PROBABILITY SAMPLING: CONCEPTS AND TERMINOLOGY

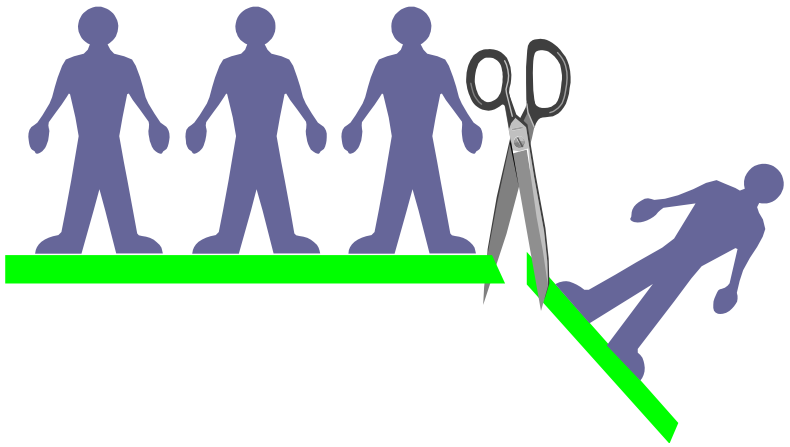
Selecting individual observations to most efficiently yield knowledge without bias

What is sampling?

- If all members of a population were identical, the population is considered to be ***homogenous***.

- That is, the characteristics of any one individual in the population would be the same as the characteristics of any other individual (little or no variation among individuals).

So, if the human population on Earth was homogenous in characteristics, how many people would an alien need to abduct in order to understand what humans were like?



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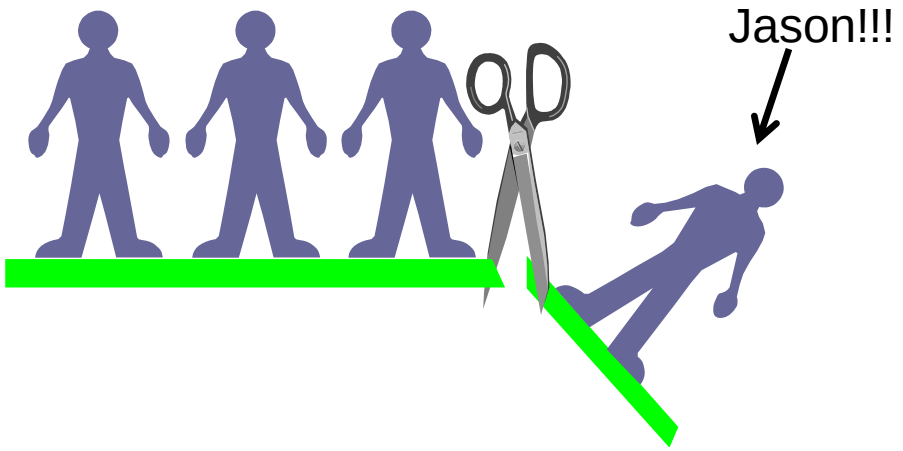
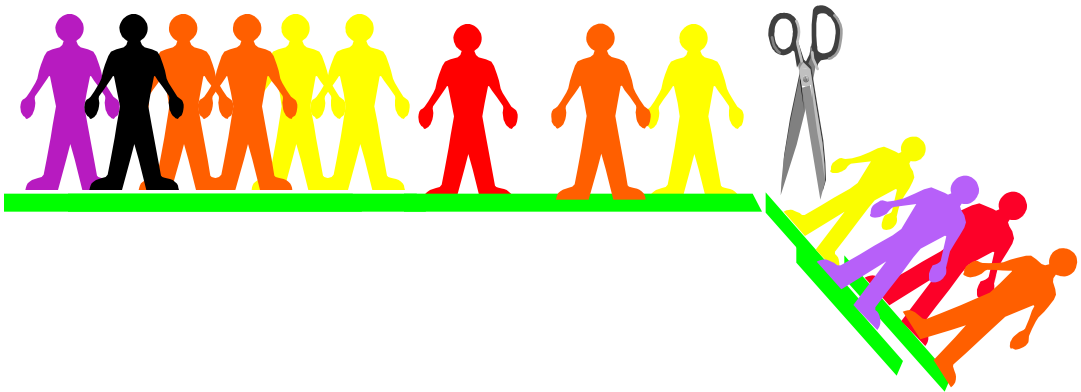


What is sampling?

- When individual members of a population are different from each other, the population is considered to be ***heterogeneous*** (having significant variation among individuals).
- How does this change an alien's abduction scheme to find out more about humans?
- In order to describe a heterogeneous population, observations of multiple individuals are needed to account for all possible characteristics that may exist.



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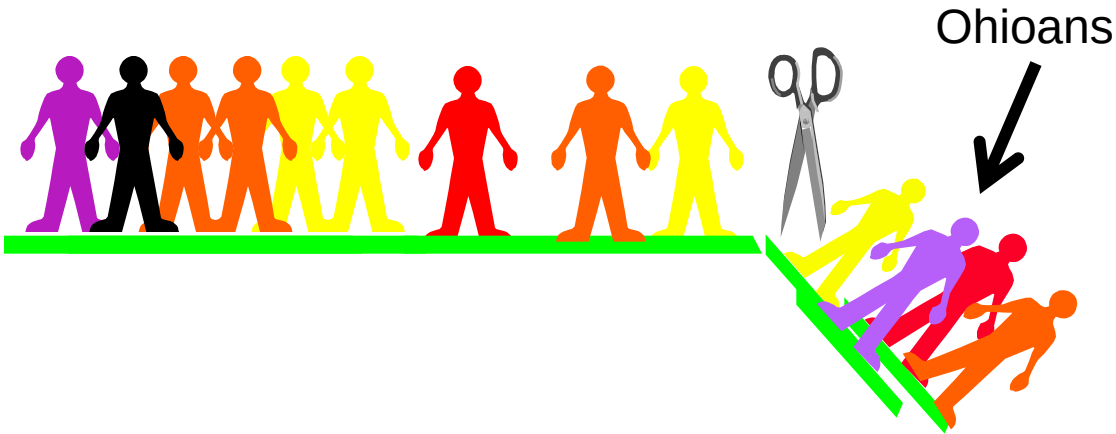

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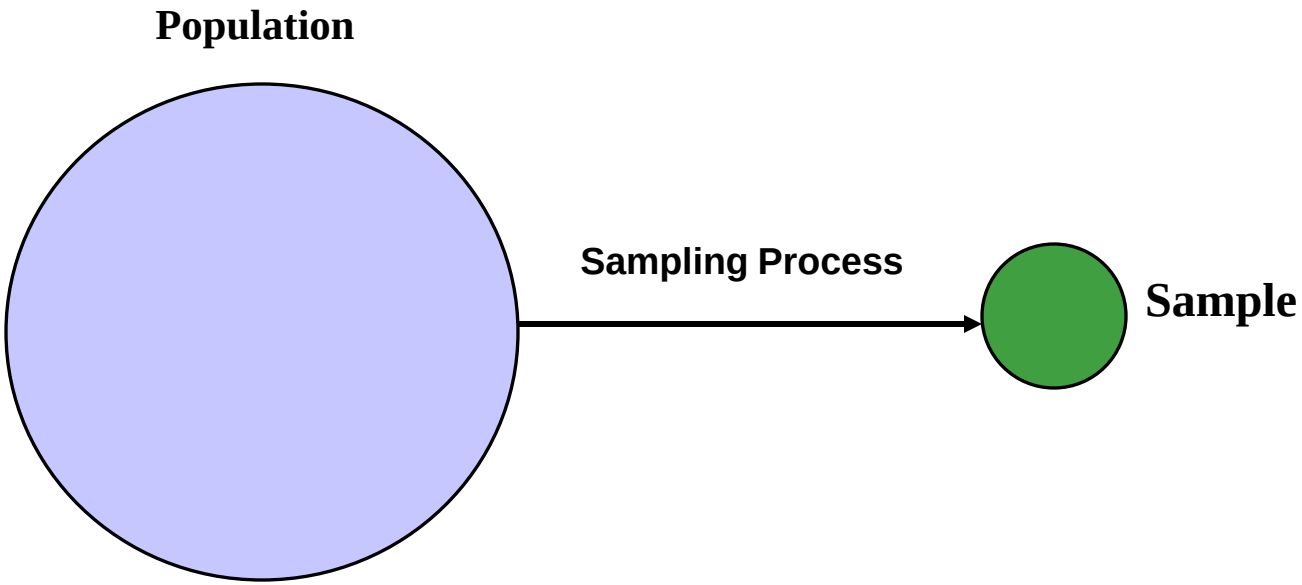

