Could AI Ever Match Gödel's Greatness?

(includes coverage of Gödel's "Either/Or" (*not* Kierkegaard's!))

Selmer Bringsjord

IFLAI 2020

4/23/20; 4/30/20

Selmer.Bringsjord@gmail.com

RAIR

Rensselaer AI and Reasoning Lab

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Monographic Context …

Gödel's Great Theorems (OUP)

by Selmer Bringsjord

- Introduction ("The Wager")
- Brief Preliminaries (e.g. the propositional calculus & FOL)
- The Completeness Theorem
- The First Incompleteness Theorem
- The Second Incompleteness Theorem
- The Speedup Theorem
- The Continuum-Hypothesis Theorem
- The Time-Travel Theorem
- Gödel's "God Theorem"
- Could a Finite Machine Match Gödel's Greatness?

STOP & REVIEW IF NEEDED!

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For later … by far the greatest of GGT; analysis based Sherlock Holmes' mystery "Silver Blaze."

Some Timeline Points

1978 Princeton NJ USA.

1940 Back to USA, for good.

1936 Schlick murdered; Austria annexed

1933 Hitler comes to power.

1930 Announces (First) *In*completeness Theorem

1929 Doctoral Dissertation: Proof of Completeness Theorem

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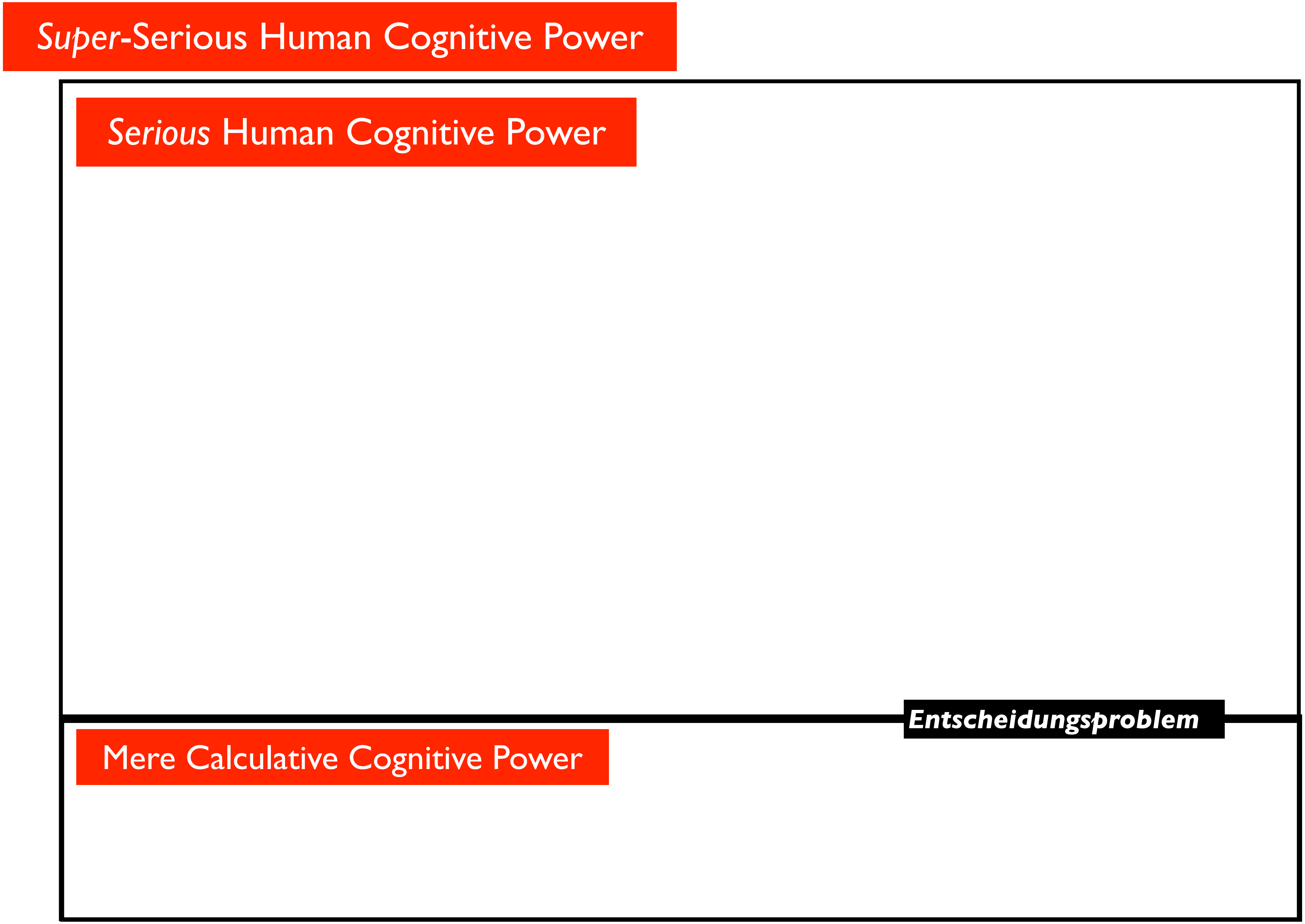
Gödel's Greatness & Games …

