# Improving Kuhn's Account of Theory Choice with Ordinal Epistemic Scales

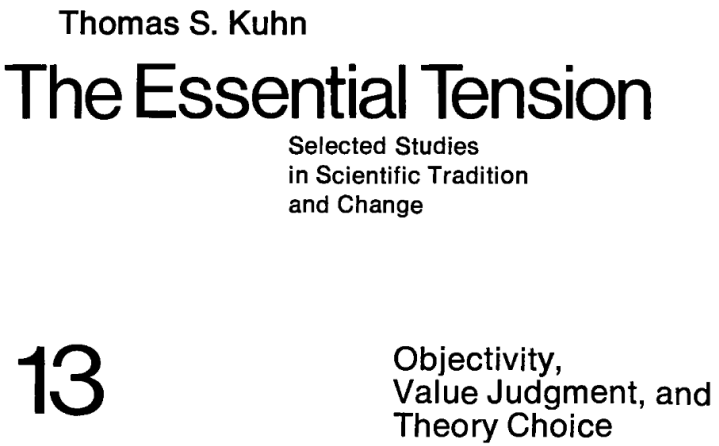
**Thomas Boyer-Kassem**

Philosophy Department, MAPP, Université de Poitiers
& Institut Universitaire de France

*"Epistemic Values and Their Scales" — Poitiers, 18 November 2025*

## The general problem (cf. Kuhn 1977)

- **Several** competing scientific **theories**.
- **Various epistemic values** (accuracy, simplicity, . . . ).
- How choose the **best theory**?




## Difference with Kuhn

- I consider the case of **one** agent — already enough work ;-).
- The aggregation is between **several value judgments**, **not** between several **agents**' judgments (or see a w.p. of mine)

$\Rightarrow$ not "voters", but "values".

## The literature

- Okasha (2011, 2015), Morreau (2014, 2025): is it analogous to a standard social choice problem + Arrow's impossibility theorem?
- They start by assuming **rankings.** Kuhn (1977) too.
  E.g. Theory A is the first on Simplicity, the third on Consistency
- But rankings are not very informative:
  - Being **first** may not mean being **excellent** or even good.
  - 2nd and 3rd may be very **close**, or very **far**...

## Another approach

- Use **qualitative judgments**.
  E.g. Theory A is **Excellent** on Simplicity, **Good** on Consistency
- The differences: more informative! and escape Arrow!

## An example (Kuhn 1977): how assess...?

**Ptolemy**. Accuracy: **Good**. Simplicity: **Fair**. Consistency : **Good**.

**Copernicus**. Accuracy: **Good**. Simplicity: **Very Good**. Consistency : **Bad**.

## Difficulties in aggregating value judgments (Kuhn 1977, p. 322)

- Values are **imprecise** (varying interp. depending on the person)
  only one agent ⇒ not my problem here ✔
- They **conflict** with each other.
  Scientists can "differ about the[ir] relative weights".
  But how combine **weights** and **qualitative judgments**?
  Unspecified by Kuhn! ✖

## ⇒ my problem:

How choose the best theory using qualitative epistemic value judgments?
(normative *vs* descriptive)

# Improving Kuhn's Account of Theory Choice with Ordinal Epistemic Scales

# Improving Kuhn's Account of Theory Choice with Ordinal Epistemic Scales

## Hypothesis: Competing Theories

There exists a finite set of **scientific theories**.
E.g. Ptolemy's theory and Copernicus's theory.

## Hypothesis: Epistemic Values

There exists a finite set of **epistemic values**,
each with a weight (weights sum to 1).
E.g. {Accuracy, Simplicity, Consistency, Scope, Fruitfulness},
with equal weights.

## Hypothesis: Ordinal Grading

There exists a finite set of **grades** arranged as an **ordinal scale** with a total order (e.g. **Excellent**, **Very Good**, **Good**, **Fair**, **Bad**...).
The agent **grades** each theory with this scale.
E.g. General Relativity. Accuracy: **Excellent**, Simplicity: **Very Good**...

## Ordinal Grading — comments

- Not hard to give an ordinal grade.
- Assume: not all values have probabilities (or ratio assessments).
  E.g. fruitfulness — ordinal only (Okasha 2011)
- Not a problem if some values receive a finer assessment than grades.

# Improving Kuhn's Account of Theory Choice with Ordinal Epistemic Scales

## The axiomatic approach

- We have to aggregate several qualitative (ordinal) value judgments.
- What does it mean for an aggregation rule to be *good*?
- The **axiomatic approach**:
  - axioms (= theoretical *desiderata*) are formulated,
  - one checks whether aggregation rules satisfy them.
- Here, **epistemic** axioms (not political ones).
  I adapt those by Balinski and Laraki (2020).

