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Standards of Scientific Computing

Perspectives from Ethics and Philosophy of Science

Claus Beisbart
Institute of Philosophy
University of Bern
Claus.Beisbart@philo.unibe.ch

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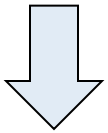
Module M4 „Ethics and Best Practices for Data Science"
CAS "Applied Data Science" (CAS ADS)

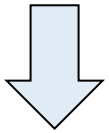
Questions

What is a good code/algorithm?

Which obligations do you have when designing software?



Standards



Justification

Illustration

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"Computing and software is at the core of many science and business projects. Consequently reproducible code is a basic criterion for high quality science and products. Scientific code should be Findable, Accessible, Interoperable and Reproducible (FAIR). Producing FAIR code is a societal obligation for researchers working with software.
Working with data may come with high responsibility and require high moral integrity. Misuse of data may not only hurt individuals, but entire political and democratic systems."

course description

Aim of this lecture

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Think about standards of scientific computing and their justification

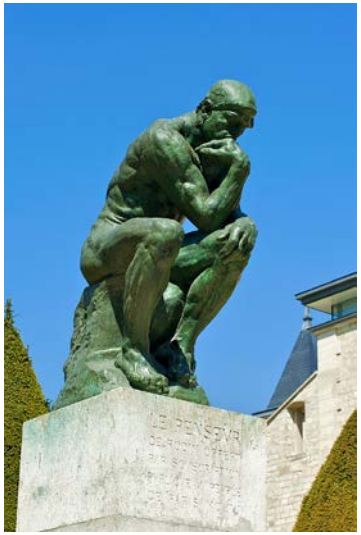
Philosophy

statue: A. Rodin (picture: D. Stockman, wikimedia commons, CC BY-SA 2.0)

Why philosophy?

Standards are not a topic in science: Value-free science

1. Science only describes how the world is like.
2. Descriptions of how the world is like don't imply what we should do.
3. Thus, science doesn't tell us what we should do.



Plan of the lecture

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1. Prelims

2. Scientific standards

Philosophy of science

3. Moral standards

Ethics

New philosophical „domain ethics“

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- Information ethics: focus on production and use of information.

  See e.g. Bynum (2018)
- Data ethics: focus on handling data.

  See e.g. Floridi & Taddeo (2016)
- Computer ethics: focus on work done with computers.

  See e.g. Bynum (2018)
- Ethics of algorithms: focus on algorithms.

  See e.g. Kraemer et al. (2011), Mittelstadt et al. (2016)

Warning: These branches of ethics overlap and are not yet settled disciplines.

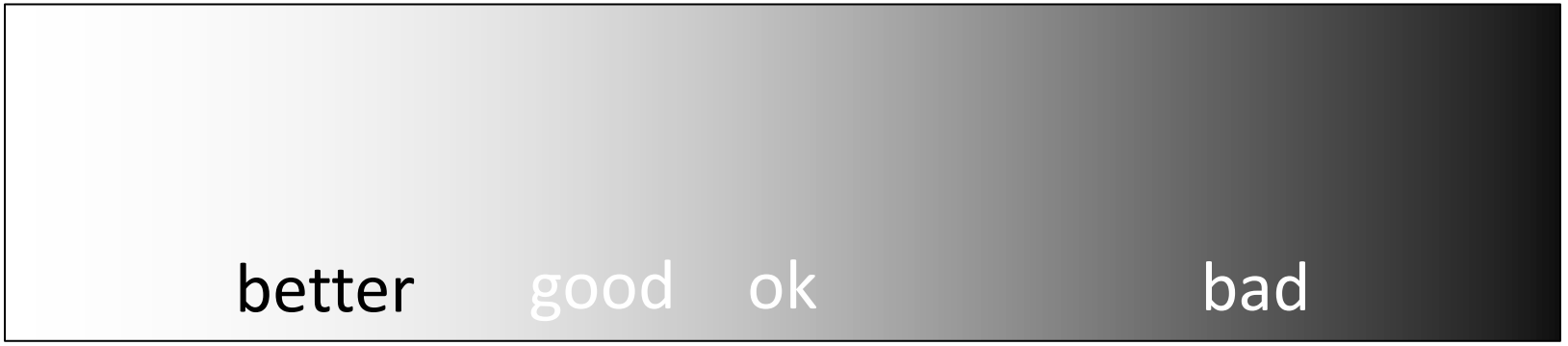
This is a good code.

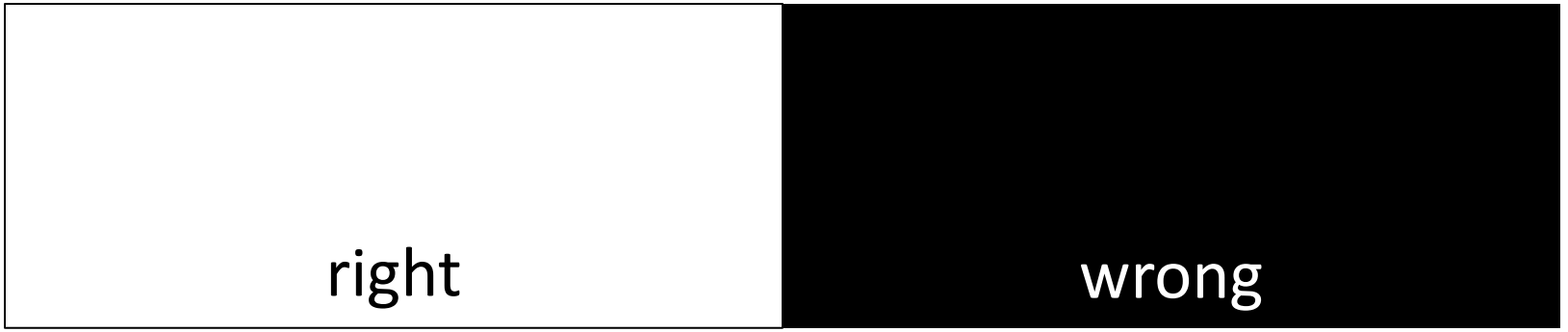
What is a good code/algorithm?