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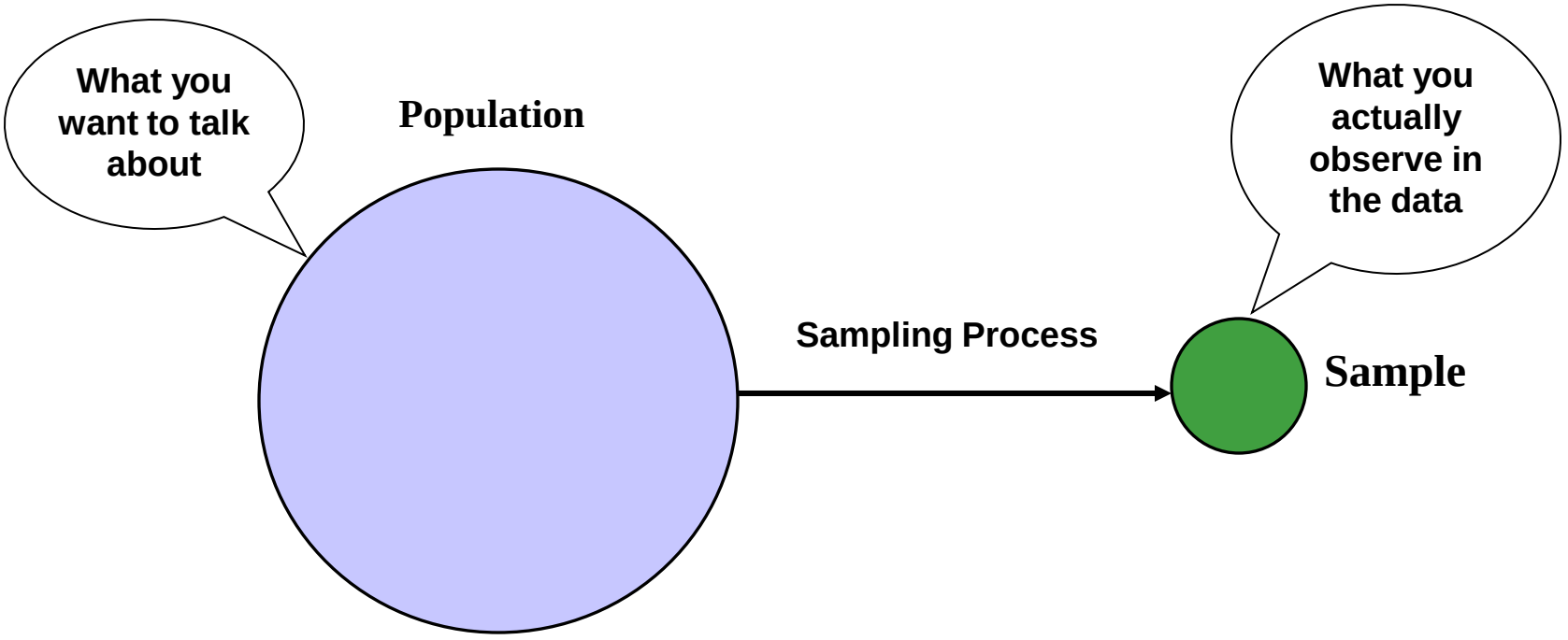

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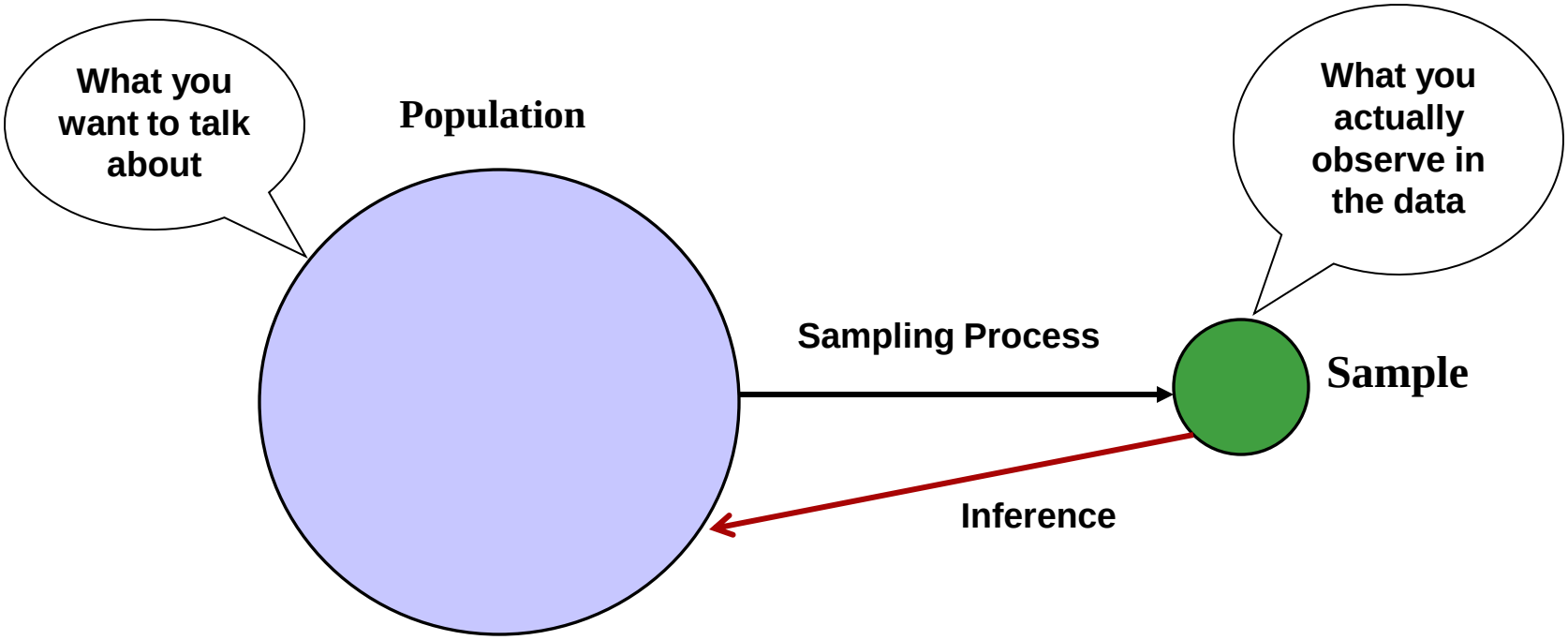
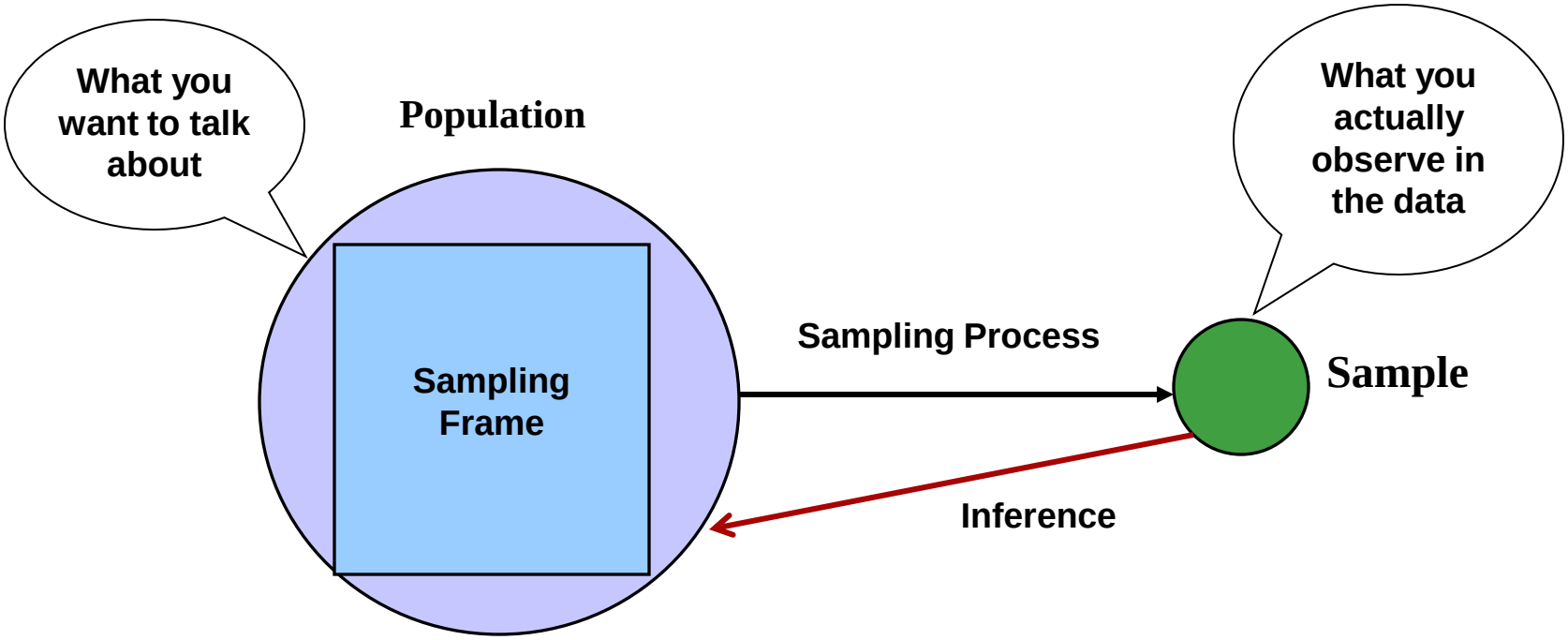


