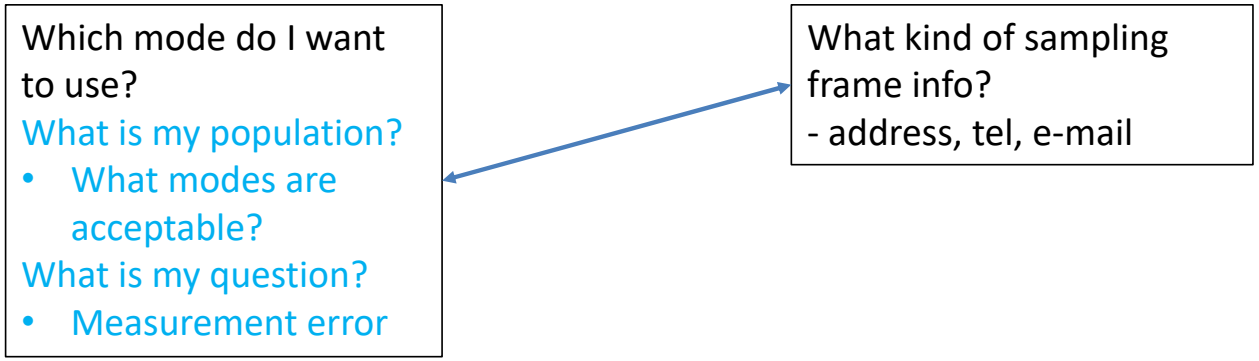
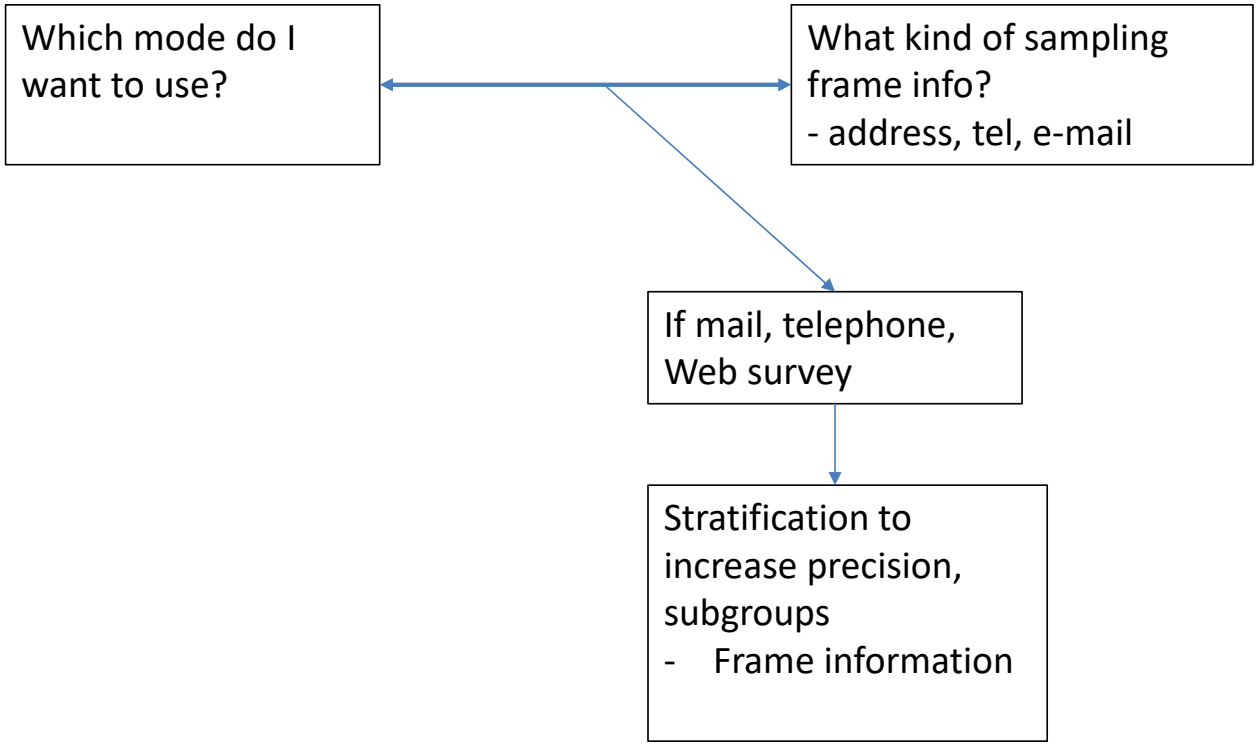
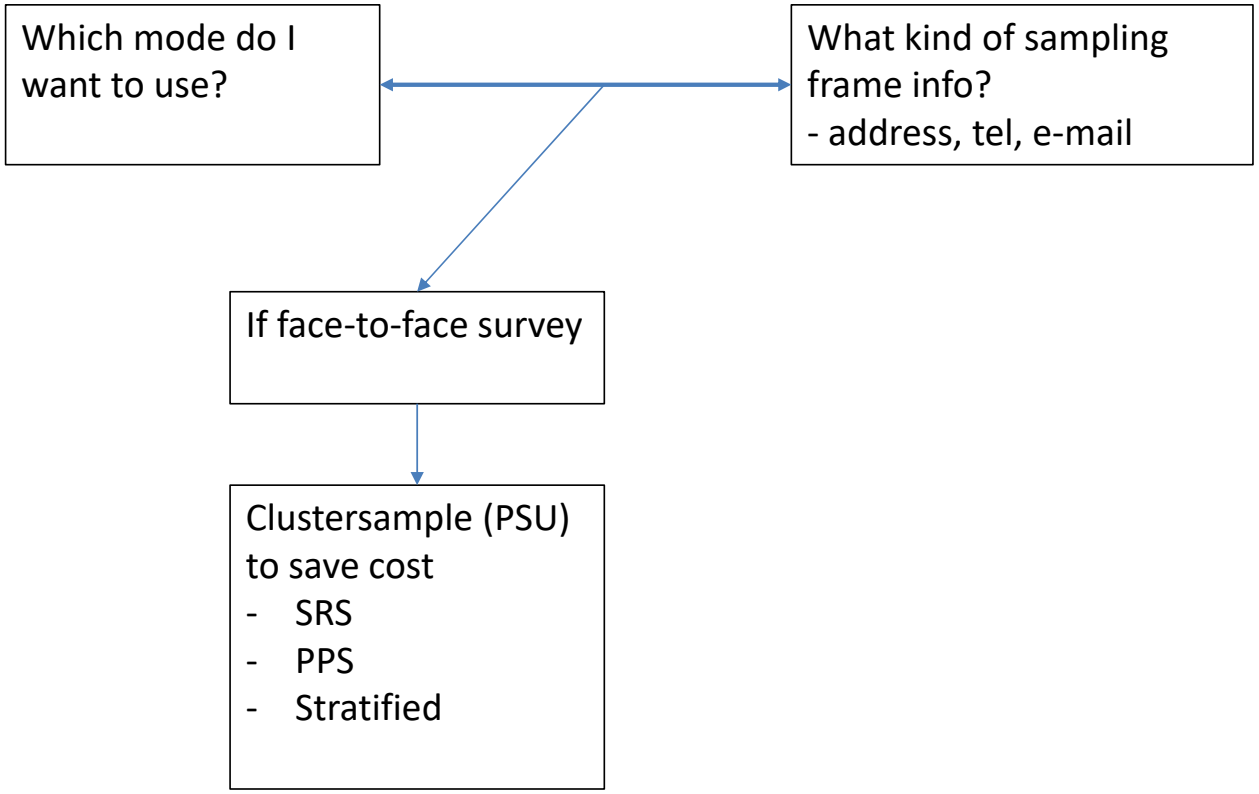
Survey Data Analysis
week 5
“R practical – Combinations of stratification and clustering”