Which obligations do you have when designing software?

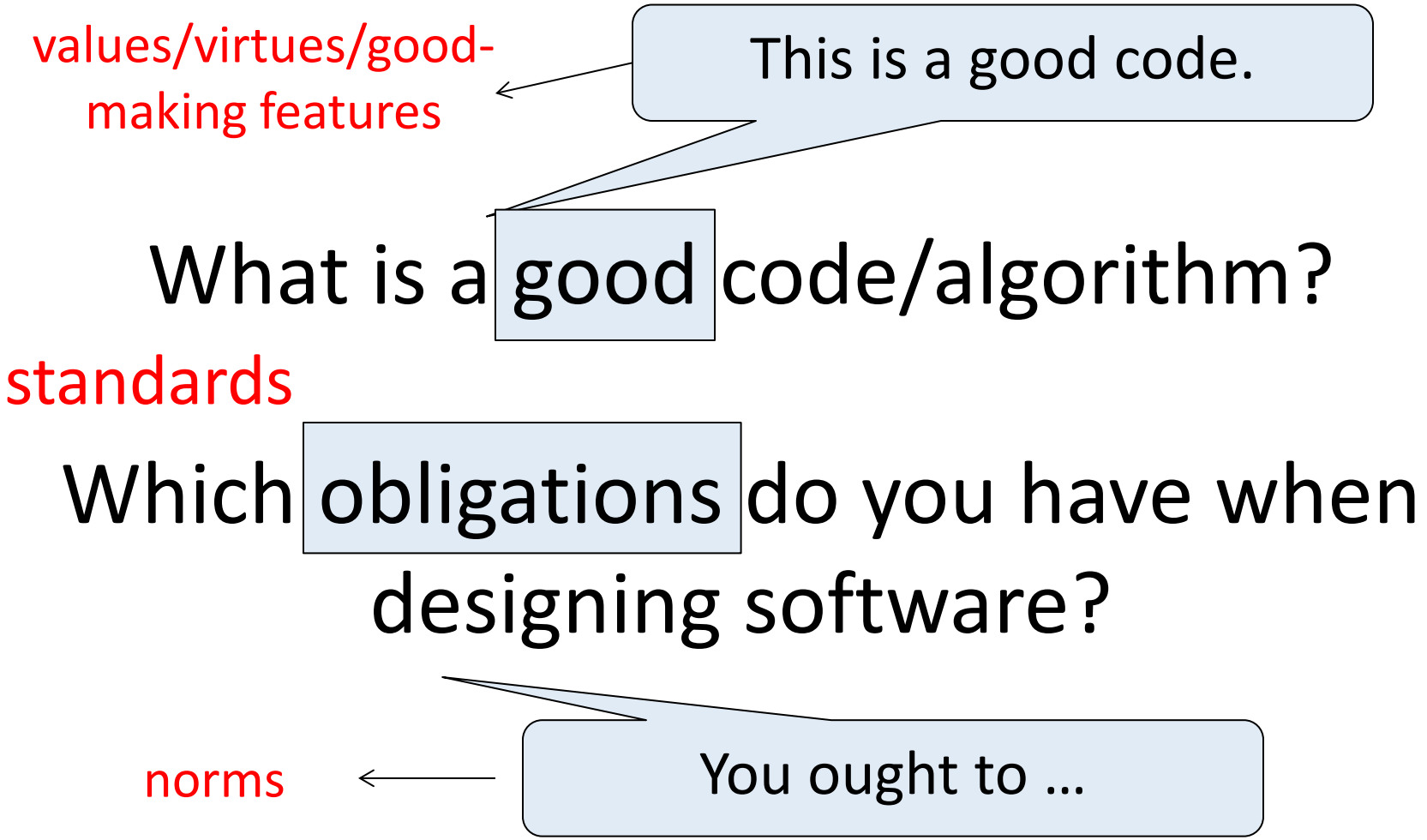
You ought to …

Illustration





Prelims


values/virtues/good-making features
This is a good code.
What is a good code/algorithm?
standards
Which obligations do you have when designing software?
norms
You ought to …

Standards

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What examples of standards can you give?

Standards

Where do standards come from?
How are they justified?

Options:

i. Type of thing under consideration
ii. Type of practice
iii. Morality

Ad i. type of object

Standard for knives: can cut

Knives have a certain function, viz. cutting.

They are the better, the more effective they are in fulfilling their function.

Ad ii. type of practice

E.g. practice: playing chess:

- norms: rules for moves.
- value: winning; moves are the better the more conducive they are to winning.

Image: R. Scheicher, wikimedia commons, here bw (public domain)

Ad iii. morality

Standards:

Values:
- Good life

Norms:
- Duties of respect
- Duties of justice

Standards

Which groups do your standards belong to?

OK, these are examples. But we need to think about standards in a more systematic way.

Ad i. type of object

What standards follow from the very idea of a code/algorithm?

Algorithm: set of instructions to fulfill a certain task.

- Instructions can be executed.
- Execution of instructions fulfills task.

Code: implementation of algorithm in programming language.

- No mistakes in the programming language.

Ad ii. type of practice

Here: science

What exactly is science? What are the underlying norms and values and what do they imply for codes?

