Statistics

Lecture 01: |Introduction

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Intro

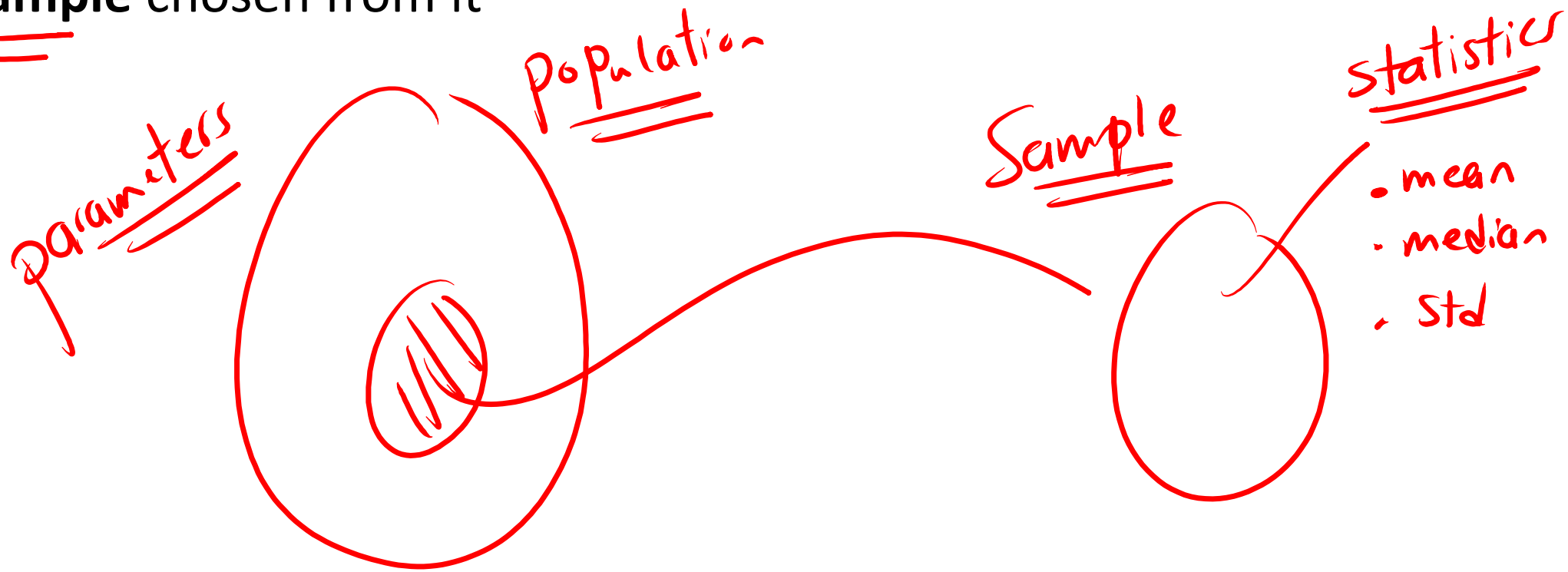
- The **collection and analysis** of data are **fundamental** to science and engineering
- A major difficulty with scientific data is that they are **subject to random variation**, or **uncertainty**.
  - When scientific measurements are repeated, they come out **somewhat differently each time**.
- **How can one draw conclusions**

Intro

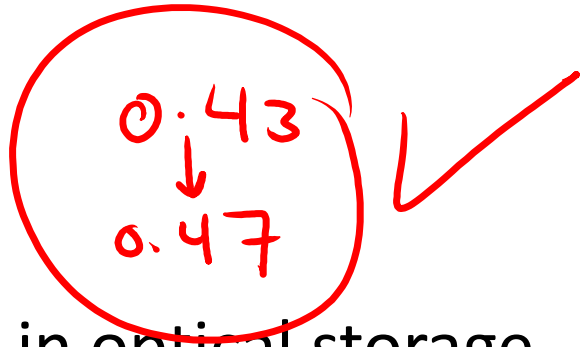
- To address this question, a **knowledge of statistics** is essential.
- **Statistics** is the field of study concerned with the collection, analysis, and interpretation of uncertain data.
- The methods of statistics allow scientists and engineers to **design** valid experiments and to **draw reliable conclusions** from the data they produce

