Sensitivity Analysis for Missing Data

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- Cases that drop from a sample across time, i.e. attrition
  - Longitudinal study of twins
  - Study of whale migration patterns using attached GPS trackers

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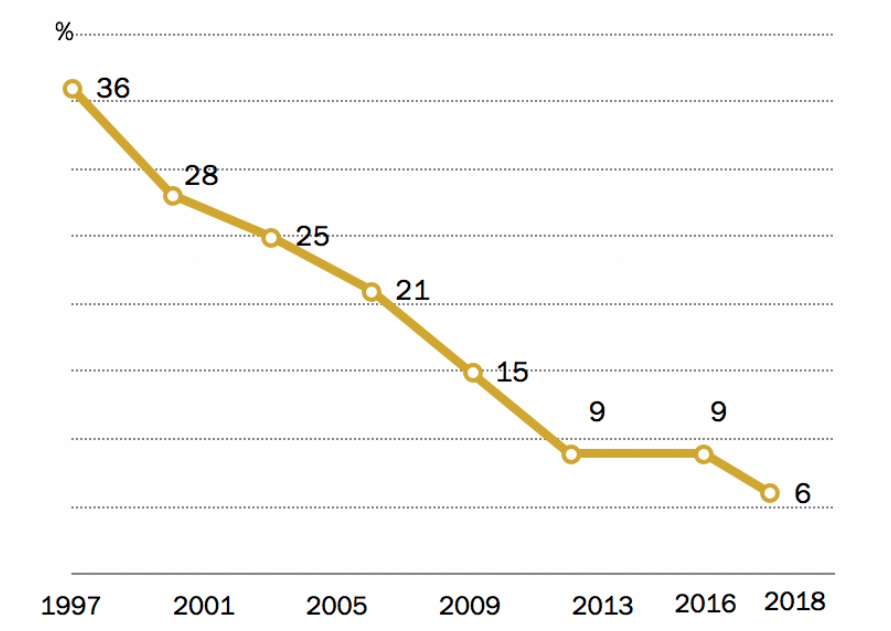
  - Potentially biased samples, when missing cases are different from those observed
- A much bigger problem when we deal with human participants
  - People have agency and might prefer not to be studied
  - For reasons of: anonimity (e.g. census), social desirability (e.g. self-reported xenophobic attitudes), mistrust (ethnicity), lack of spare time (e.g. self-completed questionnaires)
  - Samples will often be not representative of the population

Introduction

After brief plateau, telephone survey response rates have fallen again

Response rate by year (%)



Note: Response rate is AAPOR RR3. Only landlines sampled 1997-2006. Rates are typical for surveys conducted in each year.
Source: Pew Research Center telephone surveys conducted 1997-2018.

PEW RESEARCH CENTER

Implications

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  - Missing completely at random (MCAR)
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- What we do about it
  - Nothing (listwise deletion)
  - Use auxiliary data (e.g. probability weights, multiple imputation, full information maximum likelihood)
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- Missing data not at random (MNAR)
  - When neither MCAR nor MAR hold; the probability of the data being missing varies for reasons that are unknown to us
  - E.g. Offenders who believe to have been subjected to discrimination by the criminal justice system will be less likely to report their ethnicity
  - It is not easily adjustable; we can rely on sensitivity analysis to assess the extent of the bias under different scenarios

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2	-	Common assault	10	Custody
3	-	Common assault	5	Non-custody
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Imputation