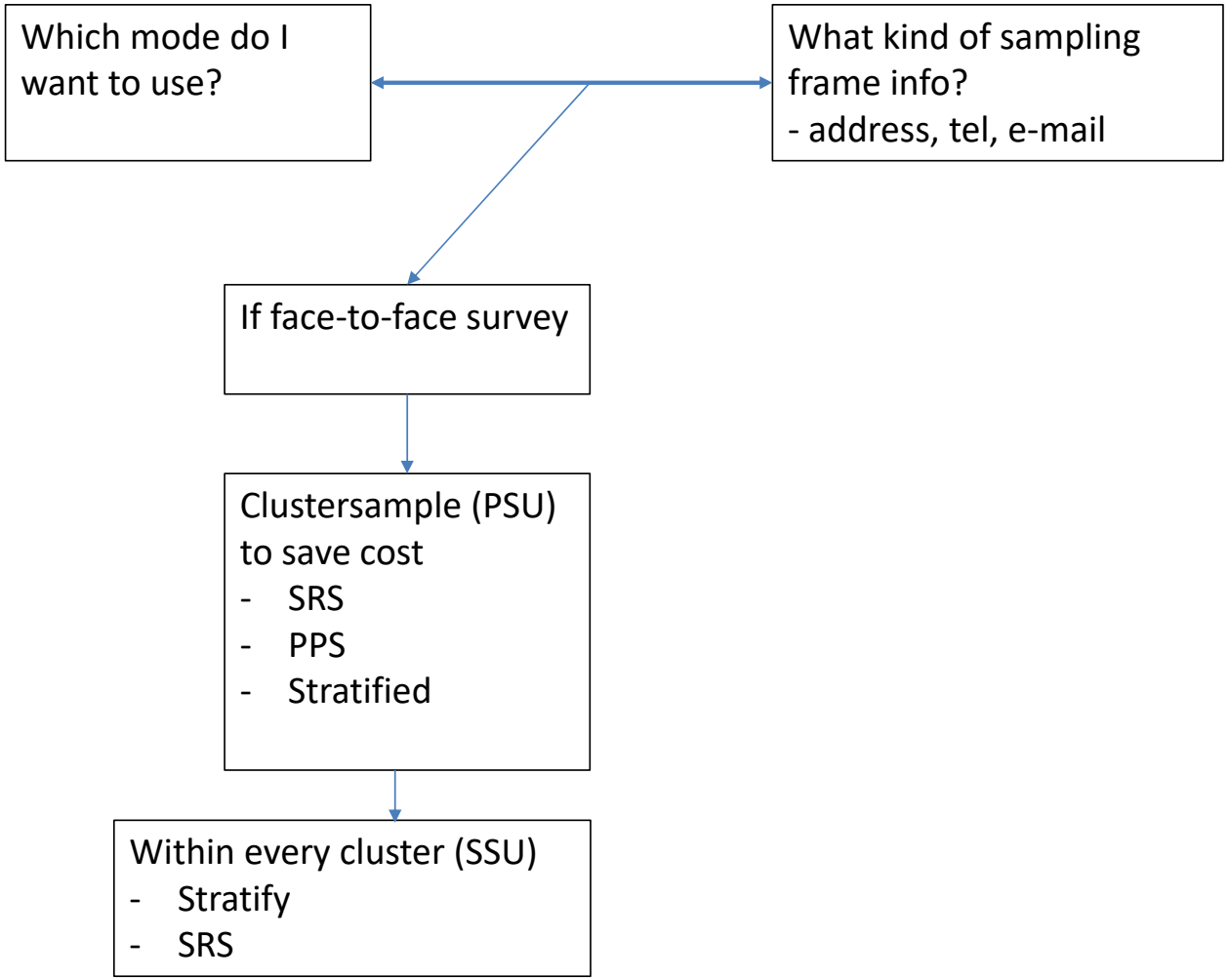
Today

- Discuss take home exercise
  - Your adopted survey
  - Questions: what do you encounter?
- Short lecture
  - Survey design:
    {population, question, frames} -> modes
  - How to stratify?
  - How to cluster?
- Set of class exercises


Which mode do I want to use?
What is my population?
• What modes are acceptable?
What is my question?
• Measurement error
What kind of sampling frame info?
- address, tel, e-mail


Which mode do I want to use?
What kind of sampling frame info?
- address, tel, e-mail
If mail, telephone, Web survey
Stratification to increase precision, subgroups
- Frame information


