Respondent Driven Sampling: Introduction and Applications

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Outline

Introduction

Application

Health and Life Study of Koreans (HLSK)

Summary

Introduction

Respondent Driven Sampling (RDS)

Network Sampling vs. RDS

RDS Inferences

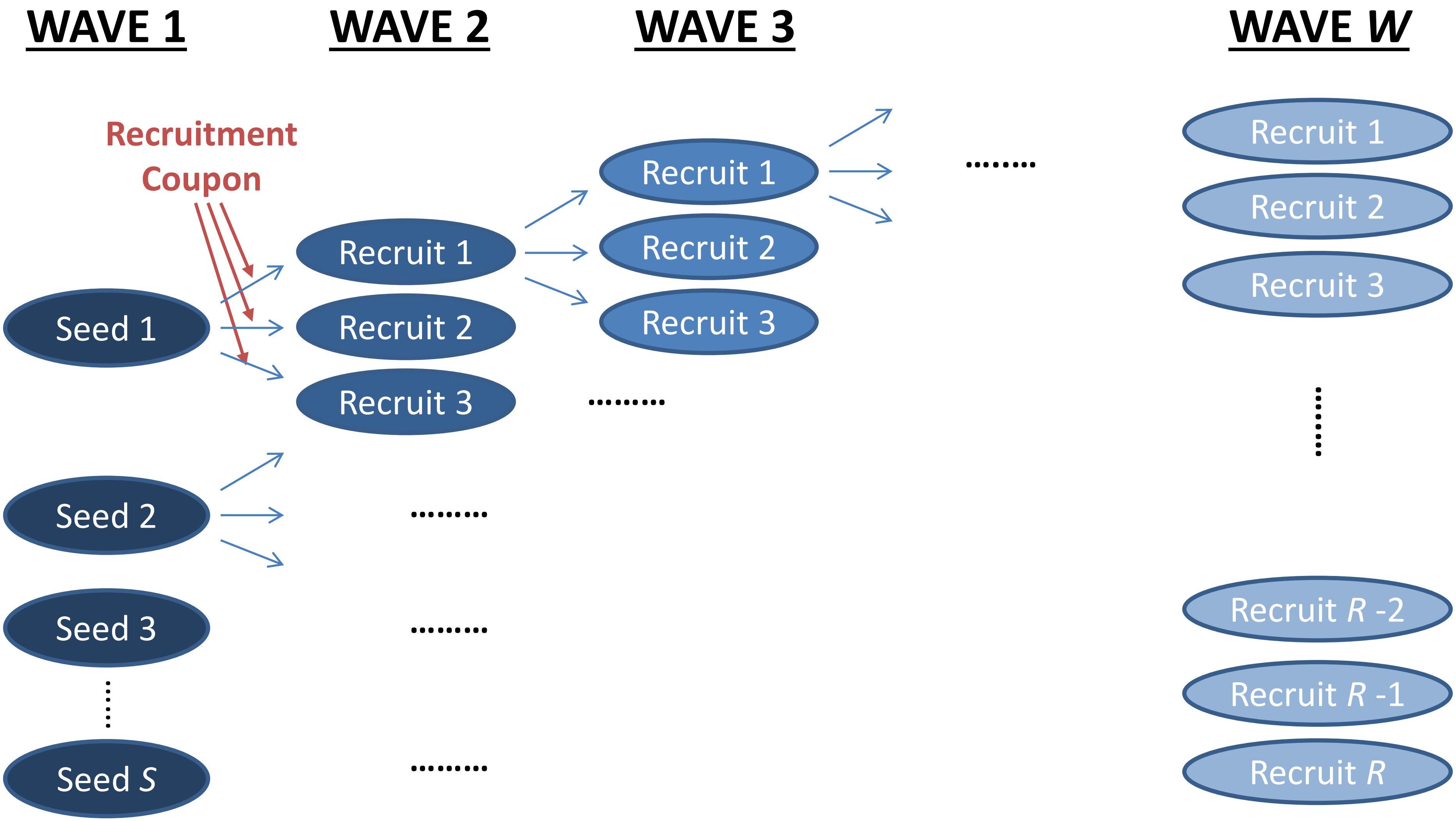
Respondent Driven Sampling – 1

- Growing interest in studying hard-to-reach, rare, elusive, hidden populations
  - HIV at-risk population: Sex workers, IDUs, MSMs
  - LGBT populations
  - Recent immigrants
- No clear and practical solution with probability sampling
  - High screening costs
  - Hesitant to be identified