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  - Each missing case replaced with a value from a similar observation in the dataset
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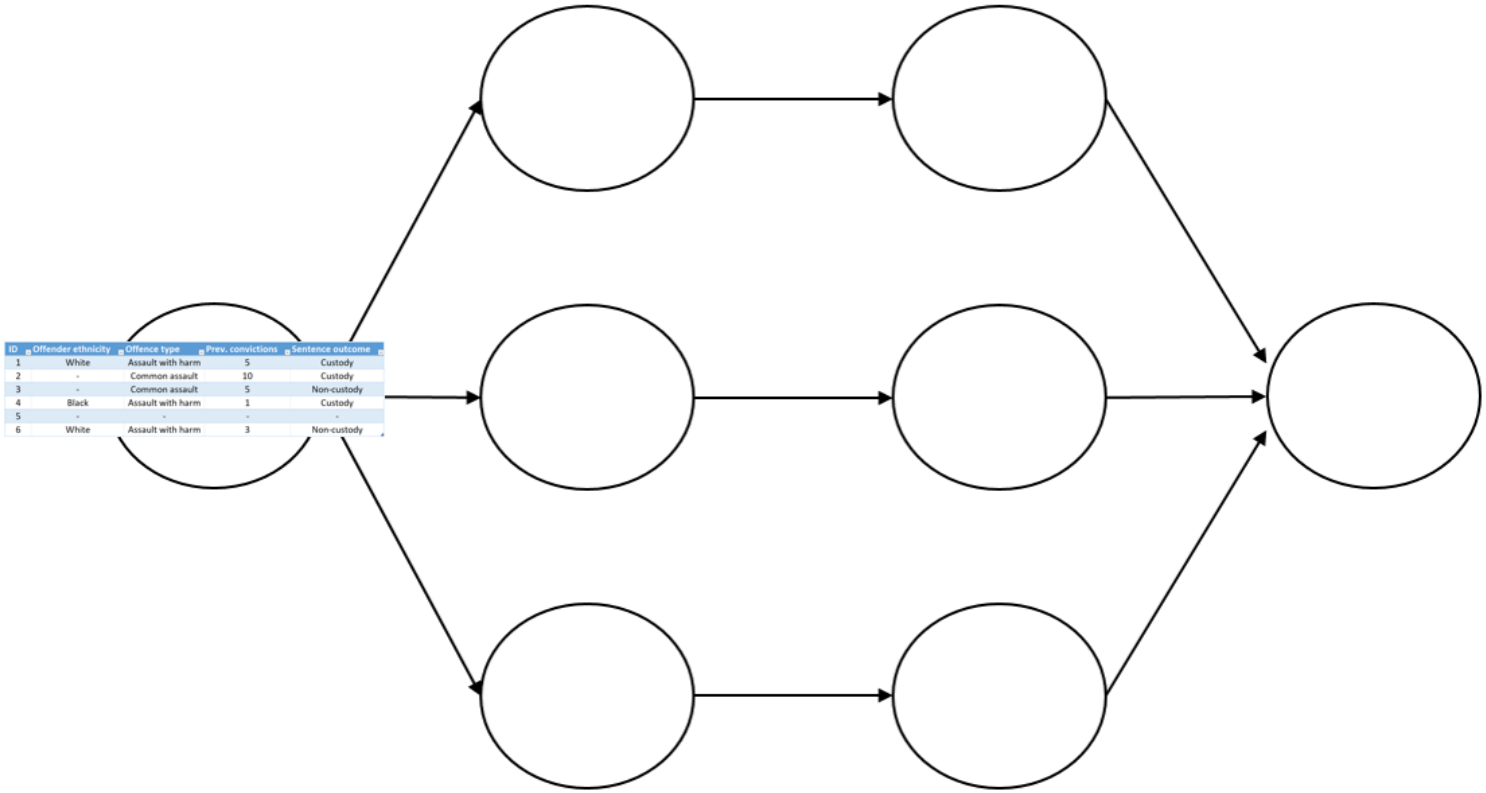
- Multiple imputation
  - Each missing value is replaced with multiple plausible values to generate multiple complete data sets
  - Having multiple values eliminates the problem of treating imputed cases as real data, i.e. accounts for the uncertainty of the imputation process
  - The analysis is conducted in each of those datasets, results from each analysis are saved and pooled into an average of estimates

