University of Zurich[UZH]

From Skinner Box experiments to Black Box games

Radical behaviorism for experimental game theory

https://osf.io/4n295/

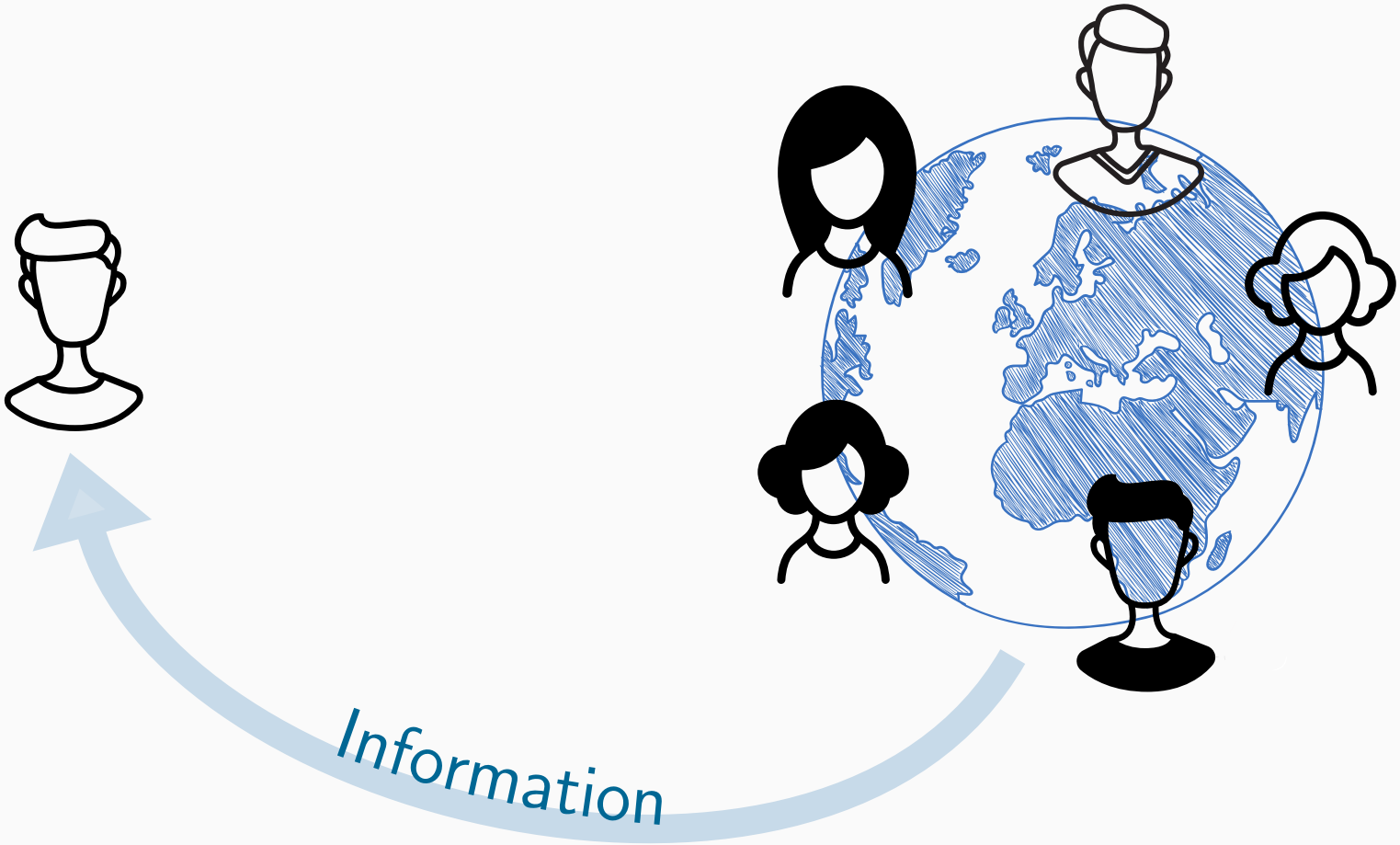
B. Ikica, P. Jiao,
A. Masiliūnas, H. Nax

October 23, 2020

University of Zürich

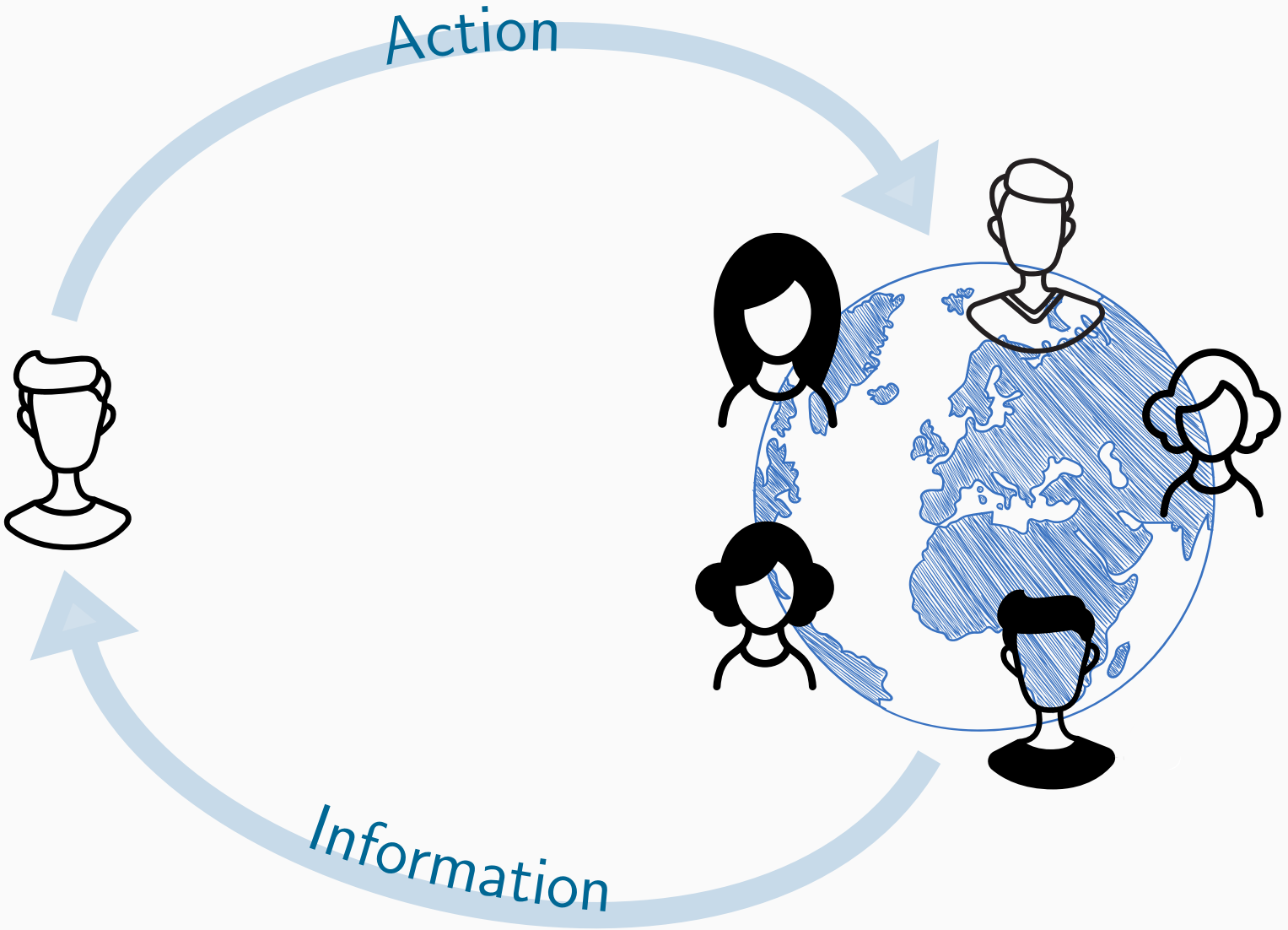
Motivation

How useful are the existing explanations of learning in complex situations?