Which mode do I want to use?
What kind of sampling frame info?
- address, tel, e-mail
If face-to-face survey
Clustersample (PSU) to save cost
- SRS
- PPS
- Stratified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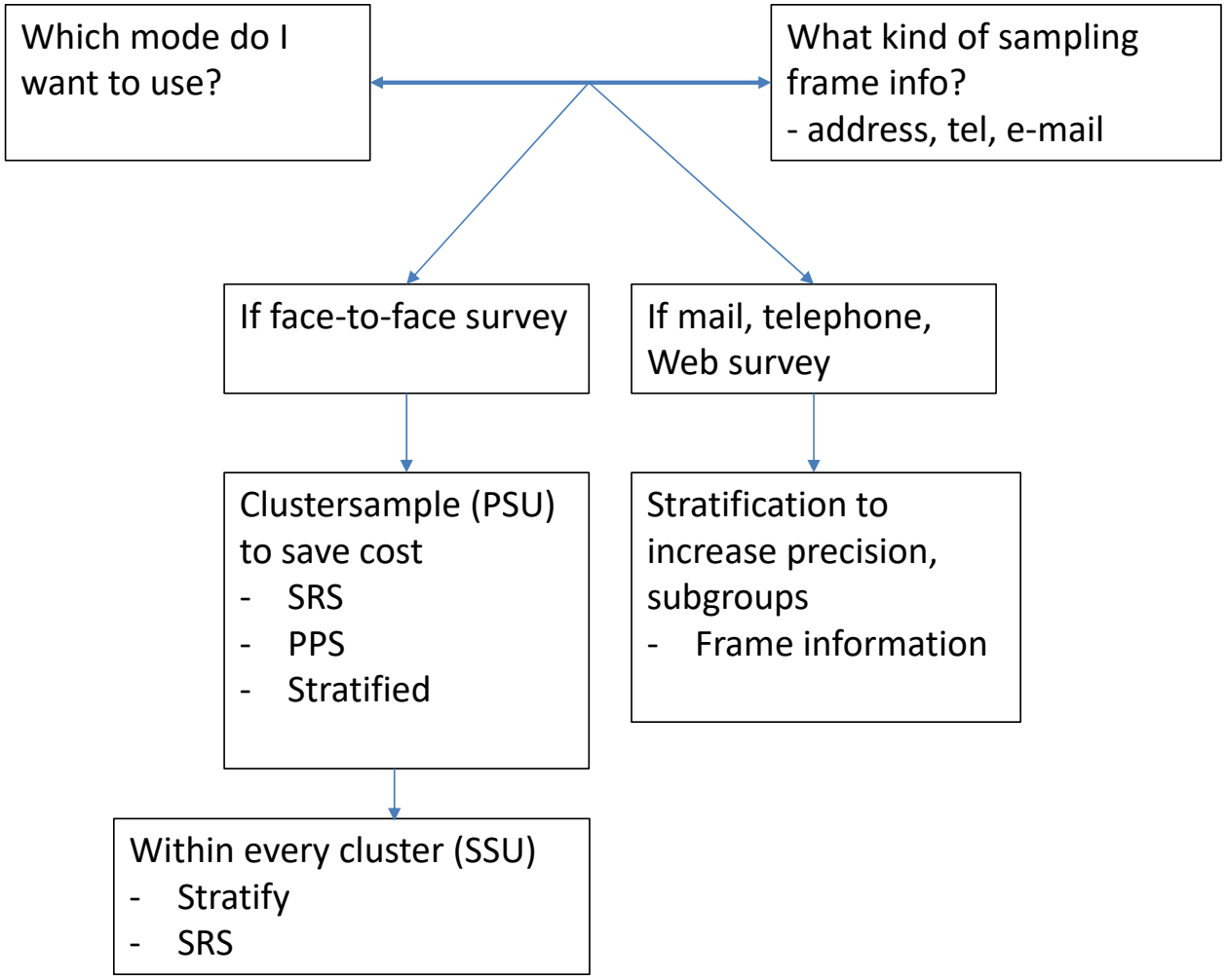
- PPS
- Stratified
Within every cluster (SSU)
- Stratify
- SRS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Stratification to increase precision, subgroups
- Frame information
Within every cluster (SSU)
- Stratify
- SRS

Class exercises

1. Hurvitz-Thompson estimator
   - Design weights
   - Inclusion robabilities
2. Stratified cluster samples
3. Other statistics

Extra slides

Not discussed in class, but in case you want to know the end of the story of the "student" sample…

Horvitz-Thompson estimation

- We discussed SRS, stratified and cluster sampling
  - With and without replacement
  - Equal + unequal probabilities
  - All with slighlty different formulas
- Horvitz and Thompson (1952) designed a general framework for inference for random (probability surveys)

