

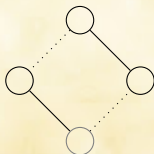
The Order of Mathematistry

Queering metascience with mathematics

Charles T. Gray[♫]
Hannah Fraser, Hien Nguyen,
Elise Gould, and Danielle Navarro

♫ Reproducibility team, The repliCATS Project
Interdisciplinary Metaresearch Group, University of Melbourne

February 2020



Outline

A value judgement is, after all, an order

Heuristics of mathematisttry

The order of mathematisttry

A question of cardinality

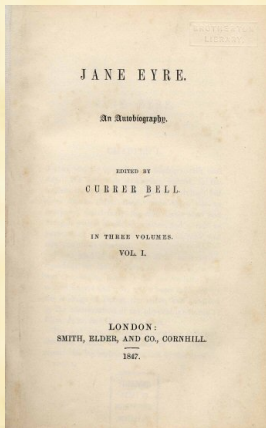
A question of density

The utility of heuristics

Other queerings

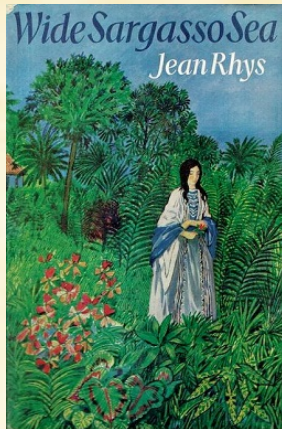
Scientific ways to discuss how to science

Queering literature



Jane Eyre, 1847

Charlotte Brontë [2]



Wide Sargasso Sea, 1966

Jean Rhys [8]

Image sources: Wikipedia.

Queering metascience

So let's build an open and reproducible science as a queer reimagining of science and not a small perturbation of the world that is. Such a system will never be perfect.

– Dan Simpson [9]

Preregistration is redundant, at best

The Centre for Open Science defines **preregistration** as specifying the research plan in advance [7].

2019: Preregistration is Hard, and Worthwhile, Nosek *et al.* [6]

2019: Is Preregistration Worthwhile? Szollosi *et al.* [10]

The diagnosticity of statistical tests depend entirely on how well statistical models map onto underlying theories, and so improving statistical techniques does little improve theories when the mapping is weak [10].

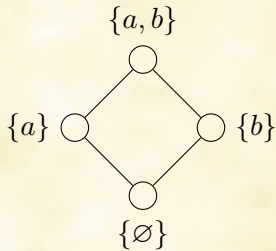
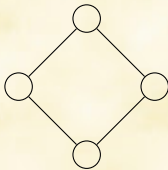
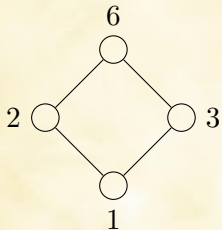
Mathematistry

Navarro, a mathematical scientist specialising in psychology, redefines Box's term **mathematistry** [1] to

‘describe using formal tools to define a statistical problem that differs from the scientific one, solving the re-defined problem, and declaring the scientific concern addressed’ [5].

We will think of **mathematistry** as the measure of strength of mapping to describe when the mapping is weak [10].

A value judgement is, after all, an order



Outline

A value judgement is, after all, an order

Heuristics of mathematisttry

The order of mathematisttry

A question of cardinality

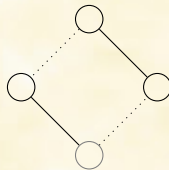
A question of density

The utility of heuristics

Other queerings

Scientific ways to discuss how to science

Heuristics of mathematistry

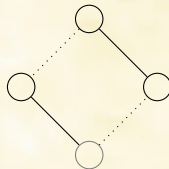


Heuristics of mathematistry

A heuristic can be thought of in terms of a mapping from $C \times M$ to some space of measuring how well a pairing ‘furthers the process of scientific discovery’ (Devezer *et al.*, 2019) [4].

`fpd` := furthers the process of scientific discovery

Heuristics of mathematistry



$$h : C \times M \rightarrow \begin{cases} \{0, 1\} & \text{if fpd or not;} \\ [0, 1] & \text{if fpd on a spectrum;} \\ H & \text{if fpd otherwise.} \end{cases}$$

Heuristics of mathematistry

Let C denote the set of all possible **scientific claims** for which we might provide evidence of, with a scientific method or procedure.

Let M denote the set of all possible **scientific methods** that can be used to provide evidence of scientific claims.

The product $C \times M$ denotes the collection of possible **pairings of claim and methodology**.

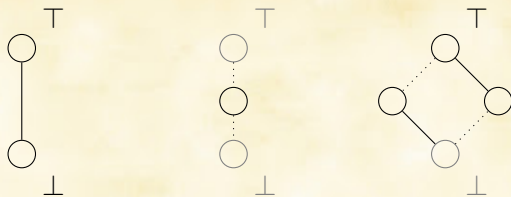
Heuristic of mathematistry

Definition

A **heuristic h of mathematistry** measures the efficacy of a pairing (c, m) of scientific claim $c \in C$, and method $m \in M$ of providing evidence of that claim, measuring how effective method m is at scientifically informing claim c .