Logico-Mathematical Landscape that Has Gödel Turning in His Grave



Logico-Mathematical Landscape that Has Gödel Turning in His Grave

Super-Serious Human Cognitive Power

Serious Human Cognitive Power

Gödel

Entscheidungsproblem

Mere Calculative Cognitive Power

Logico-Mathematical Landscape that Has Gödel Turning in His Grave

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Podcast: The Turing Test is Dead. Long Live the Lovelace Test.

Gödel

Entscheidungsproblem

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Logico-Mathematical Landscape that Has Gödel Turning in His Grave

Analytical Hierarchy

Serious Human Cognitive Power

Gödel

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Analytical Hierarchy

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Entscheidungsproblem

Polynomial Hierarchy

$$\mathbf{P} \subseteq \mathbf{NP} \subseteq \mathbf{PSPACE} = \mathbf{NPSPACE} \subseteq \mathbf{EXPTIME} \subseteq \mathbf{NEXPTIME} \subseteq \mathbf{EXPSPACE}$$

Logico-Mathematical Landscape that Has Gödel Turning in His Grave

Analytical Hierarchy

Arithmetical Hierarchy

Gödel

$\vdots$

Π_2

Σ_2

Π_1

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Σ_0

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Jeopardy!:

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$\vdots$

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Chess: Deep Blue

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$\vdots$

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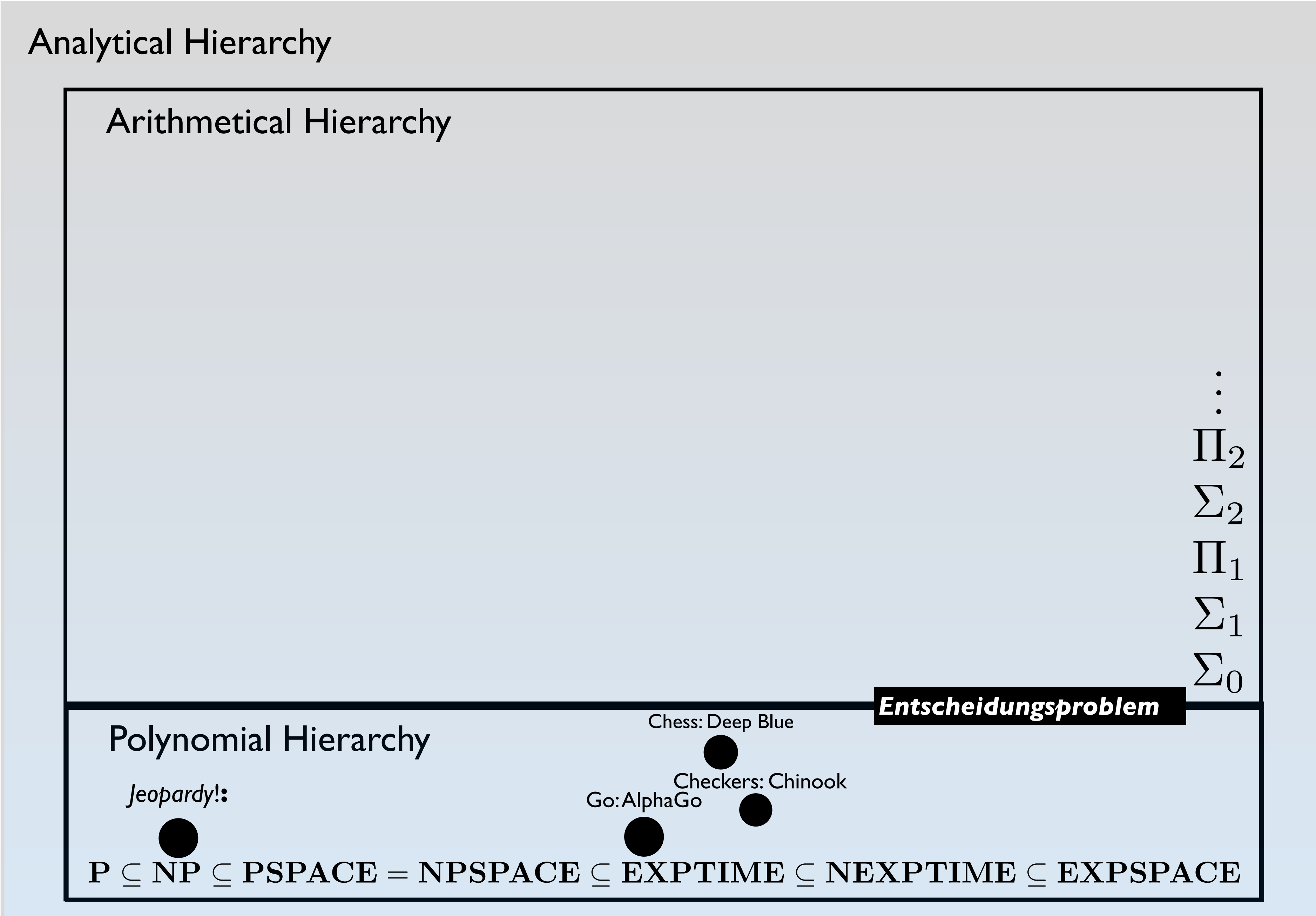
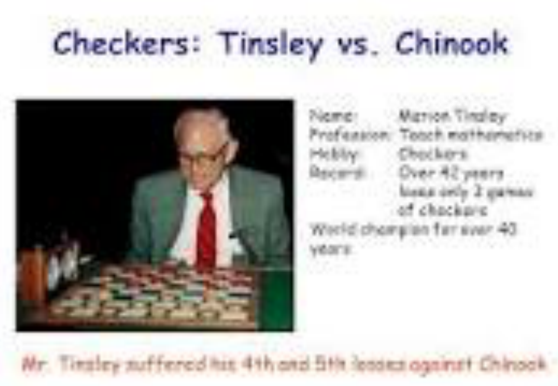


1994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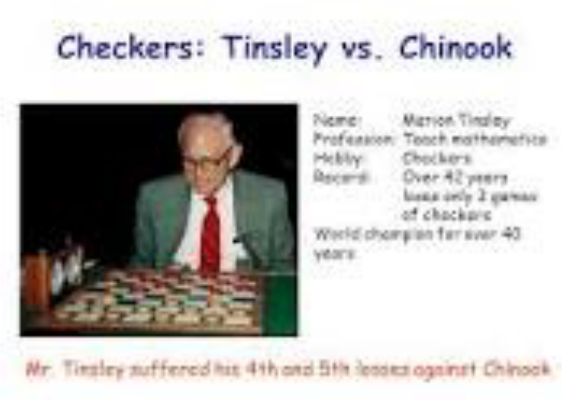
Profession: Teach mathematics
Hobby: Checkers
Record: Over 42 years loses only 3 games of checkers
World champion for over 40 years
Mr. Tinsley suffered his 4th and 5th losses against Chinook

