The Avatar method: computation of synthetic data and application in health

Olivia Rousseau, CR2TI, Nantes Université

Conflict of interest

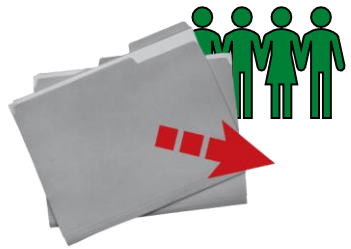
PA Gourraud is the founder of Methodomics(2008) and the co-founder of Big data Santé (2018). He consults for major pharmaceutical companies,and start-ups, all of which are handled through academic pipelines (AstraZeneca, Biogen, BostonScientific, Cook, Docaposte, Edimark, Ellipses, Elsevier, Methodomics, Merck, Mérieux, Octopize,Sanofi-Genzyme). PA Gourraud is a volunteer board member atAXA non-for-profit mutual insurancecompany (2021). He has no prescription activity with either drugs or devices

Type of data

Sensitive data

Pseudonymized data

Anonymized/Synthetic data



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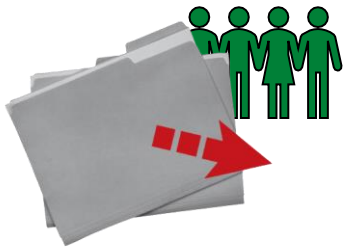

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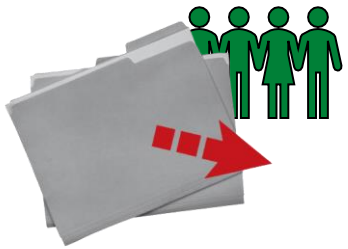


Major issue: Reidentification risk

- GDPR: General Data Protection Regularization

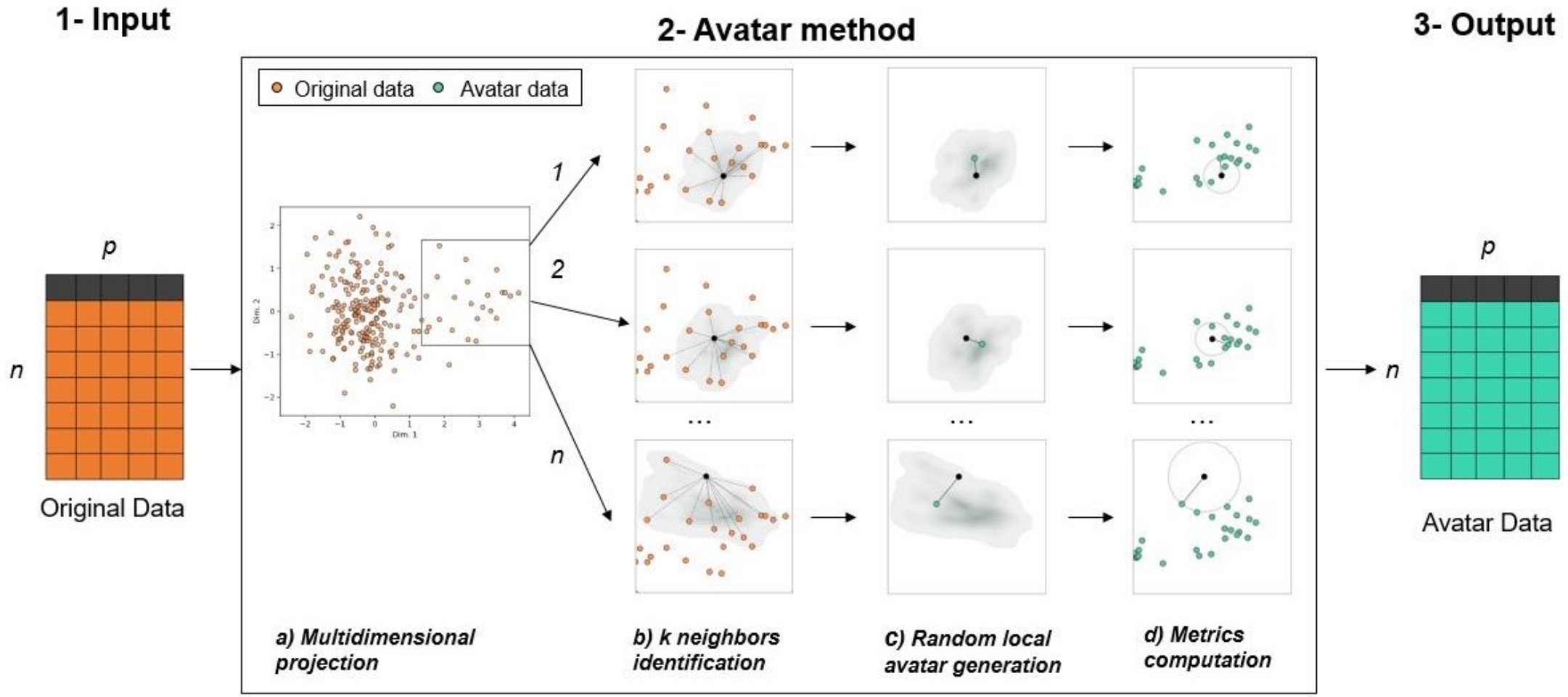
- Evaluation of the robustness of an anonymization process:
  - Singling out
  - Linkability
  - Inference

