Re: Penrose vs the Robot

Source: http://sci.tech−archive.net/Archive/sci.logic/2005−12/msg00169.html

- *From*: "Stephen Harris" <cyberguard1048−usenet@xxxxxxxxx>
- *Date*: Sat, 10 Dec 2005 01:08:41 GMT

"abo" <dkfjdklj@xxxxxxxxx> wrote in message
news:1134117891.277546.11000@xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
>
> Stephen Harris wrote:
>
>>
>> Here is David Chalmers musing on the possibilities (1989) and
>> doesn't seem to be conclusive.
>>
>> "Basic question: is the universe an infinite−state−machine or a
>> finite−state−machine?
>
> I have difficulties accepting that this is an exhaustive choice, in the
> sense in which Chalmers probably means "machine" − as some kind of
> serial, deterministic thing.
>
>> **If the second, then it is WEAKER than a Turing
>> machine, so these analog solutions are essentially weak theoretically. If
>> the first, then is it true that it is STRONGER than a Turing machine? At
>> the very least, it seems that it has different theorems of computational
>> complexity.
>> The only way a Turing machine can accomodate 'parallelism' is through its
>> states.
>
> Well ok, but two Turing machines in parallel (which can communicate)
> are not equivalent to a (deterministic) Turing machine. Its behaviour
> can be (take your pick based on your preference) non−computable or
> non−deterministic, because what gets communicated depends on the timing
> behaviour of the two machines.

I didn't know that. A couple of related ideas I came across:
Theorem: Every nondeterministic TM has an equivalent deterministic TM.
A probabilistic TM is a nondeterministic TM where each nondeterministic step
has two legal next moves.

>
> (As some point Marvin Minsky will arrive and say, that's not true! and

> anyway we thought of that back in the 1950s!)
>

I mentioned that Deutsch tried to improve the Church−Turing Thesis with something called the Church−Turing−(Deutsch) Principle. This ties into Daryl's concluding remark: "These three claims, which I think are both empirically and theoretically justified, imply that we can't meaningfully compute anything that isn't computable by a *finite* automaton. The set of mathematical formulas that we can come to know are valid is not only r.e., it is probably a regular expression, or even a finite set."**
−−
David Deutsch:
"I can now state the physical version of the Church−Turing principle:
"Every finitely realizable physical system can be perfectly simulated by a universal model computing machine operating by finite means."
This formulation is both better defined and more physical than Turing's own way of expressing it. (Deutsch 1985: 99.)"

SH: So the C−T Principle is popular among physicists but the concept still appears to face a challenge judging by the dimensional remarks below.

−−−
"Quantum mechanical measurements on a physical system are represented by observables− Hermitian operators on the state space of the observed system. It is an important question whether all observables and all unitary evolutions may be realized, in principle on physical systems [1]. It turns out that ideas from computer science are crucial to the analysis. The reason is that some problems that are classically considered uncomputable can sometimes be recast as appropriate quantum observables or unitary operations, which, if phyiscally implementable, could apparently render them computable. There has appeared to be no known principle that forbids the implementation of such quantum mechanical observables or unitary dynamics. If feasible, they would imply that quantum mechanics not only impacts computational complexity, in terms of speeding up certain computations [2], but also impacts computability."
−−
info.phys.unm.edu/papers/1997/Nielsen1997a.ps.gz

"Natural processes may take place in infinite dimensional state spaces, and it is has not been demonstrated that all such processes can be well simulated using a system with only a finite number of state space dimensions. Regardless of whether quantum computers satisfy the Church−Turing principle, it is certainly the case that the specification of a universal model computing machine satisfying the Church−Turing principle, besides being important in its own right, would also greatly simplify the question of characterizing the classes of measurements and dynamics which are realizable in physical systems."