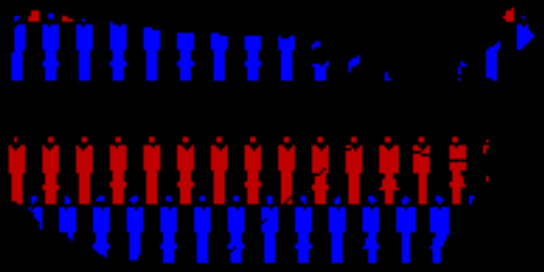
Using data to say something (*make an **inference***) with confidence, about a whole (population) based on the study of a only a few (sample).

What is Sampling?



Using data to say something (*make an **inference***) with confidence, about a whole (population) based on the study of a only a few (sample).

Who do you want to generalize to?



The Theoretical Population

What population can you get access to?

The Study Population

How can you get access to them?

The Sampling Frame

Who is in your study?

The Sample

What is sampling?

- If a sample of a population is to provide useful information about that population, then the sample must contain essentially the same variation as the population.

- ***The more heterogeneous a population is…***
  - The greater the chance is that a sample may not adequately describe a population→ we could be wrong in the inferences we make about the population.

- ***And…***
  - The larger the sample needs to be to adequately describe the population→ we need more observations to be able to make accurate inferences.

What is Sampling?

- Sampling is the process of selecting observations (a sample) to provide an adequate description and robust inferences of the population
  - The sample is ***representative*** of the population.

- There are 2 types of sampling:
  - Non-Probability sampling (Next Tuesdays' lecture)
  - Probability sampling

Probability Sampling

- A sample must be representative of the population with respect to the variables of interest.
- A sample will be representative of the population from which it is selected if each member of the population has an equal chance (probability) of being selected.
- Probability samples are more accurate than non-probability samples
  - They remove conscious and unconscious sampling bias.
- Probability samples allow us to estimate the accuracy of the sample.
- Probability samples permit the estimation of population parameters.

The Language of Sampling

- ***Sample element:*** a case or a single unit that is selected from a population and measured in some way—the basis of analysis (e.g., an person, thing, specific time, etc.).

- ***Universe:*** the theoretical aggregation of all possible elements—unspecified to time and space (e.g., University of Idaho).

- ***Population:*** the theoretical aggregation of *specified* elements as defined for a given survey defined by time and space (e.g., UI students in 2009).

- ***Sample or Target population:*** the aggregation of the population from which the sample is actually drawn (e.g., UI in 2009-10 academic year).

- ***Sample frame:*** a specific list that closely approximates all elements in the population—from this the researcher selects units to create the study sample (Vandal database of UI students in 2009-10).

- ***Sample:*** a set of cases that is drawn from a larger pool and used to make generalizations about the population