  - For mean: $\overline{y}_w = \frac{\sum w_i y_i}{\sum w_i}$

HT-estimation – a unifying framework…

HT-estimation works for all design-based sampling methods

- SRS equal probabilities: $\boldsymbol{\pi}_i$ = equal
- Stratified: $\boldsymbol{\pi}_i$ depends on strata selection
- One-stage cluster: $\boldsymbol{\pi}_i$ depends on cluster selection
- Two-stage (and more complex): cluster and within-cluster

All you need is $\boldsymbol{\pi}_i$, for every individual on your sampling frame

Our recurring example

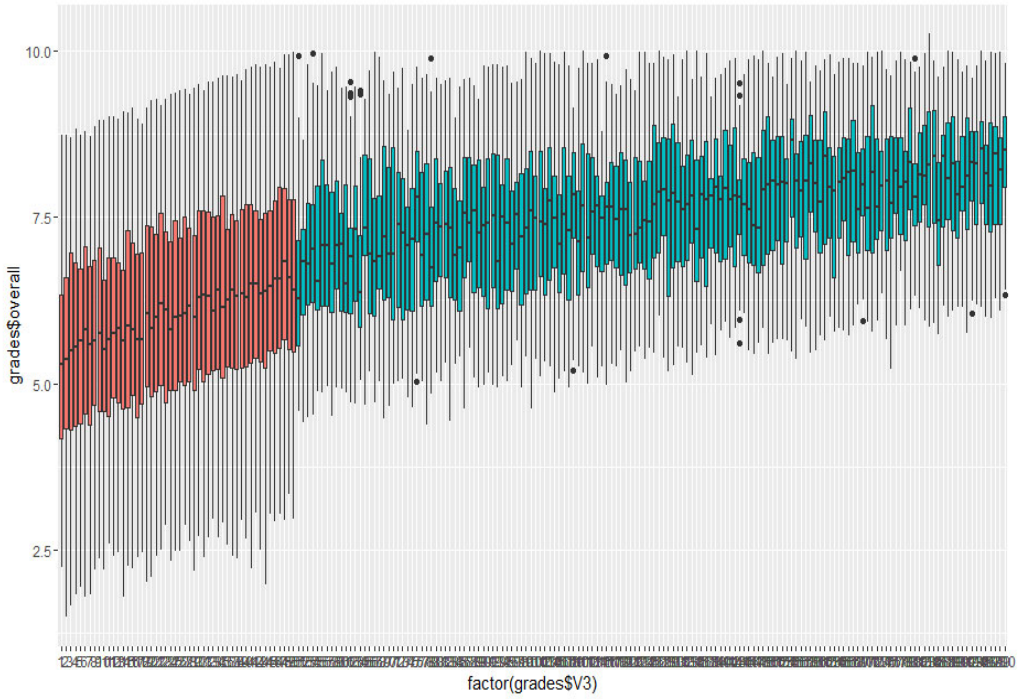
- We would like to do a survey among all students at Utrecht University
  - Population = 20.000
  - RQ: Interested in differences in **grades** and **student happiness** between programmes
  - approx. 49 BA programmes and 150 MA programmes
  - Limited budget (cannot do census) for about n=1000

- This week:

What if we combine clustering and stratification?

Example – 150 programmes (Ba/MA)