Philosophy of science
See Sect. 2

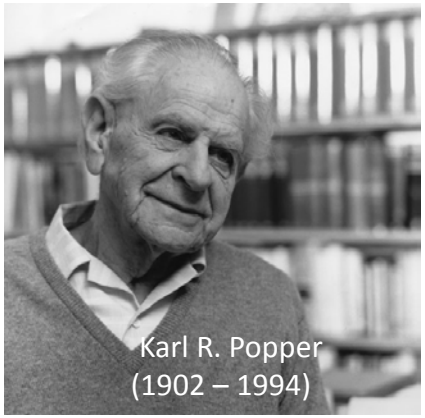
Ad iii. morality

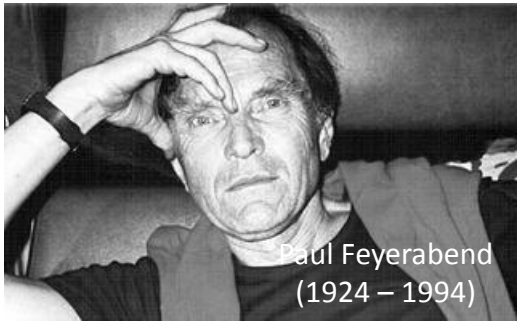
What exactly is morality? What are the underlying norms and values and what do they imply for codes?

Ethics

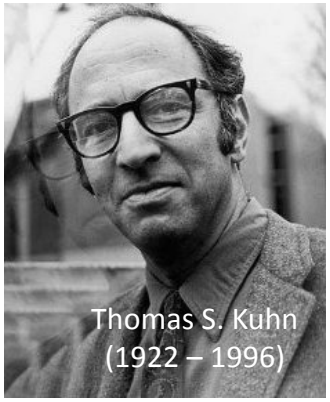
See Sect. 3

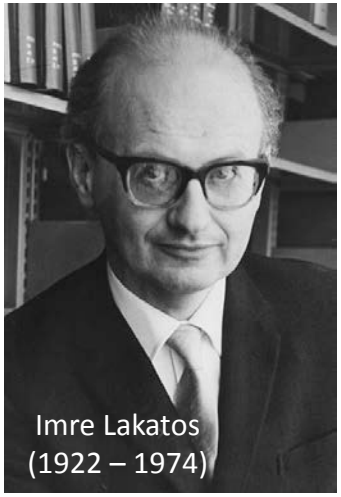
2. Scientific standards


Karl R. Popper
(1902 – 1994)


Paul Feyerabend
(1924 – 1994)


Larry Laudan
(* 1941)


Thomas S. Kuhn
(1922 – 1996)


Imre Lakatos
(1922 – 1974)

Standards in science

a. Values/goals:

Knowledge,
good theories, models, explanations
(theoretical virtues)