# Which epistemic axioms?

- **Axiome 1 (Grades)** – The aggregation function takes as input the grades given to the theories (and not a ranking).
  Natural given the hypothesis Ordinal Grading.
- **Axiom 2 (Domain)** – Grades may be assigned from the scale without restriction.
  No a priori constraint on grades, it is possible to use the full scale.
  (Objection: Morreau 2015, see below)
- **Axiom 3 (Anonymity)** – Permuting the index of the values does not change the outcome.
  There is nothing special with being Value #1 (but weights matter).
  With Axiom 1: which value gave which grade does not matter, only the set of grades does.
- **Axiom 4 (Neutrality)** – Permuting the index of the theories does not change the outcome.
  There is nothing special with being Theory #1.

# Which epistemic axioms? (cont'd)

- **Axiom 5 (Monotonicity)** – If $A \succeq B$, and one of $A$'s grades is increased, then $A \succ B$. Better epistemic evaluations should matter.
- **Axiom 6 (Completeness)** – For any pair $(A, B)$, either $A \succeq B$ or $B \succeq A$. A ranking has to be delivered for any two theories.
- **Axiom 7 (Transitivity)** – If $A \succeq B$ and $B \succeq C$, then $A \succeq C$. It may be violated with rankings as inputs (Condorcet paradox).
- **Axiom 8 (Independence of Irrelevant Alternatives)** – If $A \succeq B$, this remains true if other theories are added or removed.

**Otherwise: a weird story**

The scientist assesses her views on $A$ and $B$: the best theory is $B$.
Now a colleague tells her: *"Hey, you should also consider theory $C$."*
So the scientist thinks again, and concludes: the best theory is now $A$!

# Improving Kuhn's Account of Theory Choice with Ordinal Epistemic Scales

**Theorem** (Balinski & Laraki 2020)

There exist an **infinity** of aggregation functions which satisfy Axioms 1–8.

**Note:** asking for *grades* instead of *rankings* open huge possibilities (compare with Arrow 1951!).

**Example: "point-summing methods"**

Each grade is associated with a **number**.
Numbers received by a theory are **summed up** (or averaged).
(e.g. approval voting, Likert scales)

**Drawbacks**

- **No meaning**, **no justification** for the numbers. Could be re-scaled.
- Large sensitivity to **errors**.

# The solution: Majority Judgment

**Theorem (Balinski & Laraki 2007, 2020)**

The only aggregation function which satisfies the above-mentioned axioms, plus an error-minimization axiom, is Majority Judgment.

# Introducing Majority Judgment

- Each theory receives a grade for each value. (cf. hyp. Ordinal Grading).

- For each theory, **received grades are ranked** by decreasing order.

  P: **Excellent**, **Excellent**, **Very Good**, **Good**, **Fair**

- The middle (median) grade is the **majority grade**

  P: **Excellent**, **Excellent**, **Very Good**, **Good**, **Fair**

  *"a* **majority** *of voters think [the option] deserves* **at least** *this grade and another majority thinks it deserves* **at most** *this grade."*
  (Balinski Laraki 2012)

- Options are **ranked** according to their majority grade.

  1: **Very Good**, **Very Good**, **Very Good**, **Good**, **Fair**

  2: **Excellent**, **Very Good**, **Good**, **Good**, **Good**

# MJ – What if majority grades are the same?

- One compares **grades just around the one in the middle**.

  A: **Excellent**, [**Very Good**], **Good**, [**Good**], **Fair**

  B: **Excellent**, [**Very Good**], **Good**, [**Good**], **Good**

- If they are **the same**, one compares the grades which are **still farther** from the middle.

  A: [**Excellent**], **Very Good**, **Good**, **Good**, [**Fair**]

  B: [**Excellent**], **Very Good**, **Good**, **Good**, [**Good**]

## An option is ranked **above**:

- Either if it has **higher** grades

  A: **Excellent**, [**Excellent**], **Good**, [**Good**], **Good**

  B: **Excellent**, [**Very Good**], **Good**, [**Good**], **Fair**

  $\Rightarrow A \succ B.$

- Or if its grades are **closer**

  A: **Excellent**, [**Excellent**], **Very Good**, [**Fair**], **Fair**

  B: **Excellent**, [**Very Good**], **Very Good**, [**Good**], **Good**

  $\Rightarrow B \succ A.$

## Noticeable properties of Majority Judgment

- What is obtained is **more** than a mere **ranking**,
  each option is **evaluated with nuance**.
  Ex: being 1st with majority grade "**Very Good**"
  $\neq$ being 1st with "**Fair**"

- For each value, the question is "**How** is each theory **graded**?"

  neither "**Which** theory is **the most**.... ?"
  nor "**How** are theories **ranked**?"

