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

**WAVE 1**
- Seed 1
- Seed 2
- Seed 3
- Seed S
- Recruitment Coupon

**WAVE 2**
- Recruit 1
- Recruit 2
- Recruit 3

**WAVE 3**
- Recruit 1
- Recruit 2
- Recruit 3

**WAVE \(W\)**
- Recruit 1
- Recruit 2
- Recruit 3
- Recruit \(R - 2\)
- Recruit \(R - 1\)
- Recruit \(R\)

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Respondent Driven Sampling – 4

WAVE 1: Seed 1 → Recruit 1 → Recruit 2 → Recruit 3

WAVE 2: Seed 1 → Recruit 1 → Recruit 2 → Recruit 3

WAVE 3: Seed 1 → Recruit 1 → Recruit 2 → Recruit 3

WAVE W: Recruit 1 → Recruit 2 → Recruit 3

Recruitment Chain:
- Seed 1
- Recruit 1
- Recruit 2
- Recruit 3

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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: $\hat{p}_{B}^{RDS-I} = S_{AB} \dd_A / (S_{AB} \dd_A + S_{BA} \dd_B)$

RDS-II: $\hat{p}^{RDS-II} = \sum_{i \in S} (\dd_i^{-1} y_i) / \sum_{i \in S} \dd_i^{-1}$

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

- $S_{AB}$: 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)
- $\dd_A = \sum_{i \in A} \dd_i / n_A$
- $\dd_i$ is degree reported by respondent $i$
  - Large degree $\rightarrow$ high selection probability $\rightarrow$ small “weight”
- $n_A$ is the sample size of $A$
- $y_i$: Outcome variable
- $\hat{\pi}(\dd_i)$: estimated population distribution of degrees through successive sampling
RDS Inferences: Sampling Variance – 1

• Naïve estimator

• Direct estimator by Volz-Heckathorn ($\hat{\theta}^{VH}$)
  - 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 ($\hat{\nu}^S$)
  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
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/](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

- Site LA: n=336, 123 seeds, 638 coupons
- Site MI: n=270, 88 seeds, 519 coupons

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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)

Proportion

Age > 30, Male, Edu >= College, Married, Worked past wk, Arrived >= 2000, US Citizen, High Eng Prof, ADL Diff

ACS

UW

ACS

UW

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HLSK vs. ACS – 3

Benchmarks and Sample Estimates: LA (n=336)
HLSK vs. ACS – 4

Benchmarks and Sample Estimates: LA (n=336)
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)

<table>
<thead>
<tr>
<th>Age &gt;30</th>
<th>Edu &gt;=College</th>
<th>US Citizen</th>
<th>ADL Diff</th>
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</table>

Proportion

- 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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References