https://www.cnil.fr/fr/lanonymisation-de-donnees-personnelles

Avatar method

Patient-centric approach

Overview of the Avatar method



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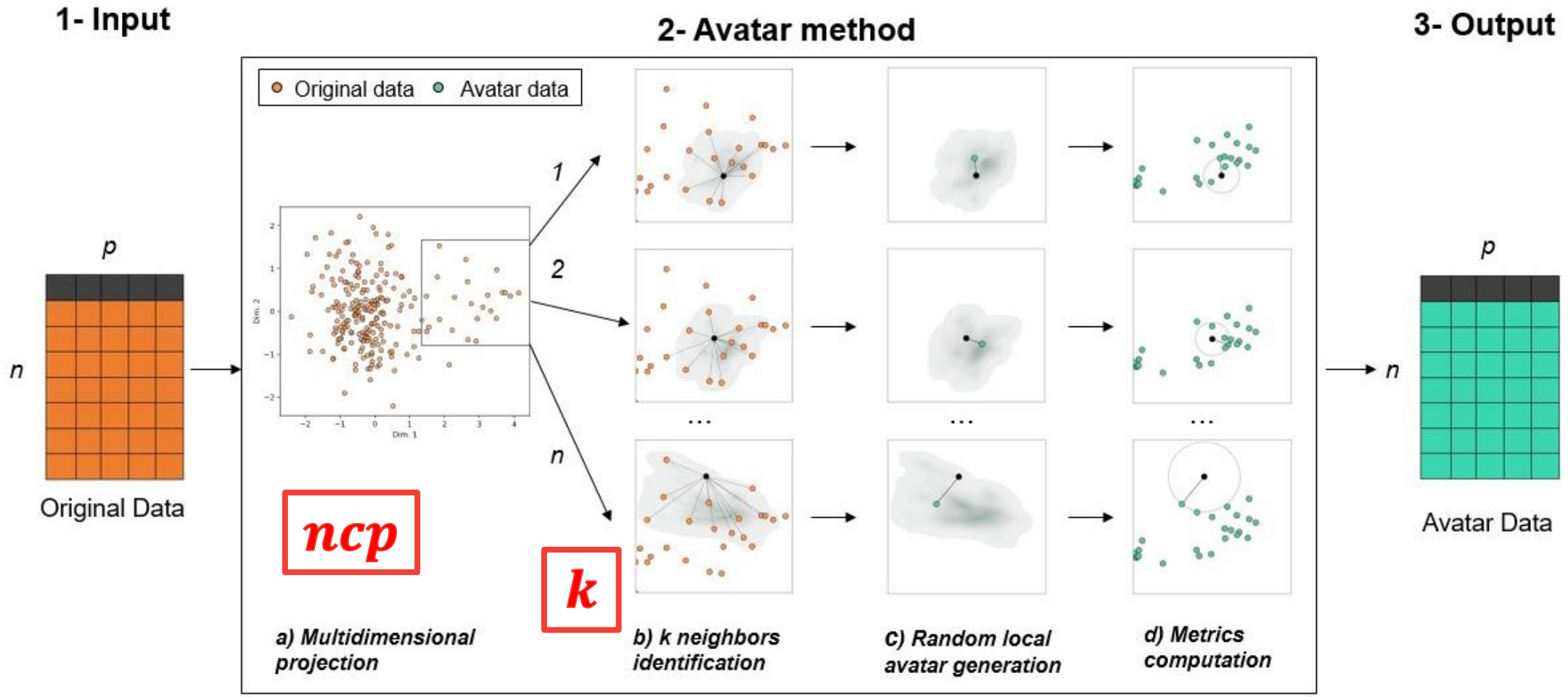
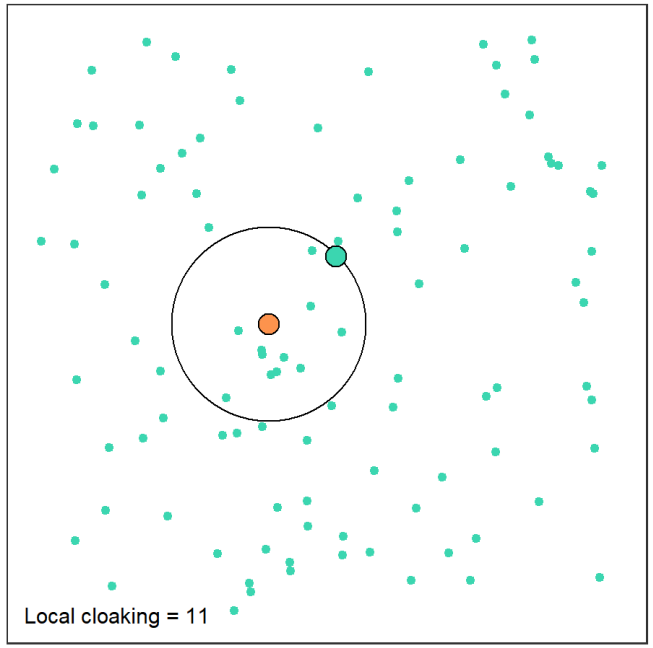
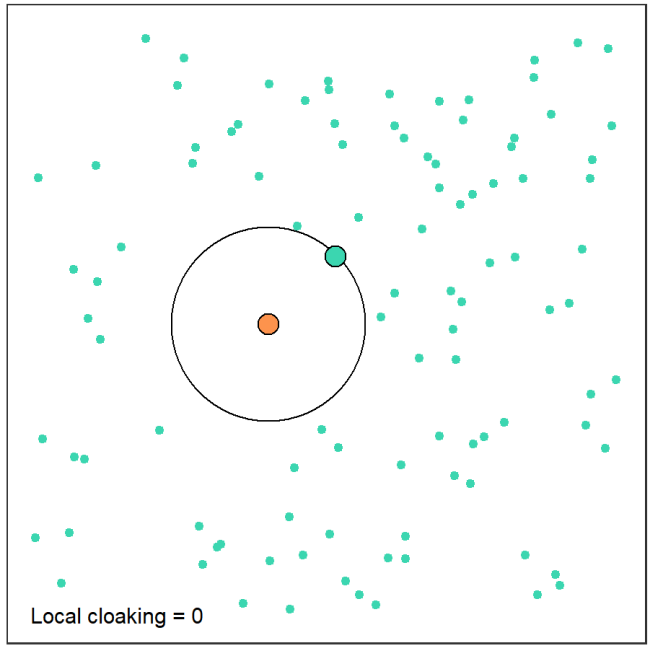


Security metrics

- Local cloaking



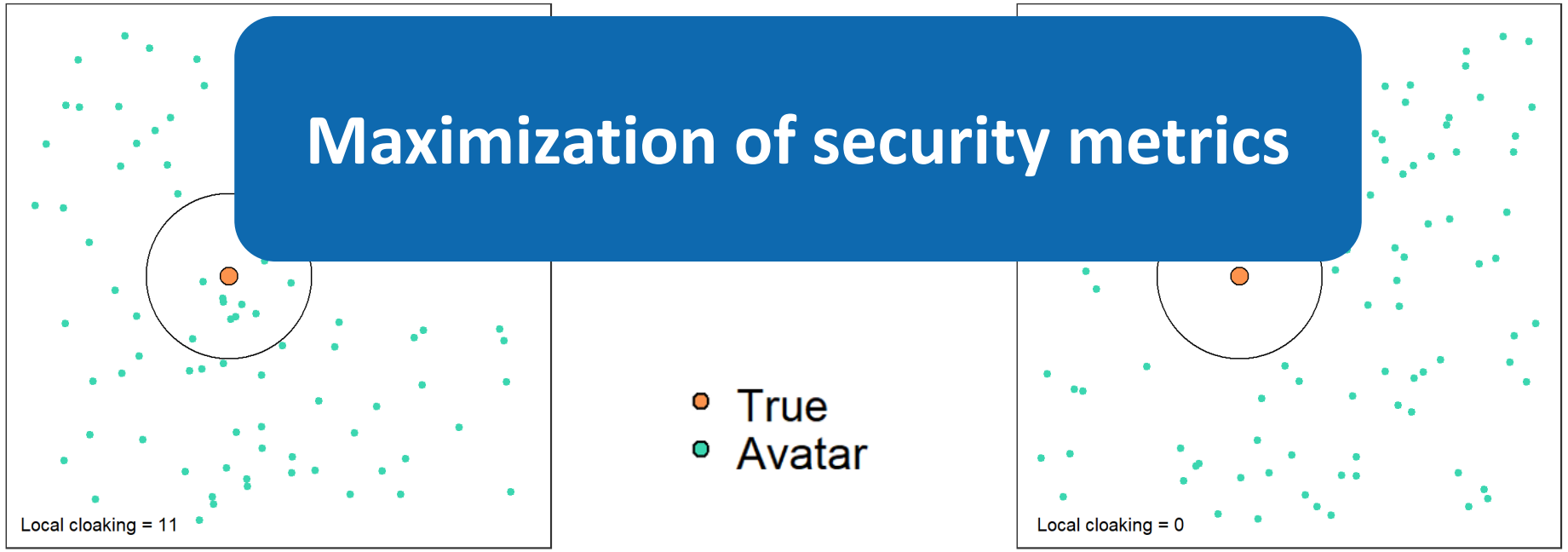
- Hidden rate



True
Avatar

Security metrics

- Local cloaking
- Hidden rate

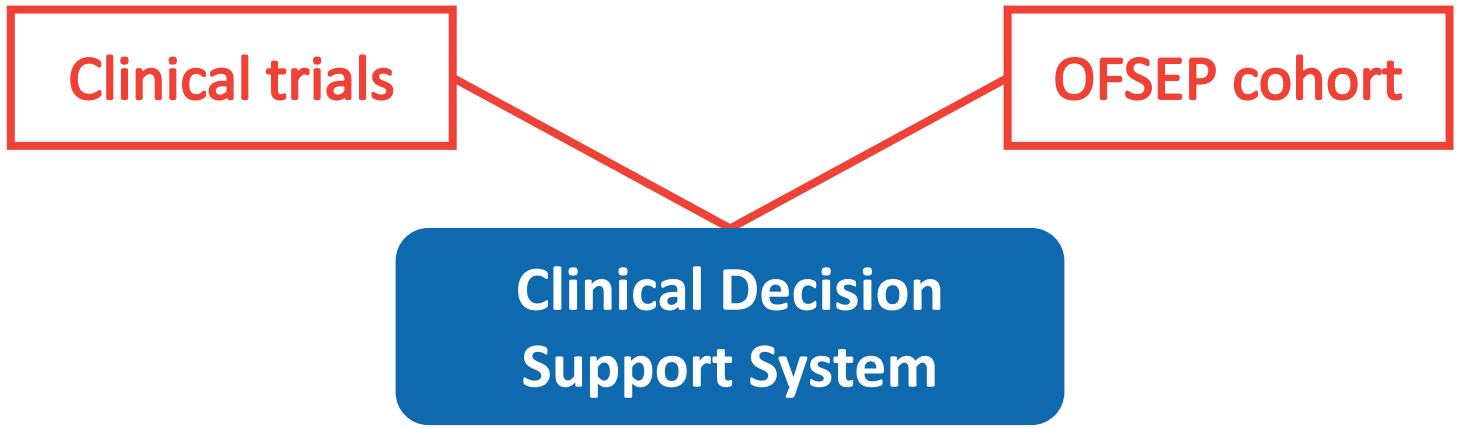


Application in health

PRIMUS project

PRIMUS project

- Multiple sclerosis: autoimmune disease



- **Objective:** Facilitate treatment choice

Data

- Clinical trial REFLEX :
  - Interferon beta-1a treatment doses study
- 518 patients
- 14 variables: 4 categorical and 10 continuous