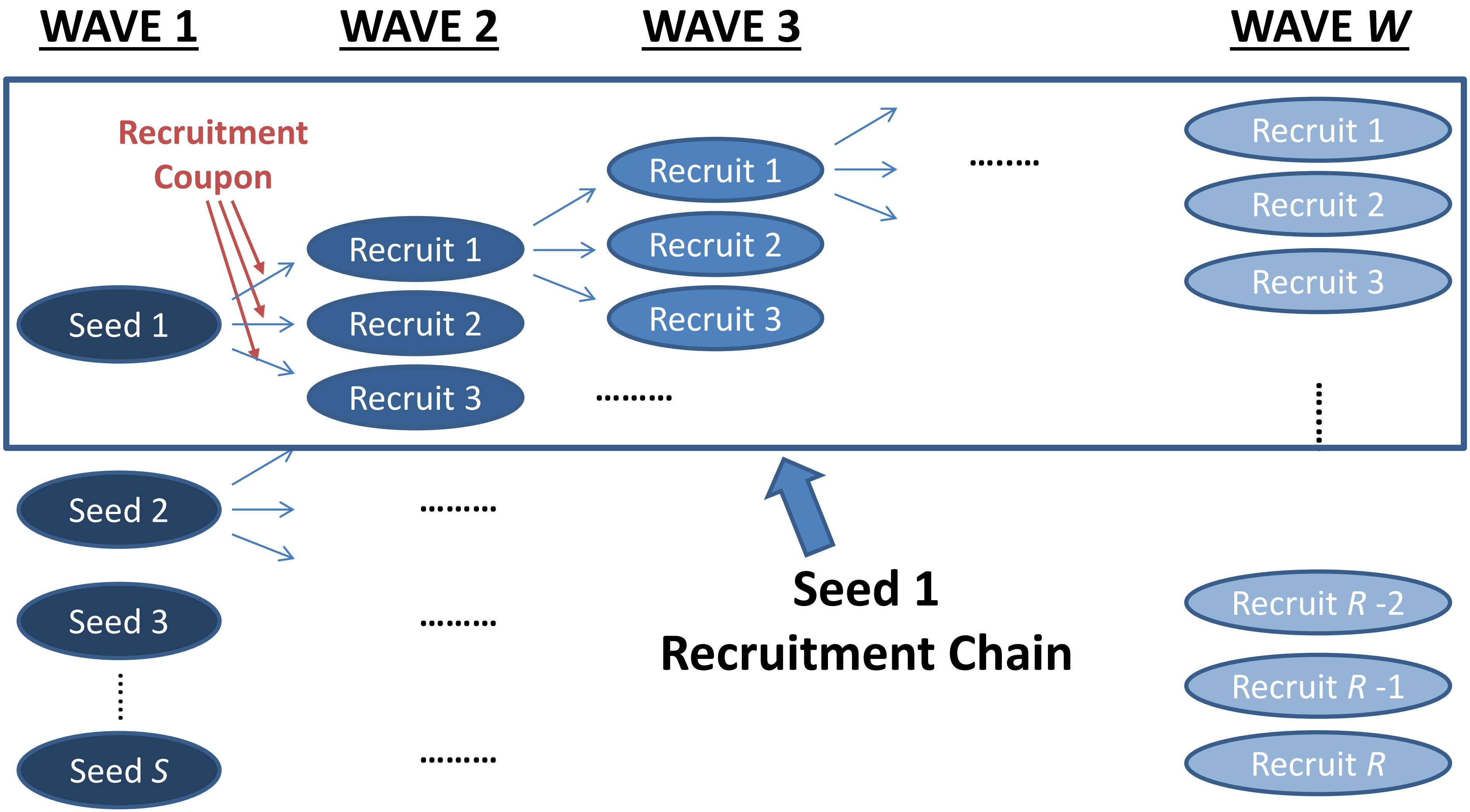
Respondent Driven Sampling – 2

- Proposed by Heckathorn (1997, 2002)
- Popular usage in public health (~$100 million research funds by NIH as of 2011)
- Exploits social networks among rare population members for sampling purposes
  - Sampled members also play a role of a recruiter
  - Incentivized recruitment from own network through coupons and this continues in waves/chains
  - Recruitment assumed to be random within each individual’s network and to follow memory-less Markov chain and reach equilibrium