Multiple Imputation



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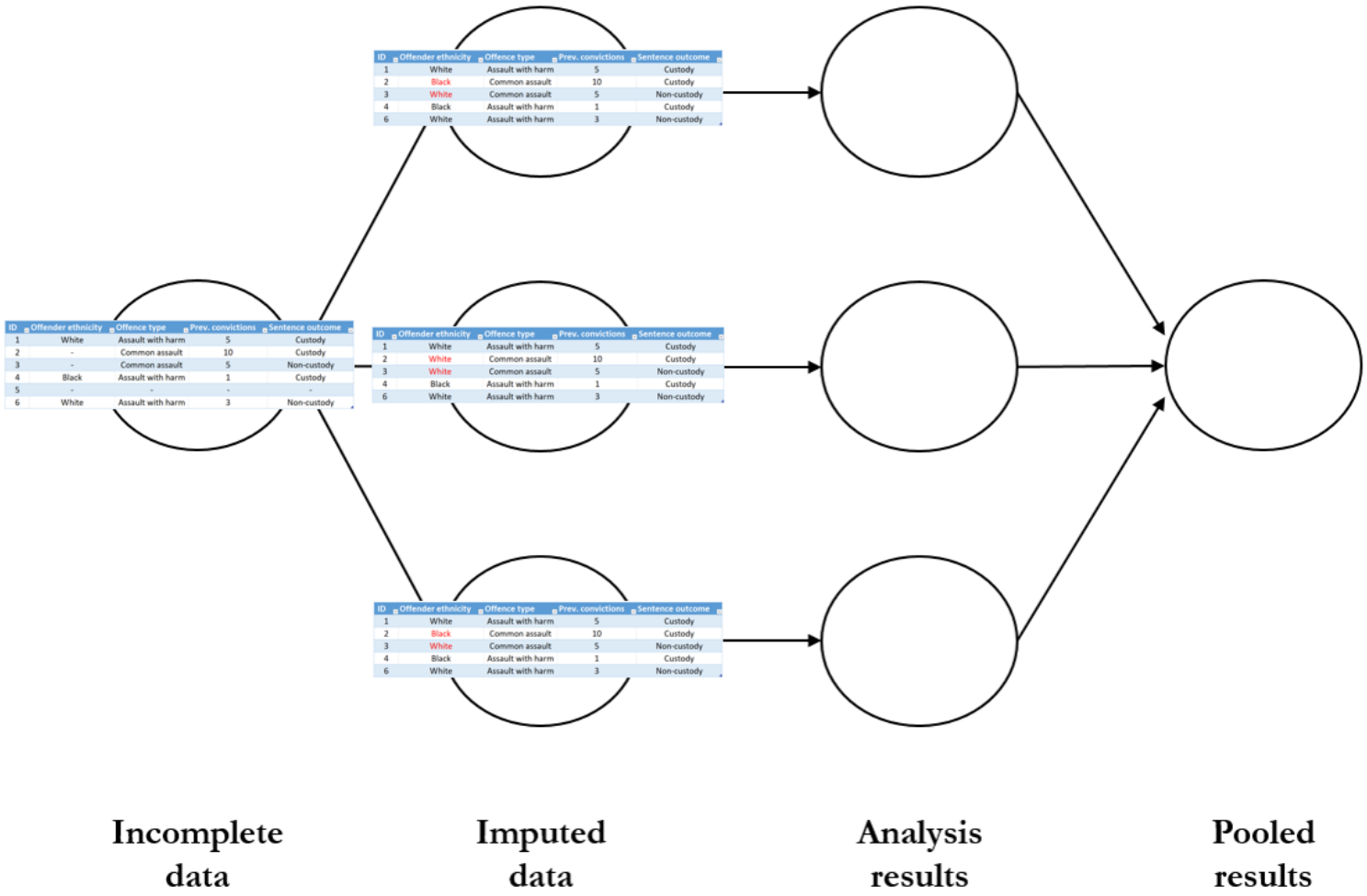

