Uncertainty quantification and robust decision-making

Initiating a transdisciplinary research program

Eisenhauer & al. (2020)

April 20, 2021

Open Source Economics

Uncertainty quantification and robust decision-making

Computational models

- **Epidemiologists** guide public mitigation efforts in the current pandemic by predicting the effect of social distancing rules on the disease's spread.

- Economists evaluate alternative welfare programs and forecast their impact on inequality in a variety of economic outcomes.

- Financial institutions manage their capital requirements by conducting stress tests about their business viability under adverse market conditions.

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$\Rightarrow$ **Uncertainty pervades**

Uncertainty quantification and robust decision-making

- **Uncertainty quantification** is a systematic attempt to characterize, manage, and reduce uncertainty.

- Robust decision-making seeks to identify potential robust strategies in light of uncertainty, characterize the vulnerabilities of such strategies, and evaluate trade-offs among them.

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Analysis pipeline

- **Robust optimization**   determine robust decisions in frequentist setting
  use of specialized algorithms

- Copula modeling

- Surrogate modeling

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Analysis pipeline

- Robust optimization

- **Copula modeling**   enable sensitivity analysis in Bayesian setting
                          approximate posterior distribution in high dimensions
- Surrogate modeling
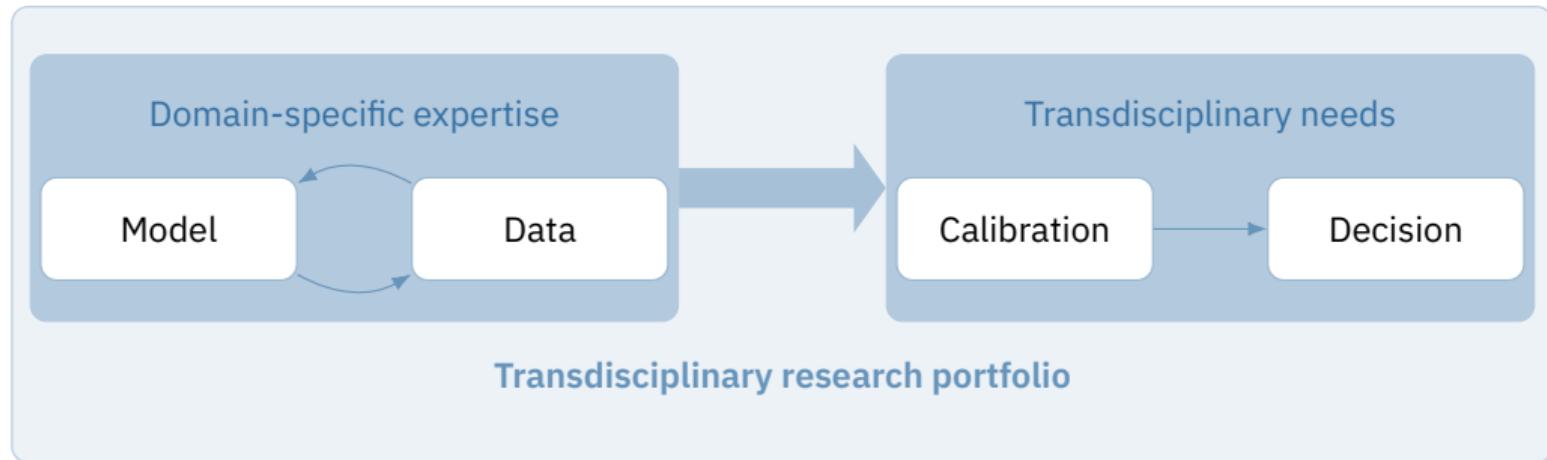
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Analysis pipeline

- Robust optimization

- Copula modeling

- **Surrogate modeling**   address computational challenges
  apply techniques from machine learning

Transdisciplinary research approach

Economics

Economics

Contributions

- interesting questions

- administrative data sources

- research codes

- decision theory

Economics

Contributions
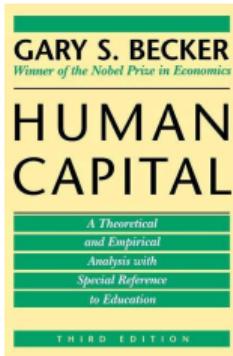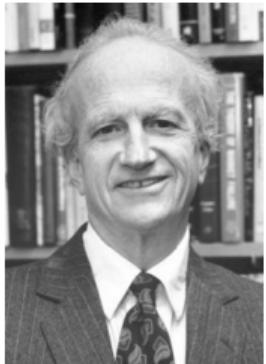
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Example

- **Eisenhauer, Gabler, Janys (2020).** *Structural econometric models for policy-making: Coping with parametric uncertainty*. in preparation for submission.