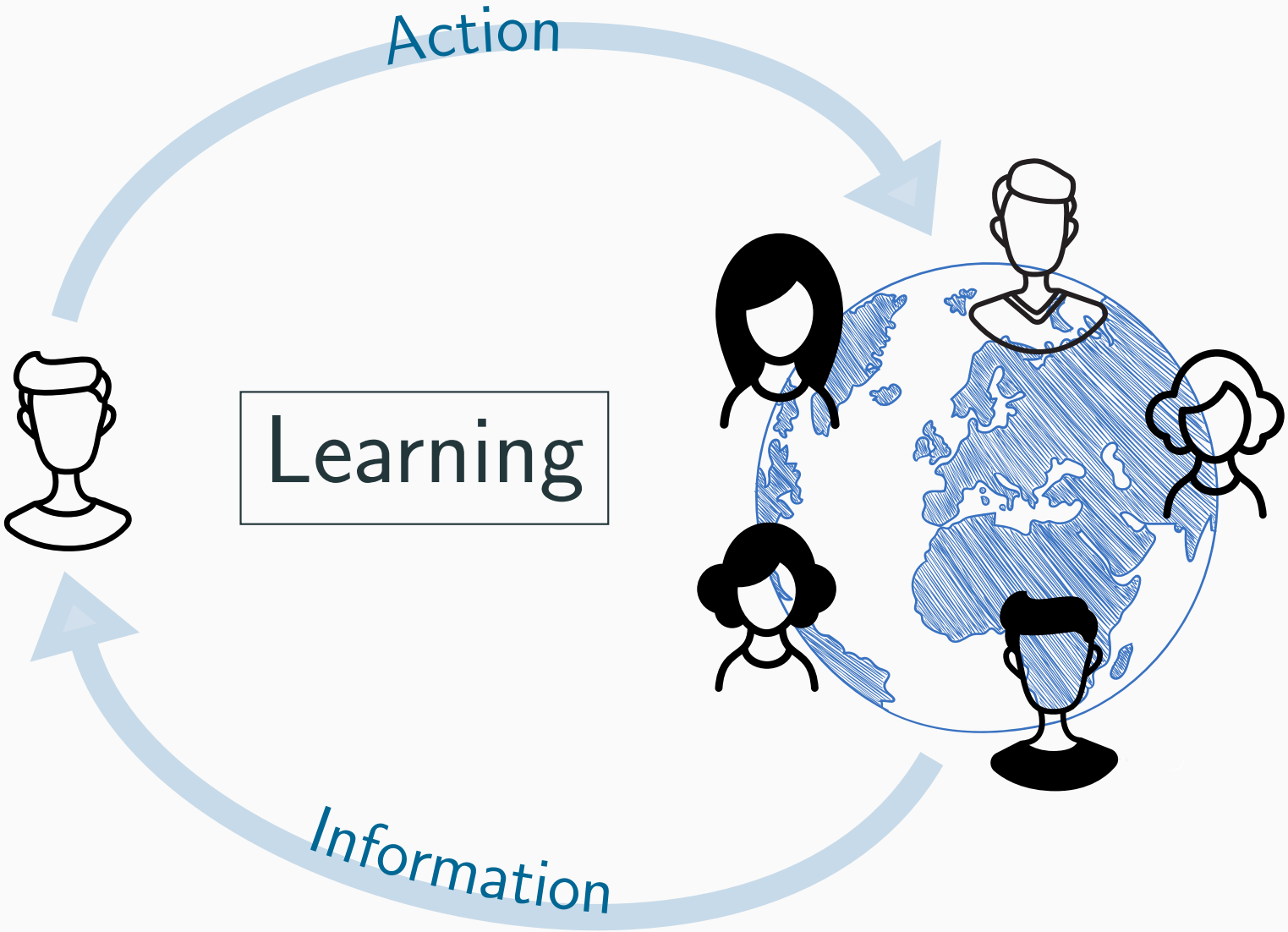
Motivation

How useful are the existing explanations of learning in complex situations?



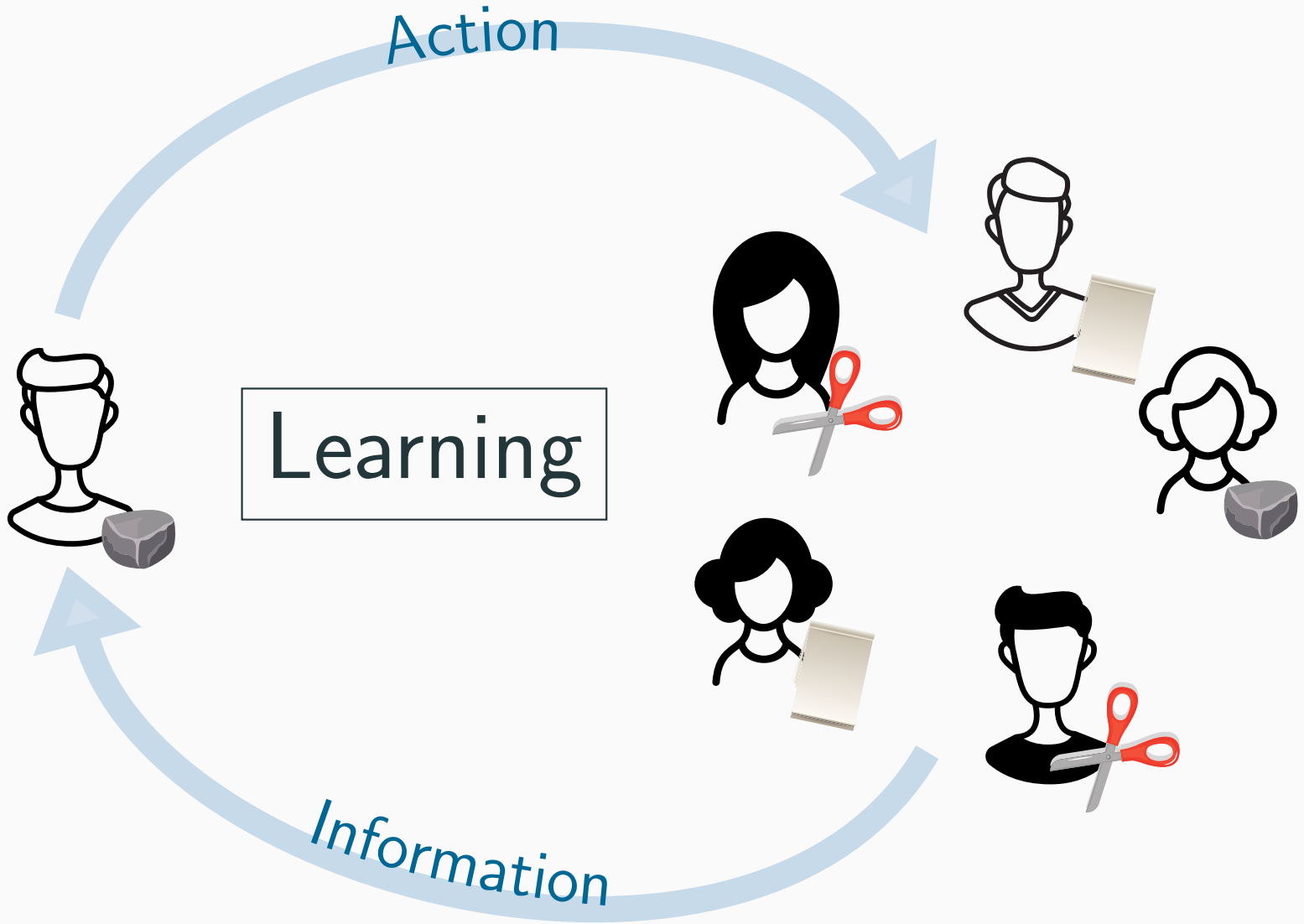
Motivation

How useful are the existing explanations of learning in complex situations?

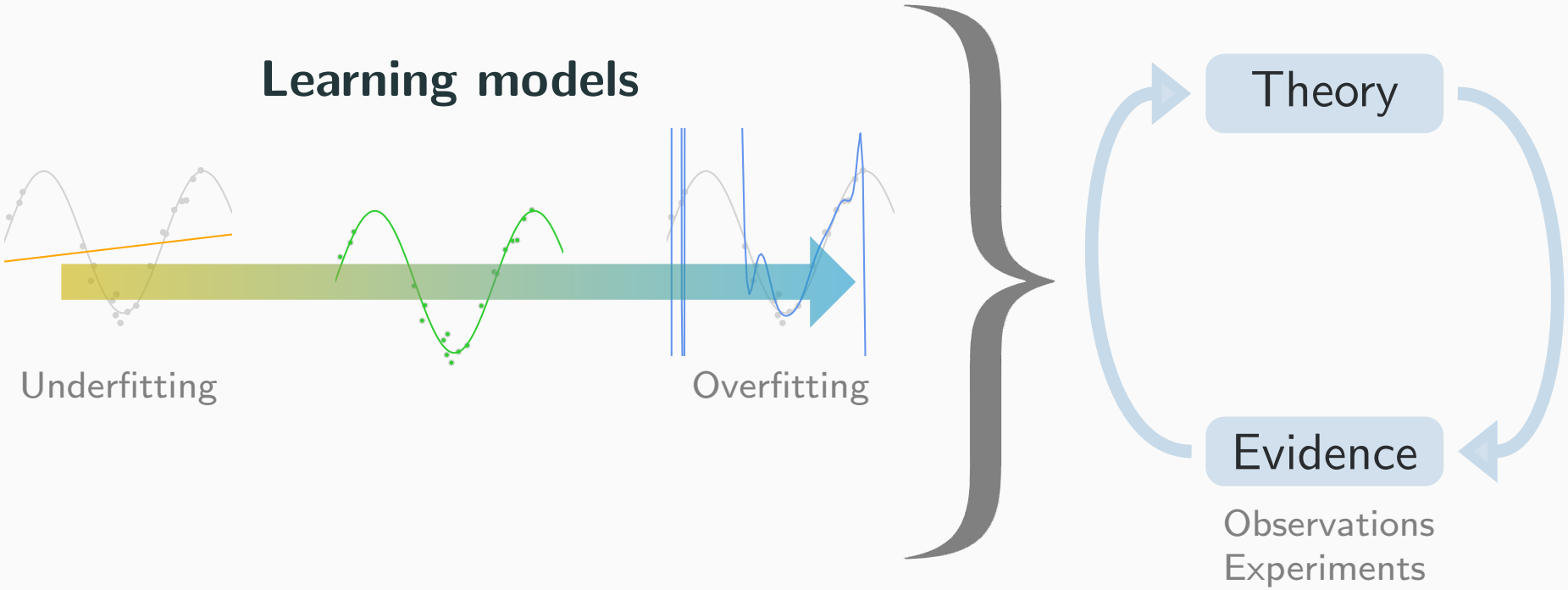


Motivation

How useful are the existing explanations of learning in complex situations?