- Treatments:
  - 172 patients: Placebo (Arm 0)
  - 171 patients: Treatment 3 time per week (Arm 1)
  - 175 patients: Treatment 1 time per week (Arm 2)

https://doi.org/10.1016/S1474-4422(11)70262-9

Data

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- 14 vari
- Treatme

Compare true and avatarized data from published results

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  - 171 patients: Treatment 3 time per week (Arm 1)
  - 175 patients: Treatment 1 time per week (Arm 2)

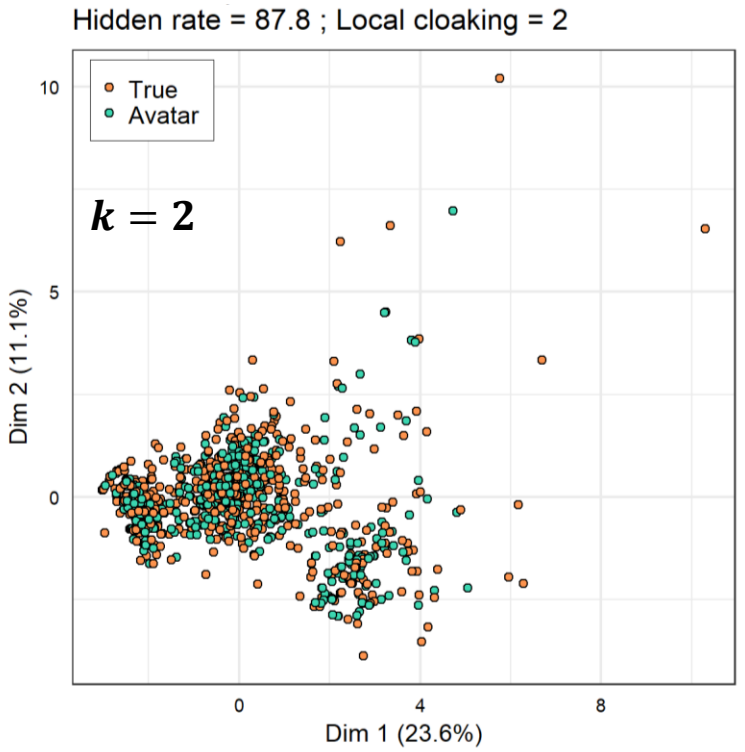
https://doi.org/10.1016/S1474-4422(11)70262-9

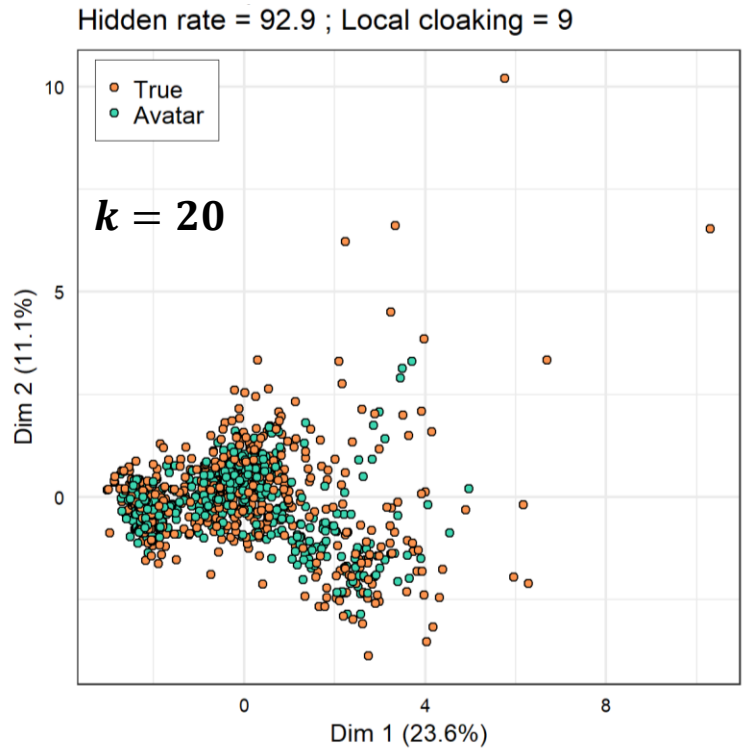
Avatar method – Parameters tests

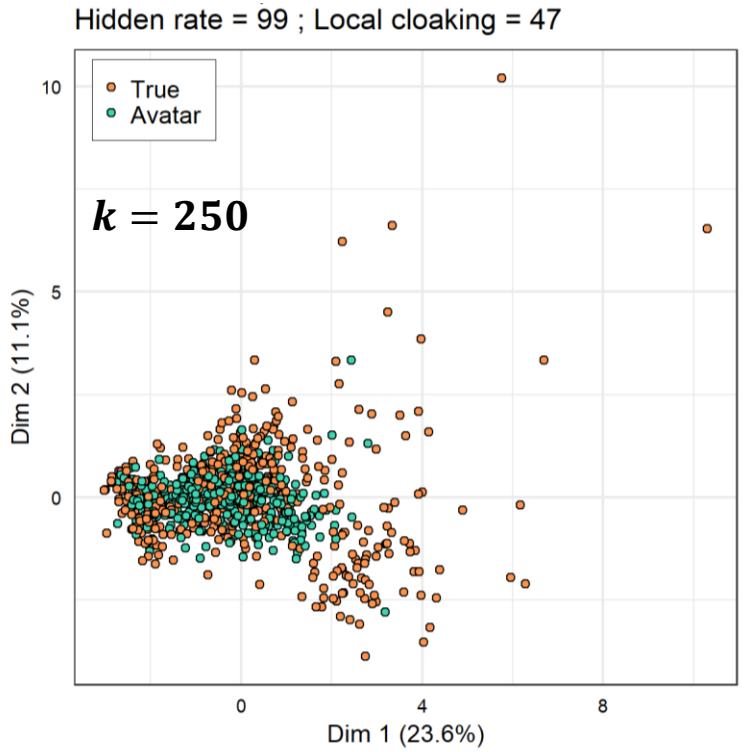
k

- Number of neighbors: $k \in \{2, 5, 10, 20, 50, 100, 250\}$

$ncp = 8$
$\%var = 80$







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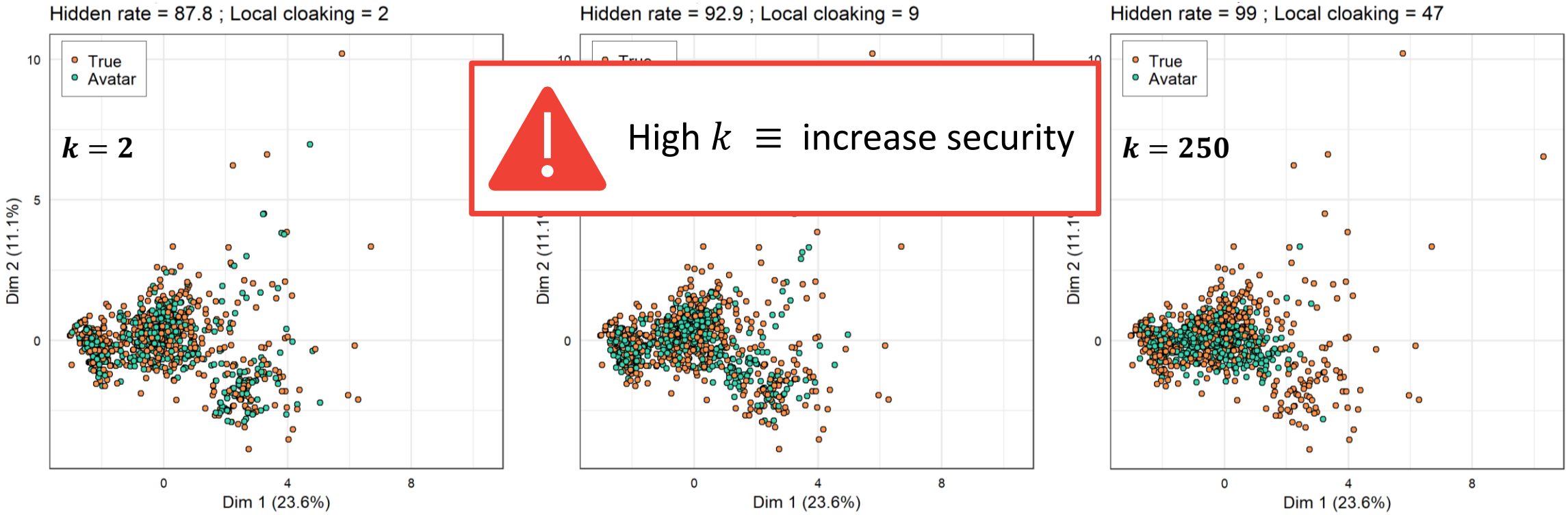


