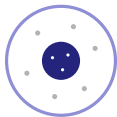


Collecting Data

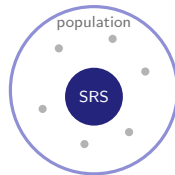
AP Statistics ■ Unit 3

AP Statistics



What we will cover

- 1 Trusting the data
- 2 Observational vs experiment
- 3 Random sampling
- 4 When sampling goes wrong
- 5 Designing experiments
- 6 Scope of inference



1

Trust

Trusting the data

The *method* of collection decides what we may claim. We study a **sample** 样本 to learn about a **population** 总体; **bias** 偏差 tilts a sample systematically off the truth.

UNDERCOVERAGE

some of the population
can never be chosen

*phone survey misses
homes without phones*

NONRESPONSE

chosen people do not
answer

*busy people ignore
the questionnaire*

RESPONSE BIAS

answers are not
accurate

*a leading question;
lying about homework*

Good data comes first – a clever calculation cannot rescue a badly collected sample.

2

Observational

Observational vs experiment

- an **observational study** 观察性研究 watches – shows only **association** 关联
- an **experiment** 实验 applies a **treatment** 处理 – can prove **cause** 因果关系

A **confounding variable** 混杂变量 tied to both explanatory and response is why observation can't claim cause.



Random assignment, for example by die roll, makes a study an experiment

3

Sampling

Random sampling

Let **chance**, not the researcher, choose – four random designs:

SRS 简单随机抽样: every group of n equally likely

Stratified 分层: SRS within similar **strata** 层

Cluster 整群: pick whole **clusters** 群

Systematic 系统: every k -th individual

Random selection lets us **generalize** 推广 the sample result to the whole population.

4

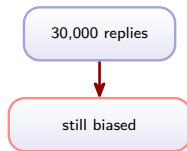
Wrong

When sampling goes wrong

Even a “random” plan can bias:

- **undercoverage** 覆盖不足: groups left out
- **voluntary response** 自愿回应: only strong feelings
- **nonresponse** 无回应, **response bias** 回应偏差, wording

A bigger sample does not fix bias –
it just makes a bigger biased sample.
Method beats size.



SRS of 1000 beats it

5

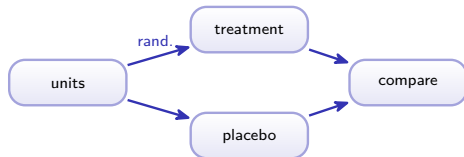
Experiments

Designing experiments

Three principles:

- **control** 控制: hold other variables equal
- **randomization** 随机化: balances unknowns
- **replication** 重复: many units per treatment

A **placebo** 安慰剂 + **double-blind** 双盲 design separate the real effect from belief.



6

Scope

Scope of inference

Two uses of randomness set what you may claim:

- random **assignment** 随机分配
⇒ cause
- random **selection** 随机选择
⇒ generalize

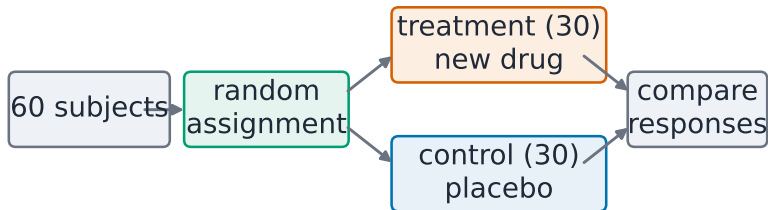
Blocking 区组化 / **matched pairs** 配对设计 remove a known source of variability.

assign: no assign: yes

cause, these only	cause + generalize
assoc., these only	assoc., generalize

select: no select: yes

Designing an Experiment



random assignment → causal comparison of responses

A completely randomized experiment compares a treatment group with a control group

Designing an experiment

confounding 混杂

another variable is tied to the treatment, so their effects **cannot be separated**

random assignment

the cure – it balances *all* other variables, known and unknown, across the groups

a control group

gives something to compare against; a placebo controls for expectation

single-blind 单盲

the subject does not know which treatment they received

double-blind

neither the subject **nor the person measuring** knows

replication

enough subjects per group that chance differences are small

Random **sampling** lets you generalise to the population; random **assignment** lets you claim causation. The two do different jobs, and the exam asks which you have.

Choosing the Right Design

Match the design to the goal: use a **completely randomized design** for uniform subjects; a **randomized block design** when a known variable (sex, age) affects the response.

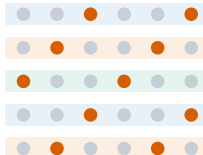
State how you would carry out the randomization.

Four random sampling designs

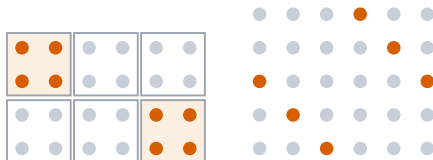
simple random



stratified



clustersystematic (every 5th)



SRS: equal chance · stratified: sample within groups ·
 cluster: take whole clusters · systematic: every k th

Four random sampling designs: who gets selected, and how

The sampling methods, and the biases

a simple random sample 简单随机样本

every group of n individuals is equally likely – the standard against which the others are judged

stratified

split into groups, then sample within each – more precise when the groups differ

cluster

sample whole groups – cheaper, and less precise

a convenience sample 方便样本

whoever is easy to reach – **biased**, and never acceptable

response bias 回应偏差

people answer **inaccurately** – bad wording, or a sensitive topic

non-response bias

the people who do not reply differ from those who do

An **observational study** 观察性研究 measures without intervening, so it can show **association** only. Only a randomised experiment supports a causal claim.

Exam tips

- Distinguish an **observational study** (finds association) from an **experiment** (can show causation).
- Good sampling is **random** (SRS, stratified, cluster) – beware bias (voluntary response, undercoverage, nonresponse).
- Good experiments use **control, randomization, and replication**; blocking handles a known nuisance variable.
- Only a randomized experiment supports a cause-and-effect conclusion.
- Name the population, sample, and any confounding clearly.

7

Recap

Worked example – spotting the bias

A school emails a survey to all students; 80 of 1000 reply, and 70 say they want a later start. Identify the flaw.

- Everyone **could** reply, so this is a **voluntary response** sample, not a random one.
- Only students who **care strongly** bother – and those wanting a later start care most.
- So the 87.5% is **biased upward**; you cannot generalise to all 1000.
- Fix: take a **simple random sample** and follow up non-responders $\Rightarrow$ a **representative estimate**.

Name the bias and say **which direction** it pushes the estimate – that is where the marks are. A big sample does **not** fix bias; only good **selection** does.

Unit 3 – key takeaways

1

Study type

observation shows association;
experiment proves cause

2

Sampling

SRS, stratified, cluster, system-
atic; bias $\neq$ fixed by size

3

Experiments

control, randomize, replicate;
placebo + blinding

4

Scope

assignment $\rightarrow$ cause; selection $\rightarrow$
generalize

Check yourself

- 1 Which study type can prove cause and effect?
- 2 What sampling method takes an SRS within each stratum?
- 3 Does a larger sample remove bias?
- 4 What must be random to generalize to a population?

cause	both
assoc.	gen.

Answers 1. a randomized experiment 2. stratified 3. no 4. random selection