Respondent Driven Sampling – 3



Respondent Driven Sampling – 4



WAVE 1 **WAVE 2** **WAVE 3** **WAVE *W***

Recruitment Coupon

Seed 1

Recruit 1

Recruit 2

Recruit 3

Recruit 1

Recruit 2

Recruit 3

Recruit 1

Recruit 2

Recruit 3

Seed 2

Seed 3

Seed *S*

Recruit *R* -2

Recruit *R* -1

Recruit *R*

Seed 1

Recruitment Chain

Network/Multiplicity Sampling

- Sirken (1972, 1975)
- Sample from a sample’s network
    - Conduct an interview with a sample
    - Roster eligible kinship members with contact information
    - Sample from the roster

Network Sampling vs. RDS

Similar:

- Rely on social networks

Different:

- Network specification
  - NS: biological siblings, immediate family members
  - RDS: jazz musicians
- Who selects the sample
  - NS: researchers
  - RDS: study participants with coupon
- Selection probability
  - NS: Known
  - RDS: (Mostly) Unknown

RDS Inferences

Issues

1. Nonprobability
   - Within network selection probability may be computed (e.g., # recruits/network size), but
   - Unclear coverage of "network"
   - Measurement error in "network size"
   - With or without replacement?
   - Seed selection probability unknown
2. Dependence
   - Recruiters and recruits are similar
3. None beyond univariate statistics

RDS Inferences: Point estimator

- For binary variables

RDS-I: $\hat{p}_B^{RDS-I} = S_{AB}\bar{\tilde{d}}_A / \left(S_{AB}\bar{\tilde{d}}_A + S_{BA}\bar{\tilde{d}}_B\right)$

RDS-II: $\hat{p}^{RDS-II} = \sum_{i\in S}\left(\tilde{d}_i^{-1} y_{i_i}\right) / \sum_{i\in S}\tilde{d}_i^{-1}$

SS (Gile): $\hat{p}^{G} = \sum_{i\in S}\left(\hat{\pi}\left(\tilde{d}_i\right)^{-1} y_i\right) / \sum_{i\in S}\hat{\pi}\left(\tilde{d}_i\right)^{-1}$

- S_{AB}: proportion of ties (i.e., connections) that cut across A and B (e.g., the proportion of female peers among all peers recruited by all male participants)
- $\bar{\tilde{d}}_A = \sum_{i\in A}\tilde{d}_i / n_A$
- $\tilde{d}_i$ is degree reported by respondent i

  Large degree → high selection probability → small “weight”
- n_A is the sample size of A
- y_i: Outcome variable
- $\hat{\pi}\left(\tilde{d}_i\right)$: estimated population distribution of degrees through successive sampling

RDS Inferences: Sampling Variance – 1

- Naïve estimator
- Direct estimator by Volz-Heckathorn ($\hat{v}^{VH}$)
  - Not usable (requires full network information for all individuals in the population)
  - Only for proportions
  - Assumes first-order Markov process
    - Dependency only between immediate recruiter-recruits
    - Dependency static across chains and waves

RDS Inferences: Sampling Variance – 2

- Bootstrap by Salganik ($\hat{v}^S$)

  1. Group non-seeds by characteristics of recruiter (e.g., recruited by male vs. female)
  2. Randomly sample a seed
  3. Sample a non-seed from the group based on the seed in 2
  4. Sample a non-seed from the group based on the non-seed in 3
  5. Continue this until the bootstrap sample size equals to *n*

  - Only for proportions
  - Assumes first-order Markov process only on the inference variable

RDS Inferences: Sampling Variance – 3

- Bootstrap based on recruitment chains

  1. Randomly sample a seed and preserve its entire recruitment chain

  2. Continue until the bootstrap sample size equals to *n*

  - Can be used for all statistics across all variables
  - Do not assumes first-order Markov process

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Health and Life
Study of Koreans

Application:
Health and Life Study of Koreans (HLSK)

Funded by the National Science Foundation (GRANT NUMBER SES-1461470)

HLSK

- Targets foreign-born Korean American adults in
  - Los Angeles County
  - State of Michigan
- Web-RDS survey

  http://sites.lsa.umich.edu/korean-healthlife-study/
  - Unique number required for participation
  - Incentive payment through checks
- Target n=800 (currently ~600)
- Benchmarks from American Community Survey

HLSK Formative Research

- 3 rounds of focus group discussions
  - ~30 participants; 2 rounds in Korean and 1 in English
  - Discussion focused on
    - Web surveys

      → URL, Web site contents, etc.
    - Concept of RDS
    - Coupons

      → Up to 2 coupons

      → "Expire" in 2 weeks
    - Level of incentives

      → $20 for main, $5 for follow-up, $0 for recruitment

HLSK Data Collection

- Started with 12 seeds in LA in June 2016
- MI added in November 2016

- LA seeds (initially)
  - Recruited through referral
  - Balanced on gender, age, dominant language
  - In-person introduction about the study