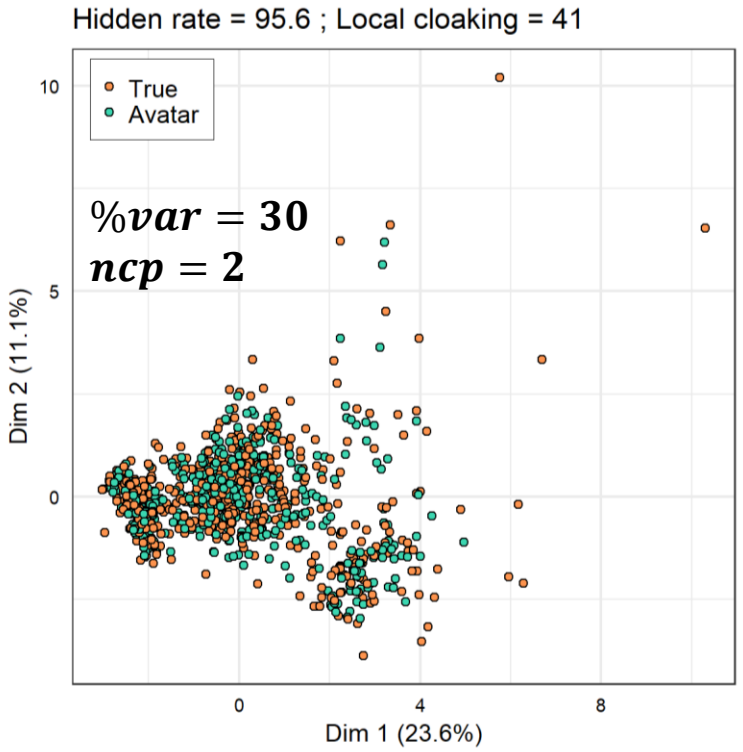
High k ≡ increase security

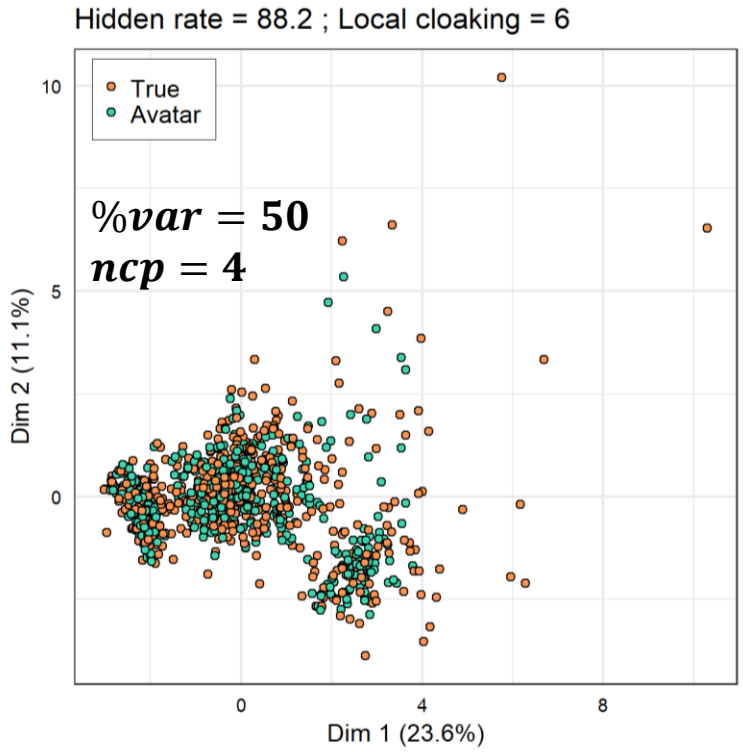
Avatar method – Parameters tests

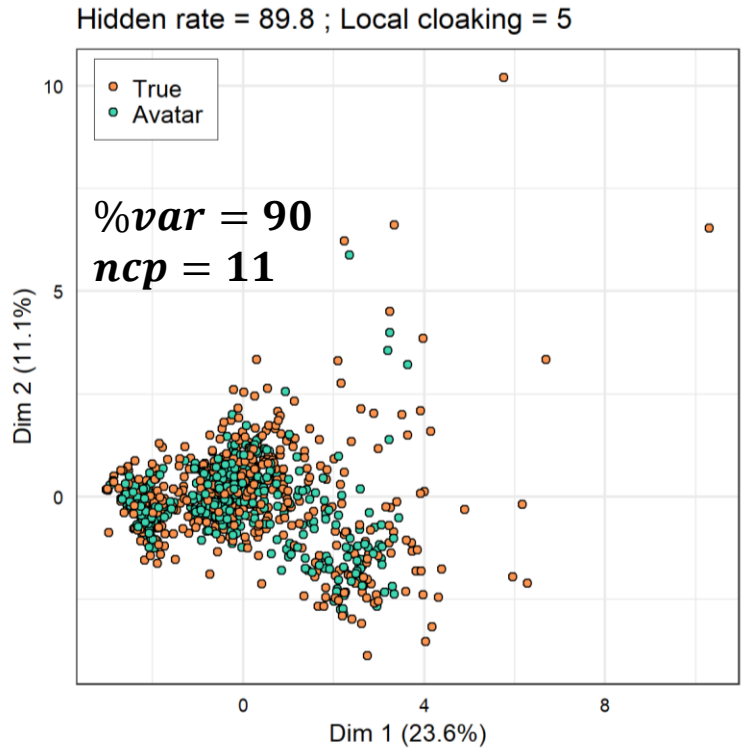
ncp

- % of explained variance: $\%var \in \{30, 50, 80, 90, 100\}$

$k = 10$







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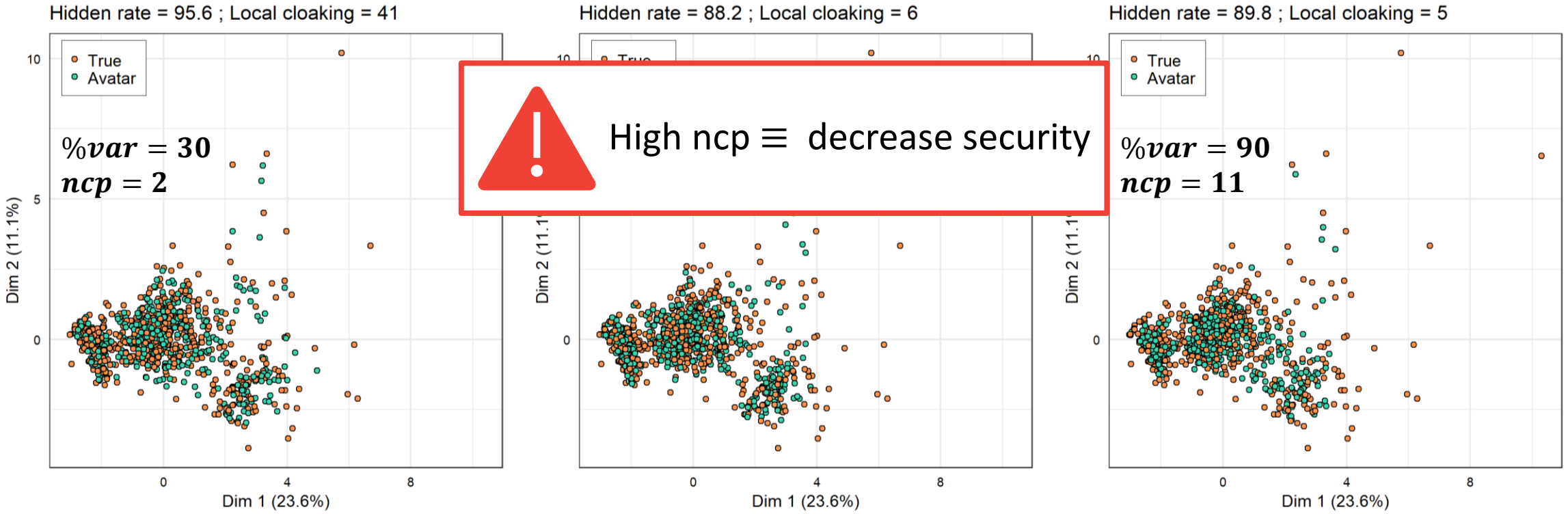