Human capital comprises the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social, and economic well-being.

- OECD

Eckstein–Keane–Wolpin models

Understanding individual decisions

- Human capital investment

- Consumption–savings decision

Predicting effects of policies

- Educational policy

- Welfare programs

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Mathematical framework and implementation
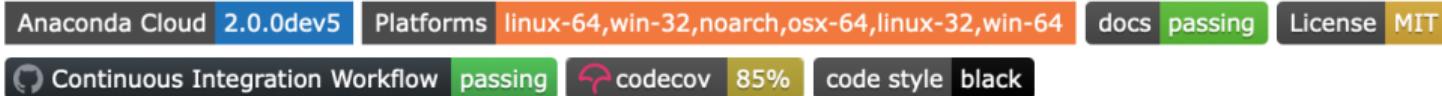
- Finite-horizon discrete Markov decision problem

- Backward induction algorithm

Community code

respy

A research code for the flexible specification, simulation, and estimation of Eckstein–Keane–Wolpin models.

| Anaconda Cloud `2.0.0dev5` | Platforms `linux-64,win-32,noarch,osx-64,linux-32,win-64` | docs `passing` | License `MIT` |

| Continuous Integration Workflow `passing` | codecov `85%` | code style `black` |
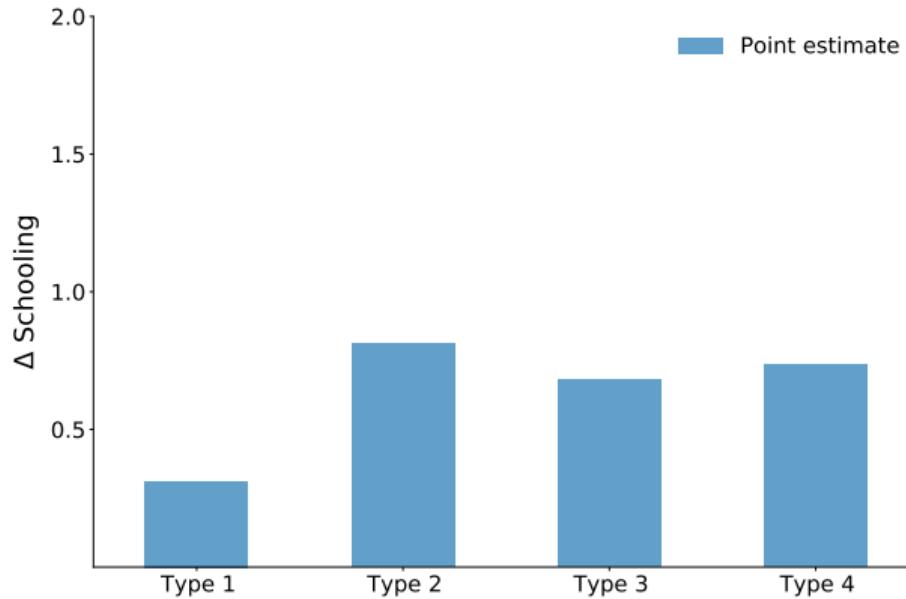
Core devs   Tobias Raabe, Janos Gabler
Docs   respy.readthedocs.io
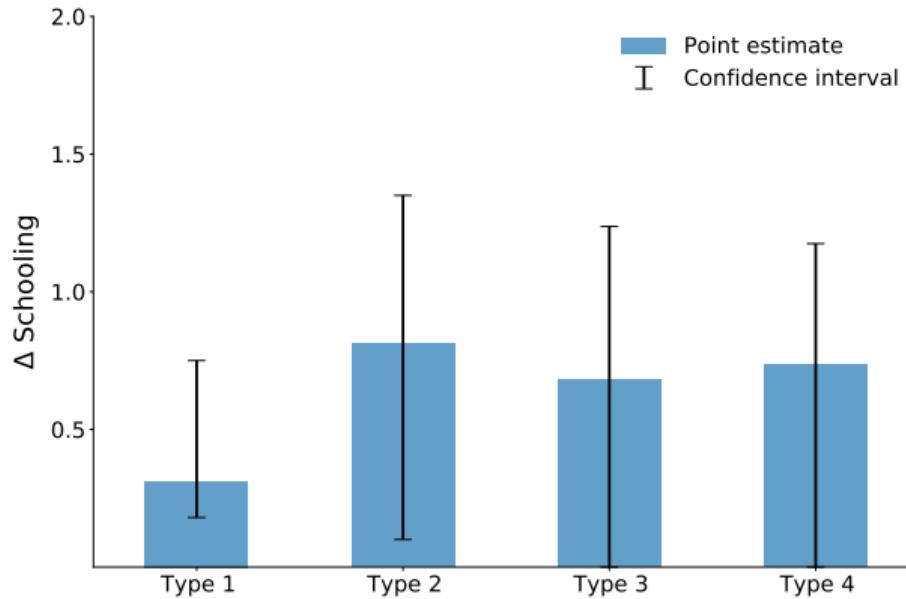
As-if ranking of policy alternatives
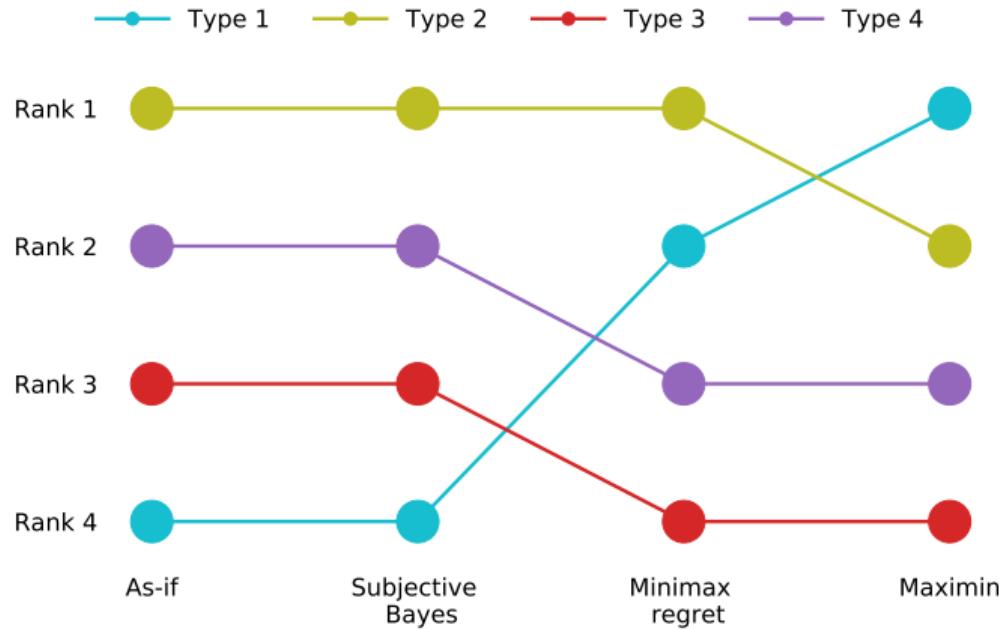
As-if ranking of policy alternatives