Motivation

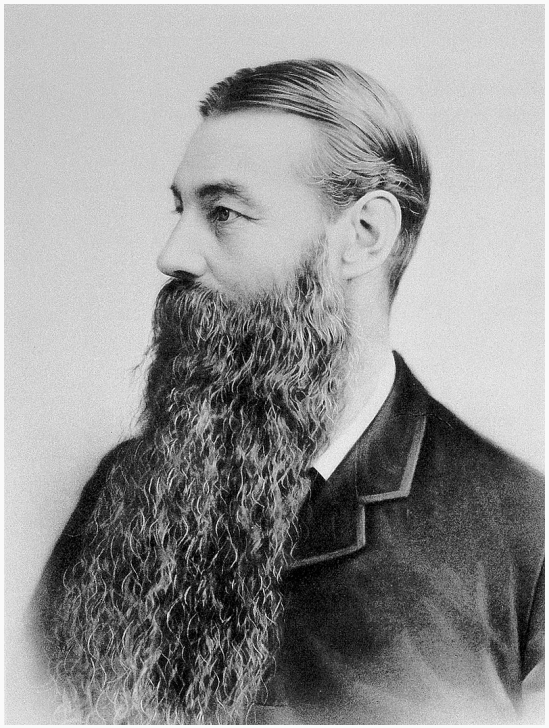

Learning models
Underfitting
Overfitting
Theory
Evidence
Observations
Experiments

Motivation

Morgan's Canon

> *In no case is an animal activity to be interpreted in terms of higher psychological processes, if it can be fairly interpreted in terms of processes which stand lower in the scale of psychological evolution and development.*

C. Lloyd Morgan, 1903

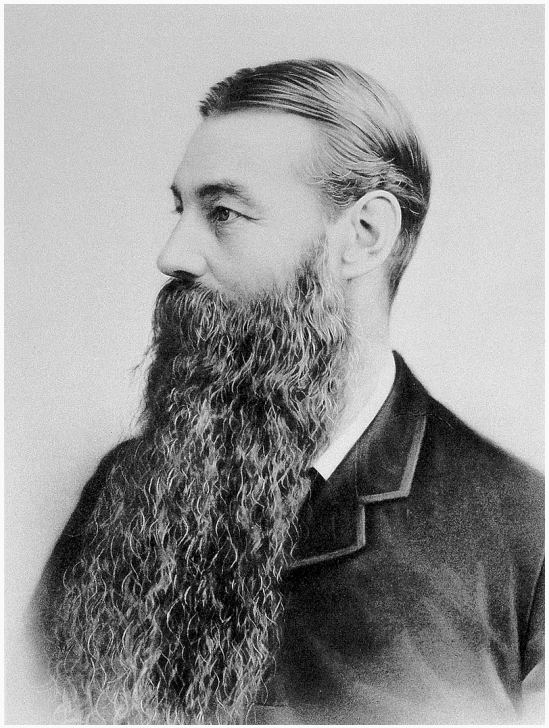


Motivation

Morgan's Canon

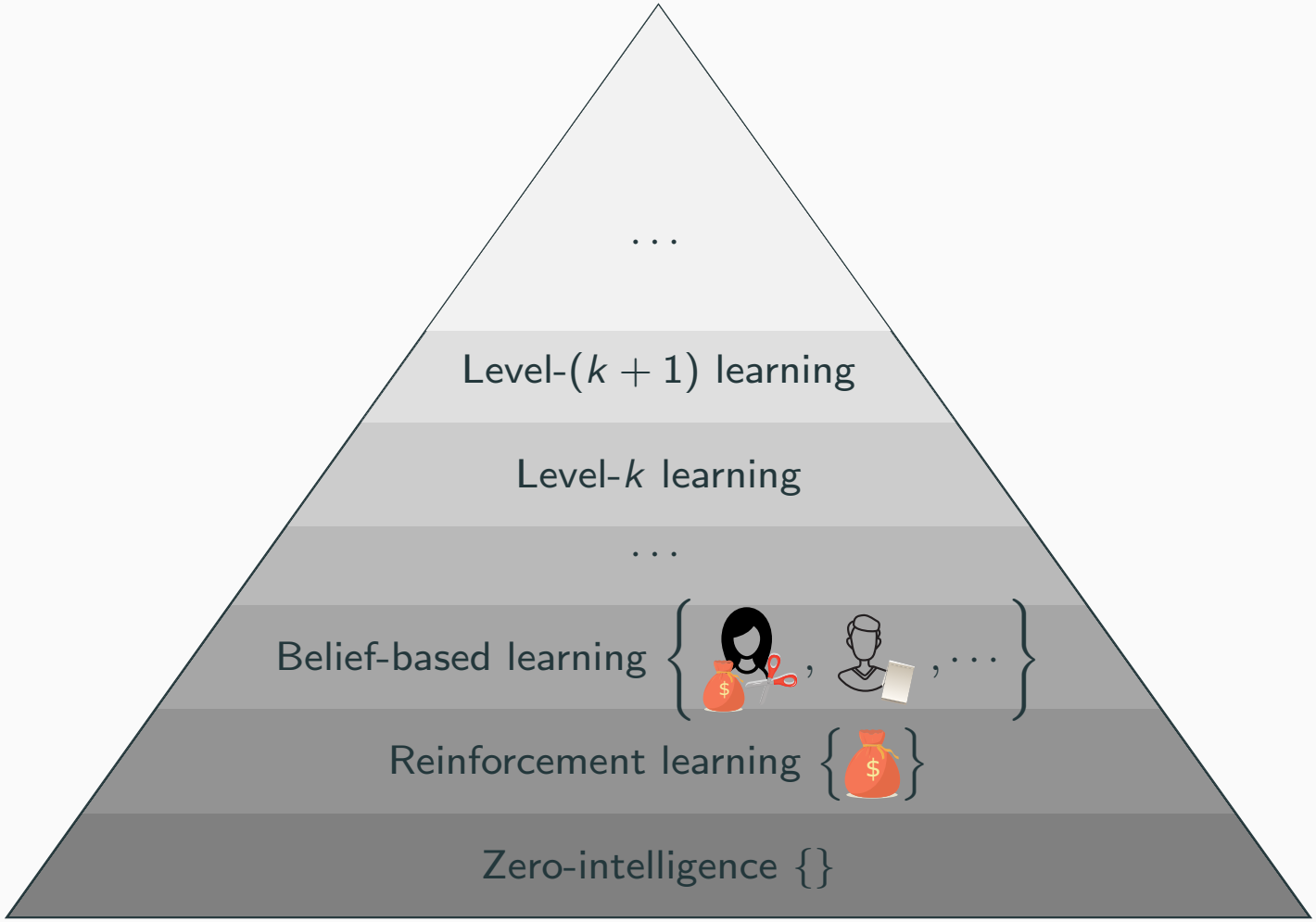
> *In no case is* **[a human]** *activity to be interpreted in terms of higher psychological processes, if it can be fairly interpreted in terms of processes which stand lower in the scale of psychological evolution and development.*