simulated data

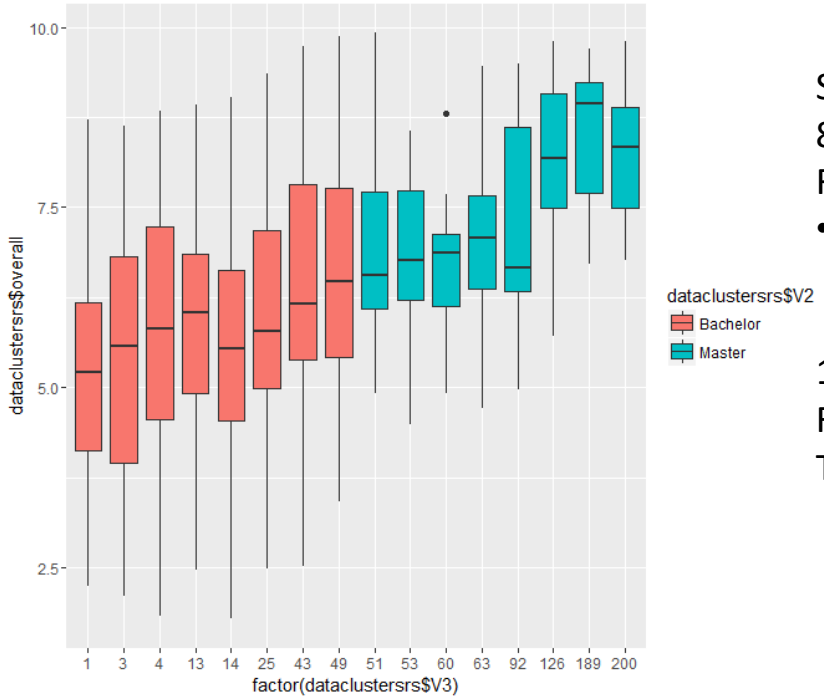


- Student grades (y)
- 200 programmes (x)
  - 50 BA, n=280 each
  - 150 MA, n=40 each

- R-code is available on Blackboard

- Population mean: 6.52

Stratified cluster sample

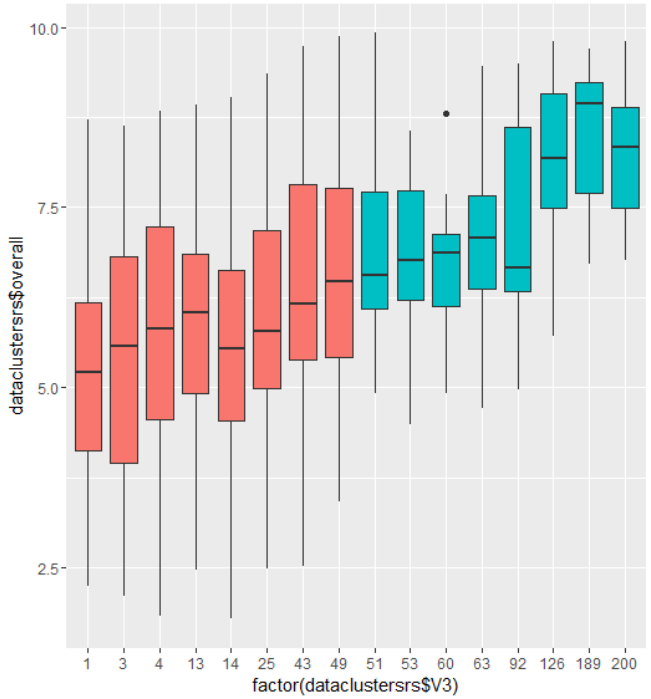


Stratify on programme (2)
8 clusters in each (can also vary)
Random sample per cluster PPS:

- sample with p=.4

16 clusters
For BA:
Total n=1000 out of population 20000

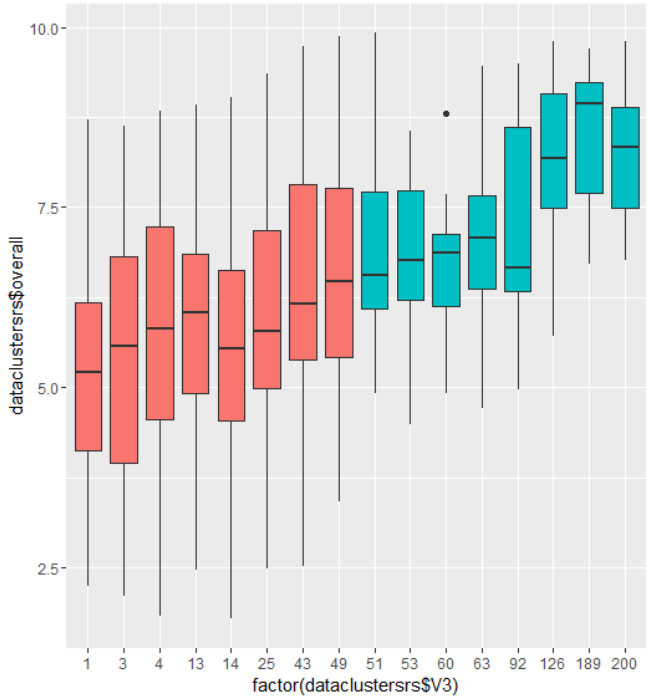
Variance estimation



- How do we calculate variances.
- Alternative: Horvitz-Thompson estimator
  - Stage 1: stratify
  - Stage 1: cluster
  - Stage 2: Select individuals