Avatars robustness – 100 synthetic datasets

- Arm 1 vs Placebo – Treatment effect on McDonald criterion (Cox)

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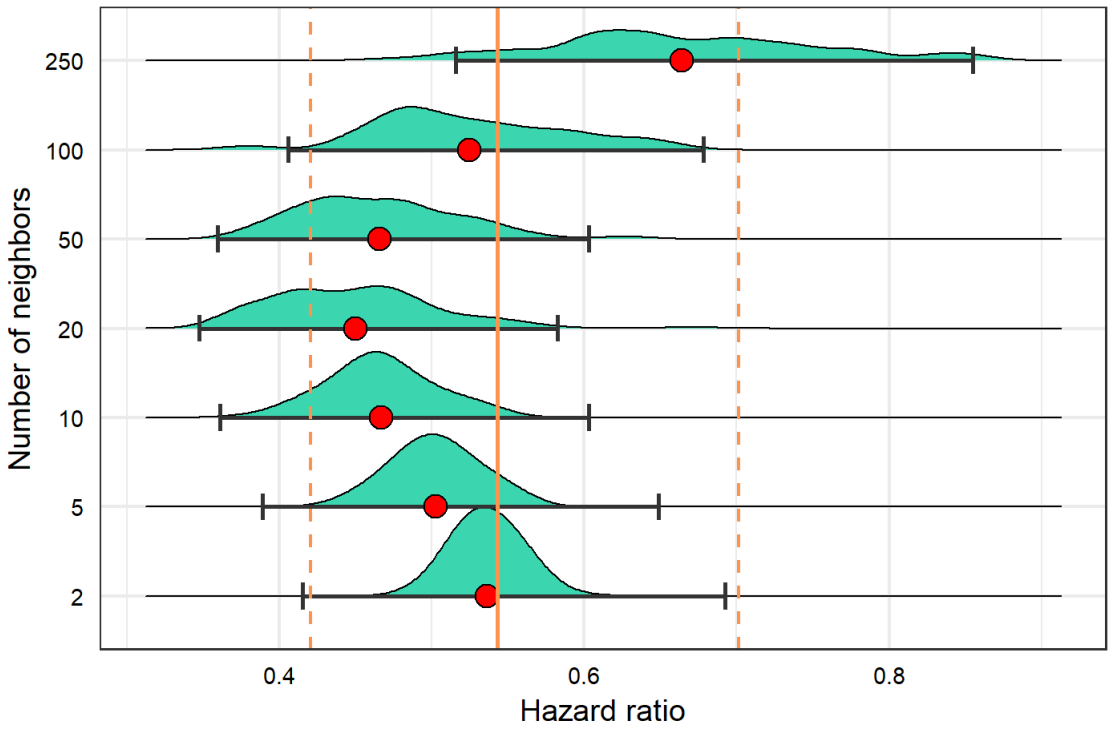

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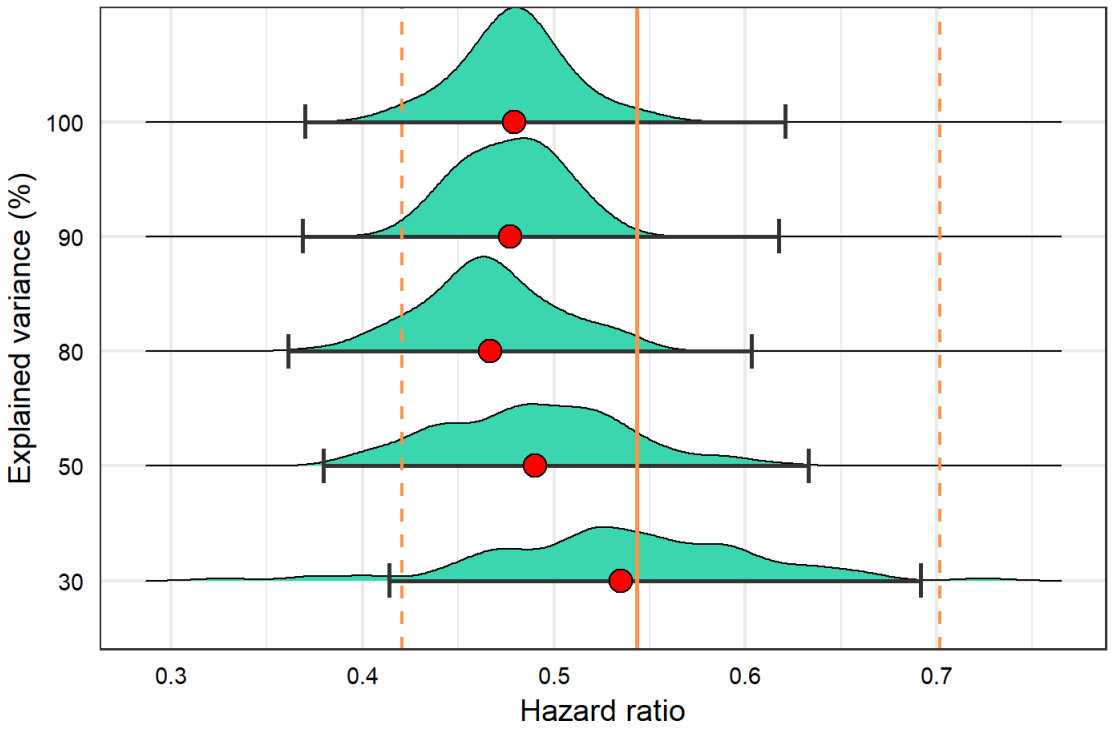

Avatars robustness – 100 synthetic datasets

- Arm 2 vs Placebo – Treatment effect on McDonald criterion (Cox)

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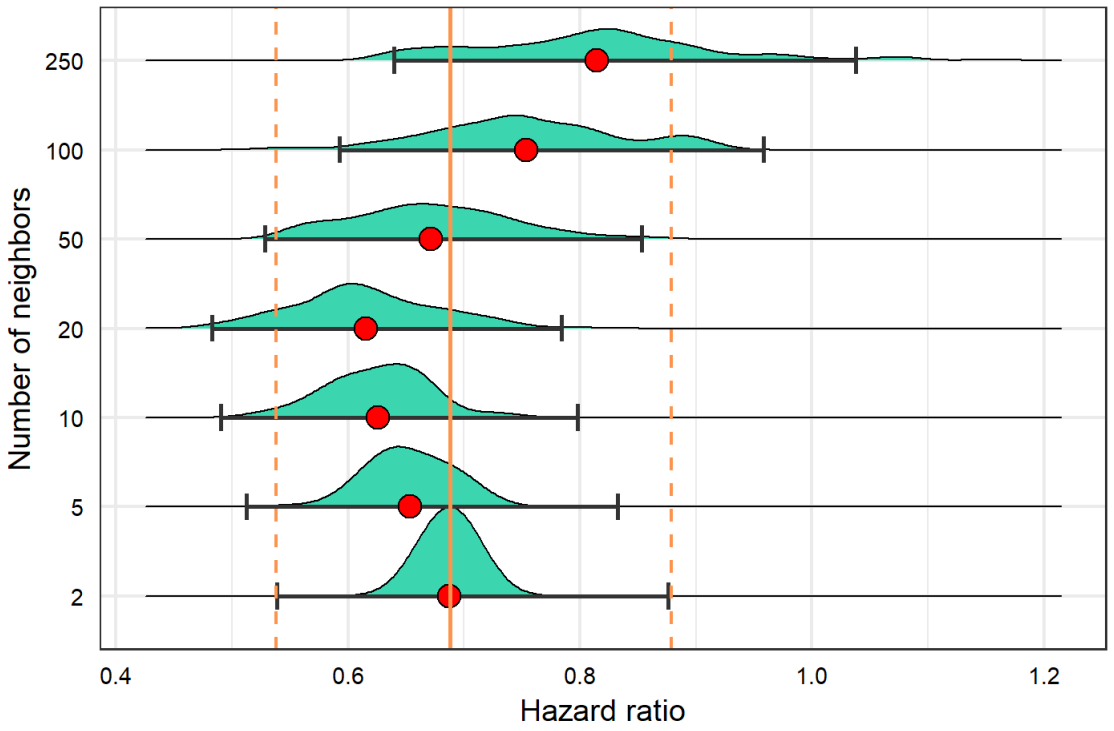