b. Scientific method

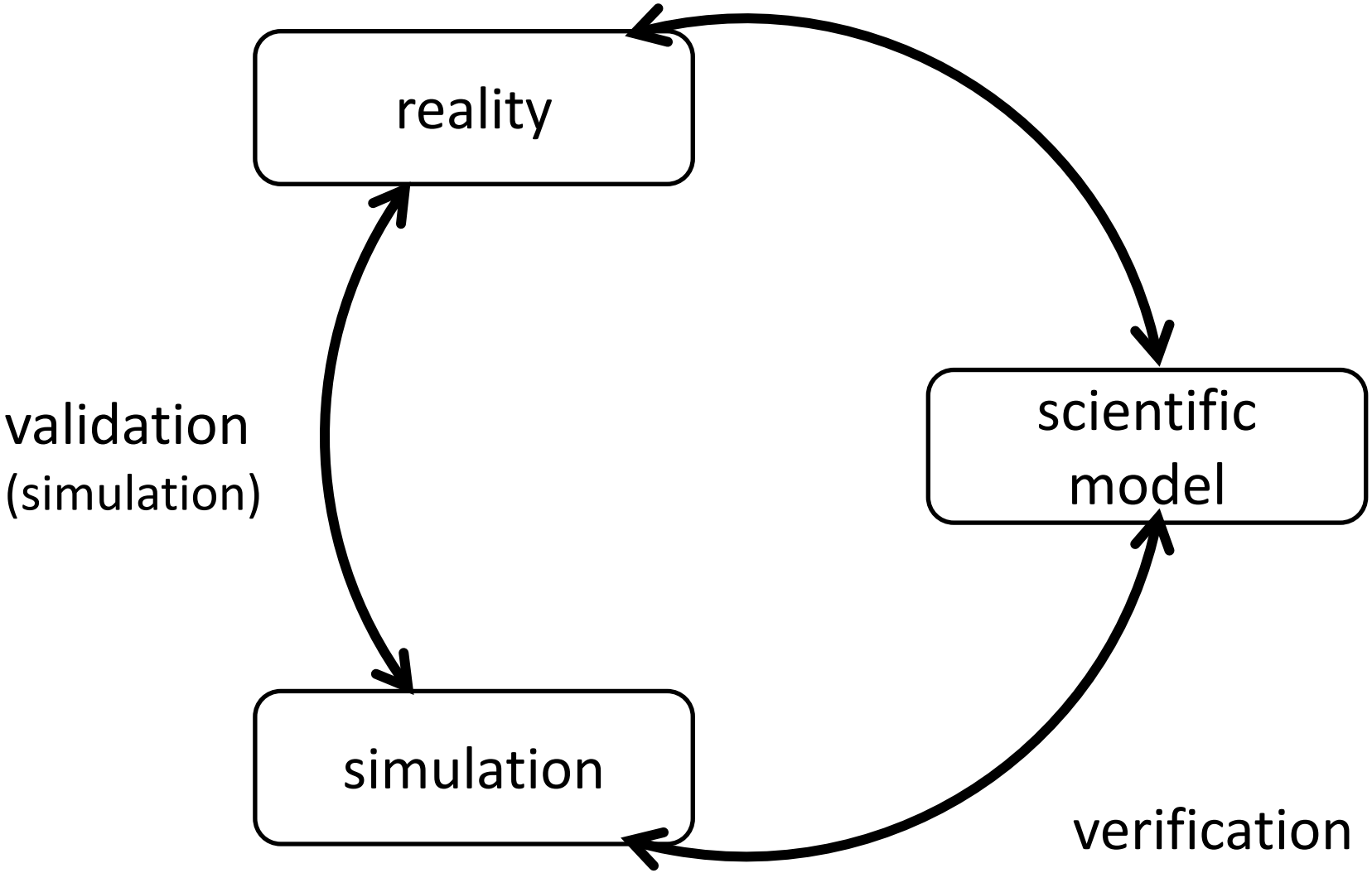
a. Theoretical virtues

- Truth
- Accuracy
- Consistency
- Empirical adequacy
- Consistency with background knowledge
- Explanatory power
- Scope
- Parsimony
- Simplicity

Application to codes

- Codes in general are not theories, explanations or models.
- But at least some of them are models or closely related: computer simulations.

Sargent cycle



V&V

Verification

„solving the equations right“

internal

mathematics

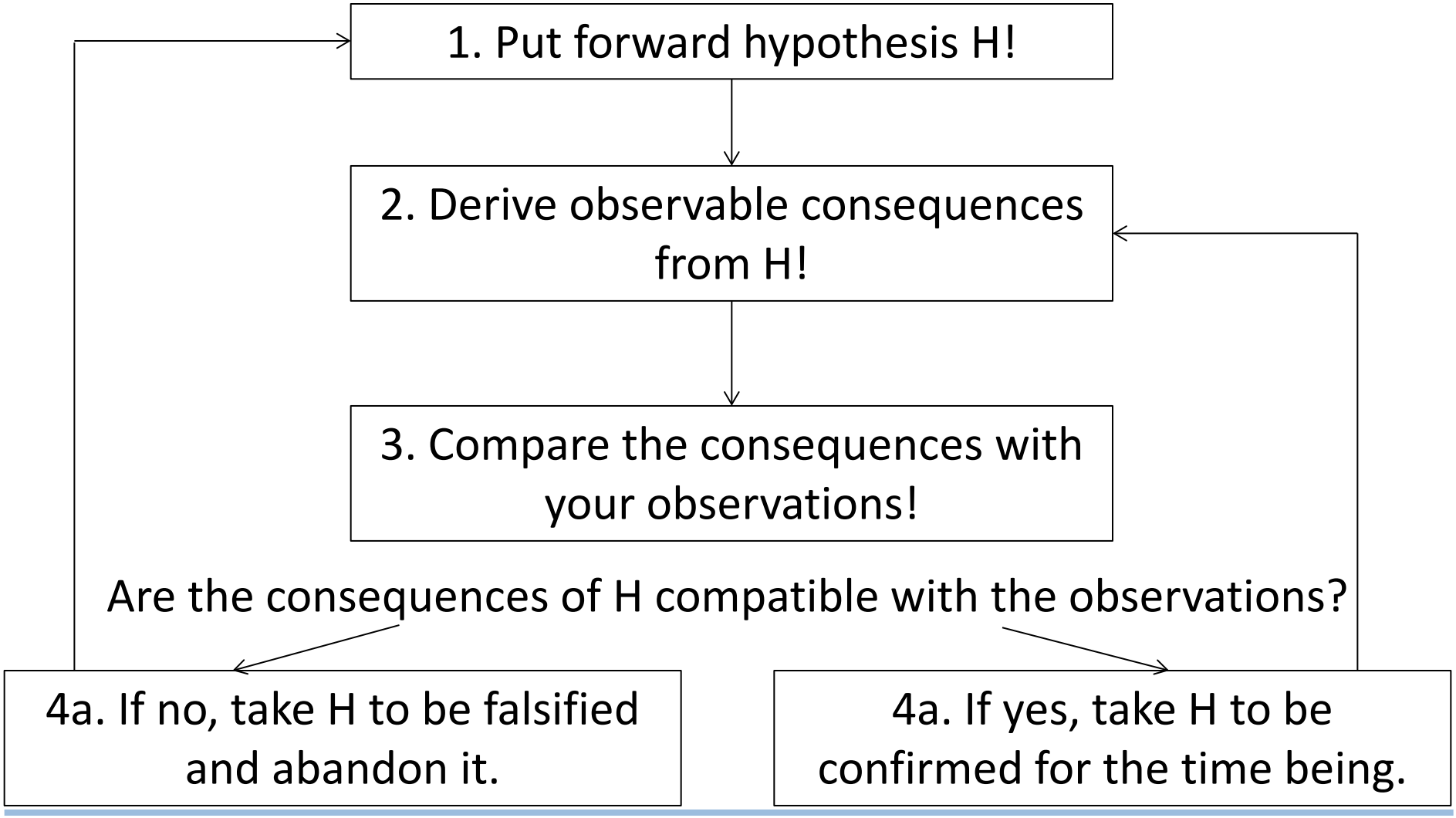
Validation

„solving the right equations“

external

empirical science

b. Sketch scientific method



Reproducibility/replicability

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Reproducibility crisis:

Journal of Personality and Social Psychology
2011, Vol. 100, No. 3, 407–425

Feeling the Future: Ex
Influ

Essay

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John P.