1994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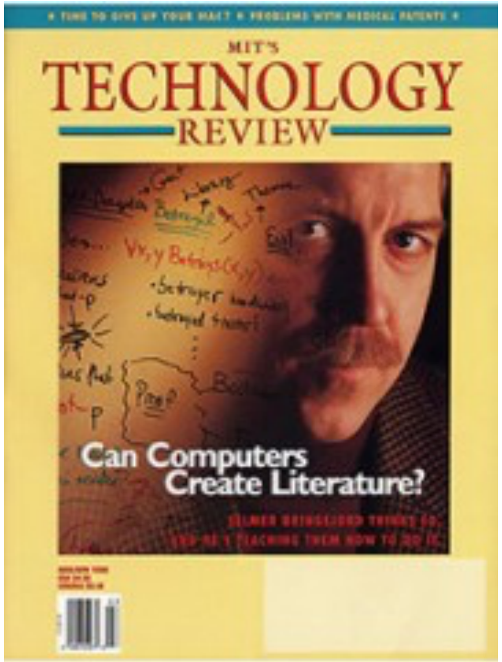
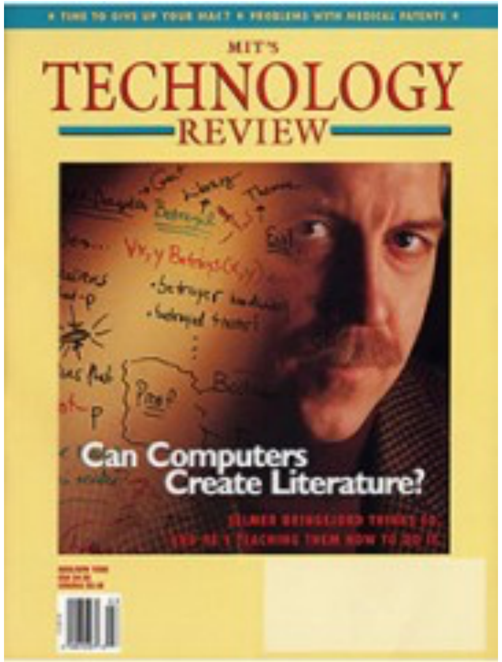


1998