Variable

response

1 2 3 4 5

Statistic

sample

Mean = 3.75

Parameter

population

Average = 3.72

Variable

1 2 3 4 5

This

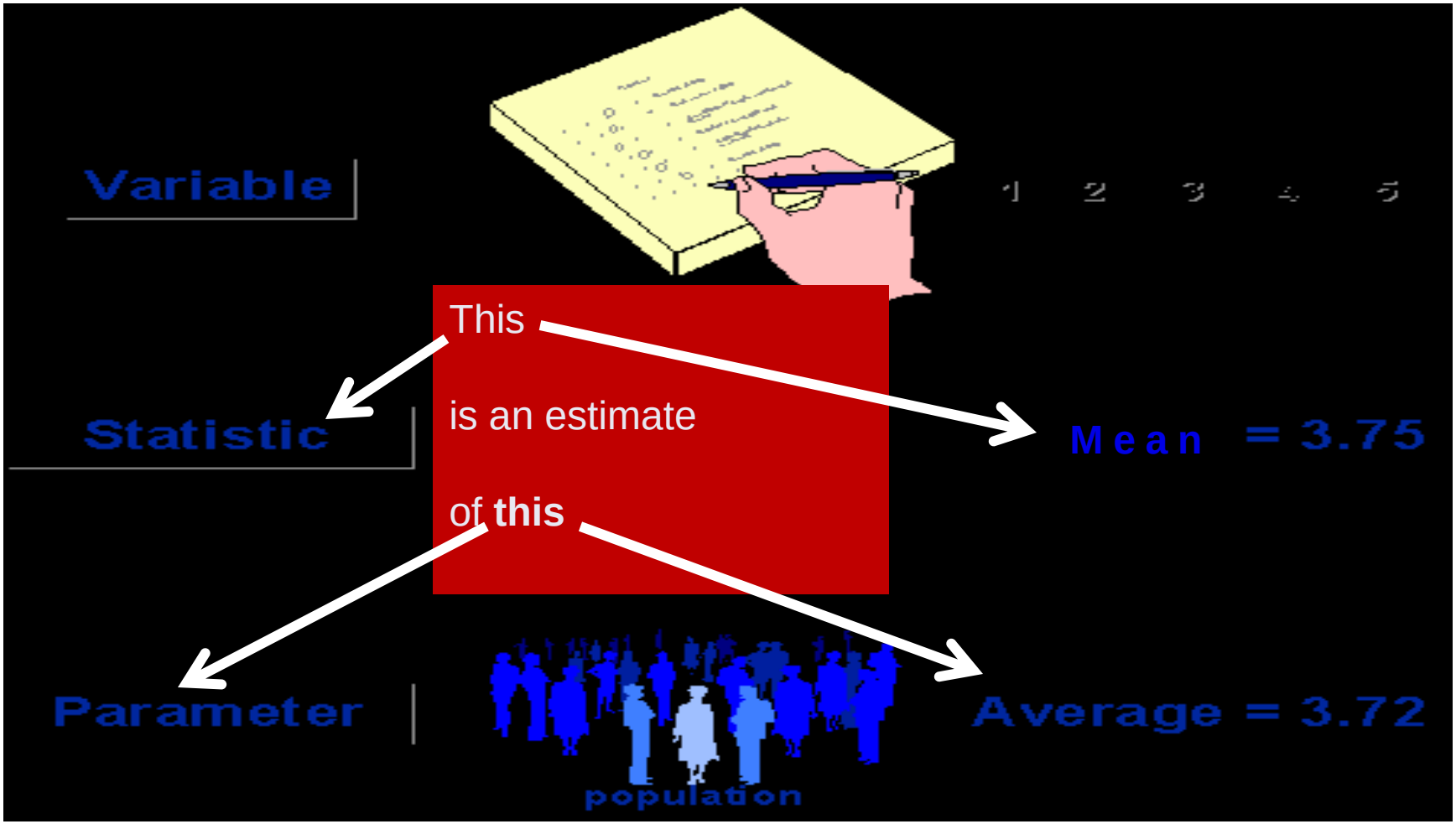
is an estimate

Statistic

Mean = 3.75

Parameter

Average = 3.72


Variable
1 2 3 4 5
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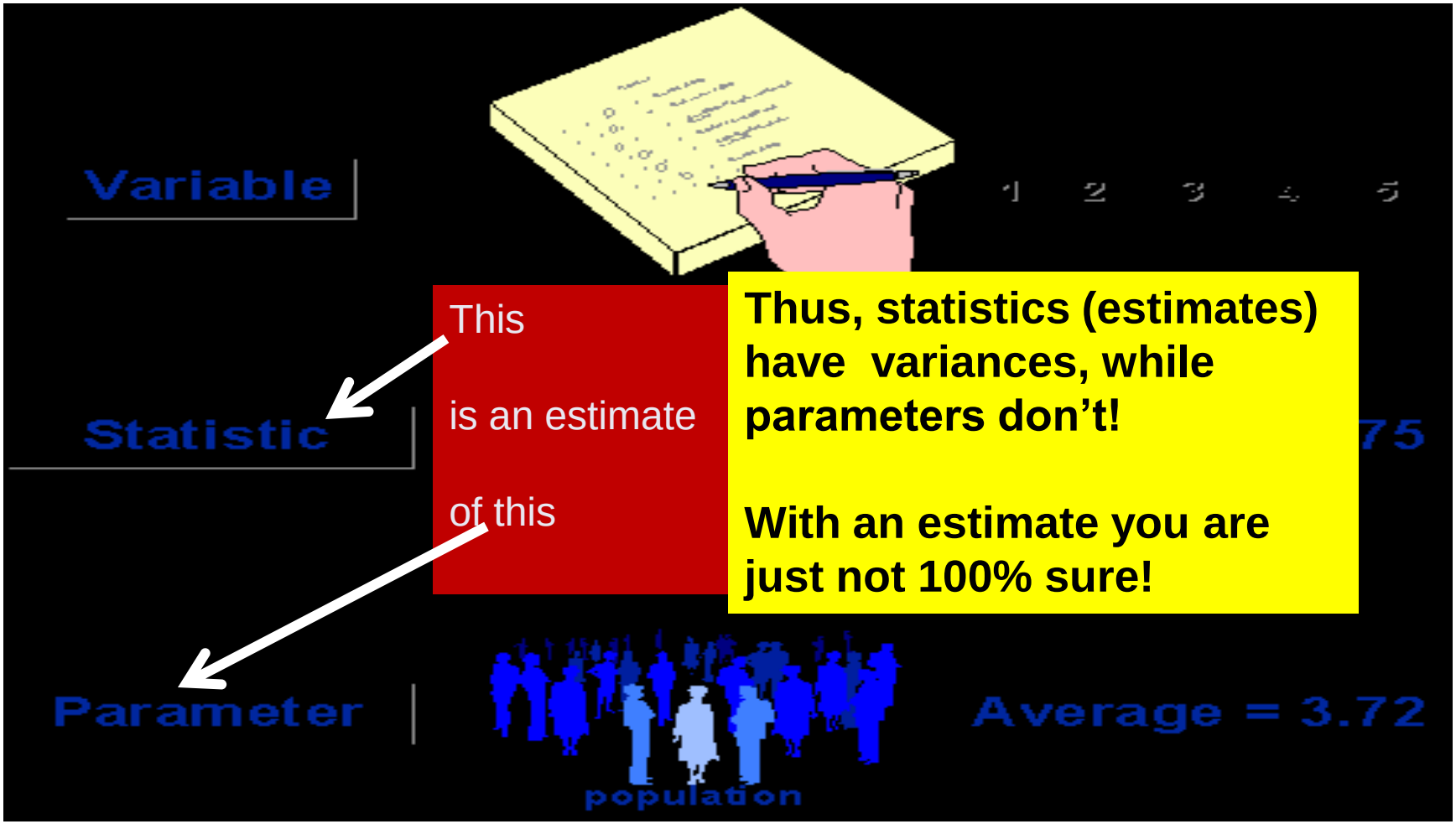
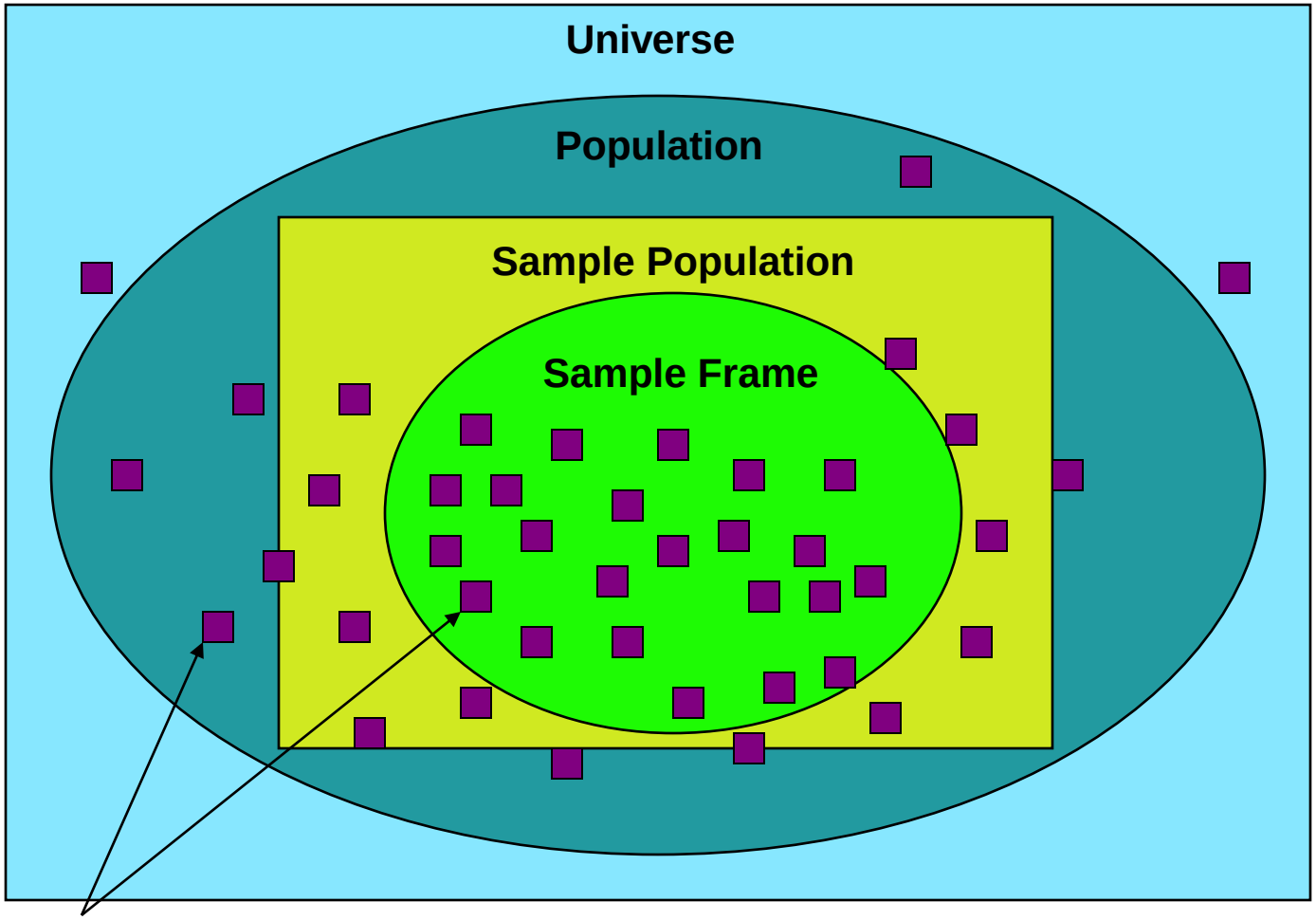

Variable
1 2 3 4 5
Statistic
This
is an estimate
of this
Parameter
Thus, statistics (estimates) have variances, while parameters don't!
With an estimate you are just not 100% sure!
75
Average = 3.72
population

Conceptual Model



How large should a Sample Be?