C. Lloyd Morgan, 1903



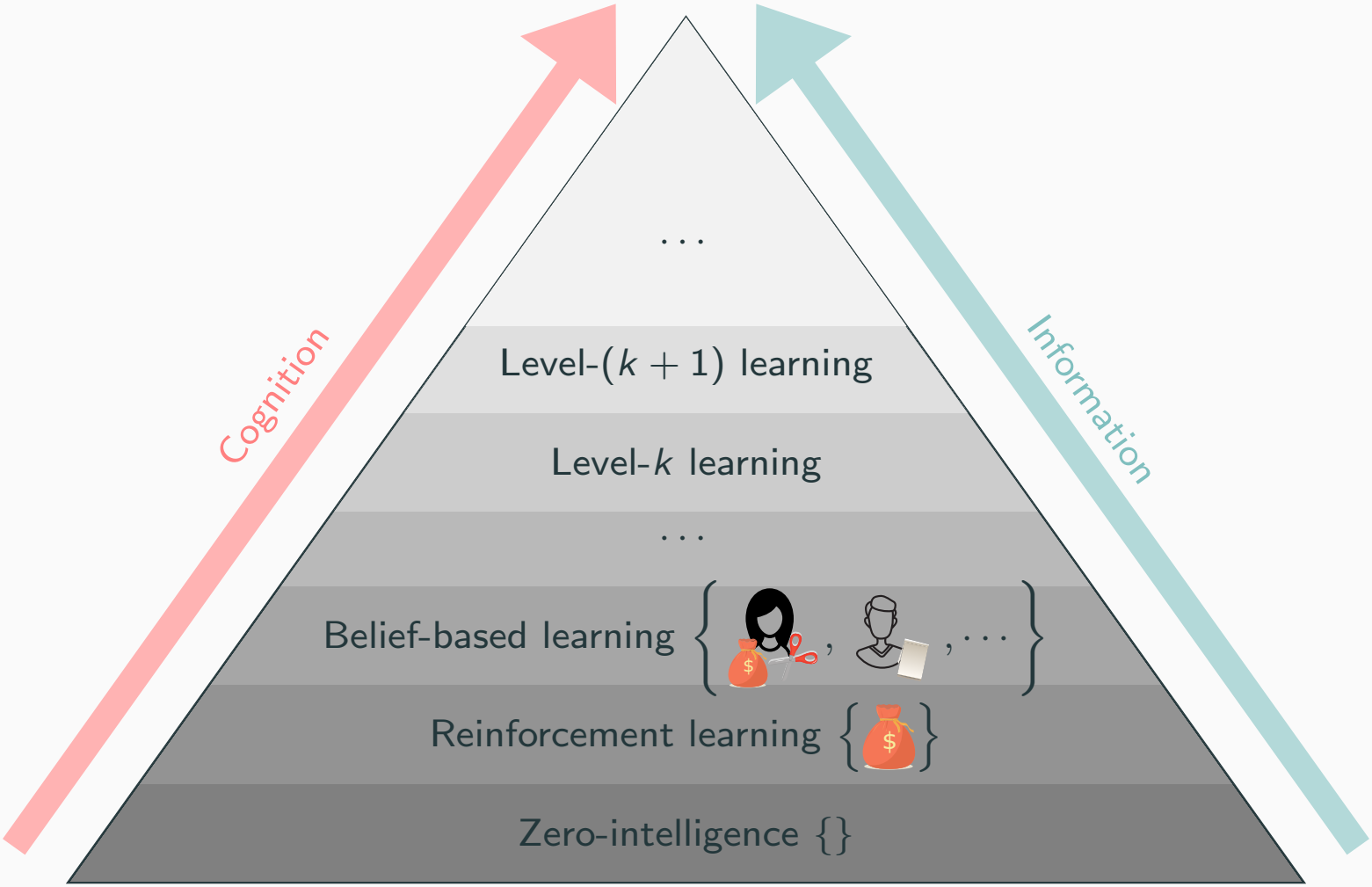
Motivation

Hierarchy of learning models



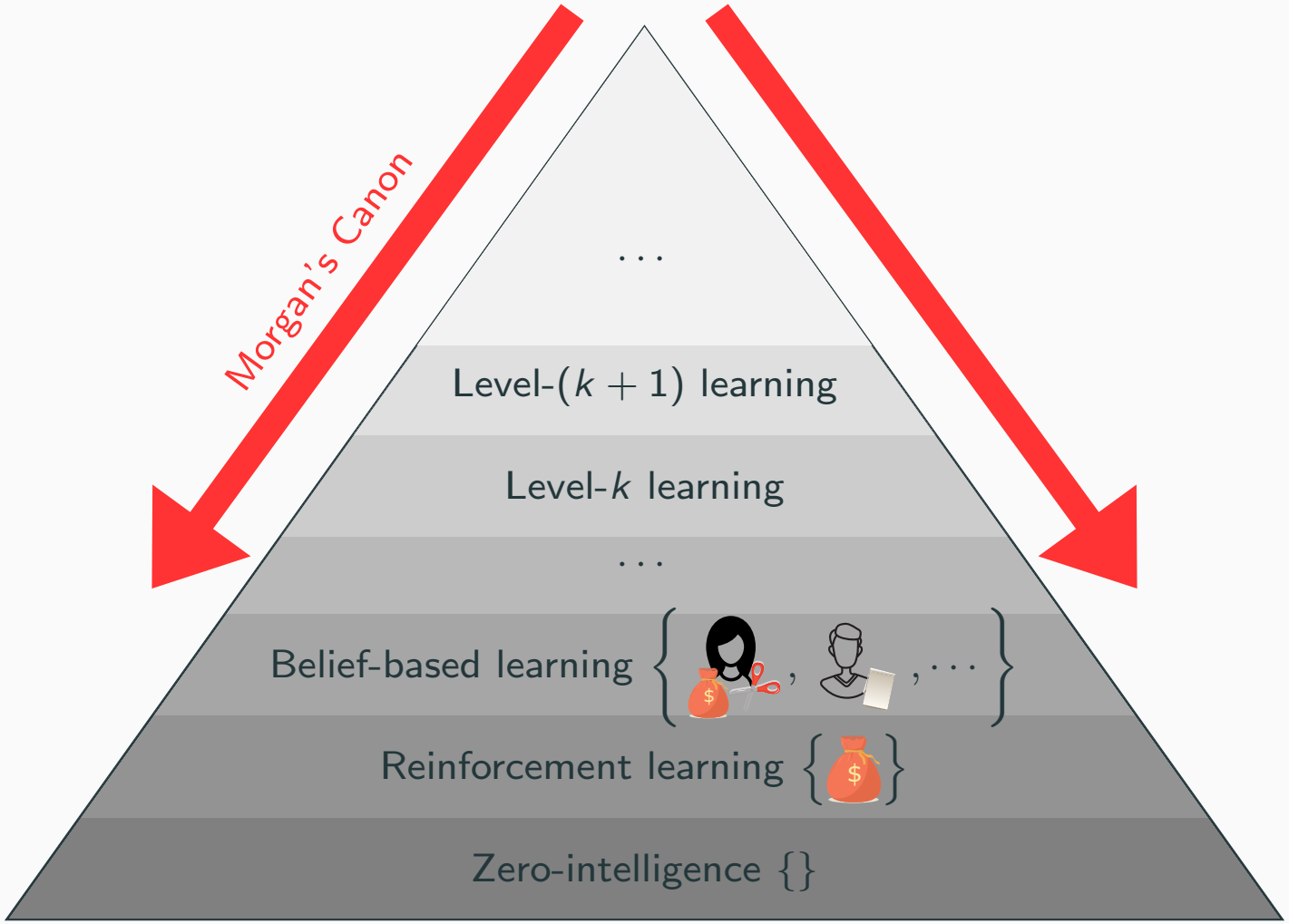
Motivation

Hierarchy of learning models



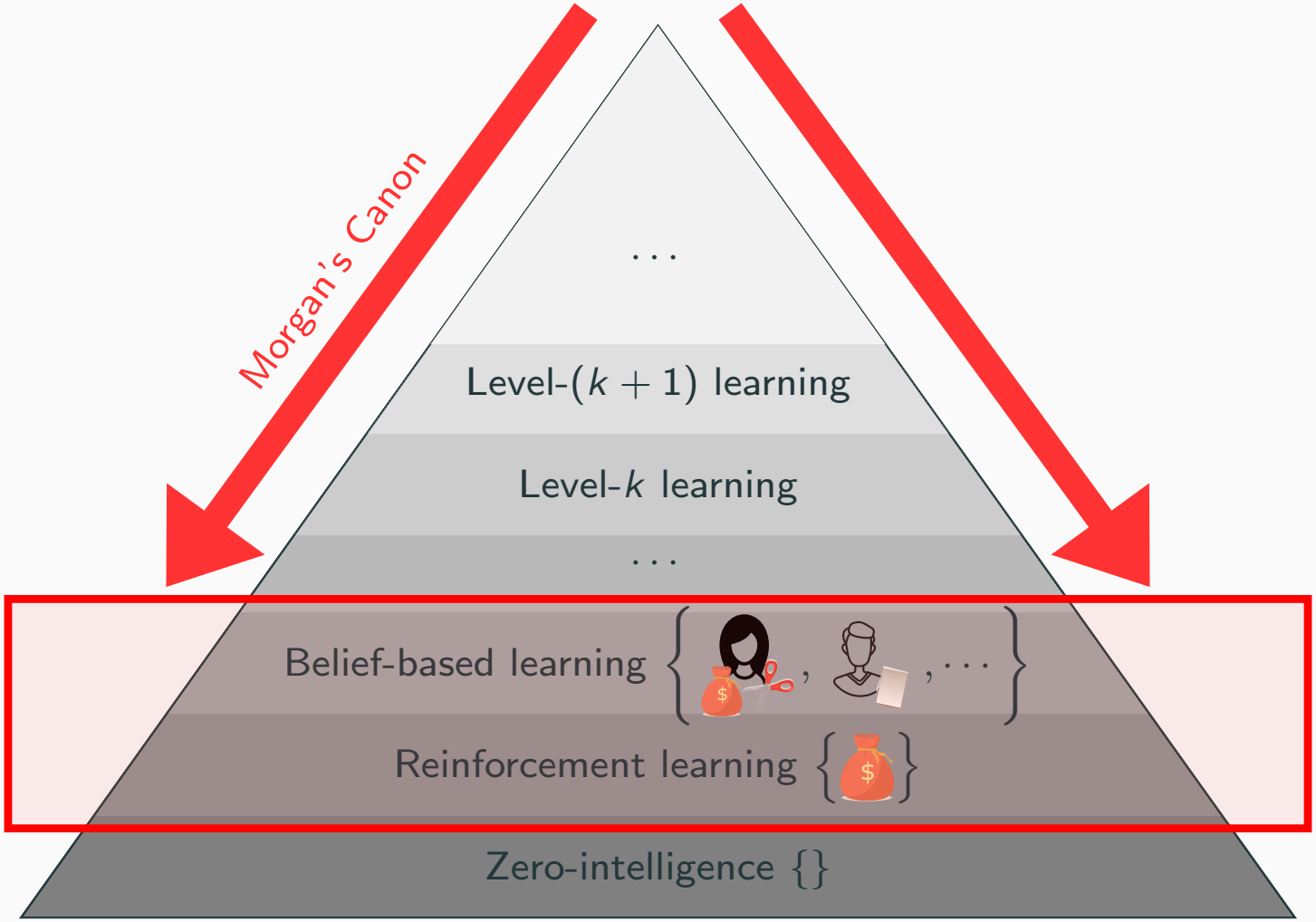
Motivation

Hierarchy of learning models



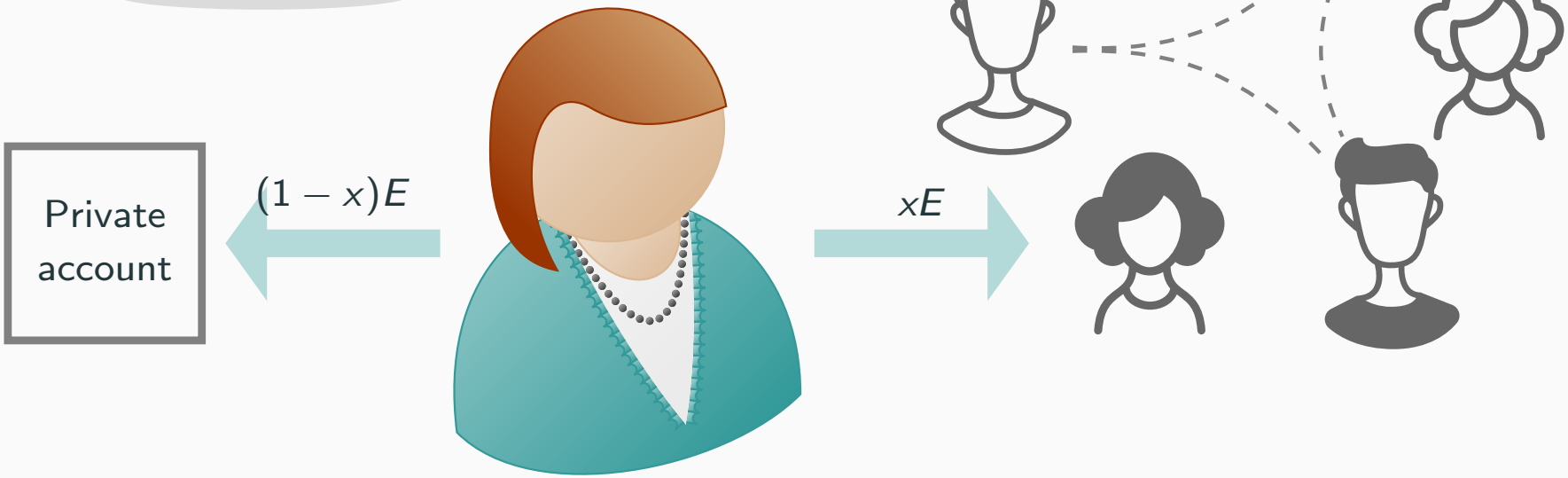
Motivation

Hierarchy of learning models



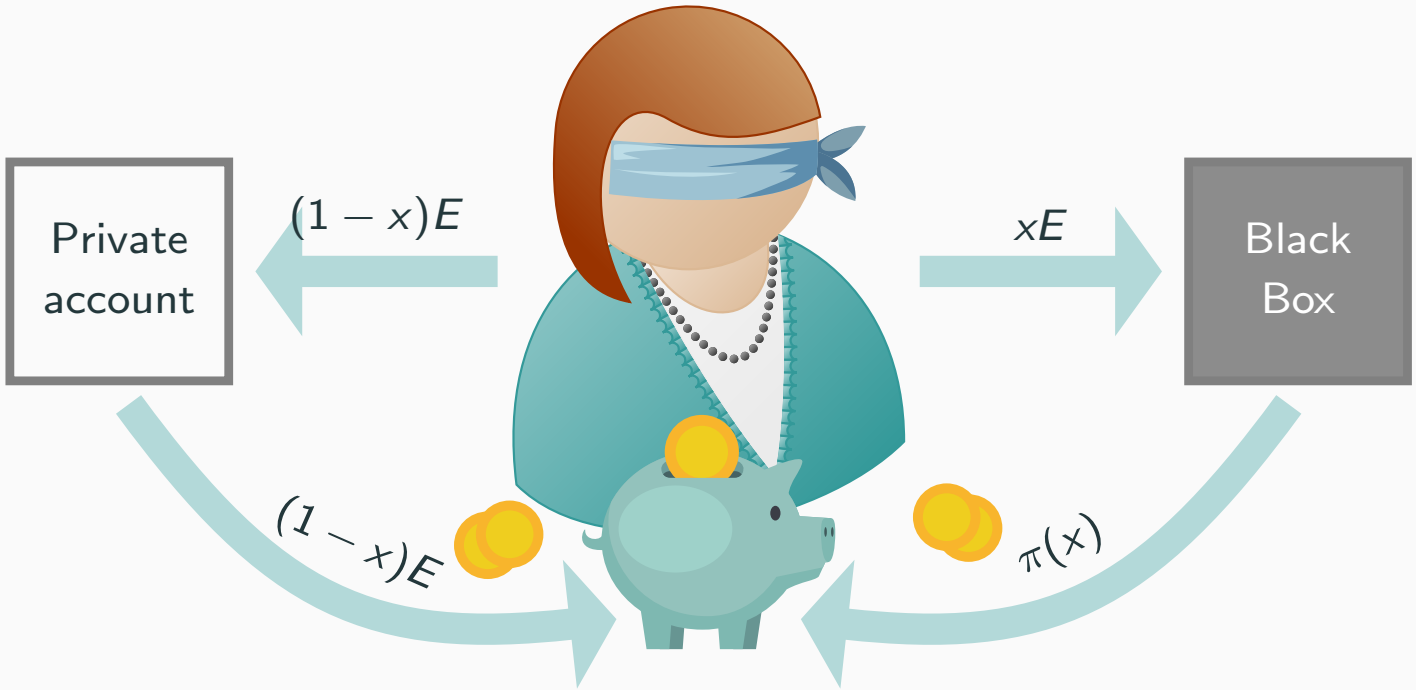
Black Box approach

Black Box approach



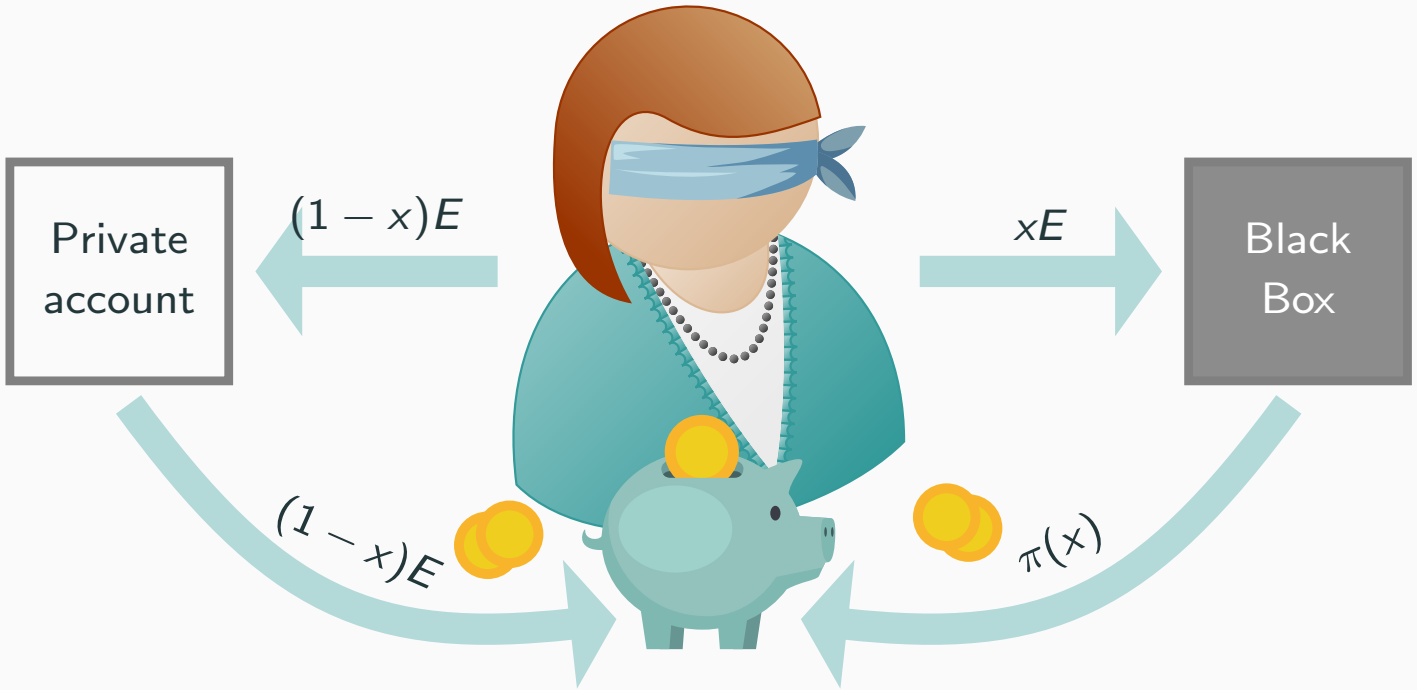
Black Box approach

Black Box approach



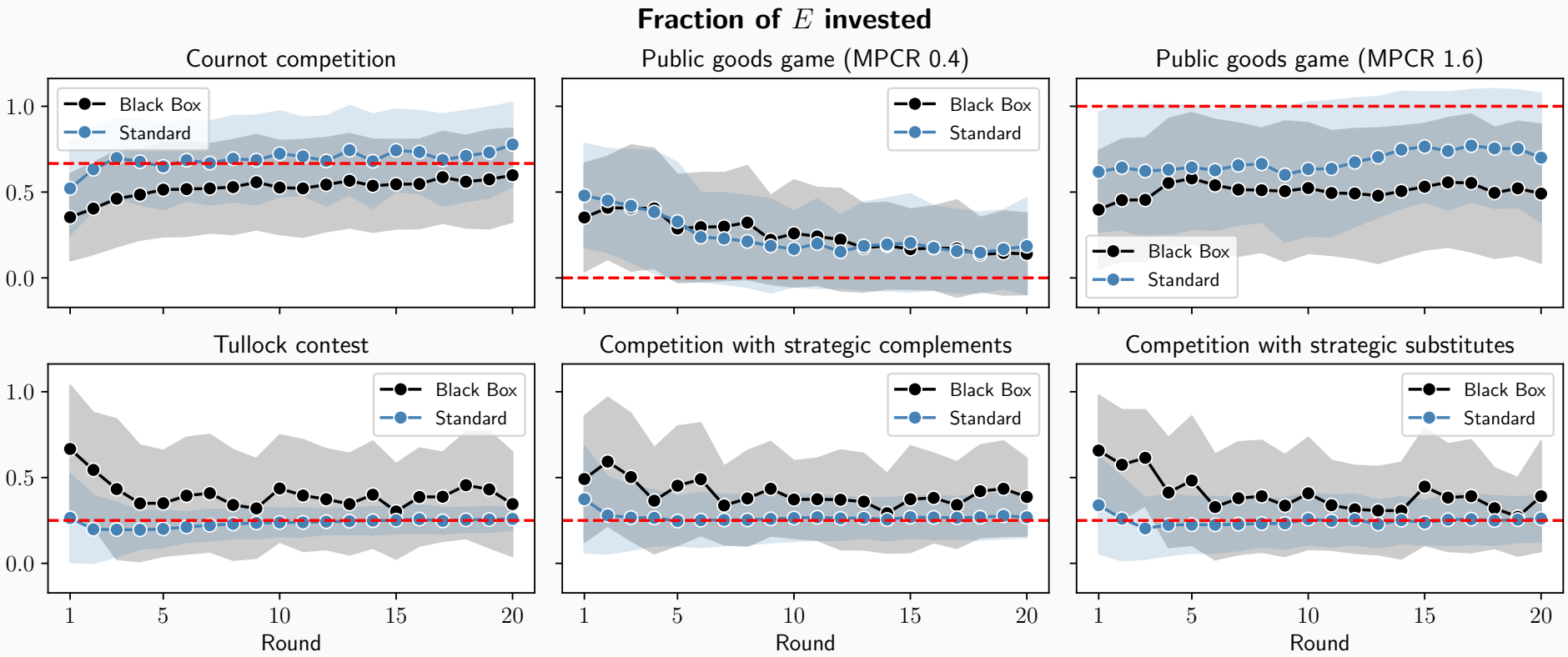
Black Box approach

1. Learning model