What is gained by using arguments based on the Church−Turing principle instead of arguments based on the Church−Turing thesis, is that it may be possible to prove the Church−Turing principle within known physical theory, for a suitable universal model computing machine. Unfortunately, it is not clear to this author that the theory of quantum computation (see [13{15] for a review), which has developed from Deutsch's original proposal, provides a candidate universal model computing machine. In particular, it is not clear that the finite dimensional state spaces accessed by quantum computers are sufficient to simulate, with arbitrary accuracy, all the processes one finds in nature.
−−

"The embedding in the Incompleteness Theorem is the same as the encoding of Turing machines into input forms acceptable for universal machines and is achieved by converting the finite description of a Turing machine into a unique non−negative integer which can then be expressed in binary or decimal or any other convenient notation. The conversion is possible as we are only dealing here with machines having a finite number of states, a finite number of symbols in its alphabet, and only a finite number of movements for their heads."

http://tph.tuwien.ac.at/~svozil/publ/ct.htm
SH: This is why you will see talk of the Zeno paradox. The realm of the quantum state is infinite, but of course then there is a collapse of the wave function or in any event the next moment of physical reality manifests into finiteness. Although it seems to me that this coalescing/actualization of probability into reality is the state requiring the one−to−one deterministic computation (computability).

arxiv.org/pdf/quant−ph/0203034
"Paradoxically, the quantum reality of Nature somehow allows us to compress the infinitely incompressible randomness into the apparently finite act of preparing the same quantum state over and over again for subsequent measurements! This quantum mechanically implied infinity seems to be both needed for and consistent with the finitely measured, see [25] and references therein for further discussion."
−−

Peter Wegner: "Penrose argues that the nondeterminism of physics may be illusory because physical phenomena maybe deterministic but noncomputable. He ascribes the nondeterministic action at a distance of the EPR experiment (section 5) to noncomputability of physics and suggests that a noncomputable model of physics could potentially resolve nondeterminism."

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http://www.cs.nyu.edu/pipermail/fom/2000−August/004244.html
Similar ideas (C−T and computability have been discussed on FOM which stands for Foundations of Mathematics under "physical computability"

"Hello Stewart,

Joe and I (and some others) too are interested in this idea, that uncomptable physical processes might occur in Nature (according to our "best theory") and that by measuring the ouput, we get a physical reasons for accepting mathematical facts independent of ZFC. It's not connected with determinism (it might involve measuring the probabilistic statistics of some quantum scattering experiment). And the issue of verifying the *theory* is out of the question.

We accept the theory at face value. The theory says: there is a certain kind of physical process P, and we can build a device M to generate this process, and the output can be measured, and the output is an *uncomputable real*. We then let it run − it produces a uncomputable ouput by this spooky physical non−algorithmic process P. We humans (if what we can calculate is the same as what some Turing machine can calculate) cannot "follow" this computation − but it physically happens nonetheless, because that's how Nature is built if the theory's right − and we can *measure* the result.

The theory states (in so many words) that the result is uncomputable (but doesn't give a prescription for our computing it, a priori as it were). Theories can *define* sets and quantities that are uncomputable (we can define "theorem of PA" or "true sentence of lang of arithmetic" (in ACA say), but Turing machines can't compute the characteristic function involved).

Joe states (I've transcribed and removed the capitals):

>For any definable−but−not−recursive sequence a1, a2, a3, there is a finite index N such that ZFC does not >decide the value of a_N; .... at some finite time we will already have obtained a new mathematical fact >independent of ZFC (but following from ZFC + T). This would demonstrate that mathematics is not logically >prior to physics.

Sure − it's highly speculative, but it's a beautiful idea which I find very attractive. It sheds quite a new light on Hilbert's optimism − his statement "non ignorabimus" − that discovering new mathematical facts might involve considerations from physical experiments.

Best wishes − Jeffrey Ketland"

SH: This mailing list includes contributions by Simpson and Harvey Friedman and can be interesting reading. And it leaves the subject somewhere in the territory of mathematical logic.

"This would demonstrate that mathematics is not logically >prior to physics"
Stephen

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- ***References***:
  - ***Re: Penrose vs the Robot***
    - *From:* abo
  - ***Re: Penrose vs the Robot***
    - *From:* Daryl McCullough
  - ***Re: Penrose vs the Robot***
    - *From:* abo
  - ***Re: Penrose vs the Robot***
    - *From:* Stephen Harris
  - ***Re: Penrose vs the Robot***
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    - *From:* abo

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