- *Sample size depends on:*
  - How much sampling error can be tolerated—levels of precision
  - Size of the population—sample size matters with small populations
  - Variation within the population with respect to the characteristic of interest—what you are investigating
  - Smallest subgroup within the sample for which estimates are needed
  - Sample needs to be big enough to properly estimate the smallest subgroup
  - http://www.surveysystem.com/sscalc.htm

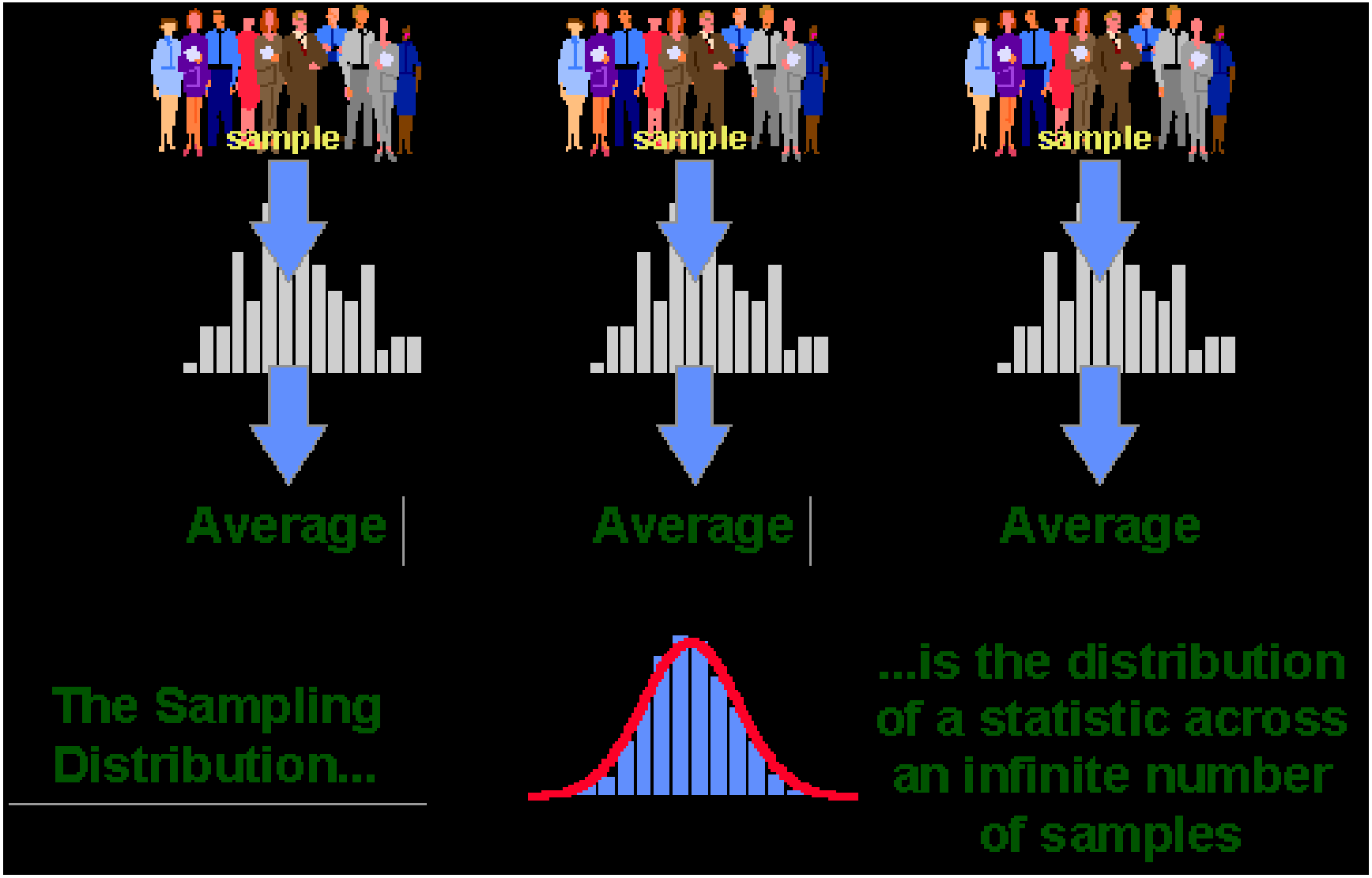
How large should a Sample Be?

	+/- 3% Sampling error		+/- 5% sampling error		+/- 10% sampling error	
Population Size	50/50 split	80/20 split	50/50 split	80/20 split	50/50 split	80/20 split
100	92	87	80	71	49	38
250	203	183	152	124	70	49
750	441	358	254	185	85	57
1,000	516	406	278	198	88	58
5,000	880	601	357	234	94	61
10,000	964	639	370	240	95	61
25,000	1,023	665	378	234	96	61
100,000	1,056	678	383	245	96	61
1,000,000	1,066	682	384	246	96	61
1000,000,000	1,067	683	384	246	96	61

Sample Statistics

- ***Parameter:*** any characteristic of a **population** that is true & known on the basis of a census (e.g., % of males or females; % of college students in a population).
- ***Estimate:*** any characteristic of a **sample** that is estimated on the basis of samples (e.g., % of males or females; % of college students in a sample). Samples have:

- ***Sampling Error:*** an estimate of precision; estimates how close sample estimates are to a true population value for a characteristic.
  - Occurs as a result of selecting a sample rather than surveying an entire population
- ***Standard Error:*** (SE) a measure of sampling error.
- SE is an inverse function of sample size.
  - As sample size **increases**, SE decreases—the sample is more precise.
  - So, we want to use the smallest SE we can to get the greatest precision!
  - When in doubt—increase sample size.


sample
sample
sample
Average
Average
Average
The Sampling Distribution...
...is the distribution of a statistic across an infinite number of samples

Sample Statistics

- SE will be highest for a population that has a 50:50 distribution on some characteristic of interest, while it is non-existent with a distribution of 100:0.

se = standard error
n = sample size
p = % having a particular characteristic (or 1-q)
q = % no having a particular characteristic (or 1-p)

$$S = \sqrt{\frac{q*p}{n}}$$

$$S = \sqrt{\frac{.9 * .1}{100}} = .03 \text{ or } 3\%$$

$$S = \sqrt{\frac{.5 * .5}{100}} = .05 \text{ or } 5\%$$

SE **decreases** as sample size (n) **increases**!

Random Selection or Assignment

- Selection process with no pattern; unpredictable
- Each element has an equal probability of being selected for a study
- Reduces the likelihood of researcher bias
- Researcher can calculate the probability of certain outcomes
- Variety of types of probability samples—*we'll touch on soon*

- ***Why Random Assignment?***
- Samples that are assigned in a random fashion are most likely to be truly representative of the population under consideration.

- Can calculate the deviation between sample results and a population parameter due to random processes.

