Estimator

Numerical measure describing a **sample characteristic** that estimates the population parameter

- Calculated from sample data
- Varies between samples
- Denoted by Roman letters: $\bar{x}$, s, s^2, $\hat{p}$

Example: Average GPA of 200 surveyed business students (sample)

Statistics (The Discipline)

The science of collecting, organizing, analyzing, interpreting, and presenting data.

What are Data?

Definition

Data consists of individual pieces of information, observations, or measurements collected from a population or sample for the purpose of analysis, interpretation, and decision-making.

Examples

- **LCBO:** Daily sales of Ontario ice wine
- **Ottawa Senators:** Ticket sales per game
- **Carleton Bookstore:** Textbook sales by department
- **Canadian Tire:** Seasonal product returns

How are Data Collected?

Primary Data

Collected firsthand for specific purpose

- Surveys/Questionnaires
- Experiments
- Interviews
- Observations

Example: RBC Bank conducting customer satisfaction surveys at their Ottawa branches.

Secondary Data

Collected by others for different purpose

- Government reports (StatsCan)
- Company annual reports
- industry publications
- Previous research

Example: Ottawa tourism statistics from City of Ottawa reports

Qualitative vs Quantitative Variables

Qualitative (Categorical) Variables

Describe a quality or category where arithmetic operations (like addition) do not make sense.

- **Example:** Major of study (Business, Engineering, etc.)
- **Example:** Product color (Red, Blue, Green)
- **Example:** Customer satisfaction (Satisfied, Neutral, Unsatisfied)

Carleton Example: Campus residence (Grenville, Leeds, Frontenac)

Quantitative (Numeric) Variables

Represent measurable quantities where arithmetic operations are valid.

- **Example:** Student's GPA (3.5, 2.8, 4.0)
- **Example:** Daily coffee sales at Tim Hortons
- **Example:** Temperature in Ottawa

Carleton Example: Tuition fees, class sizes, library hours

Quantitative Variables (Discrete vs Continuous)

Discrete

Countable number of values

- Usually counts of things
- Gaps between values
- **Examples:**
  - Number of students in STAT 2601
  - Cars in the Carleton parking lot
  - Goals scored by Ottawa Senators

Continuous

Uncountable, infinite possible values

- Can be subdivided
- No gaps between values
- **Examples:**
  - Time to walk from Tory to River Building
  - Weight of textbooks
  - Temperature in Ottawa

Levels of Measurement

Qualitative Variables

1. **Nominal Level**
   - Used when order makes no difference.
   - **Examples:** Gender (M/F), Citizenship (Canada, USA, France), Place of address.
2. **Ordinal Level**
   - Used when the order is meaningful and must be taken into account.
   - **Examples:**
     - Job Category: 1. Manager, 2. Supervisor, 3. Workers.
     - Qualification: Undergrad, Master, PhD.

Quantitative Variables

1. **Interval Level**
   - Zero is just a point on a scale (arbitrary); it does not mean "nothing."
   - **Example:** Temperature (0° means freezing point, not "no temperature").
   - *Note:* Multiplication/Division do not make sense here.
2. **Ratio Level**
   - Zero is "inherently" zero, meaning "null" or "nothing."
   - **Examples:** Age, Distance, Income, Weight, Grade.
   - *Note:* All arithmetic operations (including multiplication/division) are valid.

Levels of Measurement

Level	Type	Examples
Nominal	Qualitative	• Carleton faculties • Phone brands • Eye color
Ordinal	Qualitative	• Course year (1st, 2nd, 3rd, 4th) • Likert scale (Strongly agree to Strongly disagree) • Restaurant ratings (1-5 stars)
Interval	Quantitative	• **Continuous**: Temperature: 0°C doesn't mean "no temperature" • **Continuous**: IQ scores • **Discrete**: Calendar years
Ratio	Quantitative	• **Continuous**: Height, weight, age, time, distance • **Continuous**: Income, sales, prices: \$0 means "no income" • **Discrete**: Number of pets owned, number of pages in a book

Example: Classify the Variables

Classify each variable as **Qualitative** or **Quantitative**. Then identify its Level of Measurement (**Nominal, Ordinal, Interval, or Ratio**).