Basic Idea

- The basic idea behind all statistical methods of data analysis is to **make inferences** about a **population** by **studying** a relatively **small sample** chosen from it



Basic Idea



- Consider a machine that makes **steel rods** for use in optical storage devices. The specification for the diameter of the rods is **0.45 ± 0.02** cm.
- During the last hour, the machine has made **1000 rods**. The quality engineer **wants to know approximately how many of these rods meet the specification**.
- He does not have time to measure all 1000 rods. So he draws a **random sample of 50 rods**, measures them, and finds that **46 of them (92%) meet the diameter specification**

$\frac{46}{50} = 92\%$

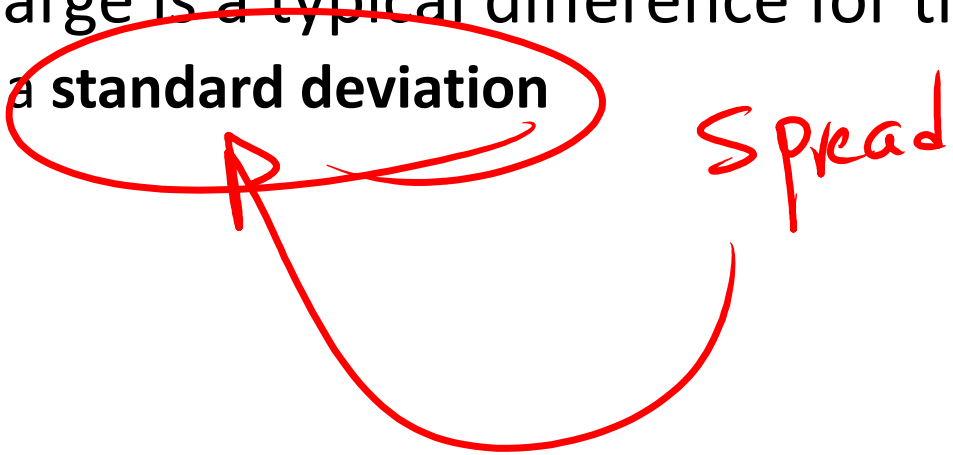
Basic Idea

- Now, it is **unlikely** that the **sample of 50 rods represents** the population of 1000 **perfectly**.
- The **proportion of good rods in the population** is likely to differ somewhat from the sample proportion of 92%.
- What the engineer needs to know is just **how large that difference is likely to be**. For example, is it plausible that the population percentage could be as high as 95%? 98%? As low as 90%? 85%?