→ It became clear the protocols would not work

  - Provide recruitment incentives
  - Add more seeds

HLSK Data Collection Progress

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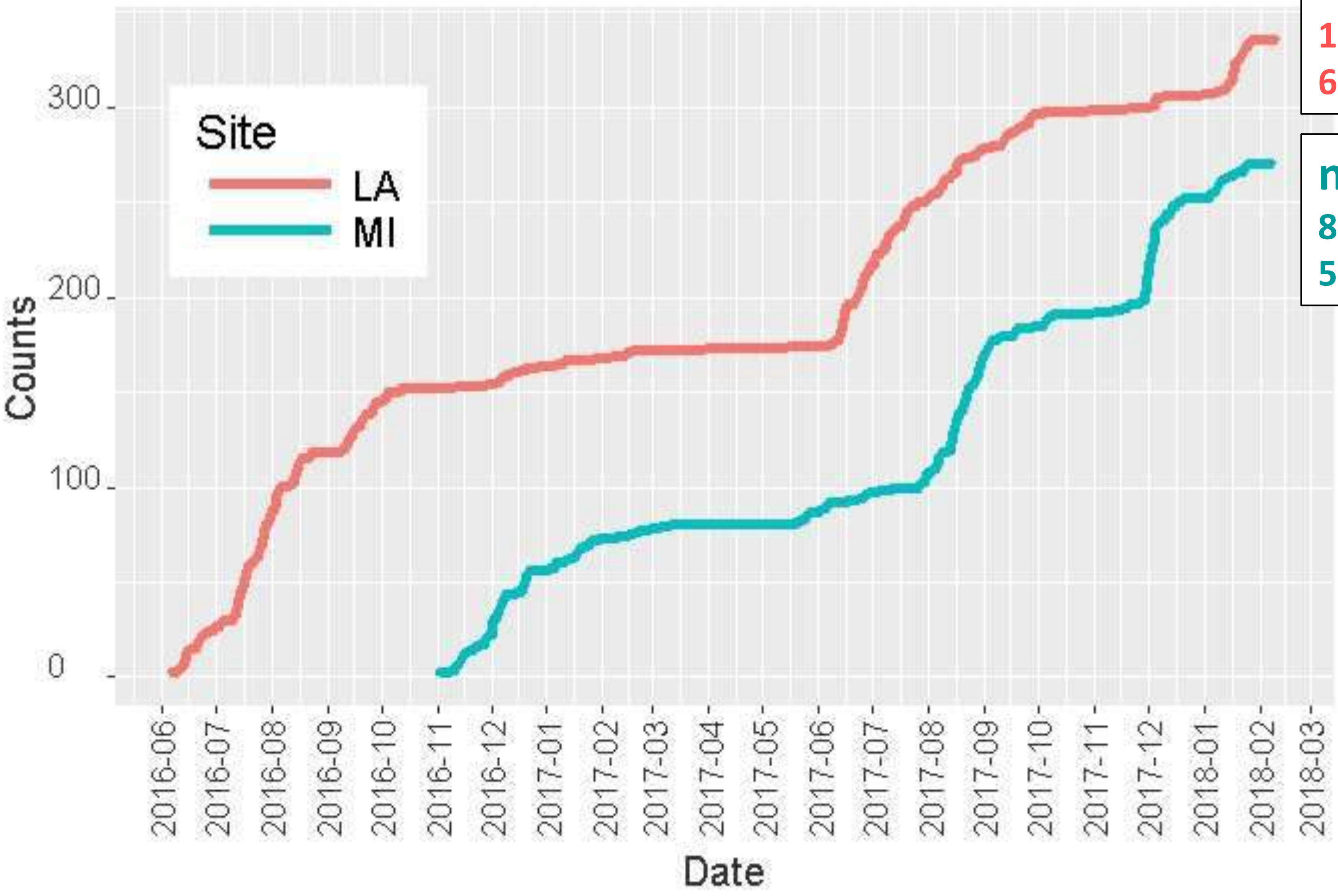