“Chess is Too Easy”



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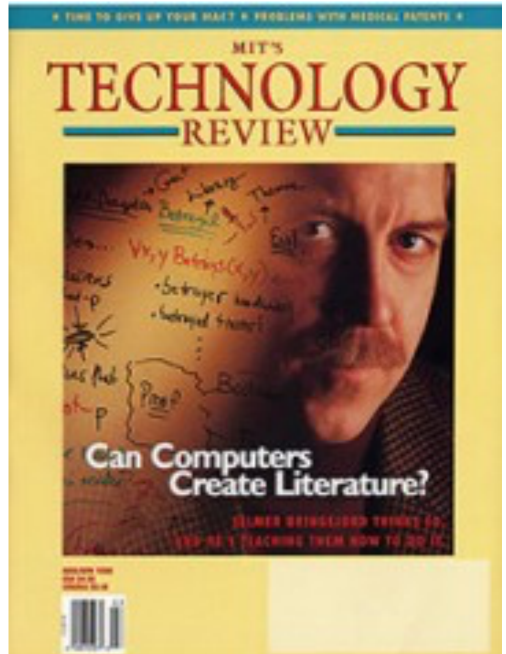
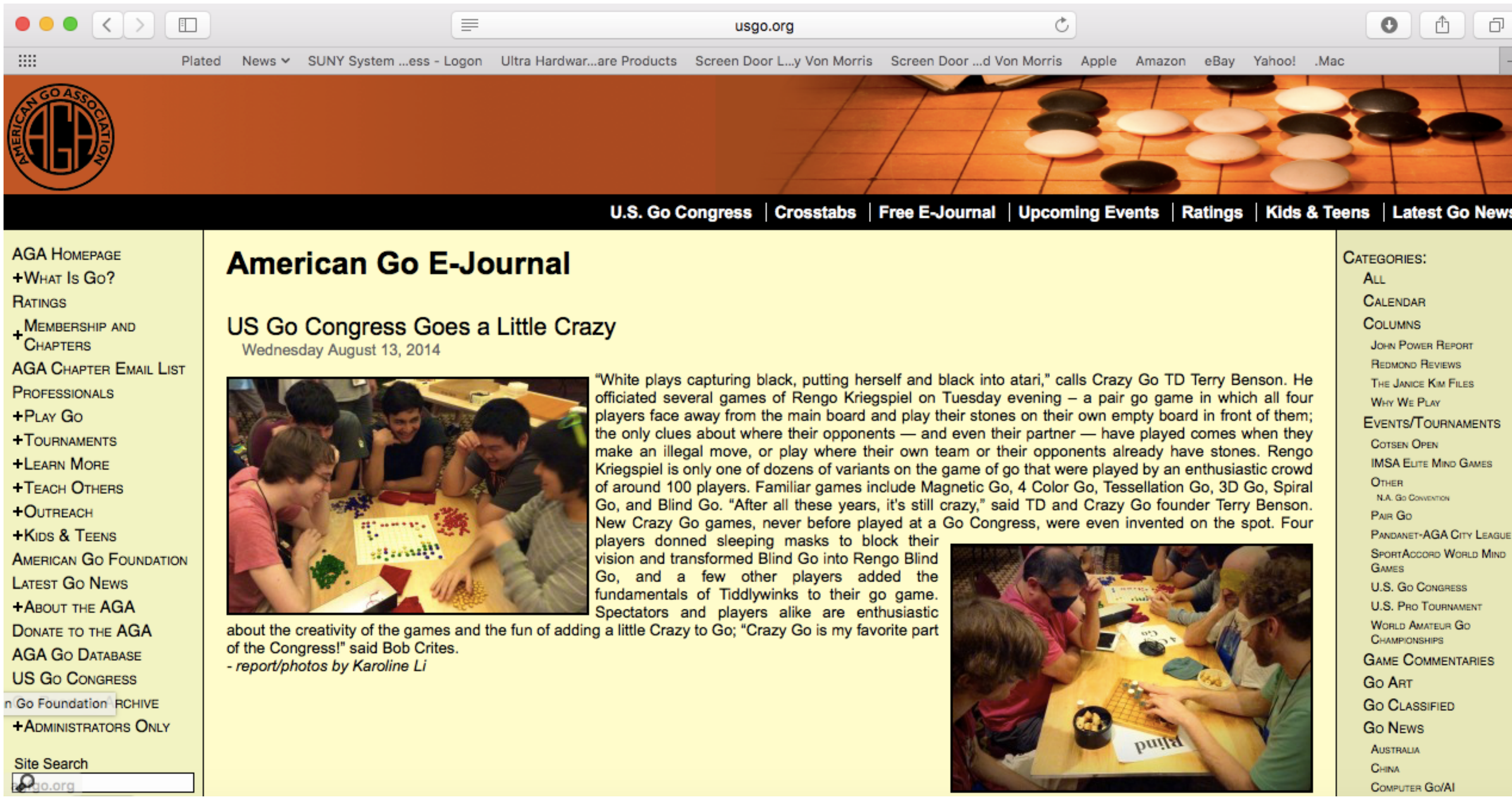


