

Human-Level Artificial Intelligence Must Be a Science

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What is AI?

- 2013: More than 60 years of AI research (starting to count with Turing's "*Computing Machinery and Intelligence*").
- Still, AI stands out between modern sciences:
 - No agreement upon what shall be AI's overall objective (i.e., "soft AI" vs. "strong AI" vs. "a bit of both" vs. "superintelligence" vs. "general intelligence" etc.).
 - No commonly accepted methodology for conducting research.
 - No consensus concerning valuation of previous developments and actual status quo in AI as story of success or perpetual failure.

⇒ **AI being a special type of science? AI being no science at all?**

(In the following: Focus on subbranch of AI dealing with Artificial General Intelligence (AGI) or Human-Level AI (HAI), i.e., the endeavor to create computer systems that exhibit intelligence at a level similar to humans.¹)

¹Treating AGI and HAI as synonymous.



HAI as Extraordinary Science? (1)

Cassimatis' "*Human-Level Artificial Intelligence Must Be an Extraordinary Science*":

- Normal scientific standards and methods often incidental and even antithetical to achieving human-level intelligence.
- Different approach required.

Cassimatis' basic positions (Part 1):

- 1 Significant qualitative difference in specificity and level of ambition between research in HAI and other sciences: Objectives of HAI "*more concrete and much more ambitious*".
- 2 (H)AI historically not conducted as a normal science: E.g. Winograd's SHRDLU as representative system, allegedly did not witness experimental evaluation or formal proofs as obligatory part of science or engineering research reports.



HAI as Science! (1)

- 1 Evaluation of level of specificity/ambition question of personal judgement only.
- 2 Claim at least debatable:
 - Winograd himself compared SHRDLU system with other parsers and programs (even offering rudimentary quantitative performance comparisons).
 - Also, e.g. consider numerous introspection reports Newell and Simon collected and methodologically analyzed by Newell and Simon as basis for development of General Problem Solver: Implementing systematic observation, data collection, analysis and subsequent model building as classical methodological pattern from the natural sciences.

⇒ No sign of “science envy” in the observation that (almost) all of AI in its approach by now has adopted the standards of science.

⇒ Gleefully approve diagnosis by Russell and Norvig: “[i]n terms of methodology, AI has finally come firmly under the scientific method”.



HAI as Extraordinary Science? (2)

Cassimatis' "*Human-Level Artificial Intelligence Must Be an Extraordinary Science*":

- Application of scientific norms and methodological standards is not favorable for achieving HAI and often stands against swift progress towards this goal!

Cassimatis' basic positions (2):

- 1 ● Against formal or empirical demonstrations of correctness or optimality, and connected computational requirements in terms of processing power and speed:
 - Believe that importance should be assigned to showing formal correctness of theorem, or to empirically demonstrating method's optimality with respect to certain normative standard, goes against nature of human intelligence.
 - Simon's notion of bounded rationality: Human rationality falls far from optimality or formal correctness in all but a few cases. ⇒ Also HAI should not use normative notions of correctness or optimality in judging and evaluating results.



- ① Problem does not reside with optimality considerations or formal proofs, but with chosen normative standards:
 - Human rationality is not optimal in any of the classical senses.
 - Human cognition most likely does not solve difficulties arising from problem's exorbitant computational complexity or intractability.
 - Still: Quantitative assessment not impossible per se.
 - Possible remedies:
 - ① New frameworks of rationality better encompassing actual human performance.
 - ② Approaches within AI successfully applying quantitative measures to problems in HAI research: Psychometric Artificial Intelligence (PAI). “[S]ome agent is intelligent if and only if it excels at all established, validated tests of intelligence” (Bringsjord, 2011).

⇒ PAI as very quantitatively focused field of research with clear normative principles:

Optimality not demanded with respect to hypothetical idealized standard but with respect to achievable and reproducible testing scores of human subjects (commonly agreed as standard means of assessing relevant human mental capacities).



Cassimatis' basic positions (3):

- Against empirical (cognitive) psychology and neuroscience:
 - Adhere to normal scientific standards in methodology, relying on experimental studies of (mostly) isolated individual capacities and functions.
 - Inevitably not being aligned with standards needed for HAI:
 - ① Phenomena studied very often not directly crucial for progress towards solving overall intelligence puzzle.
 - ② Averaging over (possibly high number of) subjects in experimental evaluation abstracts away from individual.
⇒ Yielding results which provide general, decontextualized average predictions of behavior of cognitive system, not contributing to solving intelligence puzzle on individual level.



HAI as Science! (3)

Observations by themselves correct, but...

- General cognitive psychology significantly different from differential psychology in methods, results and ambitions, but insights gained in cognitive capacities on a general level as valid to HAI as insights on an individual level.
- Each average trivially also interpretable as one possible case within population (coinciding with average).
- Average prediction can be bootstrapped into individual prediction by contextualizing with respective initial conditions and accompanying factors and context.

Staying under umbrella established by scientific standards brings along important advantages:

- Quantitative and comparative methods allow for measuring and judging progress (e.g., in case of PAI against human performance).
- Enable us to make goals and milestones specific (thus alleviating another problem within HAI context).



- 1 Strongly advocate the necessity of viewing HAI as a normal science.
- 2 Demanding that research in HAI has to be conducted within framing constraints of “normal” scientific standards.
- 3 Relying on quantitative and comparative experimental and assessment methods whenever possible.
- 4 Trying to adhere to overall principles and laws underlying cognition and intelligence that have been identified within neighboring fields.

Human-Level Artificial Intelligence must be a science.

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