n=336
123 seeds
638 coupons

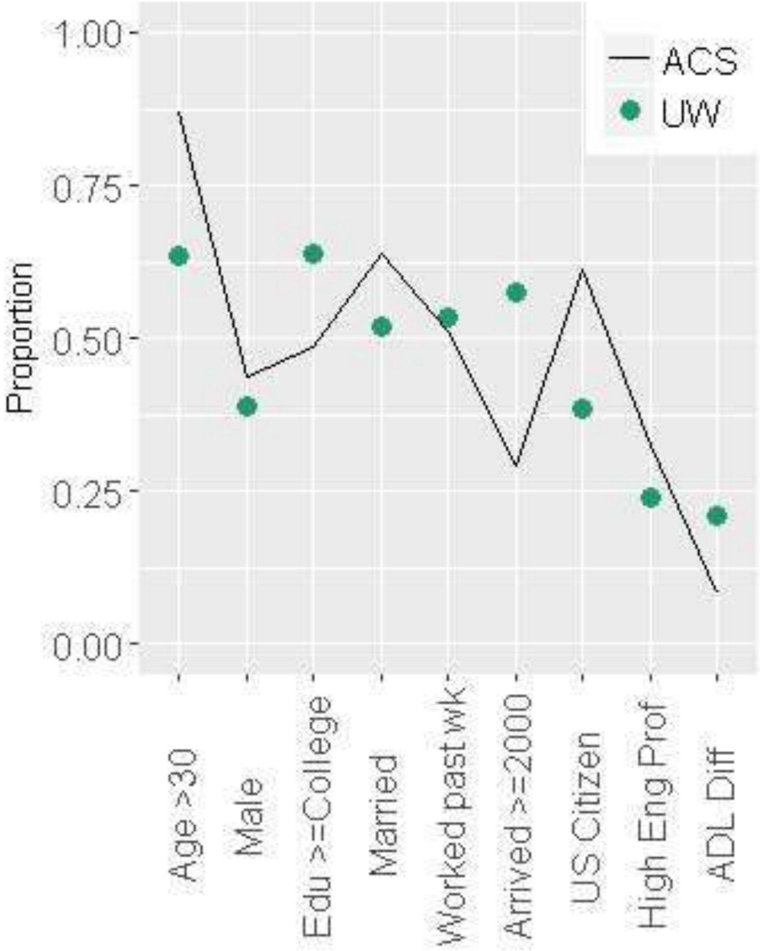
n=270
88 seeds
519 coupons

HLSK vs. ACS – 1

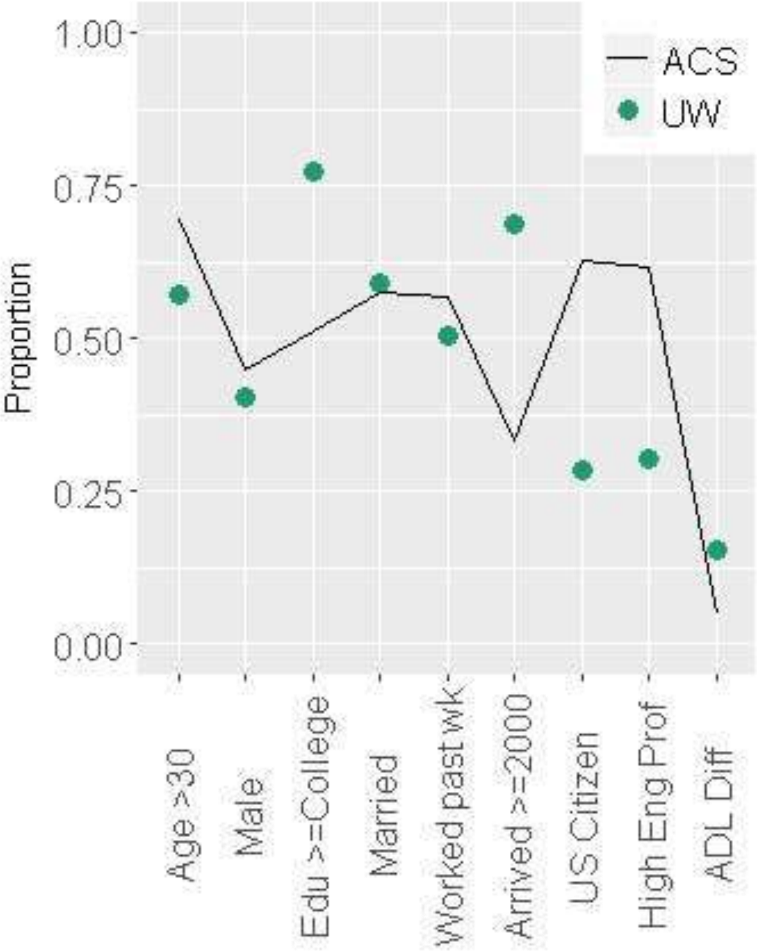
- American Community Survey 2011-2015 data
- HLSK sample estimates
  - Unweighted (UW)
  - RDS-I
  - Weighted: RDS-II
  - Weighted: Post-stratification (PS) by age, sex, educ
  - Weighted: RDS-II + PS