2. Black Box $\leftrightarrow$ standard game



Case study / Setup

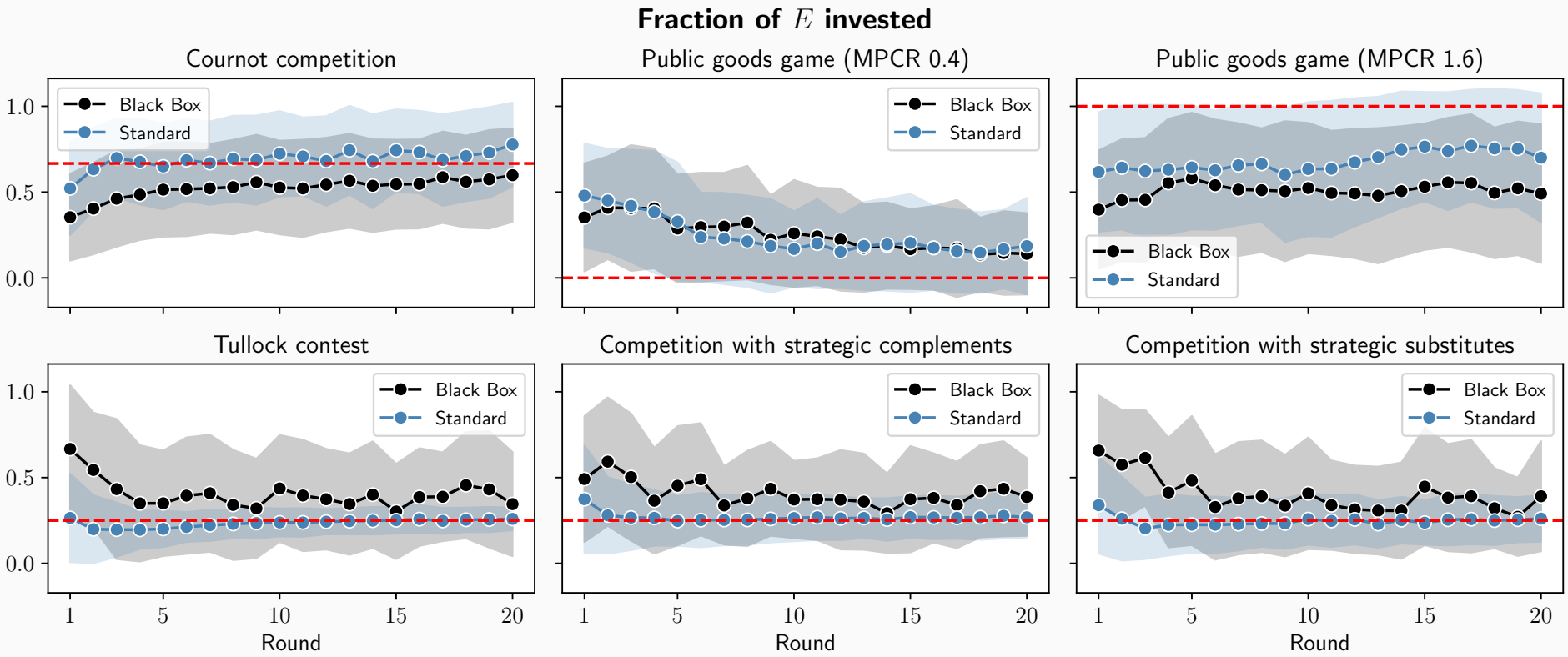
1. Experimental data



Setting	Sessions	Rounds	Subjects	Decisions
Black Box	24	20	391	7,820
Standard	32	20	580	11,600
Total	56	20	971	**19,420**

Case study / Setup

1. Experimental data



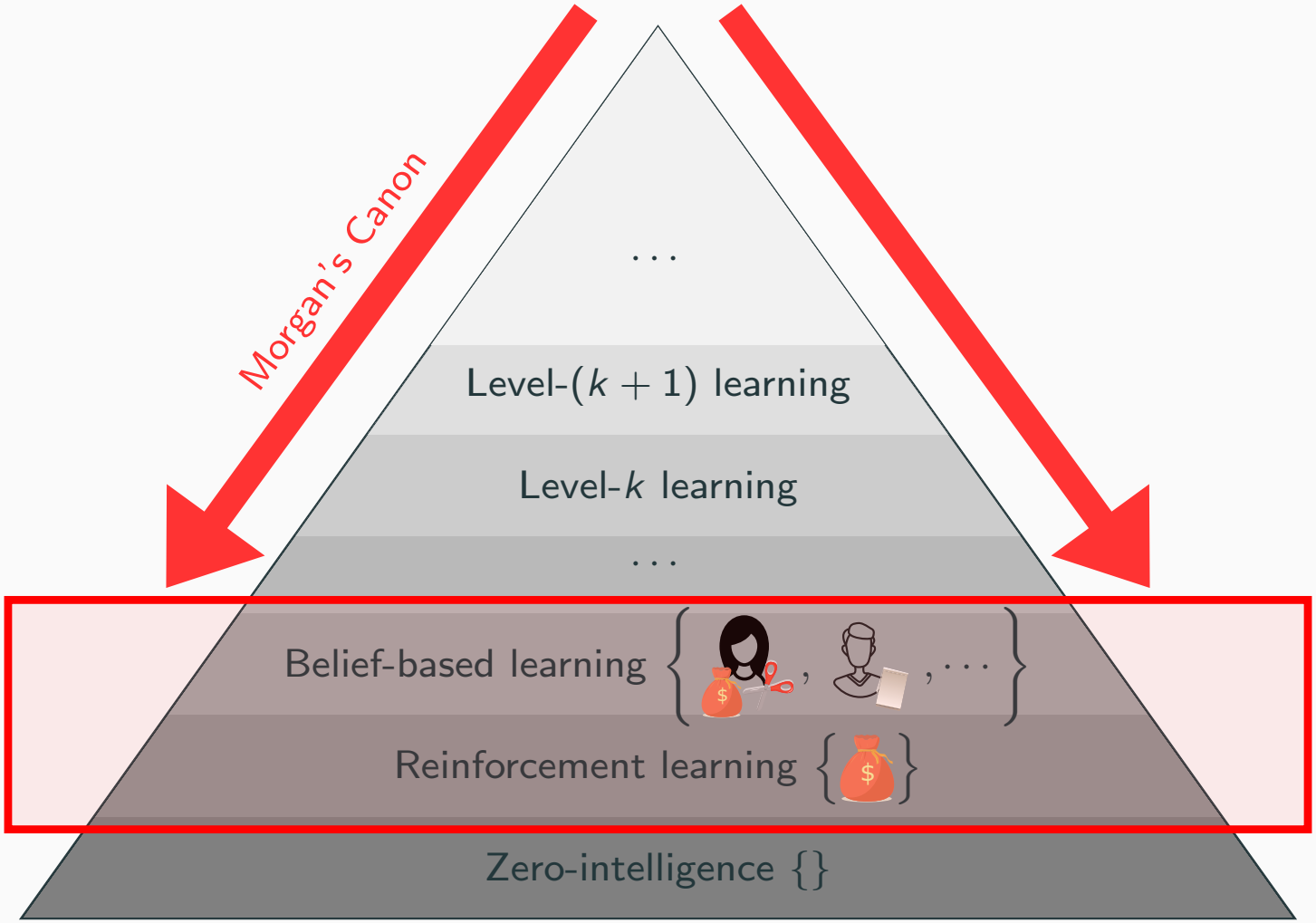
2. Learning model

Experience-weighted attraction learning

Reinforcement learning

Belief-based learning

Hierarchy of learning models



Case study / Results

	Parameter estimates				Goodness of fit				
Game	ϕ	λ	δ	ρ	LL	ρ^2	AIC	BIC	BS
Cournot	0.85	2.70	0.09	0.19	-8201	0.07	16411	16436	0.84
	0.84	6.90	0.35	0.32	-6094	0.06	12196	12220	0.80
PGG (MPCR 0.4)	0.82	4.55	0.52	0.37	-1864	0.11	3736	3756	0.65
	0.80	5.56	0.52	0.40	-1752	0.16	3512	3533	0.61
PGG (MPCR 1.6)	0.84	4.43	0.06	0.67	-2311	0.13	4629	4650	0.73
	0.82	9.55	0.46	0.75	-1454	0.22	2915	2935	0.56
Tullock	0.72	6.09	0.21	0.69	-840	0.16	1688	1705	0.71
	0.67	15.42	0.85	0.37	-2011	0.26	4029	4052	0.49
Complements	0.82	4.30	0.29	0.65	-933	0.10	1874	1891	0.79
	0.61	12.27	0.85	0.13	-2559	0.36	5125	5148	0.49
Substitutes	0.64	4.08	0.26	0.44	-842	0.18	1691	1708	0.70
	0.66	13.42	0.86	0.20	-2241	0.26	4491	4513	0.52

