Ships of Fools, Self-Driving Cars and Ensemble Failures

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Outline

- Data Engines builds and licenses self-assessment algorithms for AI ensembles (regressors/classifiers) dataengines.com/groundseer
- Non-parametric estimators of error don't get enough attention
  1. Good-Turing smoothing - how many species have I not seen?
  2. HyperLogLog - how many uniques have I seen?
  3. Algebraic Ground Truth Inference - how many errors have these algorithms made?
- History of Wisdom of the Crowd
  1. v0.9: Ancient Greek Democracy (500 B.C.)
  2. v1.0: Condorcet's 1785 Jury Theorem - Can the Internet be smarter than experts?
  3. v2.0: Dawid and Skeene (1979) show the crowd can self-assess.
  4. v2.2: 2010 Patent on algebraic, non-parametric estimator for errors.
- Ensemble failures are everywhere
  1. Plato's Ship of Fools critique: Ensembles cannot self-monitor.
  2. The Madness of the Crowd.
- This new approach is hardly mined out.

Self-Assessment Problems

Is it me or is it the World? The Artist Version

- The protagonist knows he now has great songs.
- But no one is paying attention!
- By the river, he ponders "It's me, isn't it?"
- How are we to do it?

Ensembles are the only way

Algebraic GTI has impossibility theorems

- At least three systems are required.
- A marriage lemma: two people in a relationship will never be able to tell who is the crazy one.
- Independence, not performance, is the most important quality for the ability to self-assess.
- This turns on its head arguments about "merit" for the utility of diversity in any ensemble system.

Plato's Critique of Democracy: The Ship of Fools

Can cheap sensors monitor expensive ones?

- The common shipmates cannot recognize the virtuous among them.
- A universal critique against all ensembles being able to self-monitor.
- Plato's Academy also prone to become a Ship of Fools.
- Are self-driving cars to be always prone to this ensemble failure as the start of their chain of disaster?

The Ship of Fools is an avoidable ensemble failure

Mediocre sensors can monitor good ones

- Majority voting fails as a monitoring algorithm.
- This is not a problem for Algebraic GTI.
- The most important quality - independence.

$$f_{\alpha,\alpha,\alpha} == P_\alpha P_{1,\alpha,\alpha} P_{2,\alpha,\alpha} P_{3,\alpha,\alpha} + P_\beta P_{1,\alpha,\beta} P_{2,\alpha,\beta} P_{3,\alpha,\beta}$$

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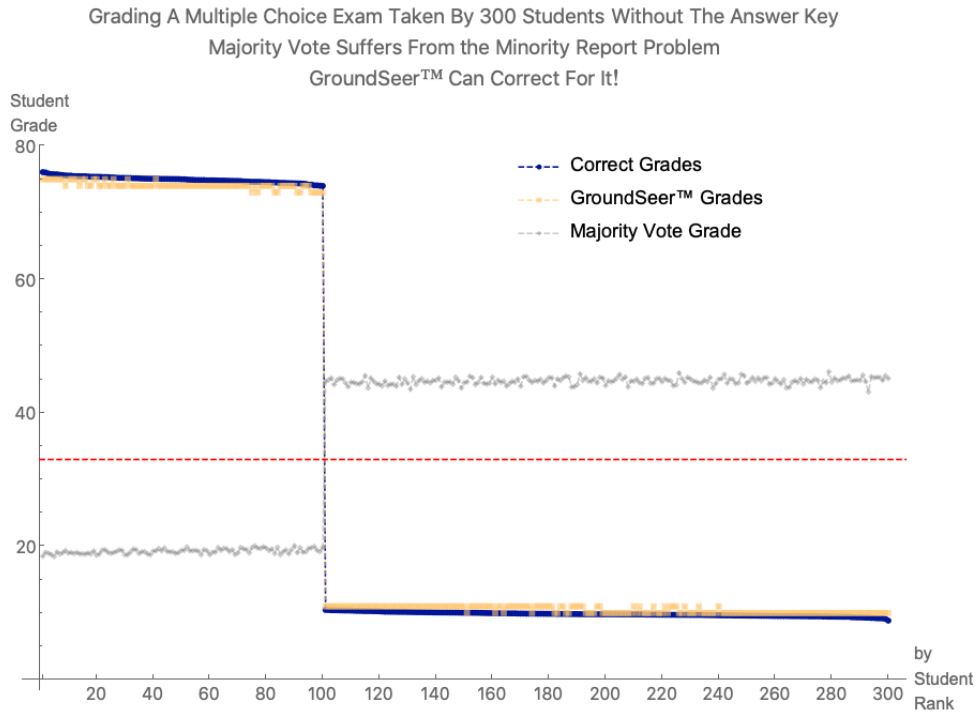
Algebraic GTI can also handle Madness of the Crowd

Madness of the crowd can be detected using an error-codes engineering philosophy

- Madness of the Crowd is another ensemble failure.
- Tom Cruise's "The Minority Report"
- While one against many is very difficult, we can harden against the majority going mad.
- This follows error-correcting codes for bit flips on a computer. You cannot get rid of all errors, but you can eliminate the common ones.
- Engineering context is important.



The huge theoretical importance of non-parametric estimators

They avoid the representation problem in Science

- Is there an algorithm that can measure your IQ without any Psychology or World Representation inside it?
- Good-Turing estimates unseen species with no Biology or NLP inside it.
- HyperLogLog estimates the unique count in a data stream without any Queueing Theory inside of it.
- Algebraic GTI estimates AI errors without any Machine Learning inside of it.

An Alternative model for Artificial and Natural Intelligence

Monitoring imperfect systems = very good single system

- All these non-parametric methods have very attractive properties for creating intelligent systems.
  1. Low memory usage.
  2. High computation load.
  3. A dumb monitor on more intelligent systems is possible.
- Scientific hypothesis: Did Nature avoid this class of algorithms when it made brains?
- Good-Turing would be a very good algorithm for a hunting robot - Have I killed everything here or are there other species to find? Should I quit or continue searching?

Reading List

Some suggestions for math, ensembles, and errors

- Ideals, Varieties, and Algorithms: An Introduction to Computational Algebraic Geometry and Commutative Algebra (Undergraduate Texts in Mathematics) by Cox et al.
- Against Method by Feyerabend
- Statistical Inference as Severe Testing: How to Get Beyond the Statistics Wars by Deborah Mayo.

- Follow us in Twitter, @DataEngines, where our Twitter Bot - a robot tortured by self-assessment powers - offers "engineering solutions to philosophical problems."
- Look around you for ensemble failures.

Thank You