Summ

There
current
false. Th
is true
bias, th
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of true
relationships probed in each scientific field. In this framework, a research finding is less likely to be true when the studies conducted in a field are smaller; when

The term *psi* denotes ano
plained in terms of know
(conscious cognitive awar
otherwise be anticipated
themselves special cases
future event on an indivi
scious, cognitive or affecti
that test for retroactive influence by "time-reversing" well-established psychological effects so that the individual's responses are obtained before the putatively causal stimulus events occur. Data are presented for 4 time-reversed effects: precognitive approach to erotic stimuli and precognitive avoidance of negative stimuli; retroactive priming; retroactive habituation; and retroactive facilitation of recall. The

is a consequence of the convenient, yet ill-founded strategy of claiming conclusive research findings solely on the basis of a single study assessed by

is only one true relationship (among many that can be hypothesized) or the power is similar to find any of the several existing true relationships. The

OPEN ACCESS Freely available online

PLoS one

Failing the Future: Three Unsuccessful Attempts to Replicate Bem's 'Retroactive Facilitation of Recall' Effect

Stuart J. Ritchie[1]*, **Richard Wiseman**[2], **Christopher C. French**[3]

1 Psychology Department, The University of Edinburgh, Edinburgh, United Kingdom, **2** School of Psychology, University of Hertfordshire, Hatfield, United Kingdom, **3** Anomalistic Psychology Research Unit, Goldsmiths, University of London, London, United Kingdom

Abstract

Nine recently reported parapsychological experiments appear to support the existence of precognition. We describe three pre-registered independent attempts to exactly replicate one of these experiments, 'retroactive facilitation of recall', which examines whether performance on a memory test can be influenced by a post-test exercise. All three replication attempts failed to produce significant effects (combined $n = 150$; combined $p = .83$, one-tailed) and thus do not support the existence of psychic ability.

Citation: Ritchie SJ, Wiseman R, French CC (2012) Failing the Future: Three Unsuccessful Attempts to Replicate Bem's 'Retroactive Facilitation of Recall' Effect. PLoS ONE 7(3): e33423. doi:10.1371/journal.pone.0033423

Editor: Sam Gilbert, University College London, United Kingdom

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Competing Interests: The authors have declared that no competing interests exist.

* E-mail: stuartjritchie1@gmail.com

Ioannidis (2005)
Bem (2011)
Ritchie et al. (2012)

Varieties of replication/reproduction

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What exactly does it mean to replicate/reproduce a study:

- Same team?
- Same location/site?
- Same object
- Same measurement conditions?
- Same conditions?
- Same techniques of analysis?

Two questions:

i. Can set-up be reproduced? (methodological r.)
ii. Can the results be reproduced, given i?

Aspects of the replicability crisis

- Use of statistical methods (p-values)
- Publication bias
- Lack of Incentives for replications
- Documentation and publication of data and codes

Data: the FAIR guiding principles

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To be Findable:

F1. (meta)data are assigned a globally unique and persistent identifier

F2. data are described with rich metadata (defined by R1 below)

F3. metadata clearly and explicitly include the identifier of the data it describes

F4. (meta)data are registered or indexed in a searchable resource

To be Accessible:

A1. (meta)data are retrievable by their identifier using a standardized communications protocol

A1.1 the protocol is open, free, and universally implementable

A1.2 the protocol allows for an authentication and authorization procedure, where necessary

A2. metadata are accessible, even when the data are no longer available

Wilkinson et al. (2016), p. 4

Data: the FAIR guiding principles

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To be Interoperable:

I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.

I2. (meta)data use vocabularies that follow FAIR principles

I3. (meta)data include qualified references to other (meta)data

To be Reusable:

R1. meta(data) are richly described with a plurality of accurate and relevant attributes

R1.1. (meta)data are released with a clear and accessible data usage license

R1.2. (meta)data are associated with detailed provenance

R1.3. (meta)data meet domain-relevant community standards

Wilkinson et al. (2016), p. 4

Codes: OSS recommendations

1. Make source code publicly accessible from day one
2. Make software easy to discover by providing software metadata via a popular community registry
3. Adopt a licence and comply with the licence of third-party dependencies
4. Define clear and transparent contribution, governance and communication processes

Code comparison projects

COMPUTATION
SCIENCE&DISCO

The cosmic code comparison project

Katrin Heitmann[1], Zarija Lukic[2], Patricia Fase
Michael S Warren[1], Martin White[3], James Ahr
Ryan Armstrong[4], Brian O'Shea[1], Paul M Ric
Joachim Stadel[7] and Hy Trac[8]

[1] Los Alamos National Laboratory, Los Alamos, NM 87545,
[2] Department of Astronomy, University of Illinois, Urbana, IL 61801, USA
[3] Department of Astronomy, University of California, Berkeley, CA 94720-3411, USA
[4] Department of Computer Science, UC Davis, Davis, CA 95616, USA