1998

Some of Gödel’s great work is at the level of chess.

But to *fully* “gamify” Gödel,
we need a harder game! …

Rengo Kriegspiel



usgo.org

U.S. Go Congress | Crosstabs | Free E-Journal | Upcoming Events | Ratings | Kids & Teens | Latest Go News

American Go E-Journal

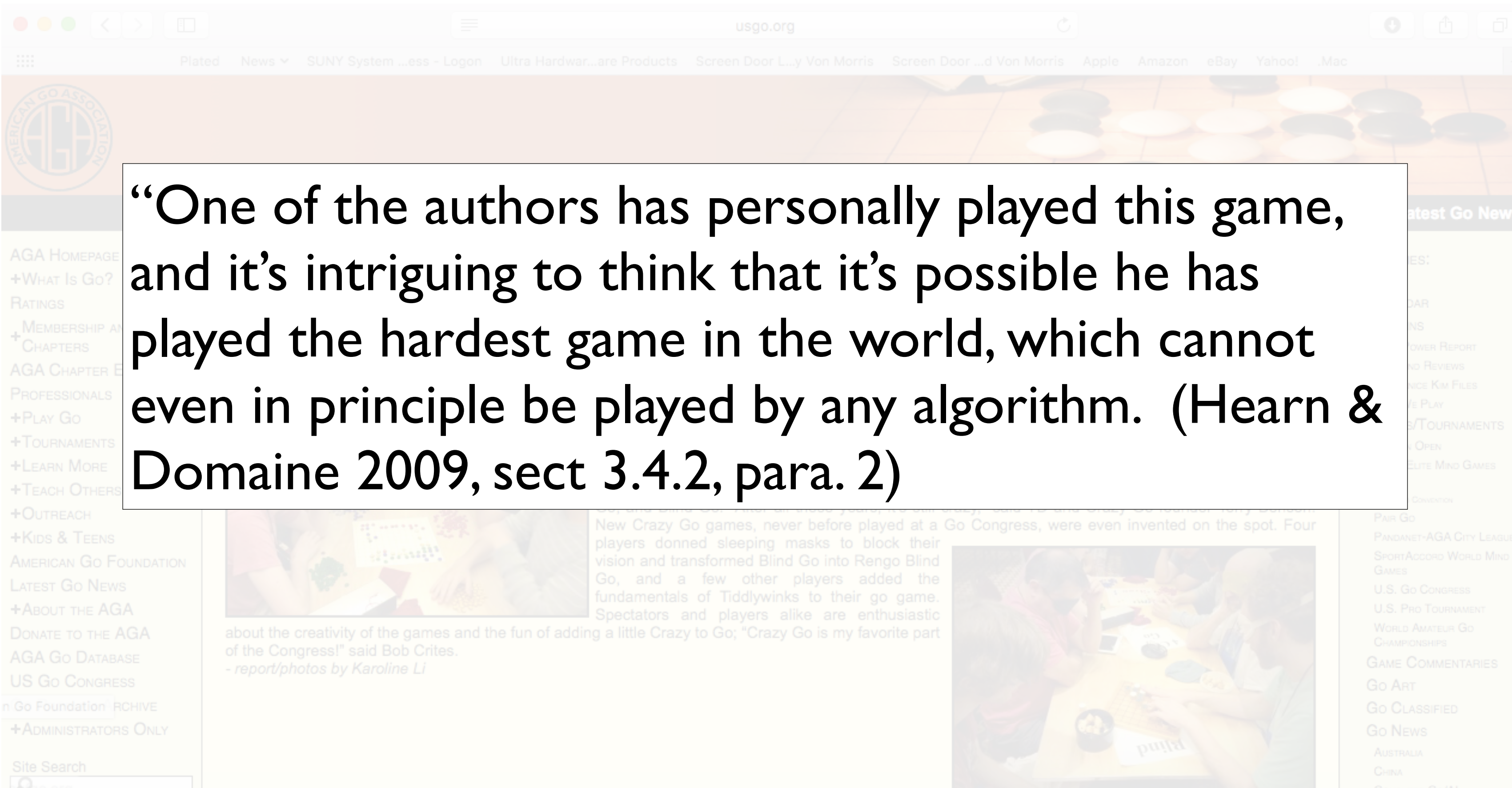
US Go Congress Goes a Little Crazy

Wednesday August 13, 2014

"White plays capturing black, putting herself and black into atari," calls Crazy Go TD Terry Benson. He officiated several games of Rengo Kriegspiel on Tuesday evening – a pair go game in which all four players face away from the main board and play their stones on their own empty board in front of them; the only clues about where their opponents — and even their partner — have played comes when they make an illegal move, or play where their own team or their opponents already have stones. Rengo Kriegspiel is only one of dozens of variants on the game of go that were played by an enthusiastic crowd of around 100 players. Familiar games include Magnetic Go, 4 Color Go, Tessellation Go, 3D Go, Spiral Go, and Blind Go. "After all these years, it's still crazy," said TD and Crazy Go founder Terry Benson. New Crazy Go games, never before played at a Go Congress, were even invented on the spot. Four players donned sleeping masks to block their vision and transformed Blind Go into Rengo Blind Go, and a few other players added the fundamentals of Tiddlywinks to their go game. Spectators and players alike are enthusiastic about the creativity of the games and the fun of adding a little Crazy to Go; "Crazy Go is my favorite part of the Congress!" said Bob Crites.