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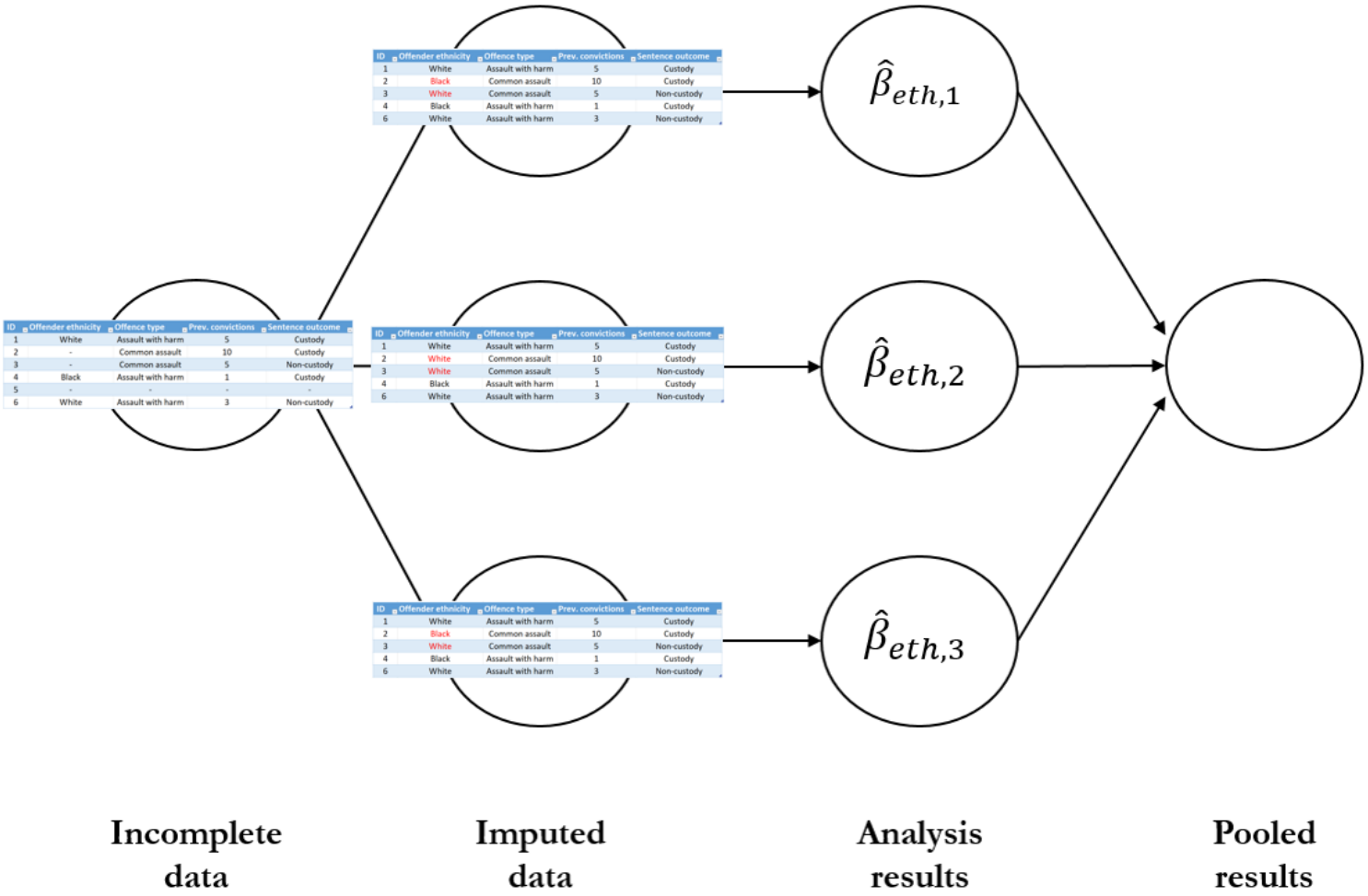