Simple Random Sampling (SRS)

- ***The*** basic sampling method which most others are based on.

- ***Method:***
  - A sample size ‘n’ is drawn from a population ‘N’ in such a way that every possible element in the population has the same chance of being selected.
  - Take a number of samples to create a ***sampling distribution***

- Typically conducted “without replacement”

- *What are some ways for conducting an SRS?*
  - Random numbers table, drawing out of a hat, random timer, etc.

- Not usually the most efficient, but can be most accurate!
  - Time & money can become an issue
  - What if you only have enough time and money to conduct one sample?

Systematic Random Sampling (SS)

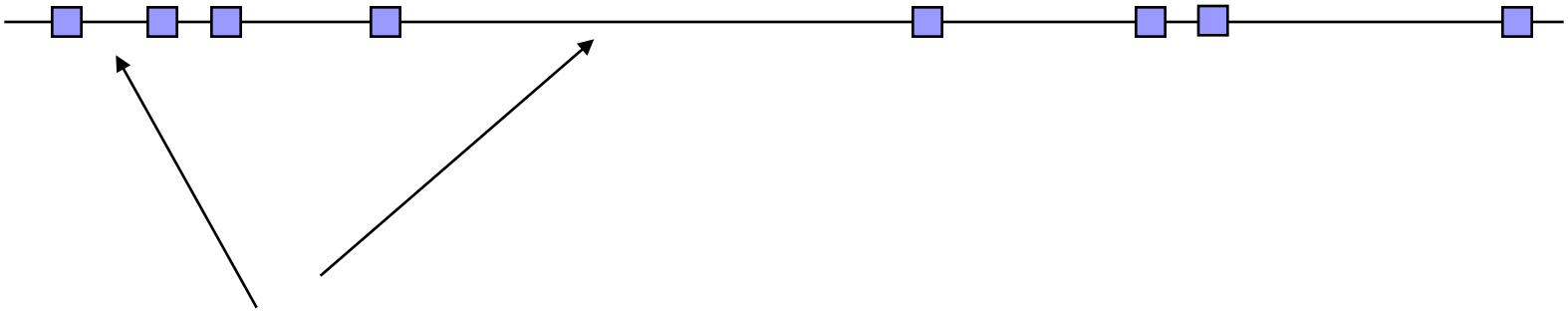
- ***Method:***
  - Starting from a random point on a sampling frame, every n^{th} element in the frame is selected at equal intervals *(sampling interval).*

- **Sampling Interval**→ tells the researcher how to select elements from the frame (1 in 'k' elements is selected).
  - Depends on sample size needed

- ***Example:***
  - You have a sampling frame (list) of 10,000 people and you need a sample of 1000 for your study…*What is the sampling interval that you should follow?*
  - Every 10^{th} person listed (10,000/1000 or 1 in 10)

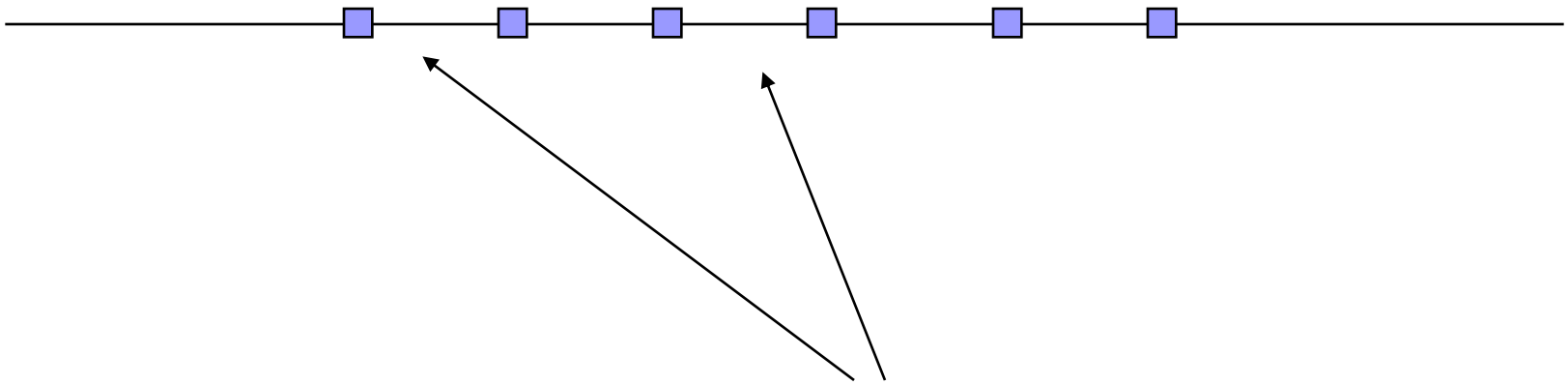
- Empirically provides identical results to SRS, but is more efficient.
- Caution: Need to keep in mind the nature of your frame for SS to work—beware of periodicity.

In Simple Random Sampling



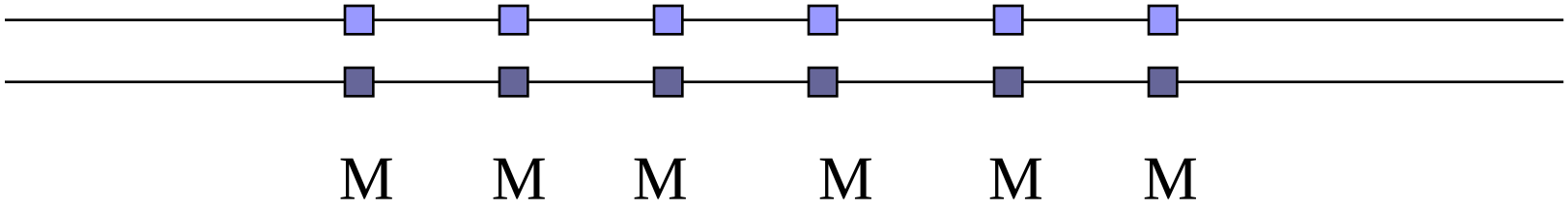
The gap, or period between successive elements is random, uneven, has no particular pattern.

In Systematic Sampling



Gaps between elements are equal and Constant→ There is periodicity.

The Periodicity Problem



If the periodicity in the sample matches a periodicity in the population, then the sample is no longer random. In fact it may be grossly biased!

Which type of sampling is more appropriate in this situation?

SRS

Stratified Sampling (StS)

- ***Method:***
  - Divide the population by certain characteristics into homogeneous subgroups (**strata**) (e.g., UI PhD students, Masters Students, Bachelors students).
  - Elements ***within*** each strata are homogeneous, but are heterogeneous ***across*** strata.
  - A simple random or a systematic sample is taken from each strata relative to the proportion of that stratum to each of the others.

- ***Researchers use stratified sampling***
  - When a stratum of interest is a small percentage of a population and random processes could miss the stratum by chance.
  - When enough is known about the population that it can be easily broken into subgroups or strata.