- Weights:
- Stage 2: per cluster:
  - Wt|s,master = 15 out of 40 -> 2.5
  - Wt|s,Bachelor = 112 out of 280 -> 2.5

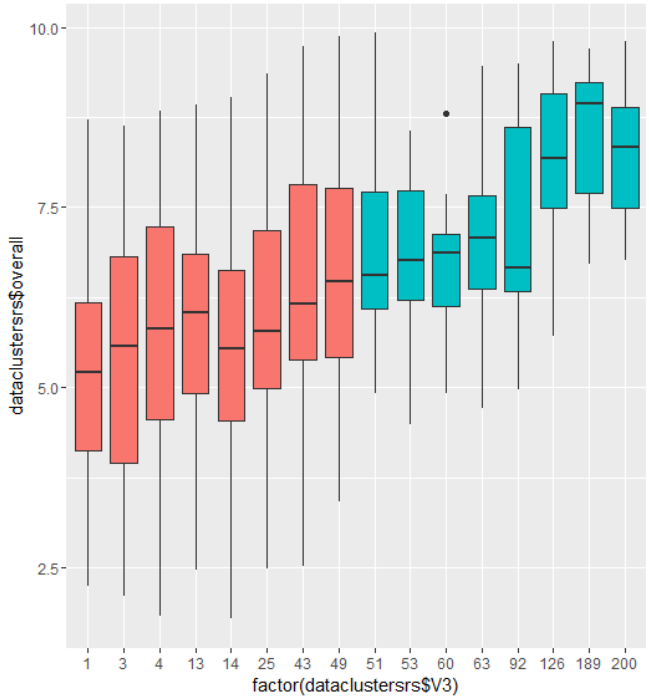
Variance estimation using weights



- Weights:
- Stage 2: per cluster:
  - Wt|s,master = 15 out of 40 -> 2.5
  - Wt|s,Bachelor = 112 out of 280 -> 2.5

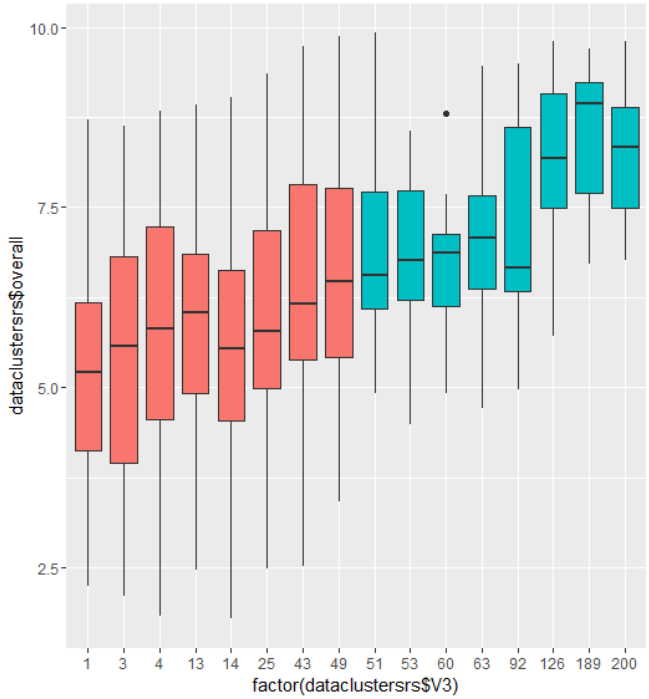
- Stage 1: clusters out of strata
  - Wt|s,master = 8 out of 150 -> 18.75
  - Wt|s,Bachelor = 8 out of 50 -> 6,25

Variance estimation – constructing weights



- Weights:
- Stage 2: per cluster:
  - Wt|s,master = 15 out of 40 -> 2.5
  - Wt|s,Bachelor = 112 out of 280 -> 2.5
- Stage 1: clusters out of population
  - Wt|s,master = 8 out of 150 -> 18.75
  - Wt|s,Bachelor = 8 out of 50 -> 6,25
- Total weight
  - Wt|s,master = 2.5 * 18.75 -> 46.875
  - Wt|s,Bachelor = 2.5 * 6.25 -> 18.75
- Rescaled weight
  - Wt|s,master = 46.875/mean(Wt) = 2,42
  - Wt|s,Bachelor = 18.75/mean(Wt)= 0,81

