Data Anonymization for Open Science

useR! 2024

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About Speakers

Jiří Novák

- Ph.D. in Statistics with topic Simulation of Synthetic Microdata
- Statistical confidentiality of Czech Census 2021

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Context of Anonymization

Statistical Disclosure Control (SDC) or Statistical Disclosure Limitation (SDL) seeks to protect statistical data in such a way that they can be released without giving away confidential information that can be linked to specific individuals or entities.

Why is confidentiality protection important?

There are three main reasons:

1. **Principle** It is a fundamental principle for Official Statistics that the statistical records of individual persons, businesses or events used to produce Official Statistics are strictly confidential, and are to be used only for statistical purposes.
2. **Legal** Legislation places a legal obligation to protect individual business and personal data. Legal frameworks regulate what is allowed and what is not allowed with regard to publication of private information.
3. **Quality** Respondents need confidence in the preservation of the confidentiality of individual information.
4. **Ethical**: It is unethical to disclose information that can be linked to specific individuals or entities.

Motivation

- Legal frameworks regulate what is allowed and what is not allowed with regard to publication of private information.
- Before sensitive statistical databases can be made available to universities for research, confidentiality must be guaranteed.
- Users of statistical outputs should be aware of the reasoning and methodology behind statistical disclosure control.

Outputs

Different outputs require different approaches to SDC and different mixtures of tools.

- Macrodata (Tabular data)
- Microdata
- Dynamic databases
- Statistical analyses

Disclosure

A disclosure occurs when a person or an organisation recognises or learns something that they did not know already about another person or organisation, via released data.

Types of disclosure risk:

(1) Identity disclosure and
(2) Attribute disclosure.
(3) Inferential disclosure

Risk and utility

SDC seeks to optimise the trade-off between the disclosure risk and the utility of the protected released data.

- Risk: the probability of a disclosure event occurring.
- Utility: the usefulness of the data for the intended purpose.
- The goal is to find a balance between risk and utility.

Risk-utility trade-off

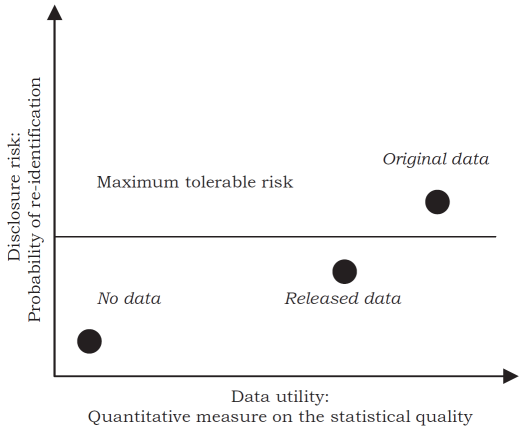

Figure 1: R-U confidentiality map (Duncan et al.,2001)

Disclosure risk

A unit is at risk of disclosure when it cannot be confused with several other units

k-anonymity

A data set is said to satisfy k-anonymity for $k > 1$ if, for each combination of values of quasi-identifiers (e.g. name, address, age, gender, etc.), at least k records exist in the data set sharing that combination.

Variables

1. Identifiers
2. Quasi-identifiers or key variables
3. Confidential outcome variables
4. Non-confidential outcome variables

Disclosure control methods

1. Masking original data
    i. Non-perturbative masking.
    ii. Perturbative masking.
2. Generating synthetic data

Non-perturbation methods

Non-perturbative masking does not rely on distortion of the original data but on partial suppressions or reductions of detail.

Table 1: Non-perturbative methods vs. data types.

Method	Continuous data	Categorical data
Sampling		X
Global recoding	X	X
Top and bottom coding	X	X
Local suppression		X

sdcMicro

- sdcMicro is an R package for statistical disclosure control.
- https://cran.r-project.org/web/packages/sdcMicro/index.html
- https://github.com/sdcTools/sdcMicro

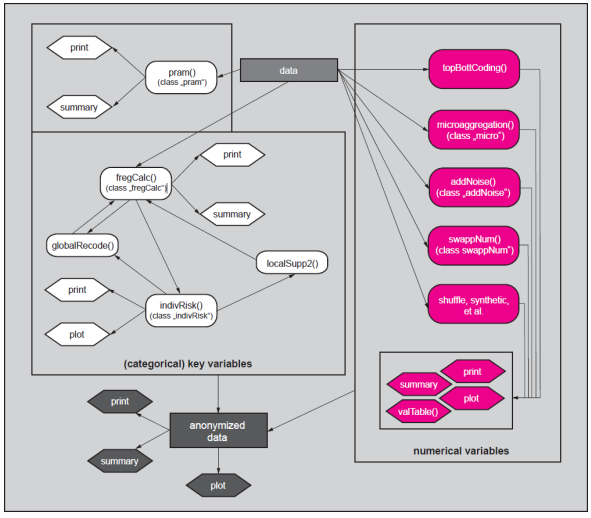

Figure 2: Certain procedures in package *sdcMicro* and their relationship

Perturbation methods

- sdcMicro

Synthetic methods

- synthpop
- simPop
- GANs