POPULATION

n = 1000; SE = 10%

equal intensity

STRATA 1

n= 500; SE=7.5%

STRATA 2

n = 500; SE=7.5%

POPULATION

n =1000, SE = 10%

proportional to size

STRATA 1

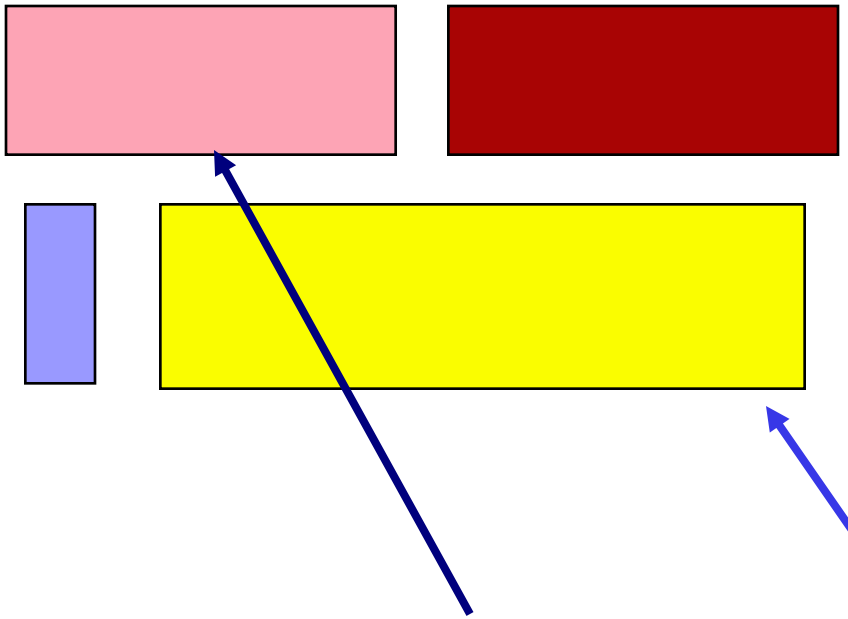
n =400

SE=8.0%

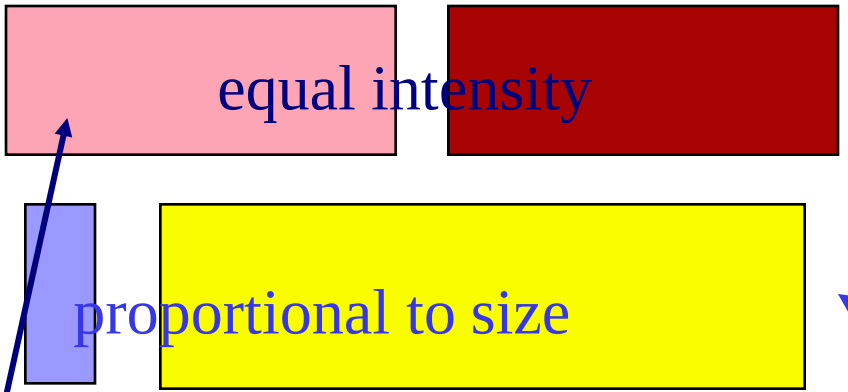
STRATA 2

n = 600

SE=5.0%



Sample equal intensity vs. proportional to size ?



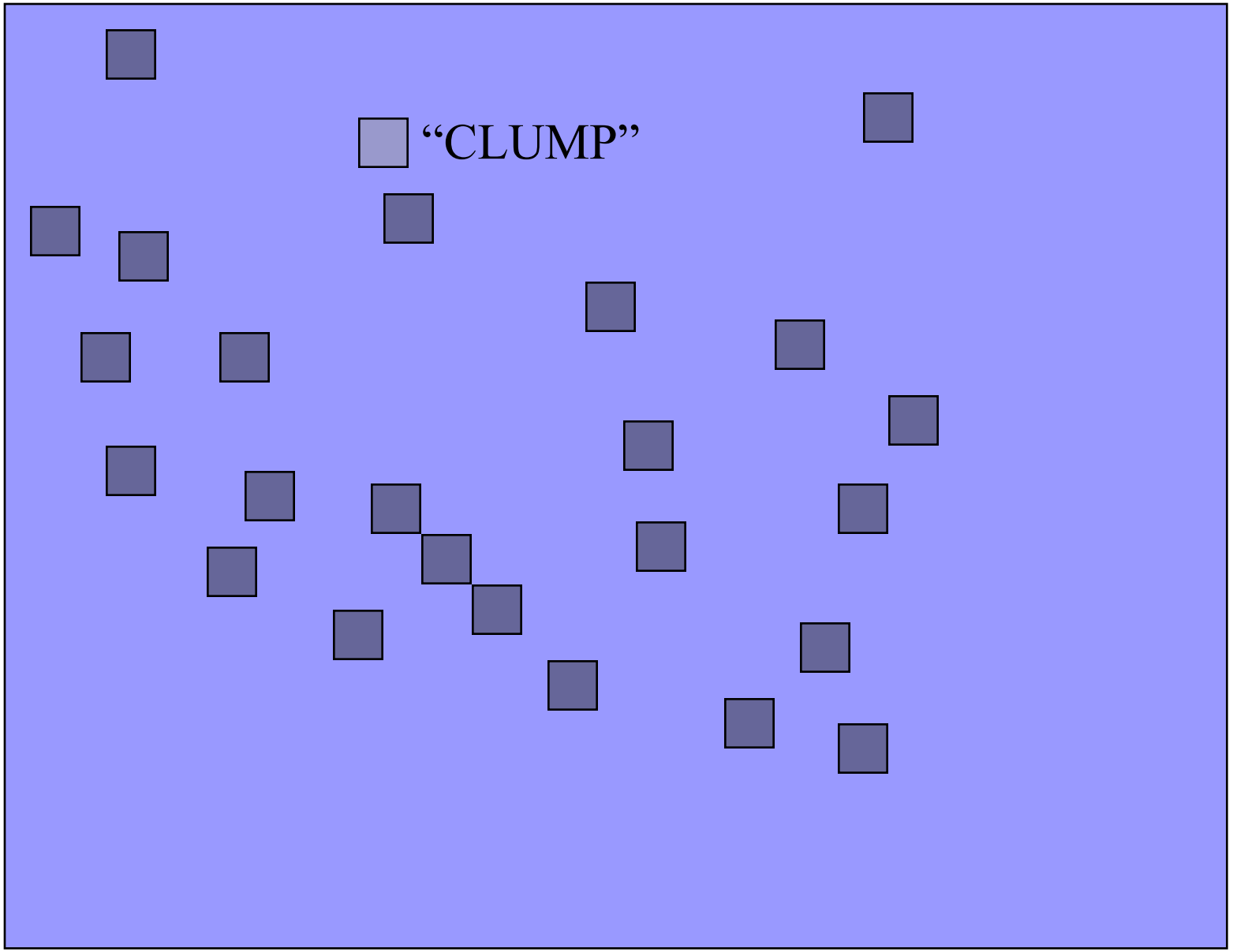
Sample equal intensity vs. proportional to size ?

What do you want to do? Describe the population, or describe each strata?

