Automated Discovery of Test Statistics

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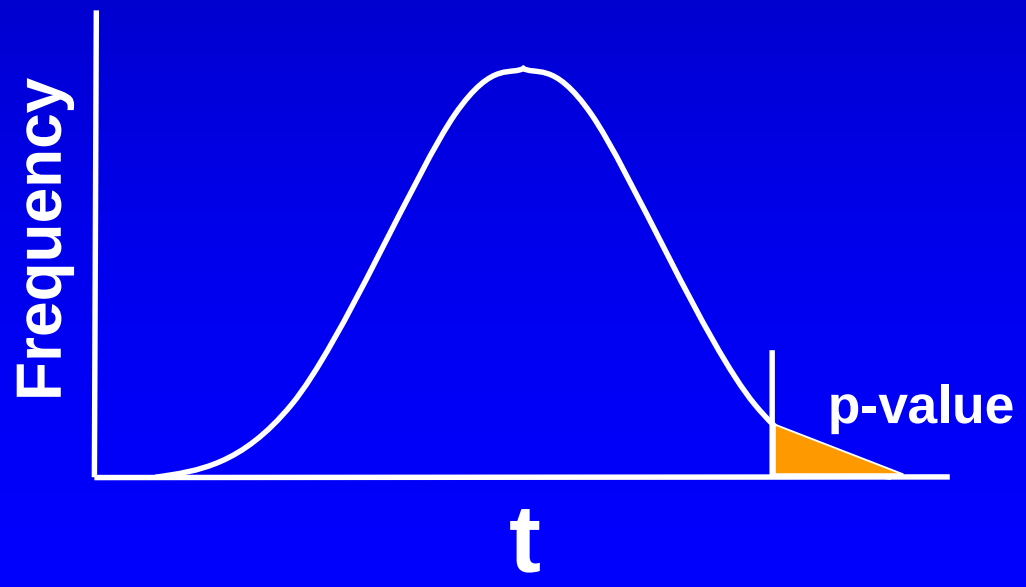
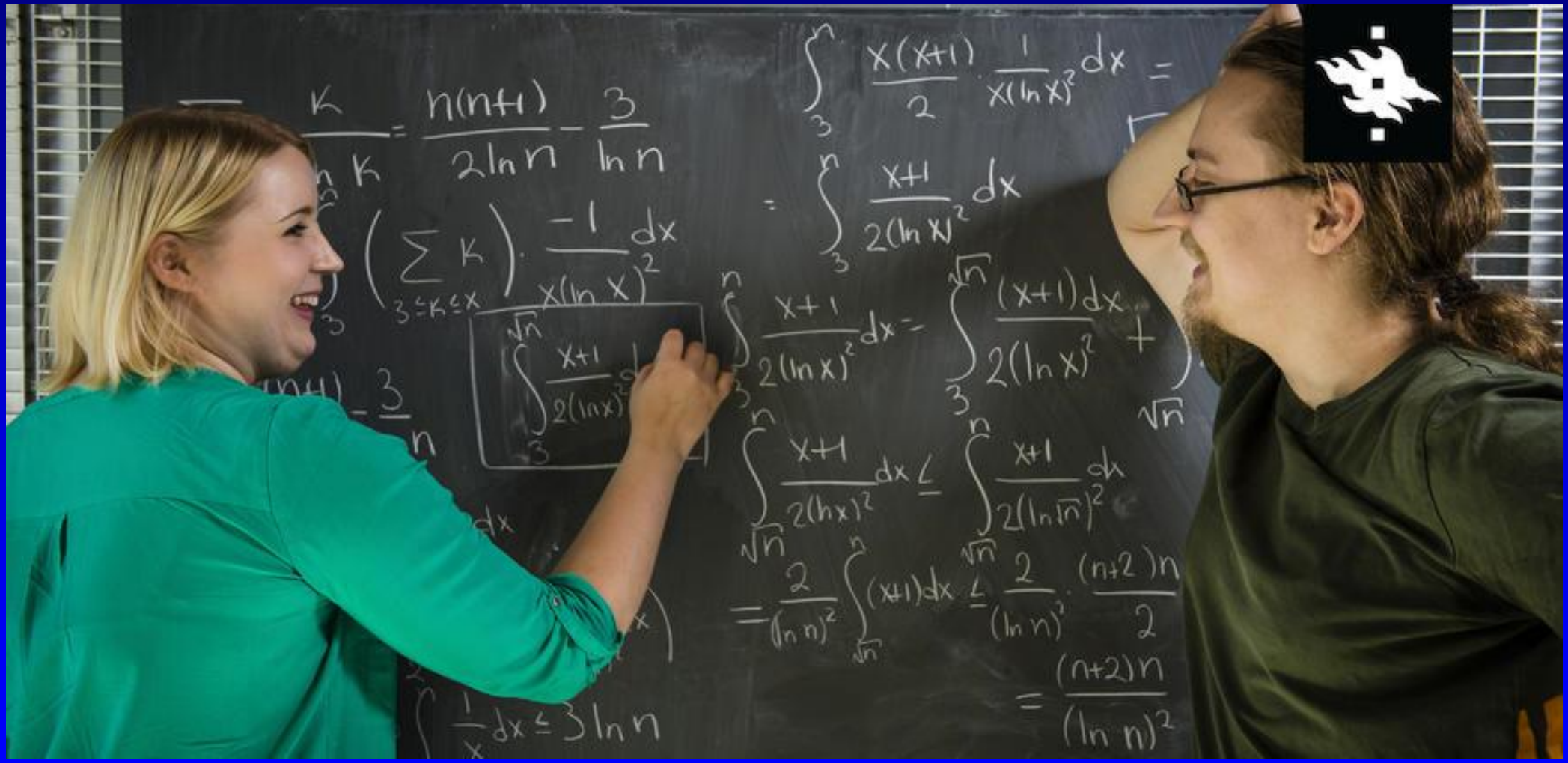
Test Statistics