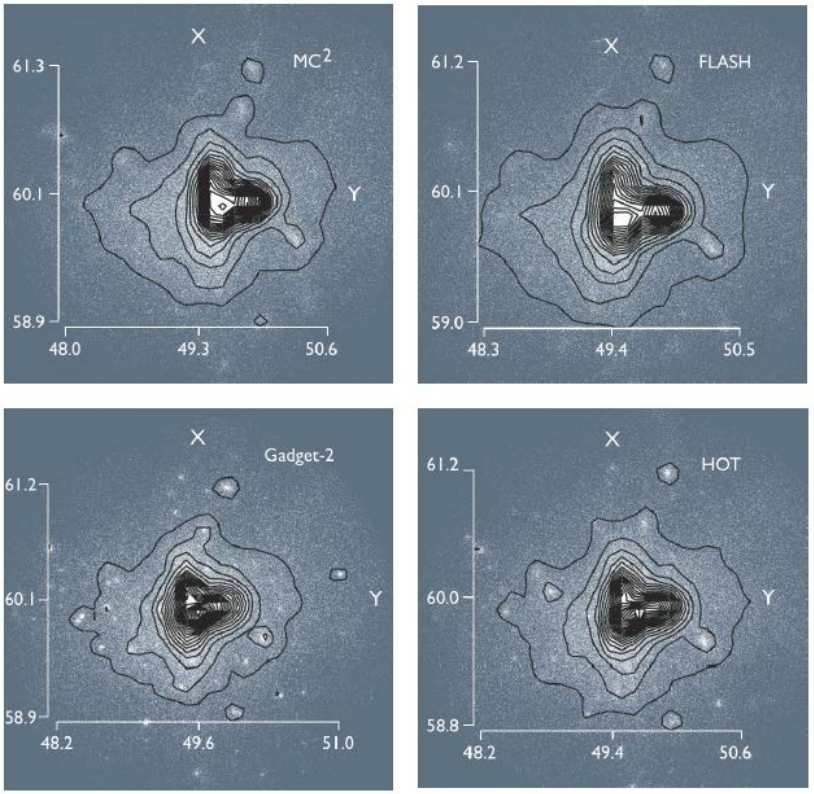
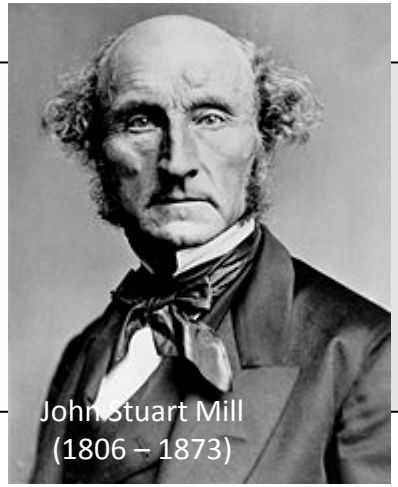


Figure 5. Two-dimensional contour plot of the projected density for halo 3 from MC^2, FLASH, GADGET-2, and HOT (left upper to right lower plot). White: particles, black: contour smoothed with a Gaussian filter.

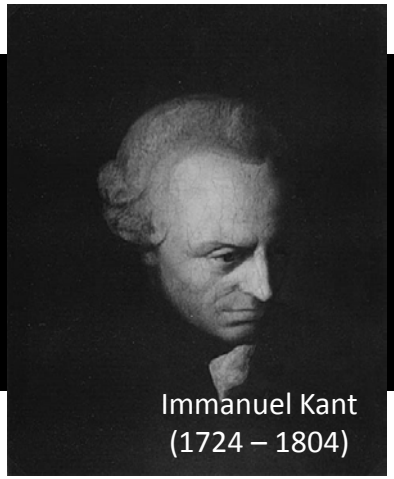
Heitmann et al. (2008), image: p. 13

3. Moral standards


John Stuart Mill
(1806 – 1873)

Value-centered

Duty-/right-centered


Immanuel Kant
(1724 – 1804)