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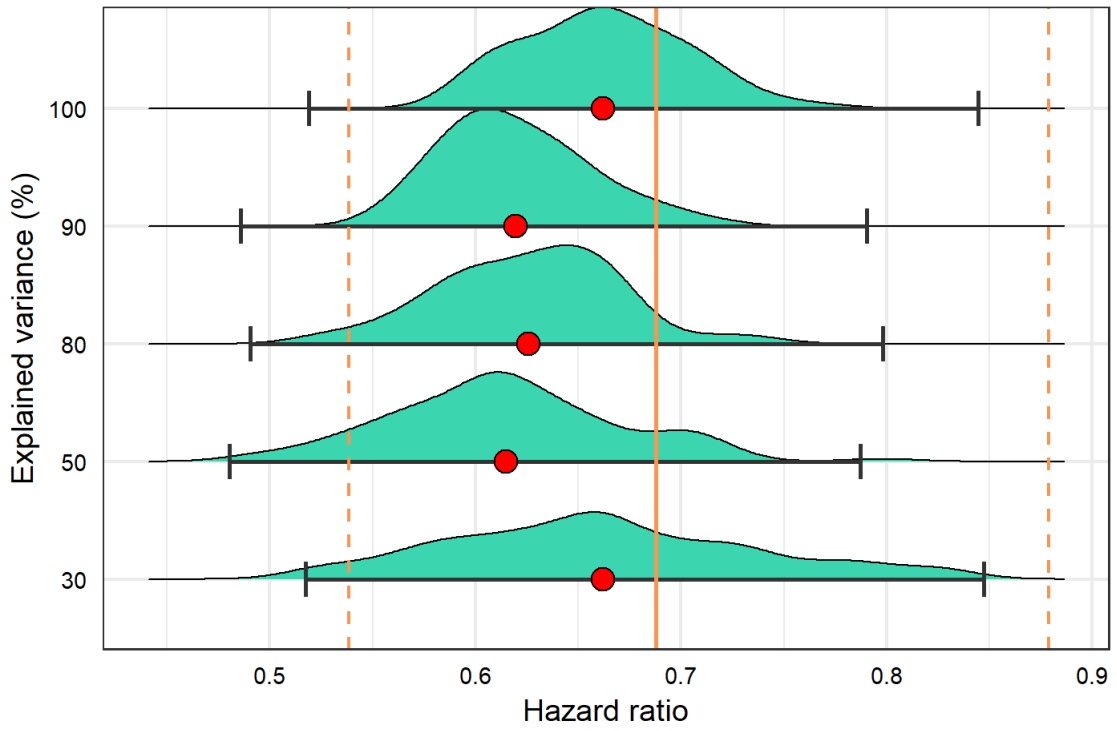

Avatar method – Security metrics

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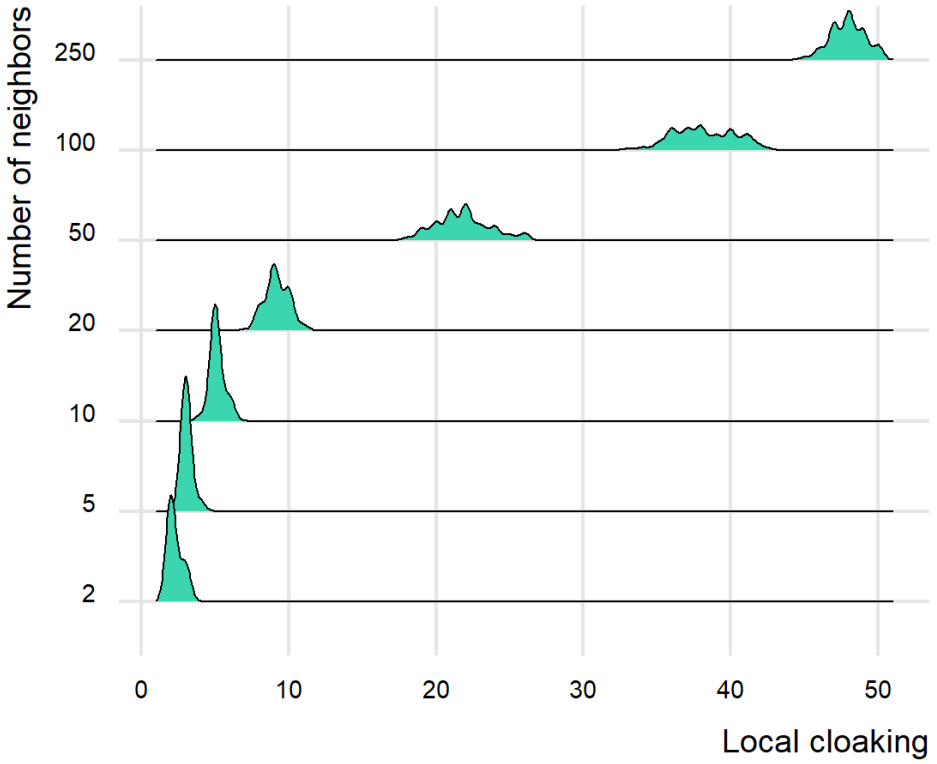