1. **Marital Status** (Single, Married, Divorced)
2. **Finishing Position** in a race (1st, 2nd, 3rd)
3. **Current Temperature** in Celsius (25°C)
4. **Number of Students** in a classroom (e.g., 30)
5. **Body Weight** in Kilograms (e.g., 72.5 kg)

Solutions:

1. Qualitative / Nominal (Categories, no inherent order)
2. Qualitative / Ordinal (Ranked, but the distance between 1st and 2nd isn't fixed)
3. Quantitative (Continuous) / Interval (No true zero; 0°C isn't "no heat")
4. Quantitative (Discrete) / Ratio (Countable; 0 means "no students")
5. Quantitative (Continuous) / Ratio (Measurable; 80kg is exactly twice 40kg)

Descriptive vs Inferential Statistics

Descriptive Statistics

Summarize and describe data

- Organize data (tables, graphs)
- Calculate measures (mean, median)
- **What happened?**

Example:

- The average grade in STAT 2601 last semester was 75%
- 60% of surveyed students prefer online lectures

Inferential Statistics

Make conclusions about population from sample

- Estimation
- Hypothesis testing
- **What does it mean?**

Example:

- Based on our sample, we're 95% confident that all Carleton students study between $10 - 15$ hours weekly
- The new teaching method significantly improves grades

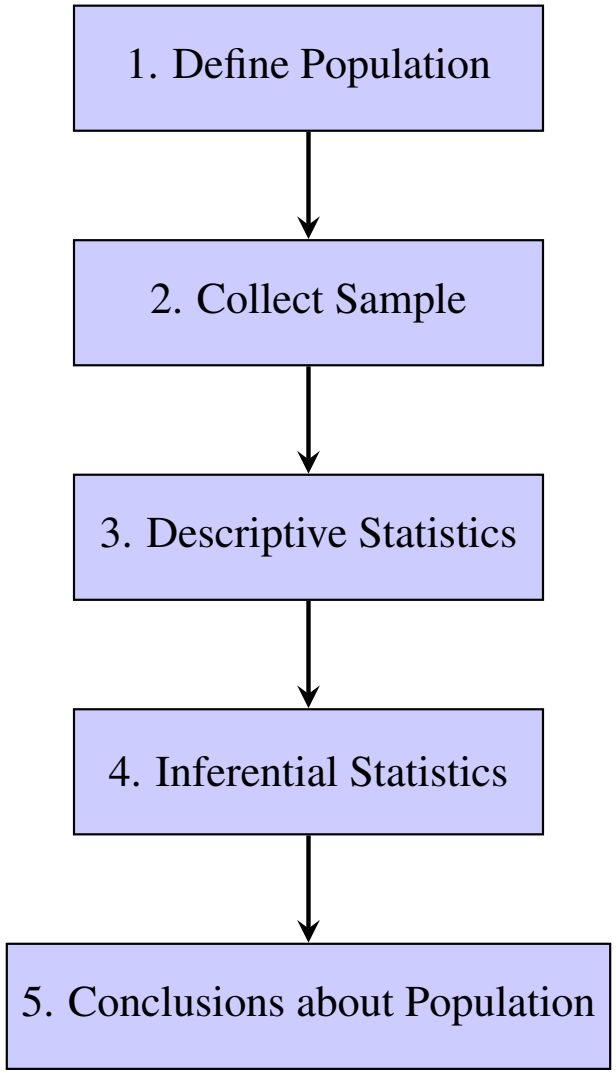
Real-World Application

Scenario: Ottawa Restaurant Chain Expansion

Problem: "Patty's Poutinerie" wants to open a new location near Carleton.
Statistical Approach:

1. **Data Collection:** Survey 300 students about poutine preferences
2. **Descriptive Stats:**
   - 40% prefer classic poutine
   - Average price willing to pay: $8.50
   - Most preferred location: Near residence buildings
3. **Inferential Stats:**
   - We can be 90% confident that true preference for classic poutine among all students is $35 - 45\%$
   - The new location has a 95% chance of being profitable

Summary: The Statistical Process



Statistics transforms raw data into meaningful information for business decision-making!

Practice Questions

Question 1

Carleton's Parking Services wants to know if they have enough spots. They count cars in 20% of lots at 10 AM. Is this population or sample data? What parameter might they estimate?

Question 2

Classify these Carleton-related variables:

- Student ID number
- Number of books borrowed from library
- Program of study
- Time spent in library (hours)
- Course rating (Poor, Fair, Good, Excellent)

Question 3

The Campus Store finds that 70% of 200 surveyed students want more Carleton-branded clothing. Is this descriptive or inferential statistics? How could they use it?