Basic Idea

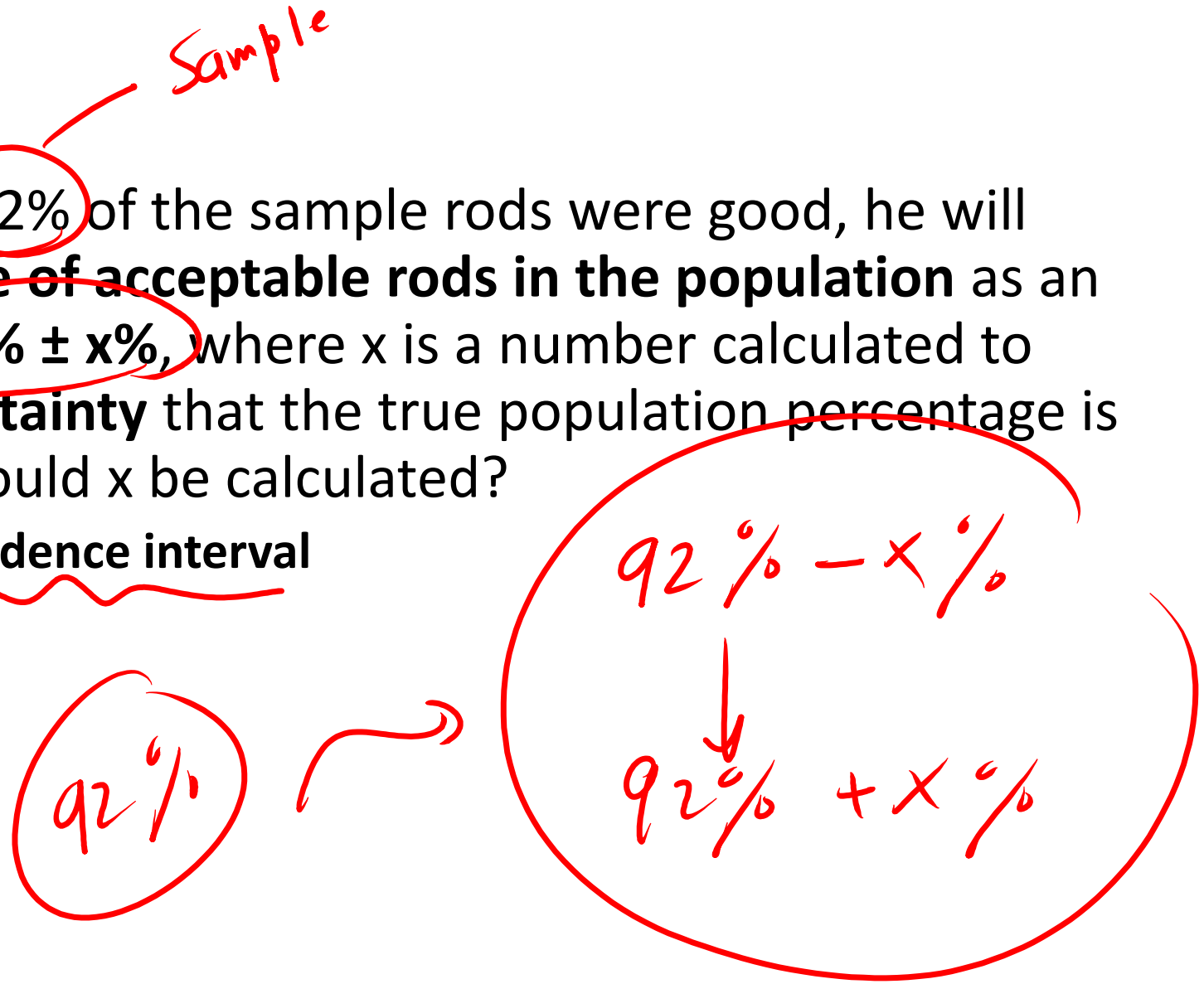
Here are some specific questions that the engineer might need to answer on the basis of these sample data:

- The engineer needs to compute a rough estimate of the likely size of the **difference between the sample proportion and the population** proportion. How large is a typical difference for this kind of sample?
  - Computation of a **standard deviation**



Basic Idea

- Having observed that 92% of the sample rods were good, he will indicate the **percentage of acceptable rods in the population** as an interval of the form **92% ± x%**, where x is a number calculated to provide **reasonable certainty** that the true population percentage is in the interval. How should x be calculated?
  - construction of a **confidence interval**



Basic Idea

- The engineer **wants to be fairly certain** that the **percentage of good rods is at least 90%**; otherwise he will shut down the process for recalibration. **How certain can he be** that at least 90% of the 1000 rods are good?
  - **hypothesis test**

Main course concern

- The topics listed here concern methods of **drawing conclusions from data**.
- These methods form the field of **inferential statistics**
- We must first learn more about methods of **collecting data and of summarizing** clearly the basic information they contain.
- These are the topics of sampling and **descriptive statistics**

To conclude

- A numerical summary of a sample is called a **statistic**.
- A numerical summary of a population is called a **parameter**.
- **Statistics are often used to estimate parameters.**