HLSK vs. ACS – 2

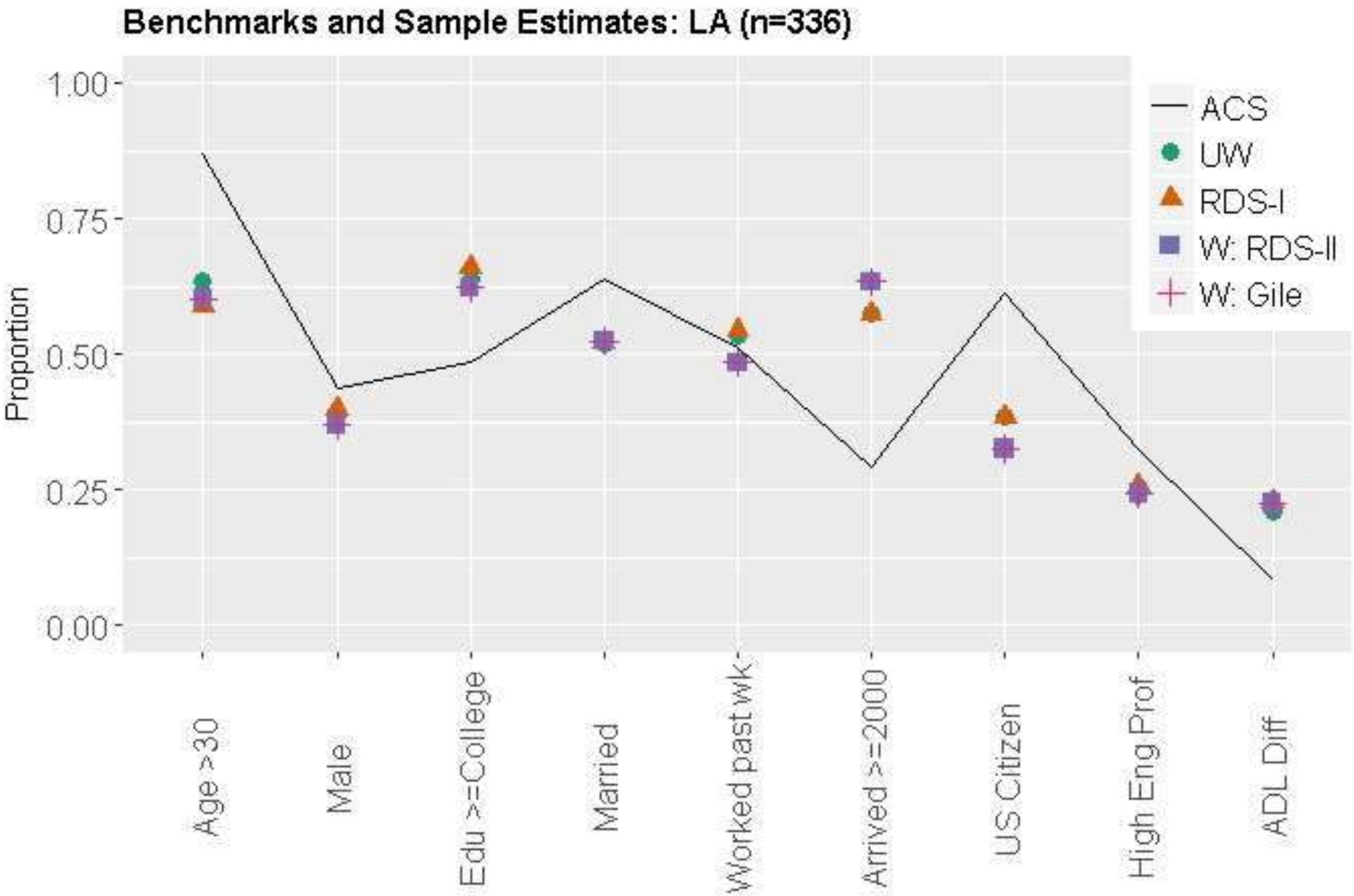
LA Estimates (n=336)



MI Estimates (n=270)



HLSK vs. ACS – 3



Benchmarks and Sample Estimates: LA (n=336)
Proportion
1.00
0.75
0.50
0.25
0.00
ACS
UW
RDS-I
W: RDS-II
W: Gile
Age >30
Male
Edu >=College
Married
Worked past wk
Arrived >=2000
US Citizen
High Eng Prof
ADL Diff