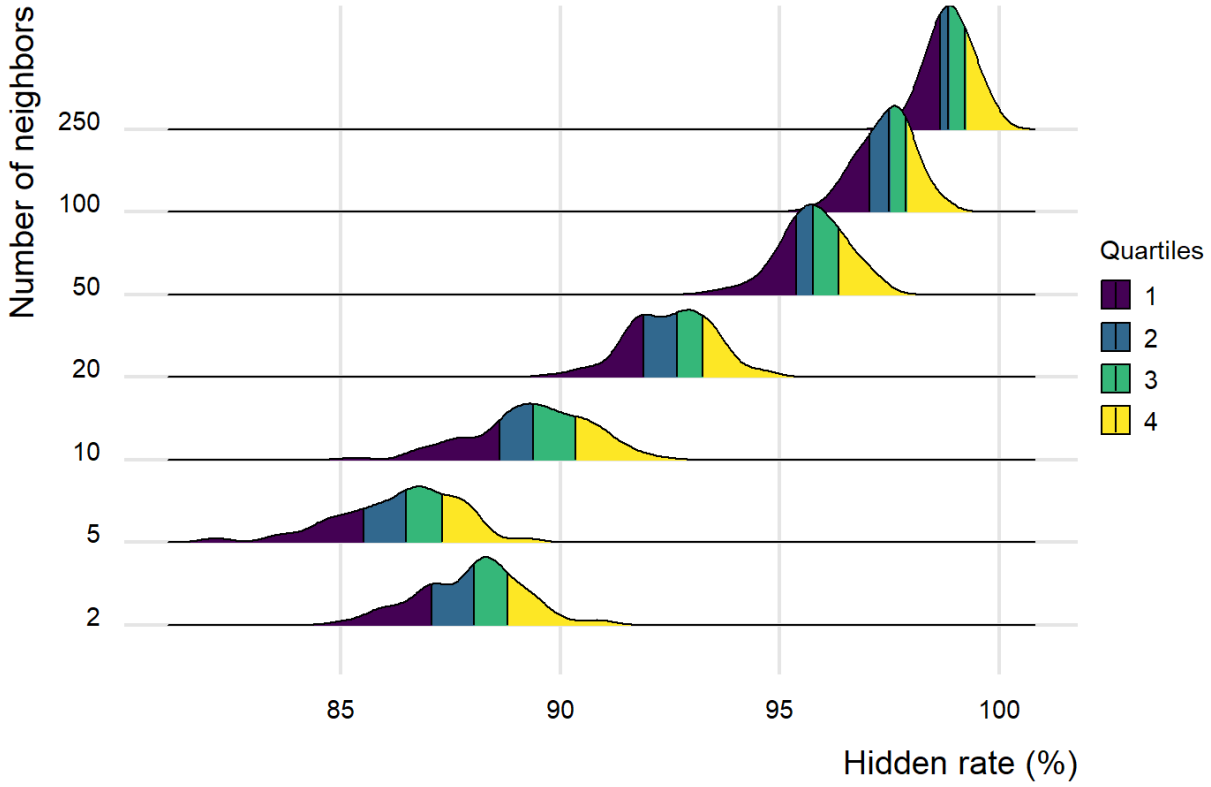

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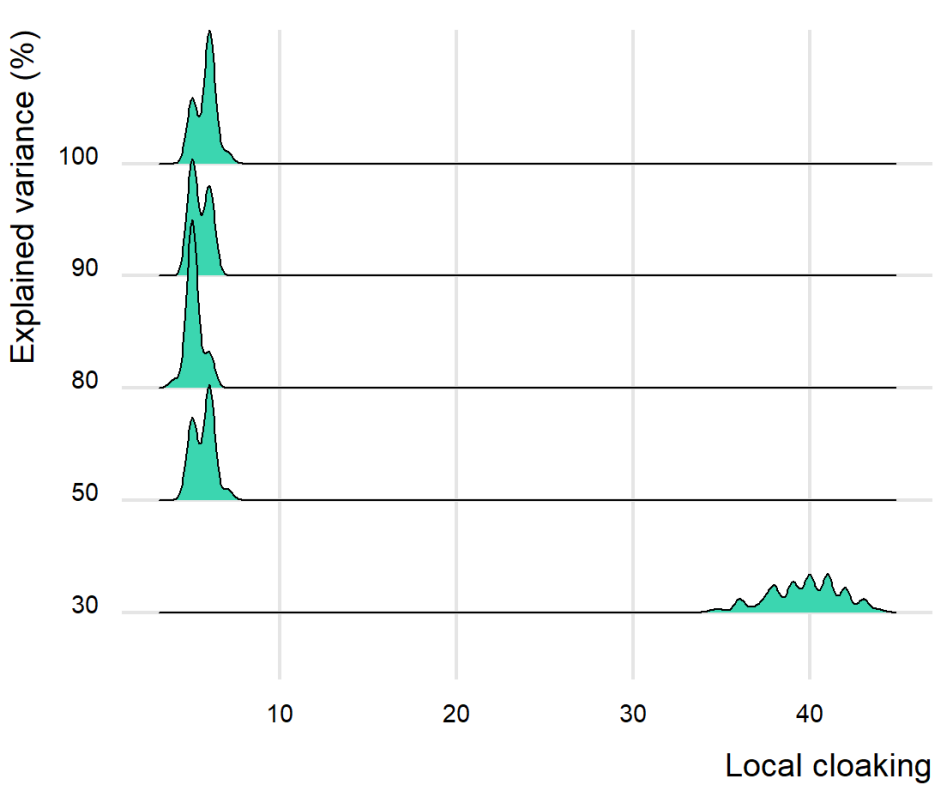
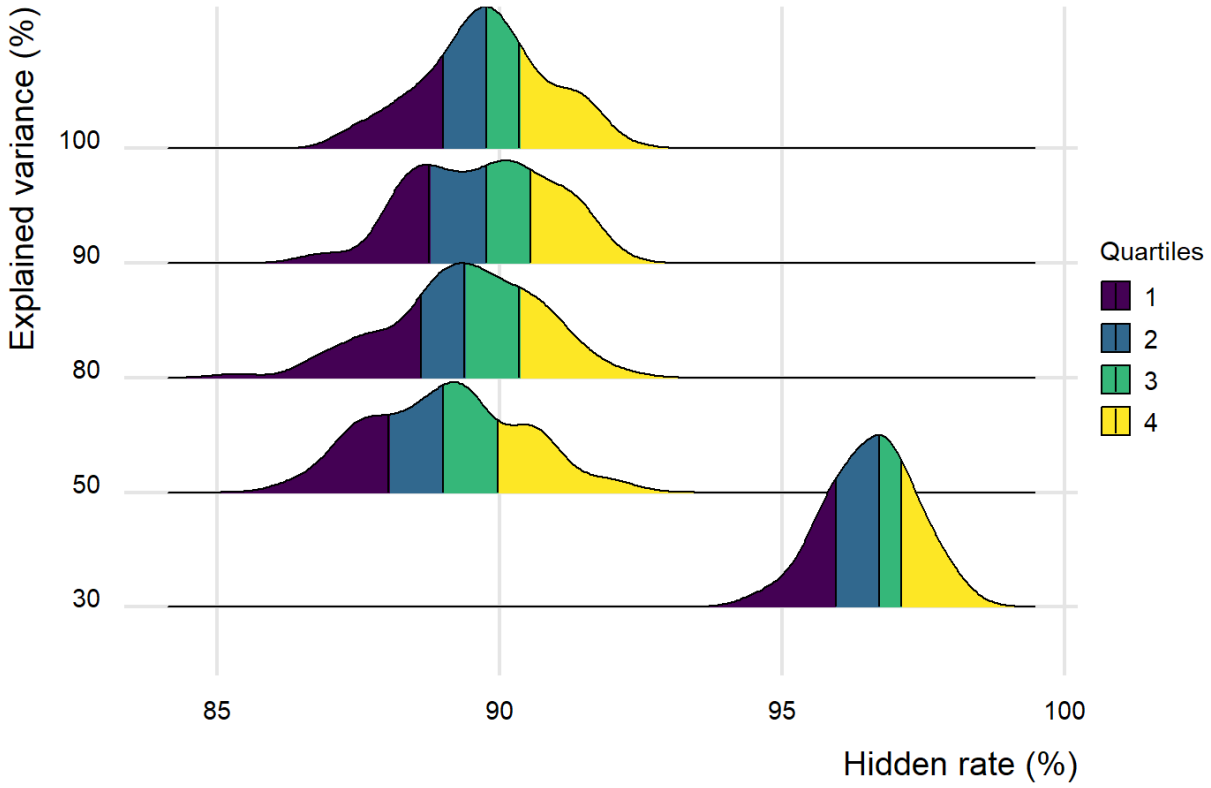
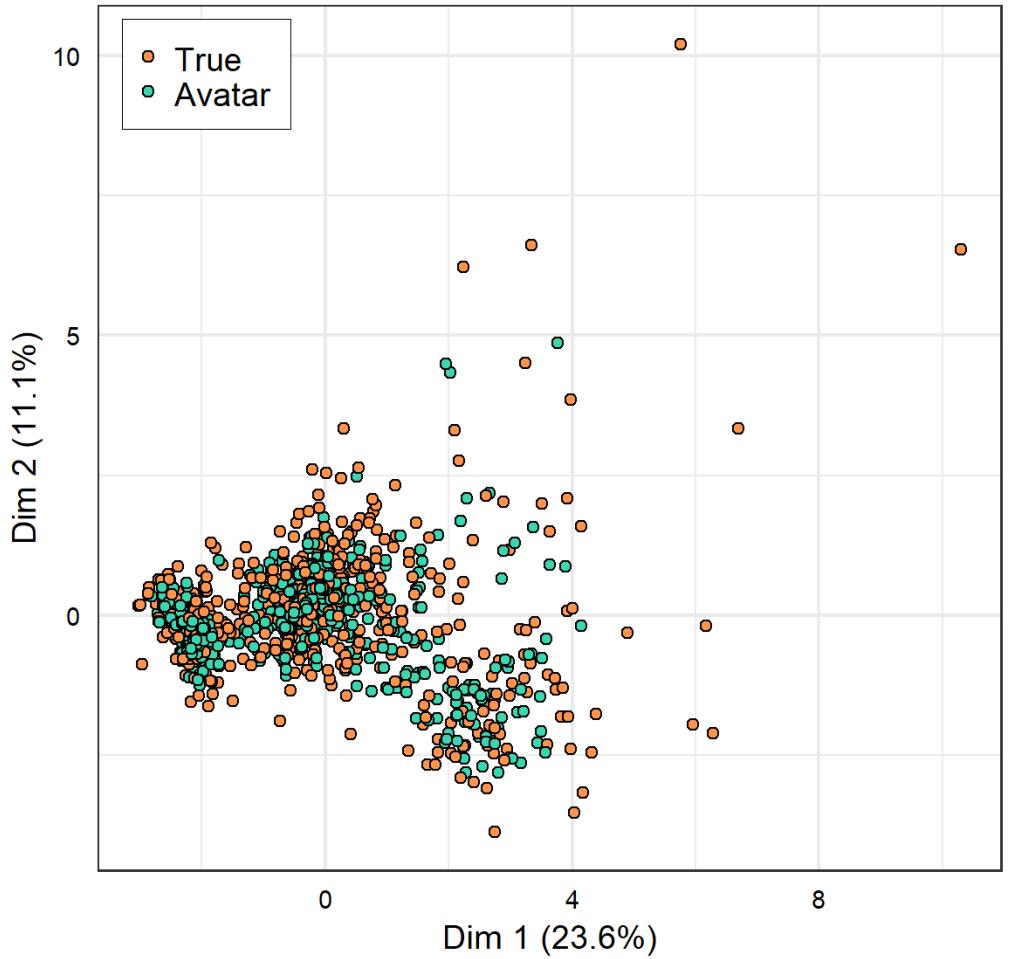