- Asking for grades provides richer information.

## Refinements

- One may give a **distribution of grades** instead of just one (Laraki and Varloot, 2022).
  E.g.: Simplicity: 80 % **Very Good** and 20 % **Fair**.

## Kuhn's example, now with grades and Majority Judgment

**Ptolemy**. Accuracy: Good. Simplicity: Fair. Consistency : Good.

**Copernicus**. Accuracy: Good. Simplicity: Very Good. Consistency : Bad.

**Grades received:**

Ptolemy. Good, [Good], Fair

Copernicus. Very Good, [Good], Bad

**Same. Look around.**

Ptolemy. [Good], Good, [Fair]

Copernicus. [Very Good], Good, [Bad]

$\Rightarrow$ Ptolemy wins!

Suppose now **Simplicity's weight is doubled**.

Ptolemy. Good, [Good, Fair], Fair

Copernicus. Very Good, [Very Good, Good], Bad

$\Rightarrow$ Copernicus wins!

# Improving Kuhn's Account of Theory Choice with Ordinal Epistemic Scales

# An Objection about the Domain axiom

## Objection (Morreau 2015)

- Recall **Axiom 2 (Domain)** – Grades may be assigned from the scale without restriction (i.e. the rule gives an output for any input).
- Arrow's theorem assumes that the sets of theories and of criteria are given.
- For a given set of theories, and a given meaning of, say, simplicity, **the grades** for Simplicity **are fixed, or rigid**.
  (there are some true grades)
- There is **no sense** in requiring them to **be able to change**.
- Hence, Arrow's theorem **cannot take off** (Morreau 2015).
- (here) Similarly, one may argue that Balinski's and Laraki's theorem **cannot apply** to theory choice.

# An Objection about the Domain axiom

## Answer #1 — not impossibility

- The axiom is not needed here in the same way: it is a **possibility** or **uniqueness** theorem.
- If the axiom is too demanding and should be dropped, the theorem just does **not** establish the **uniqueness** of MJ anymore (there may be **other** rules than MJ).
- This does **not** show that MJ **is not suitable**.

## Answer #2 — a pragmatic argument

- Unlike Arrow's original framework,
  consider a **family** of application cases.
- We want the **same rule** to apply to all these cases.
  (We may not know which case we are in beforehand.)
- Even if grades are fixed in a given case,
  **they are not fixed** within this family of cases.
- Hence it makes sense to require that grades are **unrestricted**.

# Improving Kuhn's Account of Theory Choice with Ordinal Epistemic Scales

## Summing up

- When choosing between competing theories, attributing **an ordinal grade for each value** is more informative than a ranking.
- Considering a list of desirable **epistemic axioms**, we arrive at **Majority Judgment** (not just for politics!).
- The **best scientific theory** should be individually selected with **MJ**! We now know how to **combine weights and qualitative judgments** — Kuhn has been completed.
- (I assumed here weights are given — not against Kuhn's thesis that there is no unique algorithm)

## New research paths

- This suggests **a general framework** for aggregating ordinal judgments with **several values** or criteria:
  - to choose between scientific hypotheses, models, explanations...
  - to analyze different dimensions of a single value
  - to choose between research projects, articles for a prize...
- **Future work:** consider several agents,
  and aggregate all the views (agents $\times$ values $\times$ theories).
  Does not commute

# References


Balinski & Laraki (2007), "A theory of measuring, electing and ranking," *Proceeding of the National Academy of Sciences*, 104(21): 8720-8725.

Balinski & Laraki (2010), *Majority Judgement: Measuring, Ranking and Electing*, MIT Press.

Balinski & Laraki (2020), "Majority Judgment *vs* Majority Rule", *Soc. Choice & Welf.* 54:429

Kuhn (1977), "Objectivity, Value Judgment and Theory Choice". In *The Essential Tension*, p.320-39. University of Chicago Press

Laraki & Varloot (2022), "Level-Strategypoof Belief Aggregation and Application to Majority Judgment under Uncertainty". *Proceedings of the 23rd ACM Conference*. p. 335-369.

Morreau (2014), "Mr. Fit, Mr. Simplicity and Mr. Scope: From Social Choice to Theory Choice", *Erkenntnis* 79(6): 1253-1268.

Morreau (2015), "Theory choice and social choice: Kuhn vindicated." *Mind* 124(493), 239-262.

Okasha (2011),"Theory choice and social choice: Kuhn versus Arrow." *Mind* 120:83–115.

Okasha (2015), "On Arrow's theorem and scientific rationality: Reply to Morreau and Stegenga." *Mind*, 124(493), 279-294.


**Slides & working paper:**

https://thomasboyerkassem.yolasite.com/