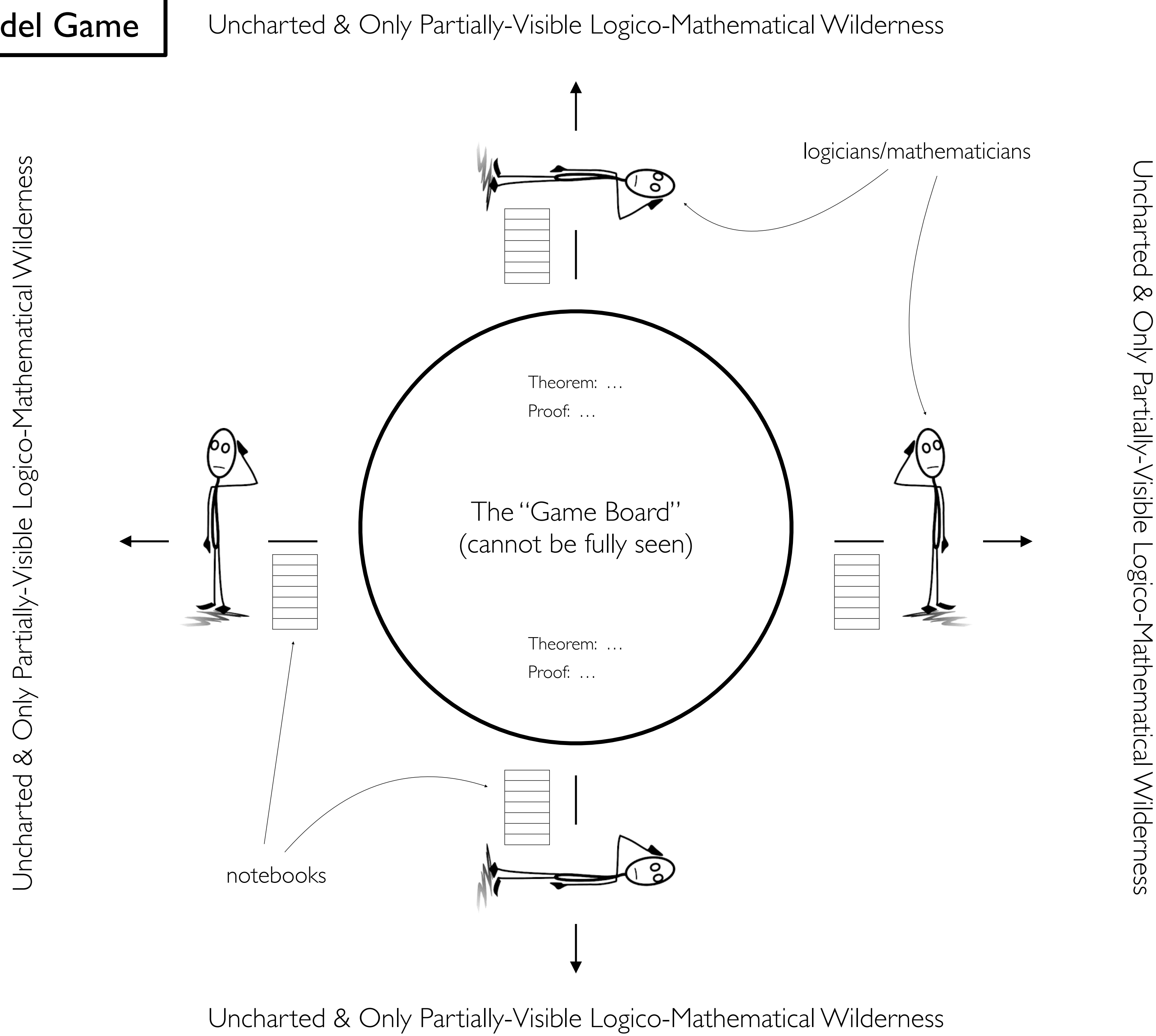
- report/photos by Karoline Li

Rengo Kriegspiel



"One of the authors has personally played this game, and it's intriguing to think that it's possible he has played the hardest game in the world, which cannot even in principle be played by any algorithm. (Hearn & Domaine 2009, sect 3.4.2, para. 2)

The Gödel Game



Gödel's Either/Or …

The Question

Q* Is the human mind more powerful than the class of standard computing machines?

Gödel's Either/Or

"[E]ither … the human mind (even within the realm of pure mathematics) infinitely surpasses the power of any finite machine, or else there exist absolutely unsolvable diophantine problems."
— Gödel, 1951

PT as a Diophantine Equation

Equations of this sort were introduced to you in middle-school, when you were asked to find the hypotenuse of a right triangle when you knew its sides; the familiar equation, the famous Pythagorean Theorem that most adults will remember at least echoes of into their old age, is:

$$\text{(PT)} \quad a^2 + b^2 = c^2,$$

and this is of course equivalent to

$$\text{(PT')} \quad a^2 + b^2 - c^2 = 0,$$

which is a Diophantine equation. Such equations have at least two unknowns (here, we of course have three: a, b, c, and the equation is solved when positive integers for the unknowns are found that render the equation true. Three positive integers that render (PT') true are

$$a = 4,\ b = 3,\ c = 5.$$

It is mathematically impossible that there is a finite computing machine capable of solving any Diophantine equation given to it as a challenge.

Background

problem?[7] In his lecture, Gödel precisely defines diophantine problems, but we don't need to bother with all of the details here; we only need to appreciate the general structure of such a problem, and that can be achieved quickly as follows, given what was introduced in Chapter 2.

