

From Social Choice to Theory Choice

Michael Morreau

ARROW'S THEOREM SEEMS TO TELL US THAT RATIONAL THEORY CHOICE IS IMPOSSIBLE

IT TELLS US NO SUCH THING

OTHER RESULTS FROM SOCIAL CHOICE IMPLY THERE ARE MANY ACCEPTABLE CHOICE RULES

Democratic Social Choice - two limiting results:

Condorcet's "Paradox" of Majority Rule:

>
I: ABC
II: BCA
III: CAB
 AB
 BC
 ~~AC~~
 CA

Arrow's Theorem: The following are incompatible:

Ordinal preferences

Preferences satisfy minimal formal requirements (*Weak Orderings*, that is reflexive, transitive, and connected relations)

Whether society prefers one thing to another just depends on the various individual rankings of that pair (*Independence of Irrelevant Alternatives*)

Unanimous strict preferences are decisive (*Weak Pareto*)

No single individual's strict preferences are decisive (*Nondictatorship*)

The domain of the aggregation function includes all "logically possible" profiles - all lists of weak orderings of the options (*Unrestricted Domain*)

Eg: with #voters = #alternatives = 3, there are 13 weak orderings of the alternatives, and $13^3 = 2197$ profiles. There are 6 strict orderings, so $6^3 = 216$ strict profiles. Even that's a lot:

Mr. Fit, Mr. Simplicity & Mr. Scope

Analogy with Social Choice: fit to the data, simplicity, scope etc. make up a society of values. "Social" ranking is comparative overall merit.

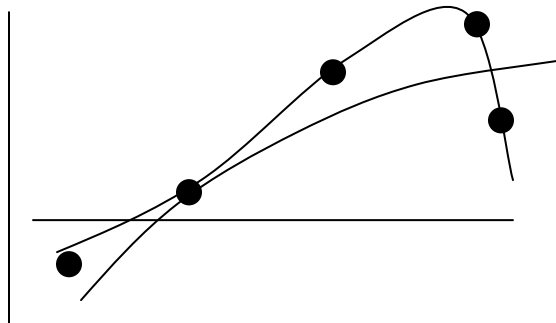
Arrovian Nihilism (Okasha 2011): Analogues of Arrow's assumptions apply in theory choice. There are no acceptable rankings of rival theories by their overall merit.

Ordinality

All historically significant theories have agreed with the facts, but only more or less. There is no more precise answer to the question whether or how well an individual theory fits the facts. But questions much like that can be asked when theories are taken collectively, or even in pairs. It makes sense to ask which of two actual and competing theories fits the facts better.

-Kuhn (1970), p. 147

Nondictatorship: Fit to the available data does not dictate overall theoretical merit because of noise:



Unrestricted Domain?

...seems unexceptionable - however the theories are ranked by the various criteria, the rule must be able to yield an overall ranking. There should be no a priori restriction on the permissible rankings that are fed into the rule. -Okasha (2011), p. 92

UNRESTRICTED DOMAIN IS NOT EVEN REMOTELY REALISTIC IN THEORY CHOICE

Simplicity, Scope rankings of theories of planetary system are constant:

Simplicity: **C**opernican Astronomy > **N**ewtonian > **P**tolemaic: CNP
Scope: Newtonian Astronomy > Copernican \approx Ptolemaic NC \approx P

6 theoretical profiles (times 4, including - extremely rare - ties for fit), one for each set of available data:

Fit:	CNP	CPN	NCP	NPC	PCN	PNC
Simplicity:	CNP	CNP	CNP	CNP	CNP	CNP
Scope:	NC \approx P	NC \approx P	NC \approx P	NC \approx P	NC \approx P	NC \approx P

Restricted Domains in Curve Fitting

LIN: class of all linear functions
PAR: all parabolic functions
CUB: all cubic functions

Simplicity: # of adjustable parameters

Scope: logical strength of corresponding hypotheses (that the function generating the data is linear, cubic, parabolic...)