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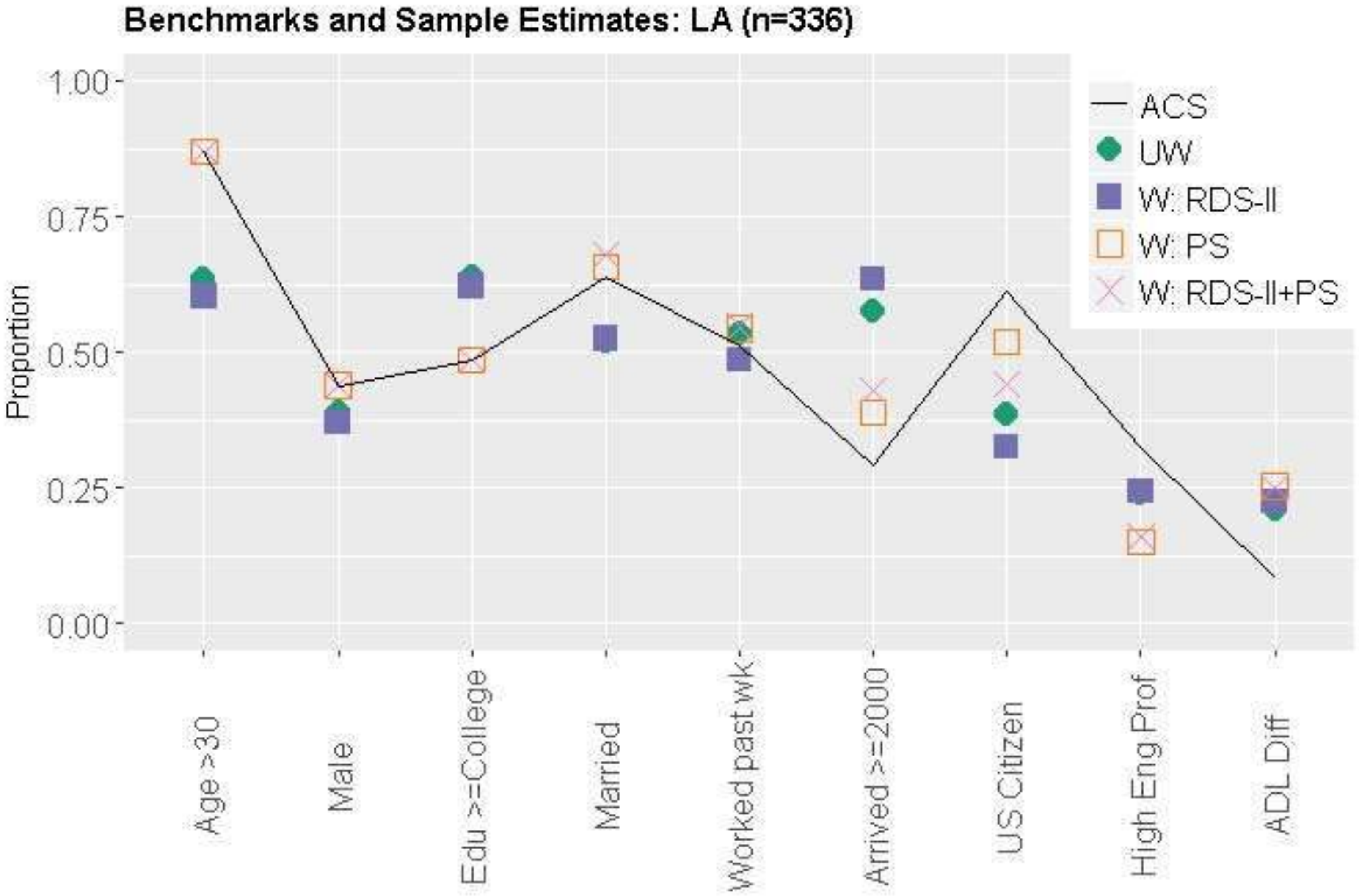
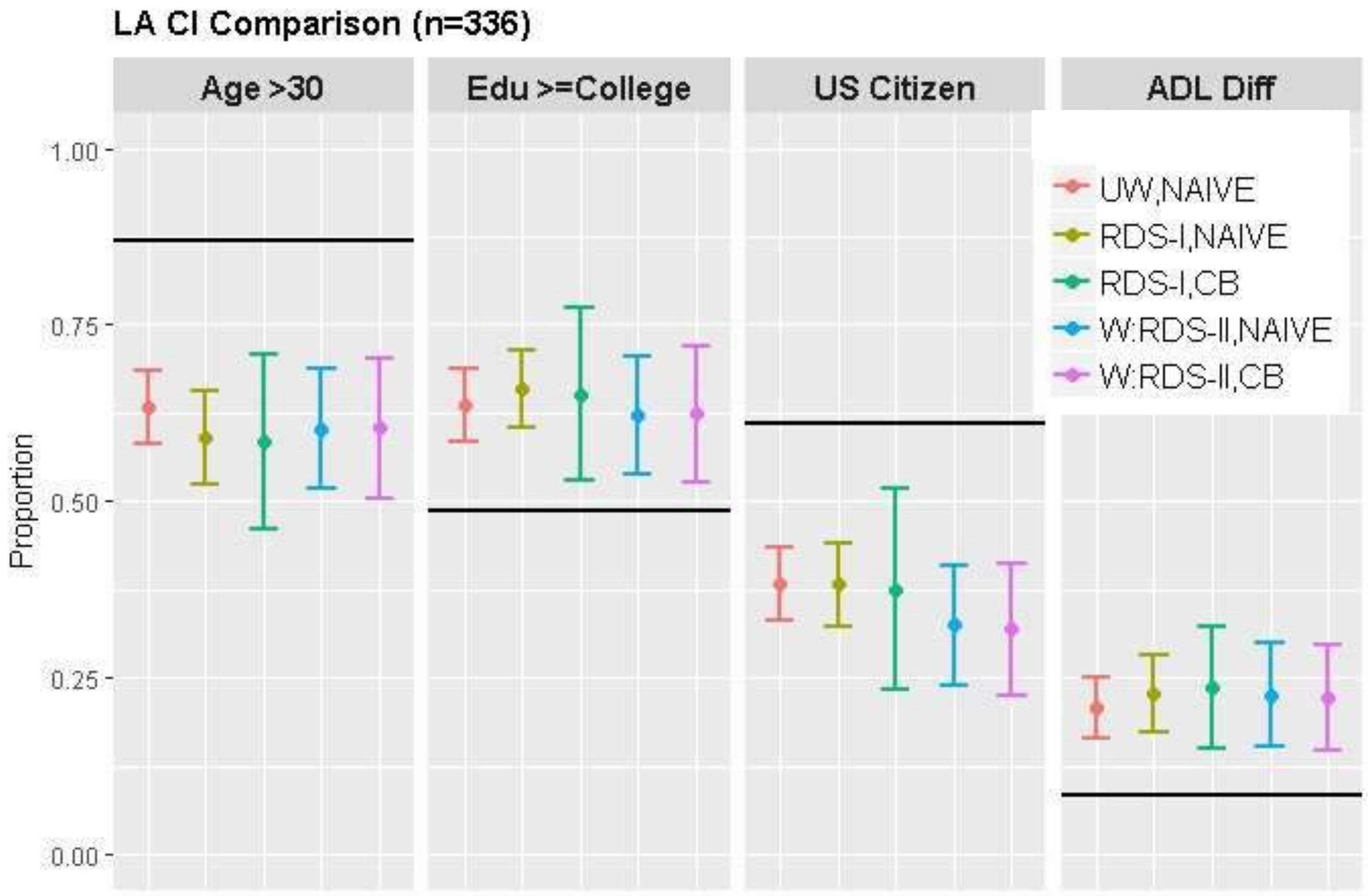
HLSK vs. ACS – 4



HLSK vs. ACS – 5

- HLSK sample estimate CI
  - Unweighted (UW), Naïve
  - RDS-I, Naïve
  - RDS-I, Chain-bootstrap (CB)
  - Weighted: RDS-II, Naïve
  - Weighted: RDS-II, CB

HLSK vs. ACS – 6


LA CI Comparison (n=336)
Age >30
Edu >=College
US Citizen
ADL Diff
Proportion
1.00
0.75
0.50
0.25
0.00
UW,NAIVE
RDS-I,NAIVE
RDS-I,CB
W:RDS-II,NAIVE
W:RDS-II,CB

Summary

What did we learn? – 1

- Non-cooperation is an issue for generating long chains (memorylessness unlikely)
- Had to improvise to make RDS “work”
- Sample size (hence, chain length) is a random variable affected by many (mostly unknown) factors
- Inferences unclear and limited

What did we learn? – 2

- YET, difficult-to sample groups can be recruited
  - highly-educated young recent immigrants
  - low Korean density areas (e.g., MI UP)

Where should we go?

- Non-cooperation is critical for
  - meeting theoretical assumptions (hence, inferences)
  - study design
  - replications of the same study

- Yet to be addressed in the literature and accounted for in inferences

Thank you

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