$$H_0: \bar{X}_1 > \bar{X}_2 = 0$$

$$t = \bar{X}_1 - \bar{X}_2 \,/\, SE$$



Theoretical Statistics



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We are the FIRST to automate the discovery of test statistics

This complex feat previously only done by humans

We Satisfy 4 Humie Criteria

(B) The result is equal to or better than a result that was accepted as a new scientific result at the time when it was published in a peer-reviewed scientific journal. ➡ **FIRST TIME**

(D) The result is publishable in its own right as a new scientific result independent of the fact that the result was mechanically created. ➡ **100s of NEW STATISTICS**

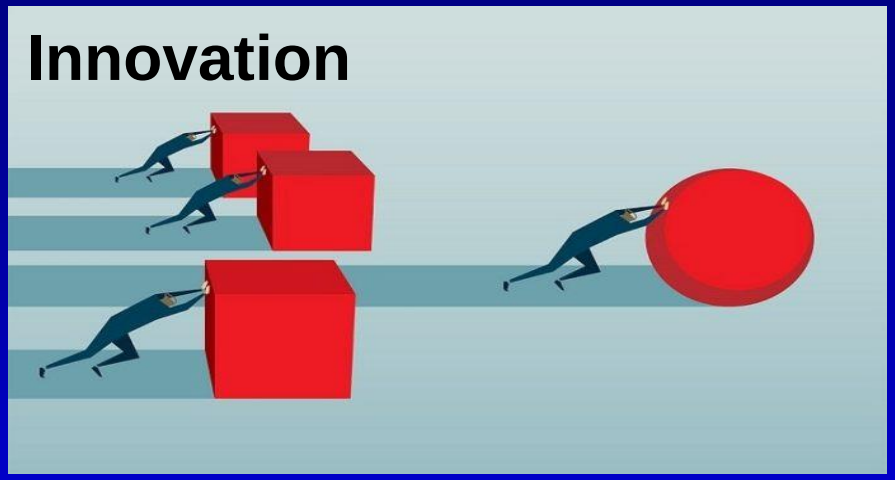
(E) The result is equal to or better than the most recent human-created solution to a long-standing problem for which there has been a succession of increasingly better human-created solutions. ➡ **GENERATED BETTER SOLUTIONS**