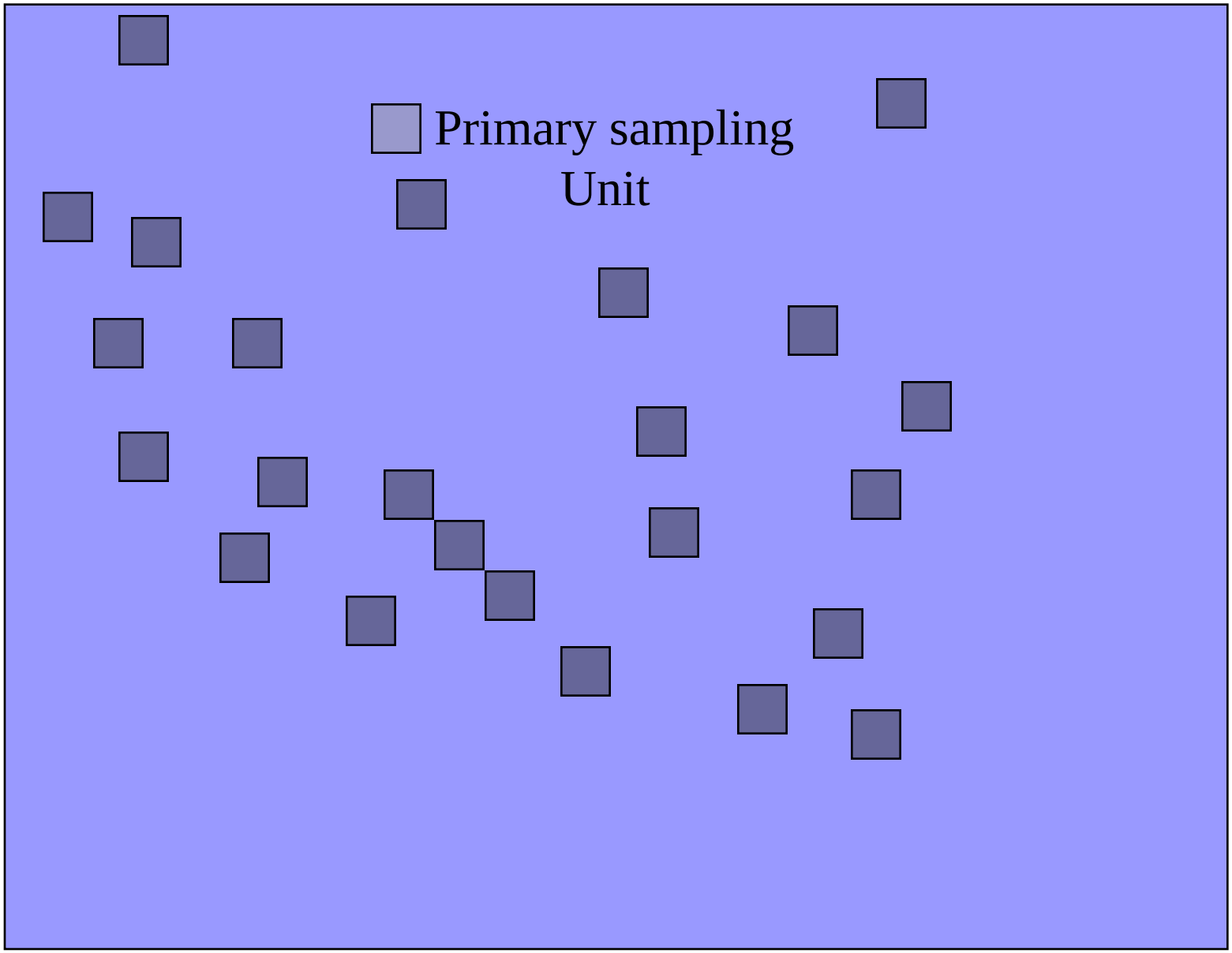
Cluster sampling

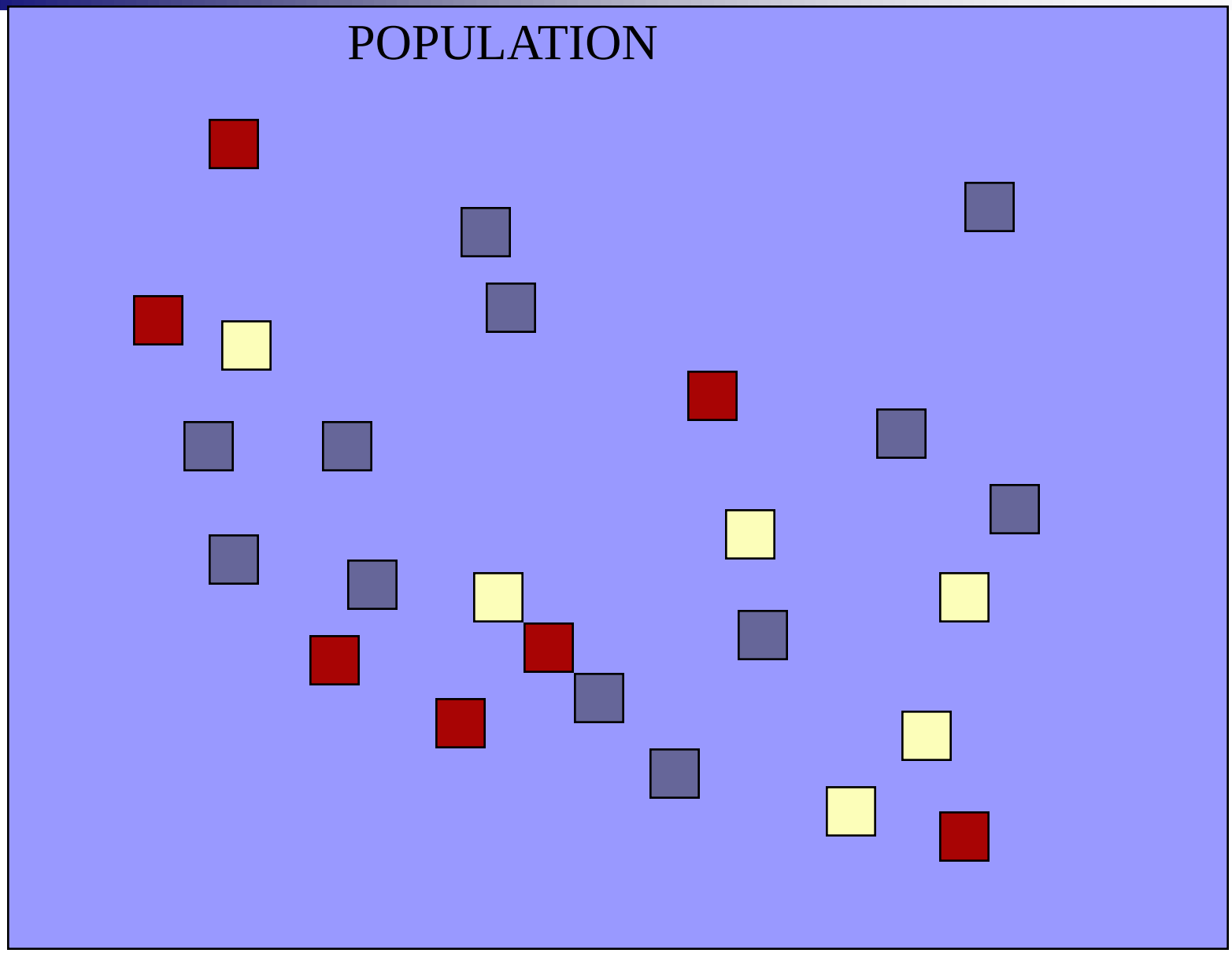
- Some populations are spread out (over a state or country).
- Elements occur in clumps (towns, districts)—Primary sampling units (PSU).
- Elements are hard to reach and identify.
- Trade accuracy for efficiency.
- You cannot assume that any one clump is better or worse than another clump.

POPULATION

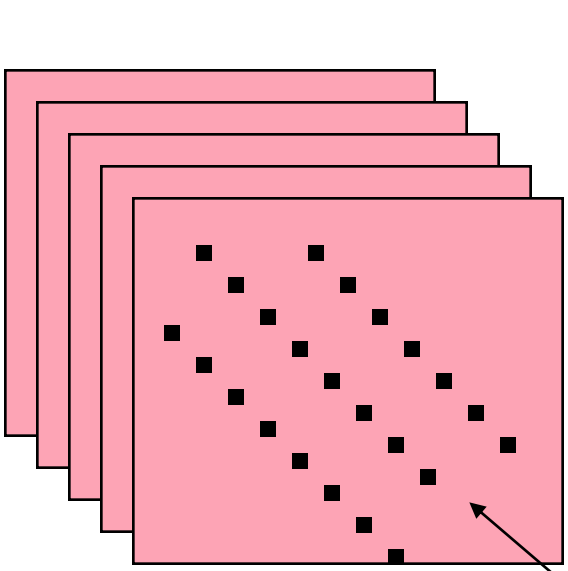


POPULATION





= Randomly selected **PRIMARY SAMPLING UNITS**.



Randomly selected
PRIMARY SAMPLING UNITS

Elements; sample ALL in the selected primary sampling unit.

Cluster sampling

- ***Used when:***
  - Researchers lack a good sampling frame for a dispersed population.
  - The cost to reach an element is very high.
- Each cluster is as varied internally but homogeneous relative to all the other clusters (each is a “clone” of the other).
- Usually less expensive than SRS but not as accurate
  - Each stage in cluster sampling introduces sampling error—the more stages there are, the more error there tends to be.
- Can combine SRS, SS, stratification and cluster sampling!!

Examples of Clusters and Strata

- ***Recreation Research:***
  - ***Strata:*** weekday-weekend; gender; type of travel; season; size of operation; etc.
  - What are some others?

  - ***Clusters:*** counties; entry points (put-in and take-outs); time of day, city blocks, road or trail segments.
  - What are some others?