Variance estimation in R – identical results




```
clus2a <- svydesign(ids=~cluster+id, strata=~programme,
          #   weights=~weights, fpc = ~fpc1+fpc2, data=dataclustersrs)
```

```
Clus2b <- svydesign(ids=~cluster+id,  #strata=~dataclustersrs$V2,
          weights=~weights,#  fpc = ~fpc1+ffpc2,data=dataclustersrs)
```

Mean: 6.04
s.e. = .15275
Deff= 8.86

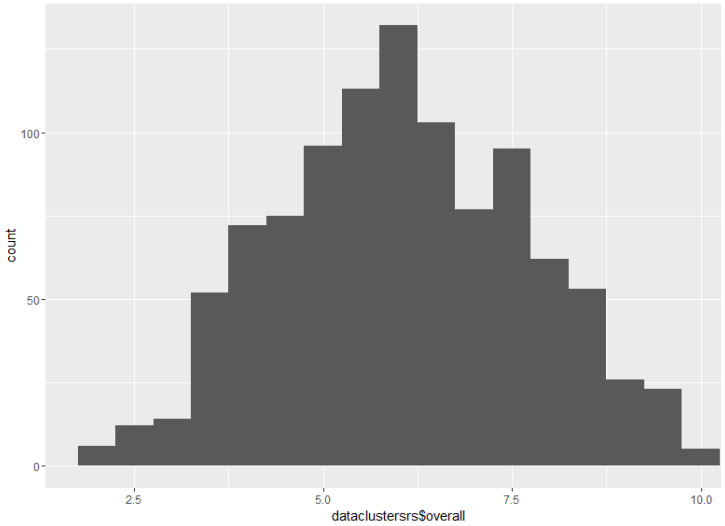
Weights

- The study doesn't stop at sampling
  - nonresponse weights (see week 44,45)
- Variance in weights indication of difference with perfect SRS design without nonresponse
  - In SRS -> Wi=1, Var(weights)=0.
  - In our design -> Var(weights)=.27
  - Likely in our design with NR: Var(weights) >.27
    - Variance inflation

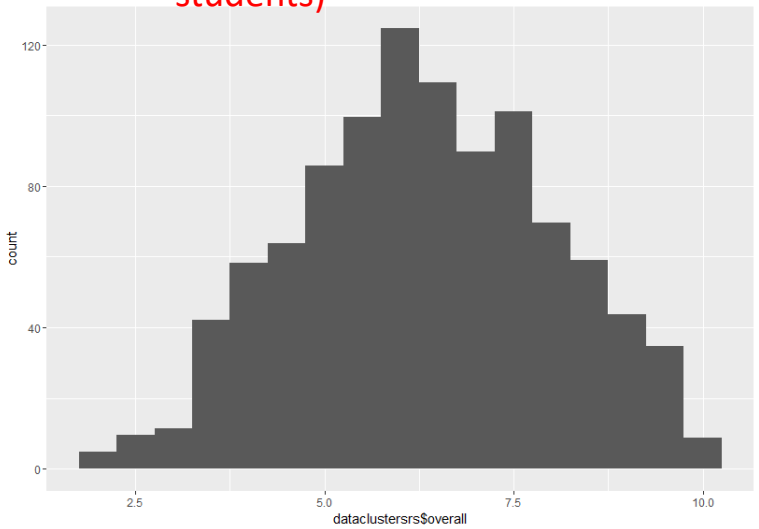
- Can trim weights if they are large (rescaled weights >3 or 5)
  - Bias becomes larger
  - Variance lower -> precision higher
  - Goal is to Minimize Mean Square Error ($bias^2$ + variance)

Weighted graphs (using ggplot2)

- Without weights



- With weights
  - Heavier mass in upper tail (high weights for MA students)



Next weeks:

- Next week:
  - Last week about sampling: model assisted estimation
    - Design based ---------- model-based
    - Ratio and regression estimation
  - Stuart 71-90
  - Lohr (2022) chapter 4
  - Finish class exercises today
  - Take home exercise:
    - Specify your survey design in R
  - Assignment 1 online
  - Deadline: 18 October 17:00
- In two weeks:
  - class-free week