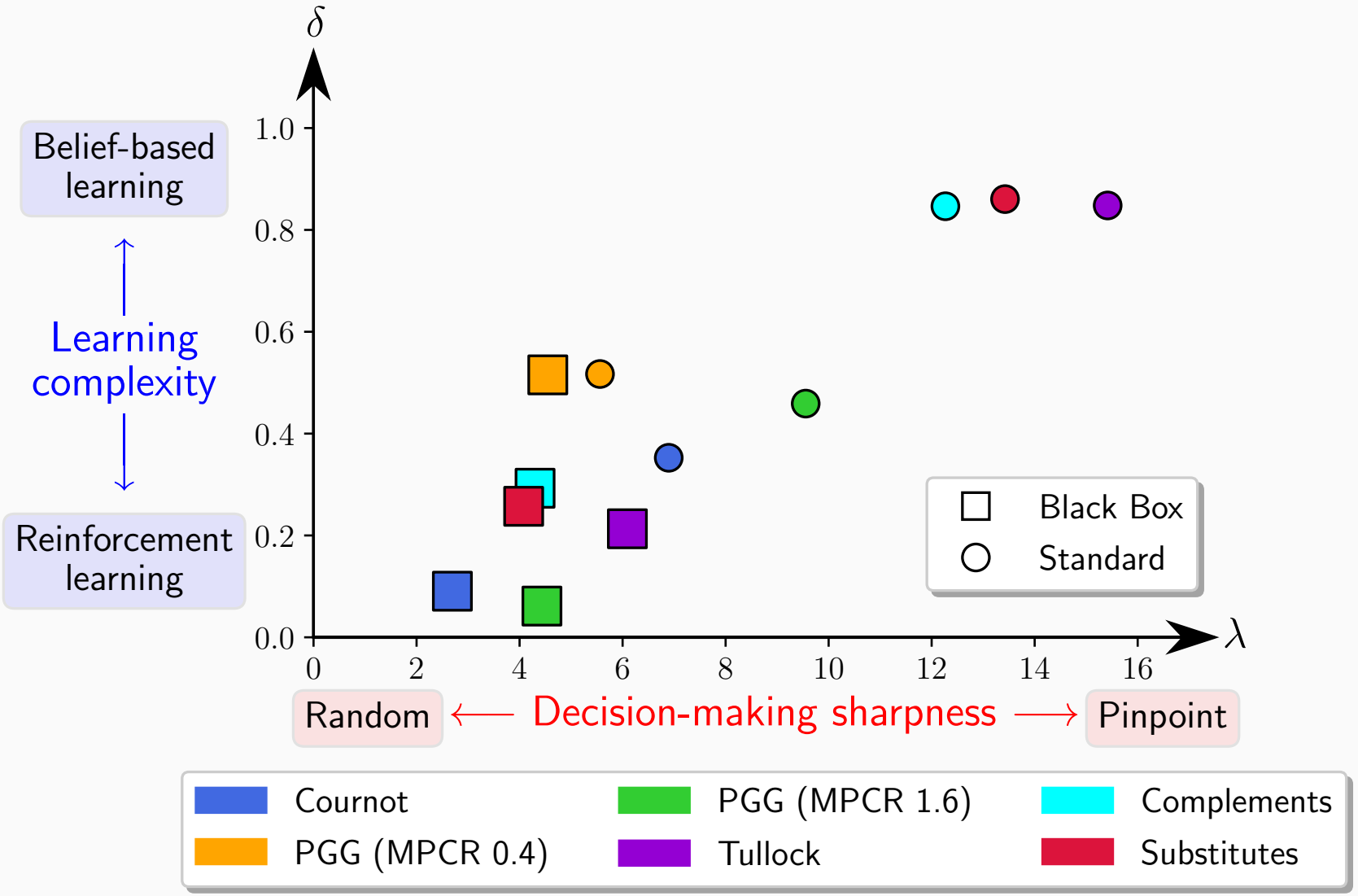
Black Box
Standard

Case study / Results

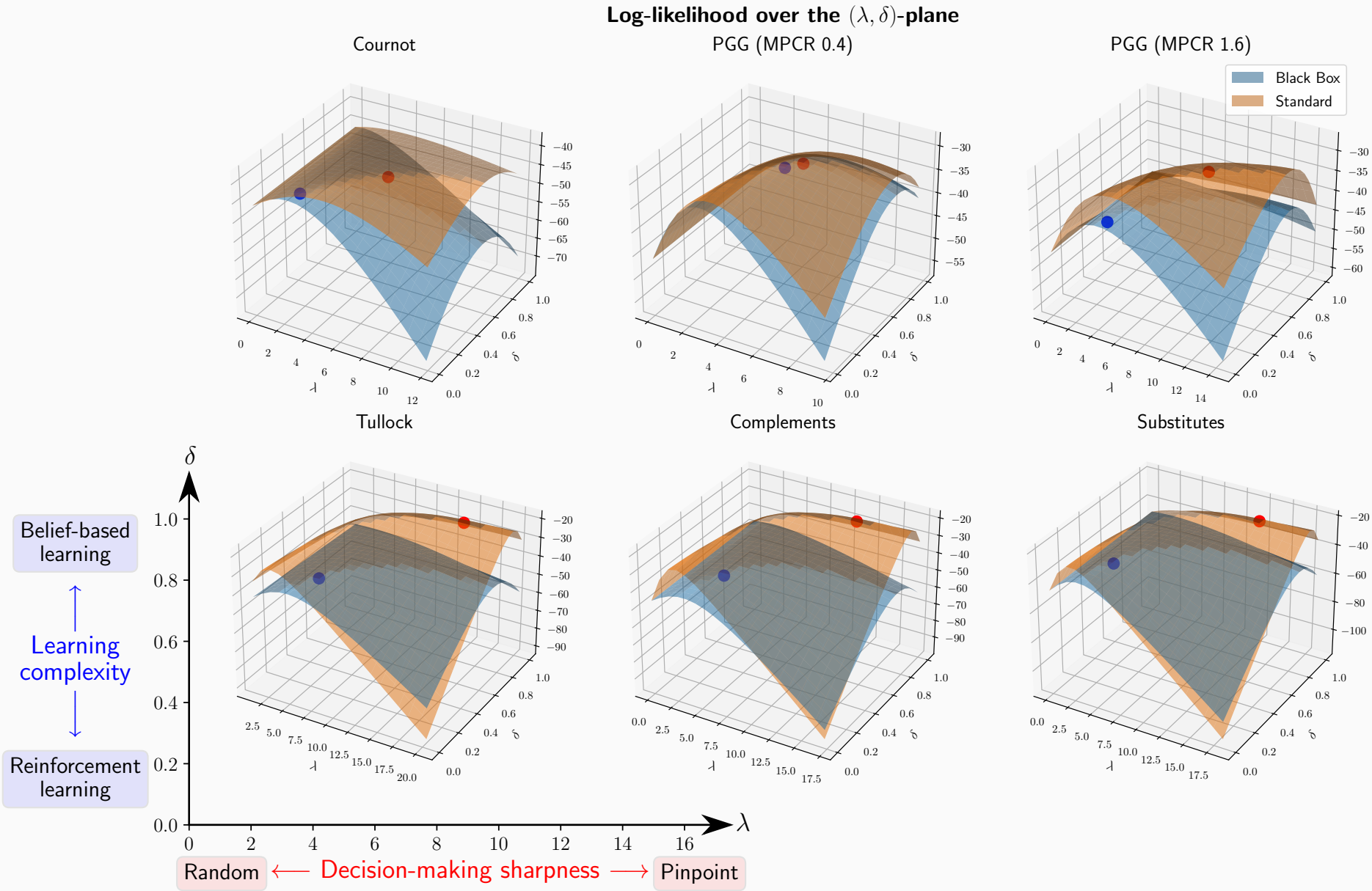
Game	Parameter estimates				Goodness of fit				
	ϕ	λ	δ	ρ	LL	ρ^2	AIC	BIC	BS
Cournot	0.85	2.70	0.09	0.19	-8201	0.07	16411	16436	0.84
	0.84	6.90	0.35	0.32	-6094	0.06	12196	12220	0.80
PGG (MPCR 0.4)	0.82	4.55	0.52	0.37	-1864	0.11	3736	3756	0.65
	0.80	5.56	0.52	0.40	-1752	0.16	3512	3533	0.61
PGG (MPCR 1.6)	0.84	4.43	0.06	0.67	-2311	0.13	4629	4650	0.73
	0.82	9.55	0.46	0.75	-1454	0.22	2915	2935	0.56
Tullock	0.72	6.09	0.21	0.69	-840	0.16	1688	1705	0.71
	0.67	15.42	0.85	0.37	-2011	0.26	4029	4052	0.49
Complements	0.82	4.30	0.29	0.65	-933	0.10	1874	1891	0.79
	0.61	12.27	0.85	0.13	-2559	0.36	5125	5148	0.49
Substitutes	0.64	4.08	0.26	0.44	-842	0.18	1691	1708	0.70
	0.66	13.42	0.86	0.20	-2241	0.26	4491	4513	0.52