Decision-theoretic criteria
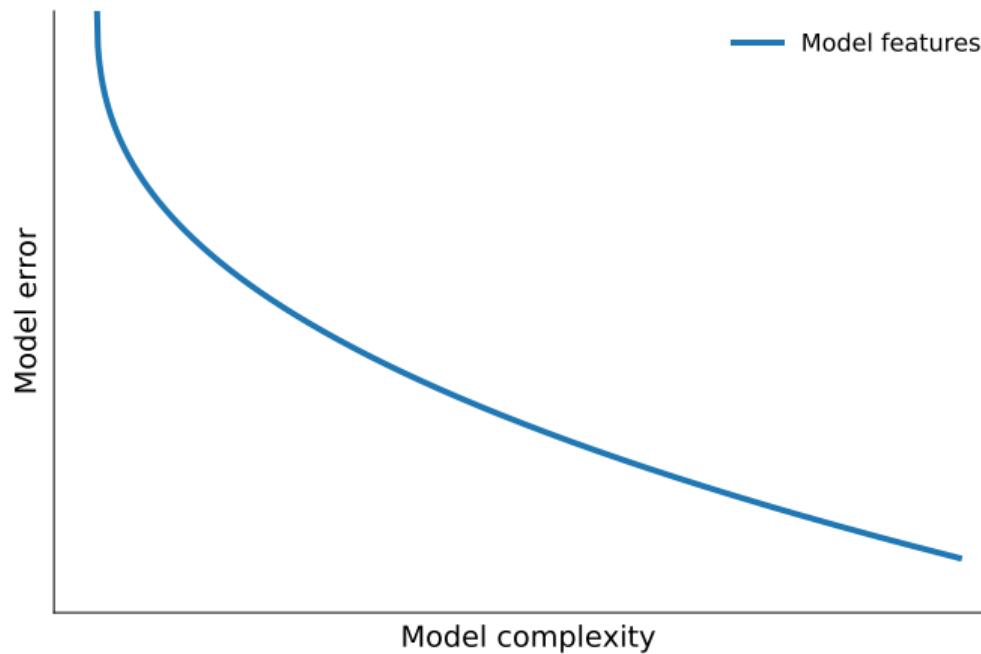
Conclusion
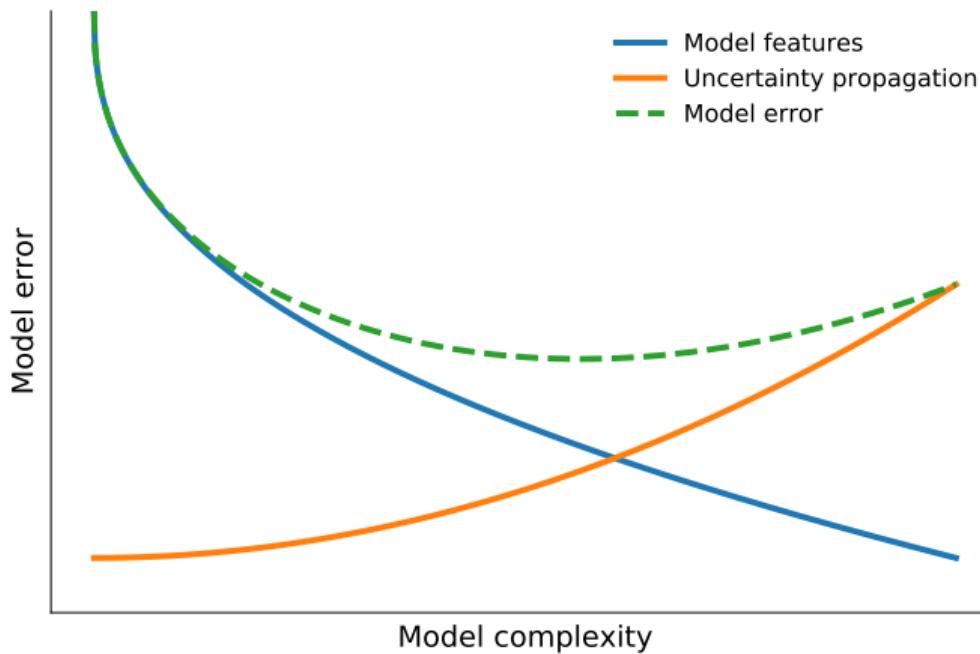
Price of complexity

Price of complexity

Appendix

Data

Eisenhauer & al. (2020): "Uncertainty quantification and robust decision-making"

Appendix Slide 2/4
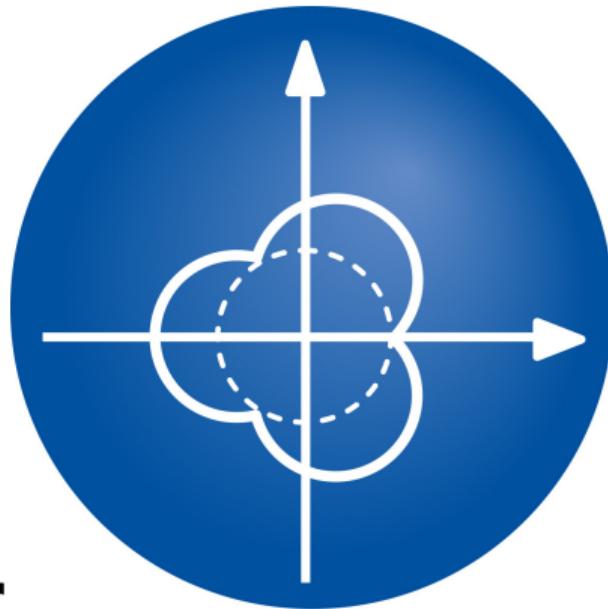
References

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