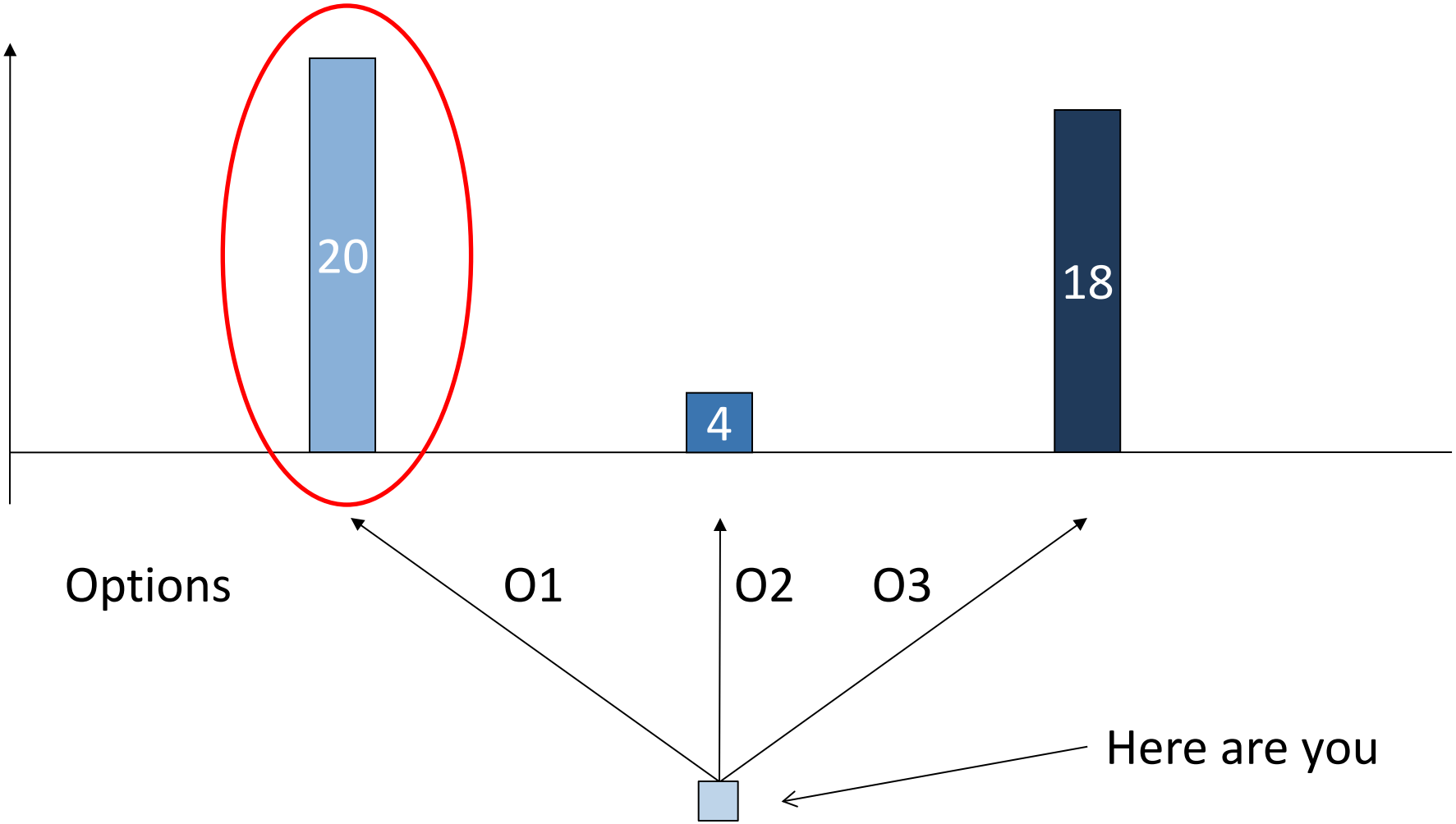
a. values

Mill: utilitarianism:

One value: human welfare/well-being

One norm: An action is morally right if, and only if, it maximizes human welfare.

Illustration



Application to codes

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How do codes impact on welfare?

- Running codes produces costs. The costs should be minimized in order to save costs.
  - Codes should be fast (save CPU time).
  - Codes should not need much storage space.
  - Codes should be reusable.
  - Codes should have broad scope of applications.

How codes implement values

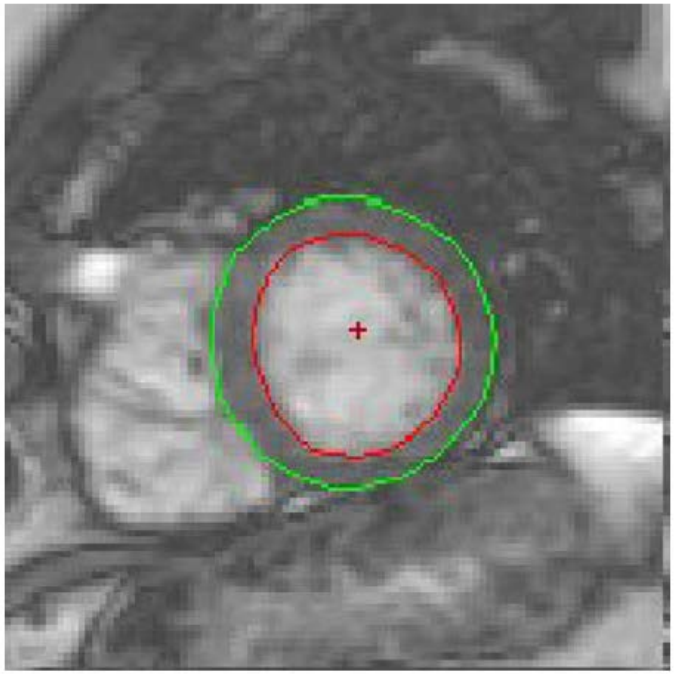
- determine blood volume using segmentation
- predict disease

Errors:

- false positives
- false negatives

Tradeoff?

Moral value



Kraemer et al. (2011), image p. 255

b. Rights and duties

Kant:

Basic rights:

- Right to privacy
- Right to autonomy

Fairness

Fairness

Prediction Fails Differently for Black Defendants

	WHITE	AFRICAN AMERICAN
Labeled Higher Risk, But Didn't Re-Offend	23.5%	44.9%
Labeled Lower Risk, Yet Did Re-Offend	47.7%	28.0%

Overall, Northpointe's assessment tool correctly predicts recidivism 61 percent of the time. But blacks are almost twice as likely as whites to be labeled a higher risk but not actually re-offend. It makes the opposite mistake among whites: They are much more likely than blacks to be labeled lower risk but go on to commit other crimes. (Source: ProPublica analysis of data from Broward County, Fla.)

Fairness

Carnegie Mellon University

News

Stories | Media Highlights | Media

News › Stories › Archives › 2015 › July › Questioning the Fairness of Targeting Ads Online

July 07, 2015

Questioning the Fairness of Targeting Ads Online

CMU Probes Online Ad Ecosystem

By Byron Spice / 412-268-9068

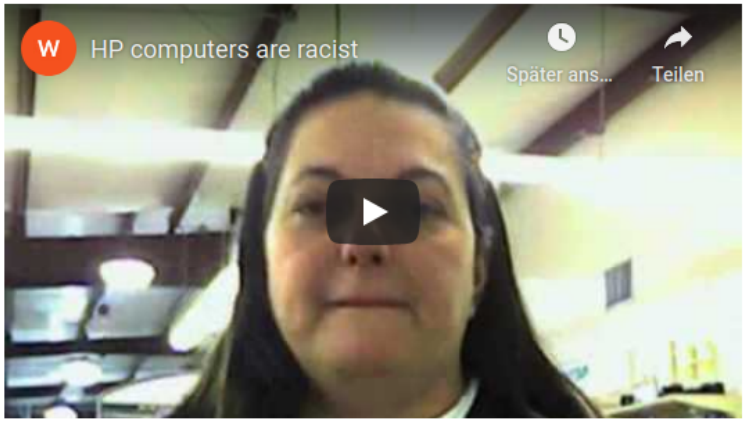
Experiments by Carnegie Mellon University showed that significantly fewer women than men were shown online ads promising them help getting jobs paying more than $200,000, raising questions about the fairness of targeting ads online.