We denote \mathbb{H} to be the set of all possible heuristics of mathematistry. For a heuristic h in \mathbb{H} , we define the value $h(c, m)$ as the **measure of mathematistry** of pairing (c, m) under heuristic h .

A value judgement on *good enough* [11] science



For a heuristic h to be a member of \mathbb{H} , there must exist a scientific method m , and two distinct scientific claims we might reasonably pair m with, c_1 and c_2 , such that

$$h(c_1, m) < h(c_2, m)$$

or, conversely, there must exist distinct methods, m_1 and m_2 , such that, for a claim c , we have

$$h(c, m_1) < h(c, m_2).$$

A relational operator of mathematistry

Definition

Let $(c_1, m_1) \rightarrow_h (c_2, m_2)$ if and only if $h(c_1, m_1) \leq h(c_2, m_2)$ under heuristic h of mathematistry.

Outline

A value judgement is, after all, an order

Heuristics of mathematisttry

The order of mathematisttry

A question of cardinality

A question of density

The utility of heuristics

Other queerings

Scientific ways to discuss how to science

Order

To be considered an order, \rightarrow_h must satisfy three properties [3].

Definition

A binary relation \leq on set P is an **order** if, for all $x, y, z \in P$, we have

- (i) $x \leq x$,
- (ii) $x \leq y$ and $y \leq x$ implies $x = y$,
- (iii) $x \leq y$ and $y \leq z$ imply $x \leq z$.

Order

- (i) **reflexivity** $x \leq x$,
- (ii) **antisymmetry** $x \leq y$ and $y \leq x$ implies $x = y$,
- (iii) **transitivity** $x \leq y$ and $y \leq z$ imply $x \leq z$.

When a binary relation satisfies (i) reflexivity and (iii) transitivity, but not (ii) antisymmetry, we say it is a **quasi-order**.

A quasi-order of mathematistry

Definition

When a binary relation satisfies (i) reflexivity and (iii) transitivity, but not (ii) antisymmetry, we say it is a **quasi-order**.

Let $\mathcal{X} \subseteq C \times M$ denote the subset \mathcal{X} of reasonable pairings $C \times M$ of claims and methods.

Lemma

The relation \rightarrow_h is a quasi-order on \mathcal{X} .

Outline

A value judgement is, after all, an order

Heuristics of mathematisttry

The order of mathematisttry

A question of cardinality

A question of density

The utility of heuristics

Other queerings

Scientific ways to discuss how to science

Outline

A value judgement is, after all, an order

Heuristics of mathematisttry

The order of mathematisttry

A question of cardinality

A question of density

The utility of heuristics

Other queerings

Scientific ways to discuss how to science

Outline

A value judgement is, after all, an order

Heuristics of mathematistiry

The order of mathematistiry

A question of cardinality

A question of density

The utility of heuristics

Other queerings

Scientific ways to discuss how to science

Outline

A value judgement is, after all, an order

Heuristics of mathematistiry

The order of mathematistiry

A question of cardinality

A question of density

The utility of heuristics

Other queerings

Scientific ways to discuss how to science

Outline

A value judgement is, after all, an order

Heuristics of mathematisttry

The order of mathematisttry

A question of cardinality

A question of density

The utility of heuristics

Other queerings

Scientific ways to discuss how to science

The order of mathematistry

References I



George E. P. Box. “Science and Statistics”. en. In: *Journal of the American Statistical Association* 71.356 (Dec. 1976), pp. 791–799. ISSN: 0162-1459, 1537-274X. DOI: 10.1080/01621459.1976.10480949.



Charlotte Brontë. *jane eyre*. OUP Oxford, 2000.



B. A. Davey and H. A. Priestley. *Introduction to Lattices and Order*. English. Google-Books-ID: vVVTxeuiyvQC. Cambridge University Press, Apr. 2002. ISBN: 978-0-521-78451-1.



Berna Devezer et al. “Scientific Discovery in a Model-Centric Framework: Reproducibility, Innovation, and Epistemic Diversity”. en. In: *PLOS ONE* 14.5 (May 2019), e0216125. ISSN: 1932-6203. DOI: 10.1371/journal.pone.0216125.



Danielle Navarro. *Between the devil and the deep blue sea: Tensions between scientific judgement and statistical model selection*. preprint. PsyArXiv, Oct. 2018. DOI: 10.31234/osf.io/39q8y.



Brian A. Nosek et al. “Preregistration Is Hard, And Worthwhile”. en. In: *Trends in Cognitive Sciences* 23.10 (Oct. 2019), pp. 815–818. ISSN: 1364-6613. DOI: 10.1016/j.tics.2019.07.009.



Centre for Open Science. *Preregistration*. 2020.



Jean Rhys. *Wide sargasso sea*. WW Norton & Company, 1992.

References II



Dan P. Simpson. *What if it's never decorative gourd season?* << *Statistical Modeling, Causal Inference, and Social Science*. 2019.



Aba Szollosi et al. *Preregistration is redundant, at best*. preprint. PsyArXiv, Oct. 2019.
DOI: 10.31234/osf.io/x36pz.



Greg Wilson et al. “Good enough practices in scientific computing”. English. In: *PLOS Computational Biology* 13.6 (June 2017). Ed. by Francis Ouellette, e1005510. ISSN: 1553-7358. DOI: 10.1371/journal.pcbi.1005510.