Statistics

Lecture 04: |Tangible Population – Conceptual Population

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Tangible Populations

- The populations consisted of actual physical objects
  - The students at a university,
  - The concrete blocks in a pile,
  - The bolts in a shipment.
- Such populations are called **tangible populations**. Tangible populations are always finite.
- After an item is sampled, the population size decreases by 1. In principle, one could **in some cases return the sampled item** to the population, with a chance to sample it again, but this is rarely done in practice

Conceptual Population

- **Engineering data** are often **produced by measurements** made in the course of a scientific experiment, rather than by sampling from a tangible population
  - Imagine that an engineer measures the length of a rod five times
- Being as careful as possible to take the **measurements under identical conditions**.
- No matter how carefully the measurements are made, they will **differ somewhat** from one another, because of **variation in the measurement** process that cannot be controlled or predicted

Conceptual Population

- It turns out that it is **often appropriate to consider data like these** to be a **simple random sample** from a population.
- The population, in these cases, consists of all the values that might possibly have been observed.
- Such a population is called a **conceptual population**, since it does not consist of actual objects

Conceptual Population

- A **geologist weighs a rock several times on a sensitive scale**. Each time, the **scale gives a slightly different reading**.
- Under what conditions can these readings be thought of as a **simple random sample**? What is the population?

Conceptual Population

- If the **physical characteristics of the scale remain the same** for each weighing, so that the **measurements are made under identical conditions**, then the readings may be considered to be a **simple random sample**.
- The population is **conceptual**. It consists of all the readings that the scale could in principle produce

Conceptual Population

- A **new chemical process** has been designed that is supposed to produce a **higher yield of a certain chemical** than does an old process.
- To study the yield of this process, we run it **50 times and record the 50 yields**. Under what conditions might it be reasonable to treat this as a **simple random sample**?
- Describe **some conditions under which it might not** be appropriate to treat this as a **simple random sample**

Conceptual Population

- The **population is conceptual** and consists of the set of all yields that will result from this process as many times as it will ever be run.
- What we have done is **to sample the first 50 yields** of the process.
- If, and only if, we are confident that **the first 50 yields are generated under identical conditions**, and that they do not differ in any systematic way from the yields of future runs, then we may treat them as a **simple random sample**

Conceptual Population

- There are **many conditions under which the 50 yields could fail to be a simple random sample**.
- For example, with chemical processes, it is sometimes the case that **runs with higher yields tend to be followed by runs with lower yields**, and vice versa.
- Sometimes **yields tend to increase over time**, as process engineers **learn from experience** how to run the process more efficiently.
- In these cases, the **yields are not being generated under identical conditions** and would **not** be a **simple random sample**

Conceptual Population

- The **last example** shows once again that a **good knowledge of the nature of the process under consideration** is important in deciding whether **data may be considered to be a simple random sample**.
- **Statistical methods** can sometimes be used to show that a given data set is not a simple random sample.
- For example, sometimes experimental conditions gradually change over time.
- A simple but effective method to detect this condition is to **plot the observations in the order they were taken**.
- A **simple random sample** should **show no obvious pattern or trend**

Conceptual Population

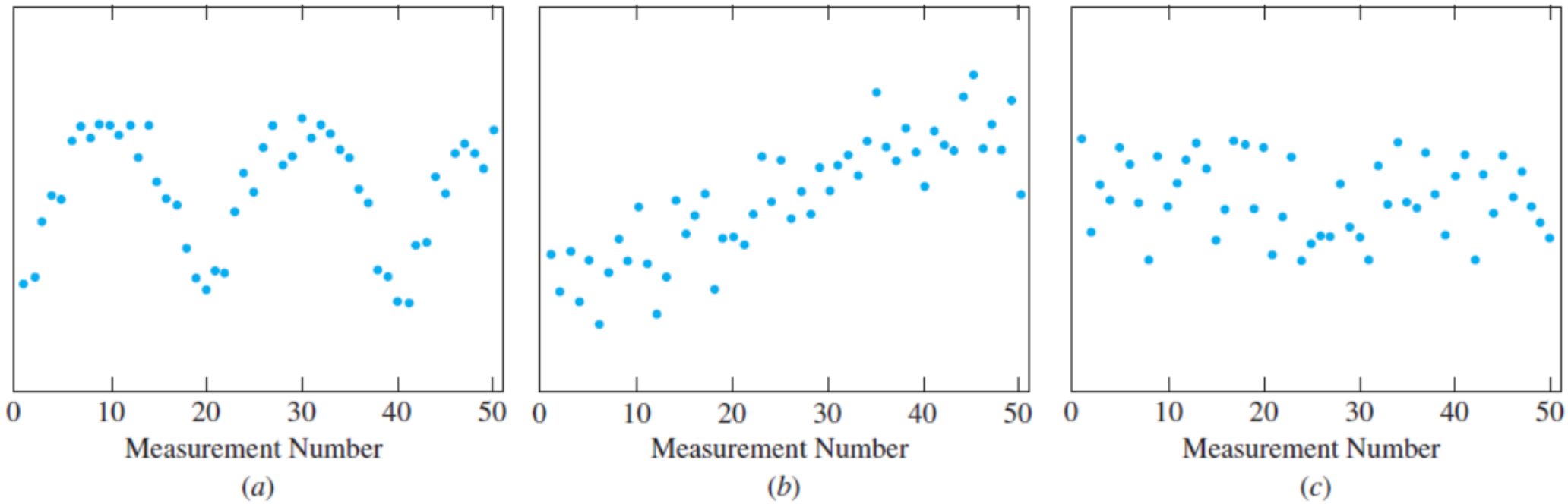

FIGURE 1.1 Three plots of observed values versus the order in which they were made. *(a)* The values show a definite pattern over time. This is not a simple random sample. *(b)* The values show a trend over time. This is not a simple random sample. *(c)* The values do not show a pattern or trend. It may be appropriate to treat these data as a simple random sample.

Conceptual Population

- The **plot in Figure 1.1c does not appear to show any obvious pattern** or trend. It might be **appropriate to treat** these data as a **simple random sample**.
- **However**, before making that decision, it is still important to **think about the process that produced the data**, since there may be concerns that don’t show up in the plot
- The **next Example** is one case in which a **plot can look good**, yet the **data are not a simple random sample**.

Conceptual Population

- A new chemical process is **run 10 times each morning for five consecutive mornings**. A plot of yields in the order they are run **does not exhibit any obvious pattern** or trend.
- If the new process is put into production, it will be run **10 hours each day, from 7 A.M. until 5 P.M**. Is it reasonable to consider the 50 yields to be a simple random sample?
- What if the process will always be run in the morning?

Conceptual Population

- The sample is **drawn only from that portion of the population that consists of morning runs**, and thus it is **not a simple random sample**.
- There are many things that could go wrong if this is used as a simple random sample. For example, **ambient temperatures may differ** between morning and afternoon, which could affect yields
- **If the process will be run only in the morning**, then the population consists only of morning runs. Since the **sample does not exhibit any obvious pattern or trend**, it might well be appropriate to consider it to be a **simple random sample**