https://www.cmu.edu/news/stories/archives/2015/july/online-ads-research.html

Fairness

BRIAN X. CHEN 12.22.09 12:26 PM

HP Investigates Claims of 'Racist' Computers



Meet "Black Desi." He and his friend "White Wanda" made a video titled "HP computers are racist," which has been a viral hit in recent weeks. (See above.) In an attempt to prove their claim, Desi demonstrated that an HP MediaSmart computer's facial-tracking software could not follow the movements of his face, but it could do so just fine for his white friend Wanda.

https://www.wired.com/2009/12/hp-notebooks-racist/

Causes of algorithmic discrimination

- Misuse of models
- Bias in training data

See Lepri et al. (2018)

Algorithmic fairness

Issues:

- What does it mean?
- How is it implemented?

Some ideas

- “fairness through blinding”: Don’t use variables such as gender, race, etc.

  problem:
  such variables may be correlated with others

- “group fairness” by “statistical parity”: the fraction of people who obtain a benefit should be the same for every group

  problems:
  accuracy and lack of individual fairness

Lepri et al. (2018, pp. 615-618)

Some ideas

- “individual fairness”: people with similar characteristics should obtain same chance of a good

See Lepri et al. (2018, pp. 615-618)

Philosophical question:
What is justice?

Justice

Aristotle: There are several kinds of justice:

- Distributive

"suum cuique"

???

Equality of what?

- Retributive justice

The general argument

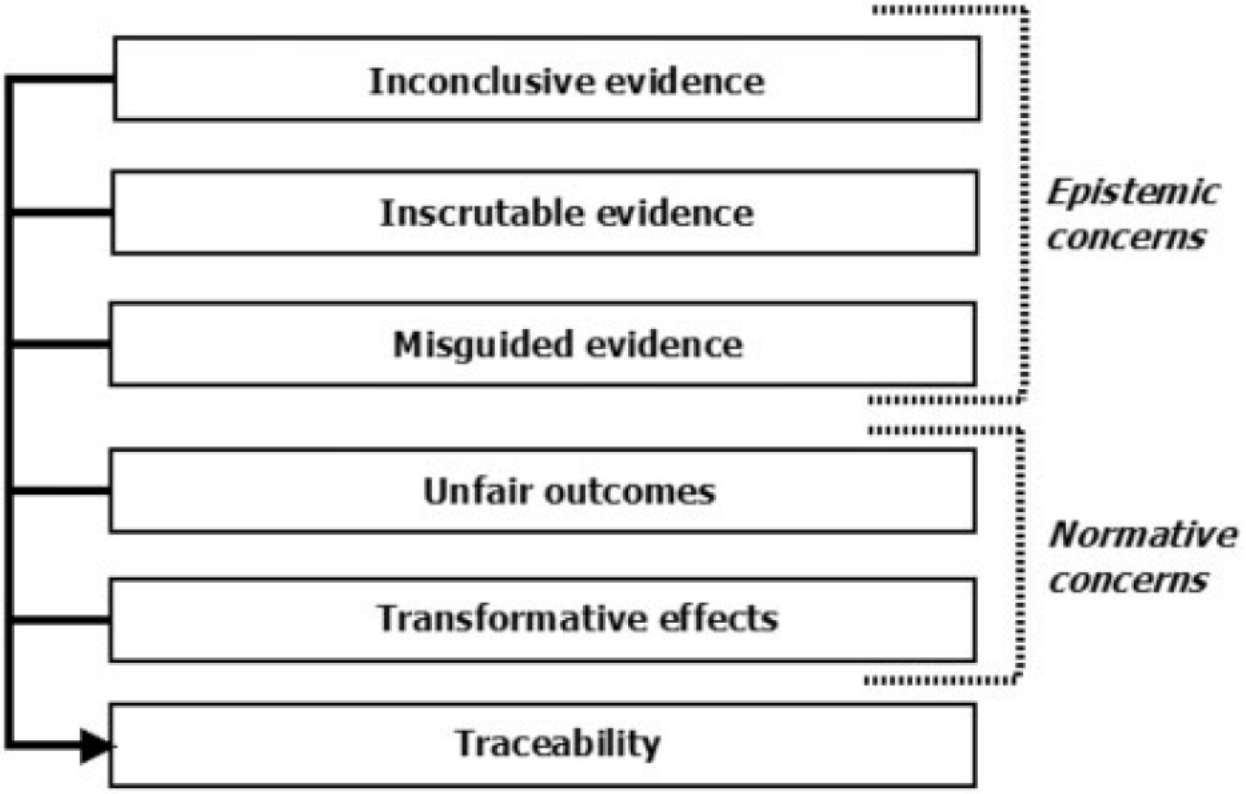
Algorithms/codes are subject to ethical concerns since:

Codes take decisions that make a difference with respect to moral values, rights/duties and justice

Consequences

1. Choose moral solutions!
2. Negotiate solutions with stakeholders!
3. Document the moral perspective inherent in code!

Systematic account?



Mittelstadt et al. (2016, Fig. 1, p. 4)

Summary

Standards for software and software development come

- Function of software: SQA, …
- Practice of science:
  - Reusability, documentation, …
- Morality:
  - Reasonable trade-offs in values
  - Respect for autonomy
  - Algorithmic fairness

Many thanks!

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