PRIMUS selected avatar

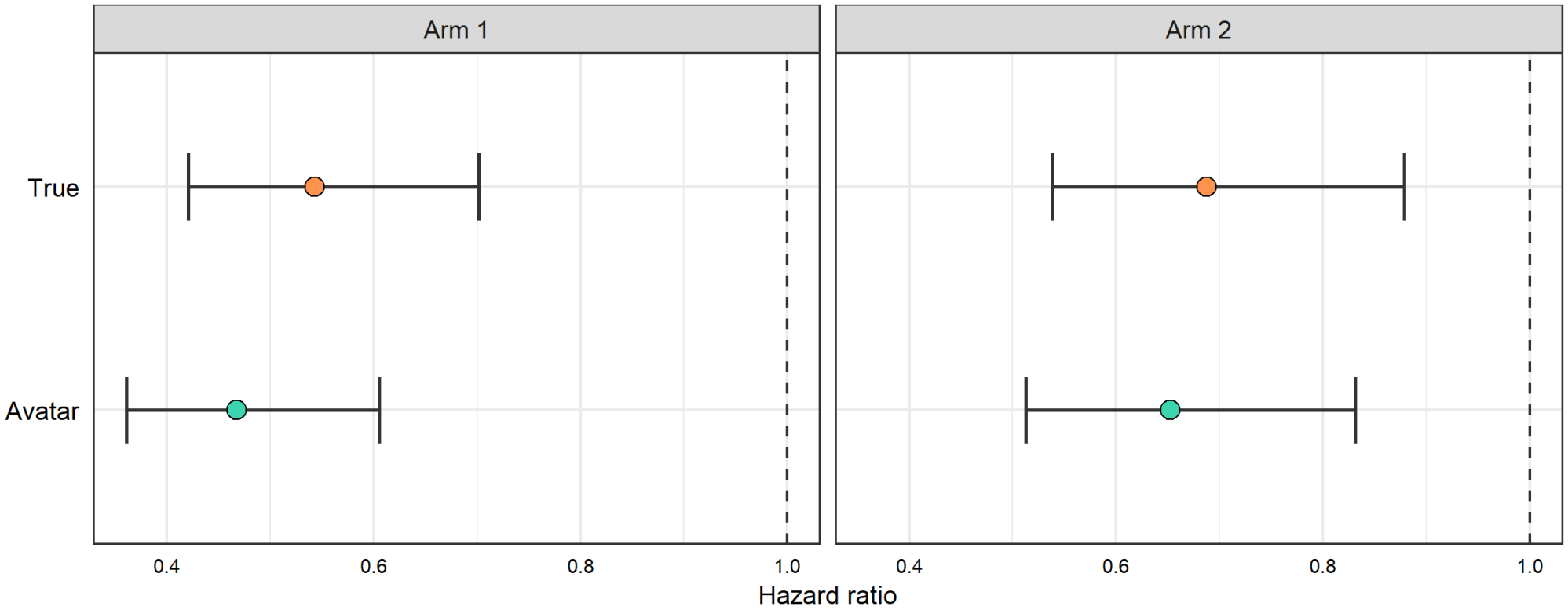


- $k = 10$
- $\%var = 80 \rightarrow ncp = 8$

- Hidden rate = 90%
- Local cloaking = 5

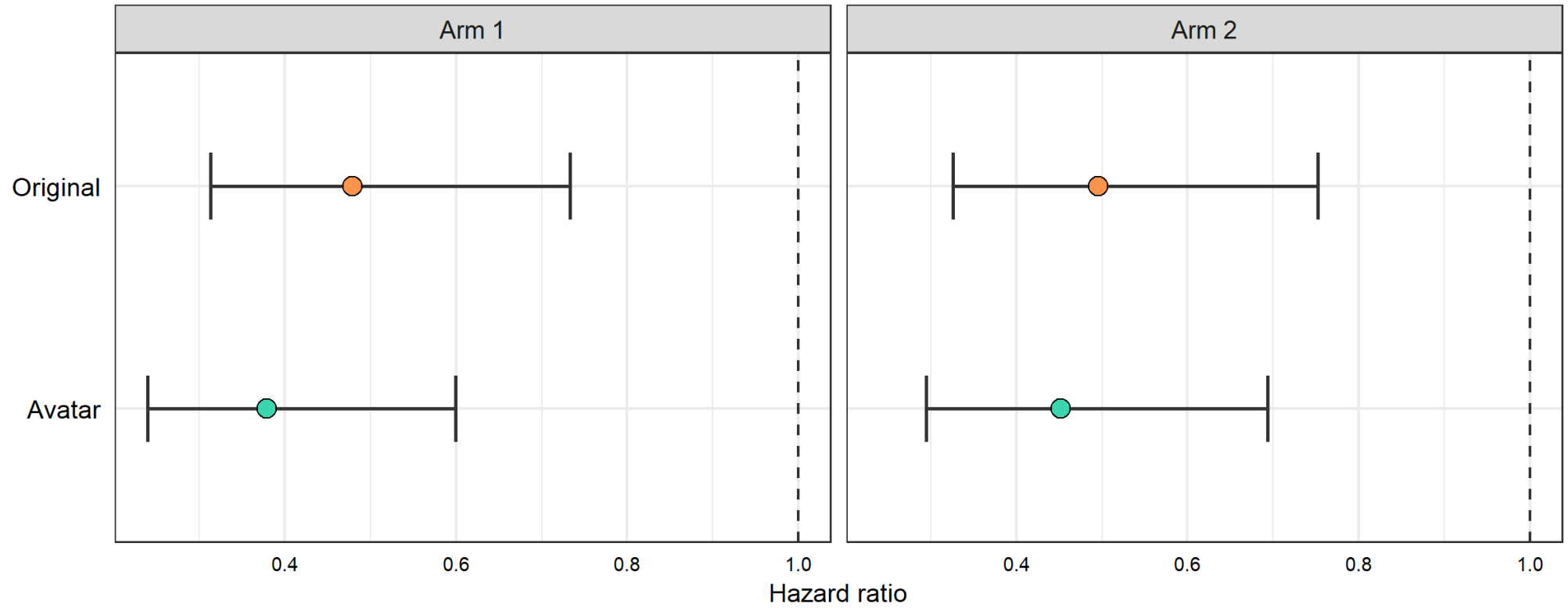
PRIMUS selected avatar

- Primary endpoint: McDonald criterion



PRIMUS selected avatar

- Secondary endpoint: clinically definite multiple sclerosis criterion



Conclusions & Perspectives

Conclusion

- No need to risk **re-identification** of patients
- **Avatar method** keeps global characteristics and protect patients

Conclusion

- No need to risk **re-identification** of patients
- **Avatar method** keeps global characteristics and protect patients

Data characteristics

Data security

Ongoing works & Perspectives

ICAN project – Intracranial aneurysm study

KTD-innov project – Kidney transplantation study

First year medical study grades database

Use of column weights parameter for multidimensional projection step

Acknowledgments

Team 3

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Octopize

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Matthieu Wargny
Sandrine Coudol
Thomas Goronflot

CHU Rennes

Gilles Edan

Variables contribution