Each diophantine problem has at its core a polynomial $\mathcal{P}$ whose variables are comprised by two lists, $x_1, x_2, \ldots, x_n$ and $y_1, y_2, \ldots, y_m$; all variables must be integers, and the same for subscripts n and m. To represent a polynomial in a manner that announces its variables, we can write

$$\mathcal{P}(x_1, x_2, \ldots, x_k, y_1, y_2, \ldots, y_j).$$

But Gödel was specifically interested in whether, for all integers that can be set to the variables x_i, there are integers that can be set to the y_j, such that the polynomial equals 0. To make this clearer, first, here are two particular, simple equations that employ polynomials that are both instances of the needed form:

E1 $3x - 2y = 0$

E2 $2x^2 - y = 0$

All we need to do now is prefix these equations with quantifiers in the pattern Gödel gave. This pattern is quite simple: universally quantify over each x_i variable (using the now-familiar $\forall$), after which we existentially quantify over each y_i variable (using the also-now-familiar $\exists$). Thus, here are the two diophantine problems that correspond to the pair E1 and E2 from just above:

P1 Is it true that $\forall x \exists y (3x - 2y = 0)$?

P2 Is it true that $\forall x \exists y 2x^2 - y = 0$?

The Crux

$\exists \mathcal{P}$ s.t. no human mind could ever decide $\forall x_1 \forall x_2 \cdots \forall x_k \exists y_1 \exists y_2 \cdots \exists x_j (\mathcal{P}(x_1, x_2, \ldots, x_k, y_1, y_2, \ldots, y_j)$?

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Yes.

The Crux

$\exists \mathcal{P}$ s.t. no human mind could ever decide $\forall x_1 \forall x_2 \cdots \forall x_k \exists y_1 \exists y_2 \cdots \exists x_j (\mathcal{P}(x_1, x_2, \ldots, x_k, y_1, y_2, \ldots, y_j)$?

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↓

The human mind is *not* infinitely more powerful than any standard computing machine.

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Yes.

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The human mind *is* infinitely more powerful than any standard computing machine.

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Earlier Gödelian Argument for the "No."

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Outline

Figures (1)

Tables (1)

Table 1

ELSEVIER

Applied Mathematics and Computation

Volume 176, Issue 2, 15 May 2006, Pages 516-530

A new Gödelian argument for hypercomputing minds based on the busy beaver problem ☆

Selmer Bringsjord, Owen Kellett, Andrew Shilliday, Joshua Taylor, Bram van Heuveln, Yingrui Yang, Jeffrey Baumes, Kyle Ross

Show more

https://doi.org/10.1016/j.amc.2005.09.071

Abstract

Do human persons hypercompute? Or, as the doctrine of *computationalism* holds, are they information processors at or below the Turing Limit? If the former, given the essence of hypercomputation, persons must in some real way be capable of infinitary information processing. Using as a springboard Gödel's little-known assertion that the human mind has a power "converging to infinity", and as an anchoring problem Rado's [T. Rado, On non-computable functions, Bell System Technical Journal 41 (1963) 877–884] Turing-uncomputable "busy beaver" (or Σ) function, we present in this short paper a new argument that, in fact, human persons can hypercompute. The argument is intended to be formidable, not conclusive: it brings Gödel's intuition to a greater level of precision, and places it within a sensible case against computationalism.

A New One Coming! — in …

A New One Coming! — in …

Will AI Succeed?

A New One Coming! — in …

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A New One Coming! — in …

Will AI Succeed?


A New One Coming! — in …

Will AI Succeed?

 

Yes.

A New One Coming! — in …

Will AI Succeed?


No. Yes.

Gödel v. AI "Scorecard"

The Particular Work	Nutshell Diagnosis	Beyond AI?

Gödel v. AI "Scorecard"

The Particular Work	**Nutshell Diagnosis**	**Beyond AI?**
Completeness Thm. (Ch. 3)	Reduction lemma impressive.	Likely Not

Gödel v. AI "Scorecard"

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Time-Travel Thm. (Ch. 8)	Unqualified to even guess.	Unknown.
[illegible]	[illegible]	[illegible]

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⋆Philosophical Reasoning	Undeniably beyond foreseeable AI.	Yes

Og på den glade merknaden for Selmer (men ikke for Bill), er forelesningene våre fullstendige.