Black Box
Standard

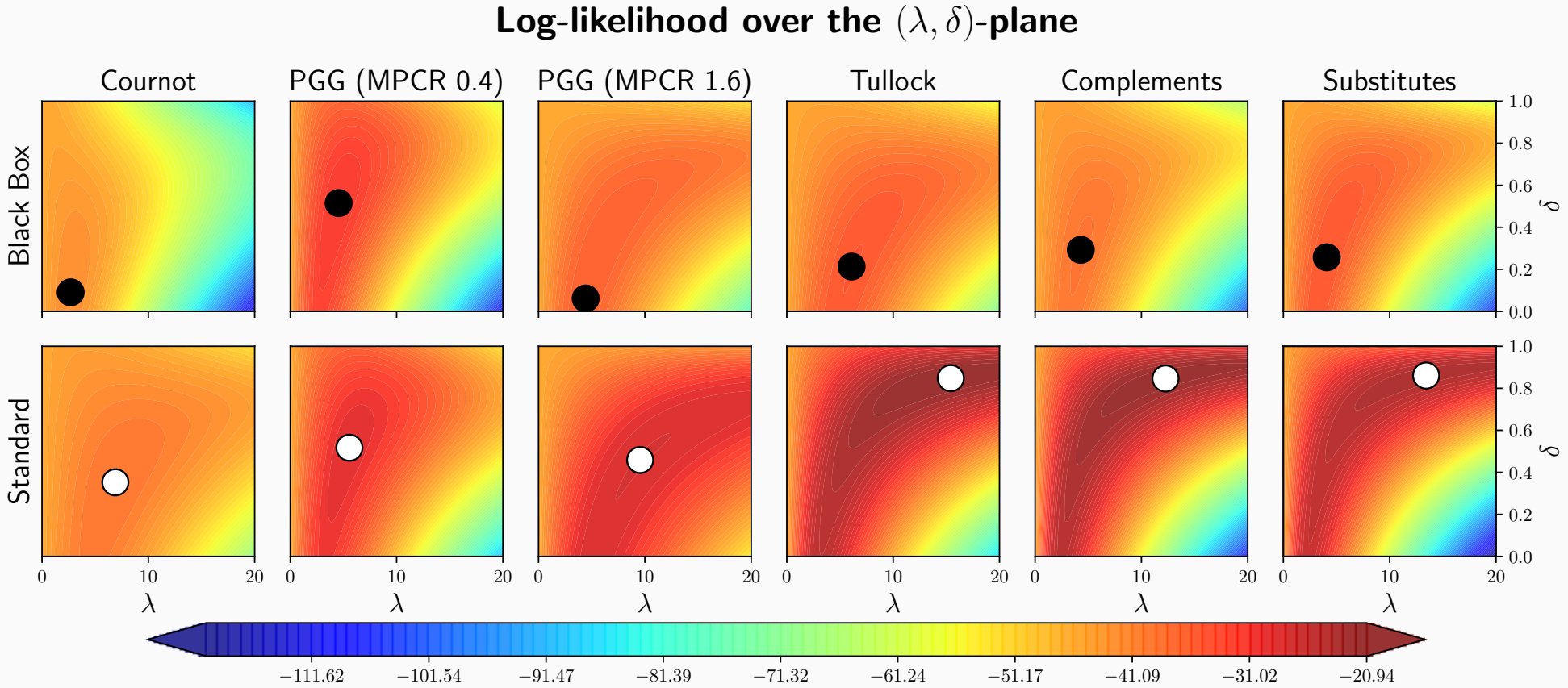
Case study / Results



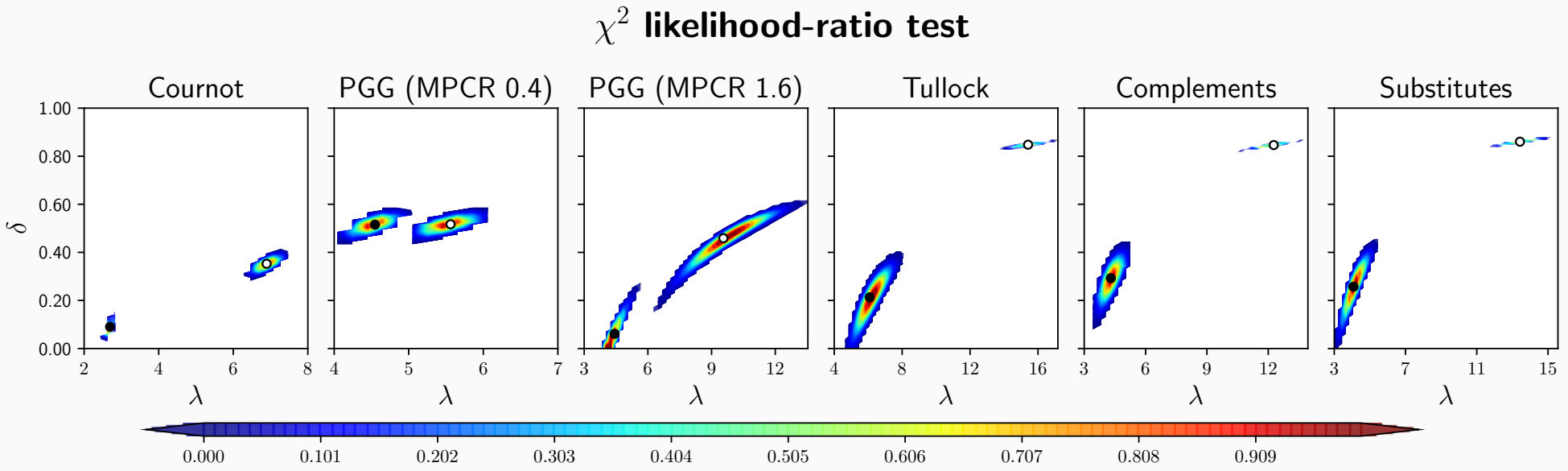
Case study / Results



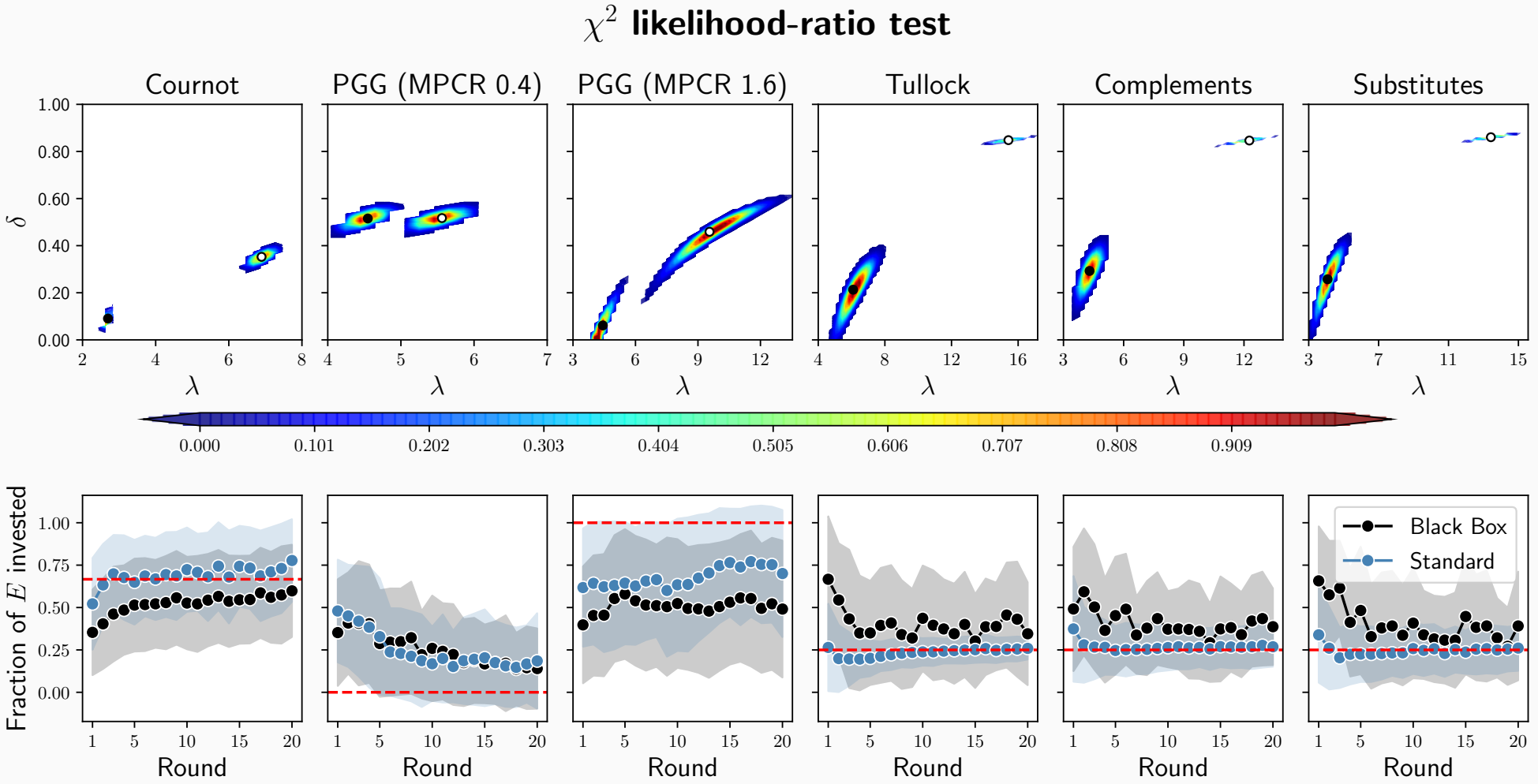
Case study / Results



Case study / Results



Case study / Results



Take-home message

> *... all models are approximations. Essentially, all models are wrong, but some are useful. However, the approximate nature of the model must always be borne in mind.*

George E. P. Box & Norman R. Draper, 1987