Rankings by simplicity, scope, are inherent in the models:

Simplicity: LIN > PAR > CUB
Scope: LIN > PAR > CUB

Fit to data can only increase with increasing complexity:

Fit: LIN \leq PAR \leq CUB

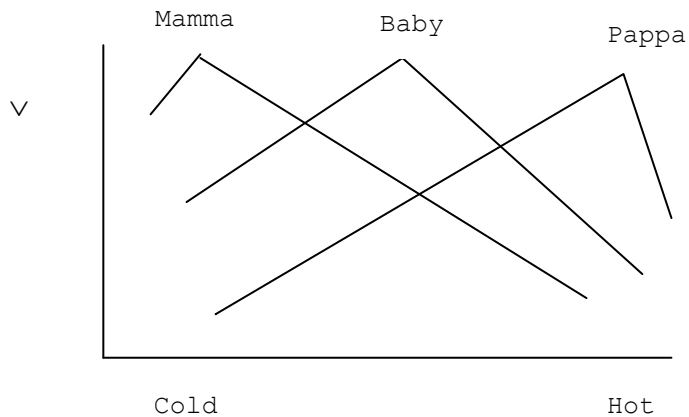
There are just 4 admissible profiles, differing only in rankings by fit to the data.

ARROW'S THEOREM IS IRRELEVANT TO THEORY CHOICE

What about positive results from theory of social choice, concerning choice in restricted domains? Are they applicable?

There are Acceptable Theory-Choice Rules

Single-Peaked Preferences:



Each of the three bears has a "sweet spot" somewhere along a common linear ordering of the alternative temperatures for porridge. Their liking for the various alternatives drops off monotonically as we proceed from their sweet spot in either direction along this ordering.

With only single-peaked profiles in the domain of the social-choice rule, and an odd number of voters, majority rule is Arrow Consistent:

Produces a weak ordering (Duncan Black (1948))

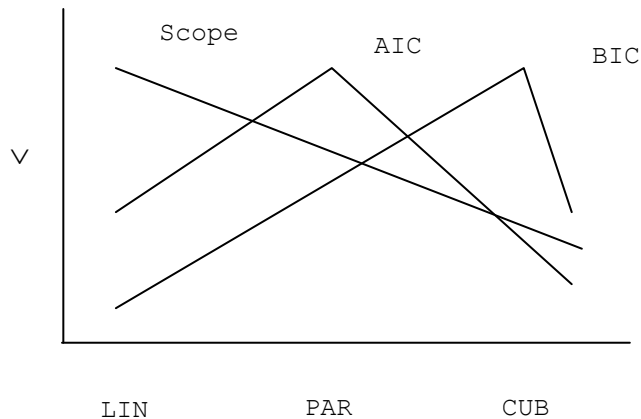
Satisfies Weak Pareto, Independence

Is Nondictatorial (assume a minimum of variety among profiles in the domain)

Maximizing Choice with Majority Rule: Warm Porridge

Single-Peaked Theoretical Rankings in Theory Choice:

AIC, BIC: Model selection criteria that reward models for fit to data but penalize them for excessive complexity.



In Practise: use both. Hopefully both have same peak. If not, choose model you prefer for some personal reason (great scope, simplicity, conservativeness, high prior probability)

Domain: single-peaked profiles. Scope ranking constant in all of them. Position of AIC and BIC peaks depends on available data.

Arrow Consistent (Non Dictatorship: sufficient that AIC and BIC peaks swap places in different profiles, and in some profile neither of them has maximal scope).

Majority Rule: one model is better than another, overall, if it is better by more criteria than not.

Maximizing Choice with Majority Rule: Choose the common peak of the AIC and the BIC if there is one. Otherwise, choose whichever of the two peaks has the greatest scope.

Bibliography

Arrow, Kenneth 1951: Social Choice and Individual Values. New York: John Wiley.

Black, Duncan 1948: "On the Rationale of Group Decision Making," The Journal of Political Economy 56: 23-34.

Condorcet, 1785: Essay on the Application of Analysis to the Probability of Majority Decisions.

Forster, Malcolm R. and Elliott Sober 1994: 'How to Tell When Simpler, More Unified or Less Ad Hoc Theories Will Provide More Accurate Predictions'. British Journal for the Philosophy of Science, 45, pp. 1-35

Kuhn, Thomas 1970: The Structure of Scientific Revolutions, second edition. Chicago: University of Chicago Press.

-1977a: 'Objectivity, Value Judgment, and Theory Choice', in his 1977b, pp. 320-339

-1977b: The Essential Tension. Chicago: University of Chicago Press.

Okasha, Samir 2011: 'Theory Choice and Social Choice: Kuhn versus Arrow'. Mind 120, 477, pp. 83-115.