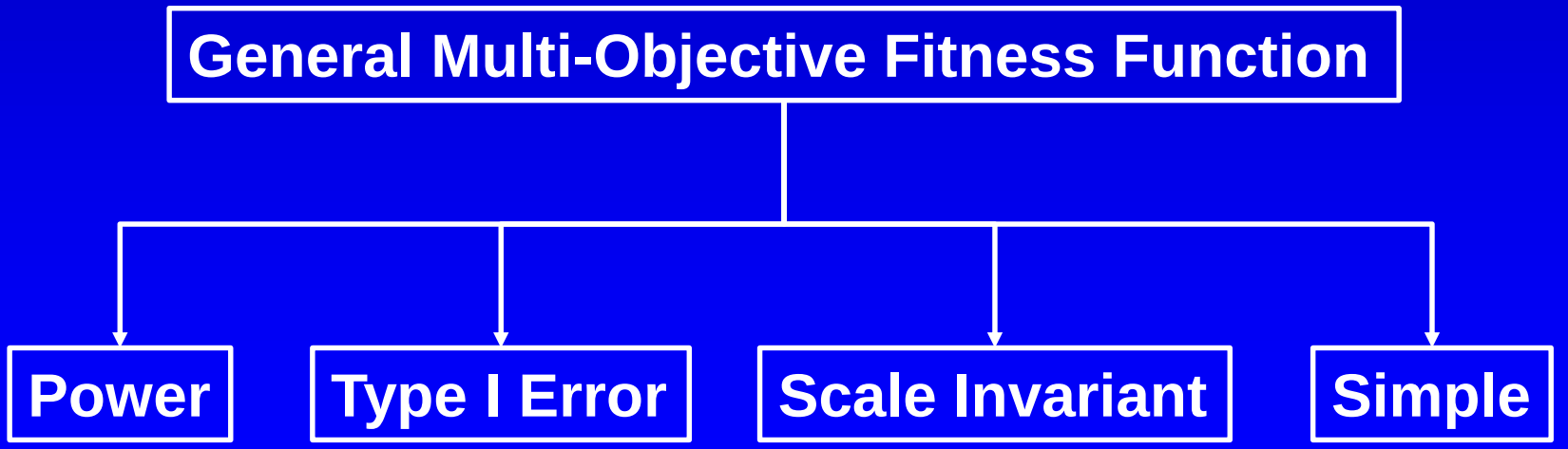
(G) The result solves a problem of indisputable difficulty in its field. ➡ **TEST STATISTIC DISCOVERY IS TEDIOUS**

Why Human Competitive?

- New statistics are **needed more than ever**, with data exploding in quantity, volume, and complexity.
- The field of mathematical statistics is **shrinking**.
- This task is done by hand on pencil and paper and is thus extremely **laborious**.
- Despite the ubiquity of computers, **no automated method exists… until now!**
- Automation will greatly **accelerate** the discovery of new test statistics.

Why Human Competitive?





Why the Best Humie entry?

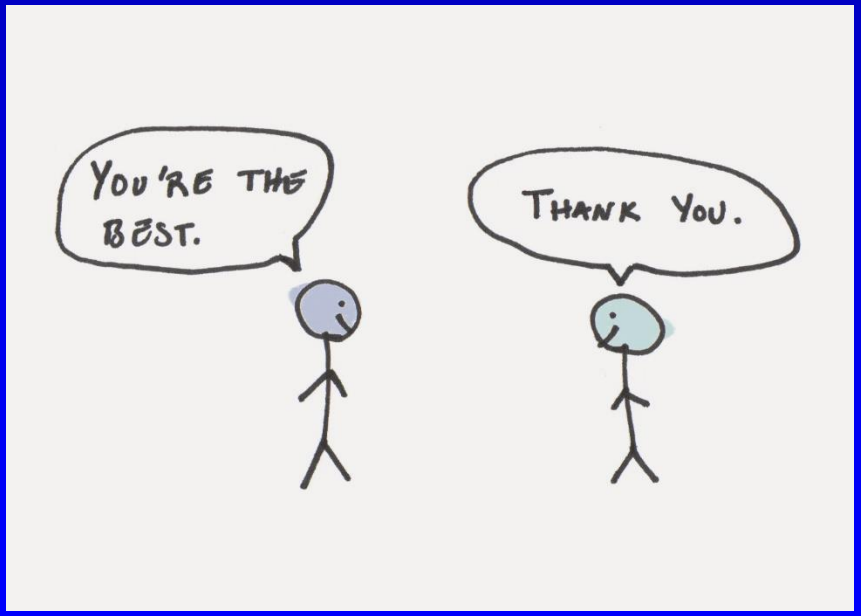
- **First time in history** a machine has invented new test statistics in a fully **automated** manner.
- Several important **challenges** met and overcome:
  - Engine for generating mathematical candidates
  - General fitness function that allows for innovation.
  - System for tinkering with test statistics as a human would.
- Most ML/AI solutions develop a **model** of data with **clear** objective criteria.
- **Test statistics are much harder…** system must know what makes a good statistic.

Why the Best Humie Entry?

New Test Statistic

- **Biology**
- **Chemistry**
- **Engineering**
- **Physics**
- **Medicine**

Acknowledgments

- AutoStats Team
  - **Randy Olson, Yong Chen, Moshe Sipper**
- NIH grants AI11679, LM012601, LM010098

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