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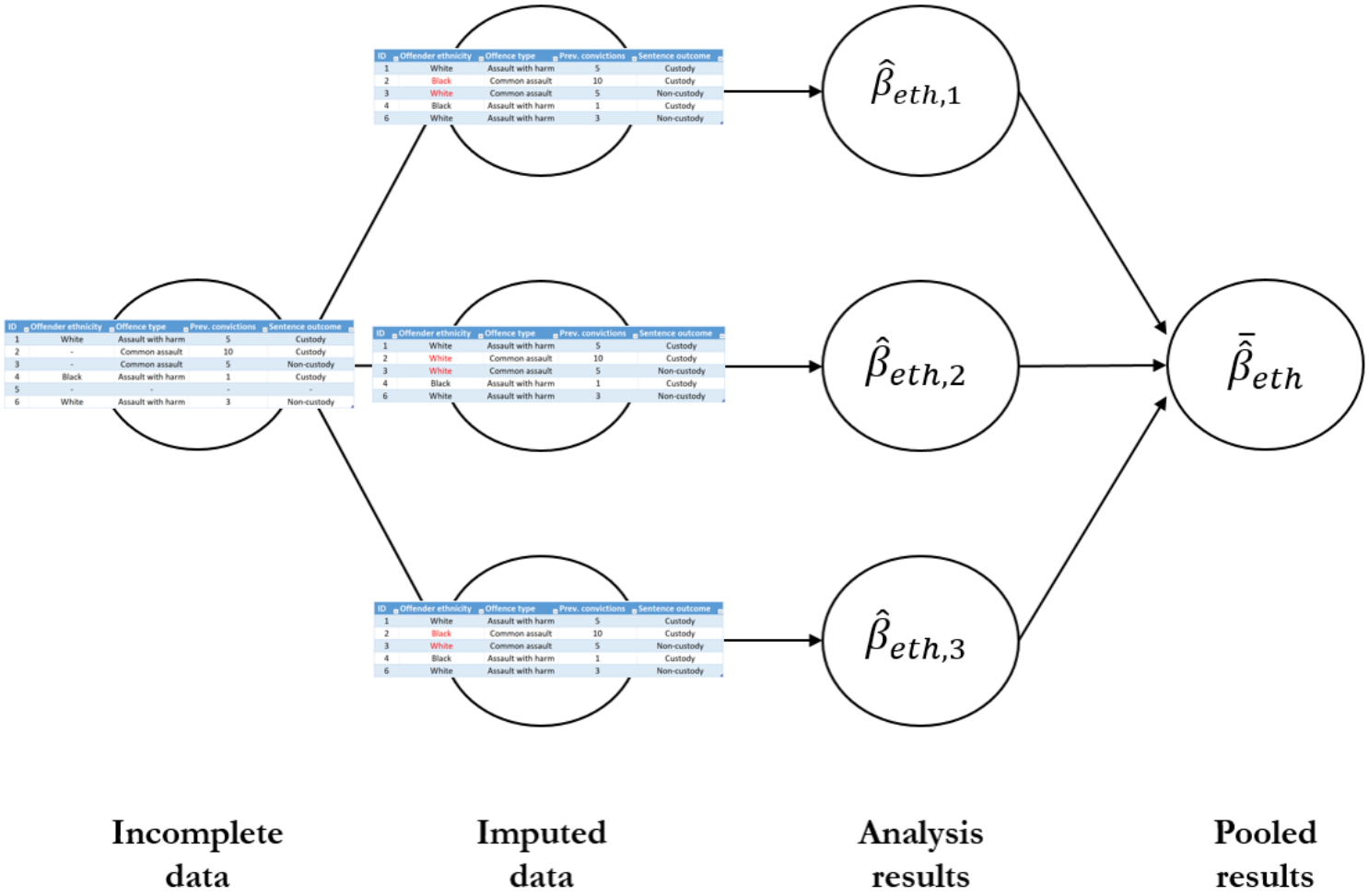

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- We can still rely on subjective or imperfect insights about the mechanisms behind the missingness
- For example, insights based on ...
  - Administrative data exploring the same population
  - Missing data analyses undertaken on different populations (i.e. literature review)
  - Interviews with experts, or individuals from the target population
  - Our own educated guess

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- Question: Have you encountered similar MNAR problems?

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- Then we replicate our analysis using the simulated data and note discrepancies in our estimates of interest

Sensitivity Analysis

- To undertake effective sensitivity analysis need to rely on two key skills
- Develop a good intuition about the missing mechanism
  - Subject specific knowledge, our key strength as social scientists
- Turn that 'soft' knowledge into statistical simulations
  - We will see how in the practical
  - Where we will explore different forms of missing ethnicity data in a study of disparities in sentencing

Workshop

- We will structure the practical as follows
  - Present the dataset (a pre-formatted version of Crown Court data from the Sentencing Council)
  - Estimate our naive model showing the effect of offenders' ethnicity on the probability of receiving a custodial sentence after controlling for key case characteristics
  - Simulate MCAR, MAR, and MNAR to assess their impact the effect of ethnicity that we have naively assumed when we disregard the missing data
  - Repeat this process for sentence length (if we have time)

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    Question: What would be the problem of relying just on multiple imputation in our example where offender's ethnicity is MNAR?
  - Undertaking sensitivity analysis to assess the robustness of our findings should be the default