Kragujevac J. Sci. 23 (2001) 47-50.

THOUGHT EXPERIMENT AND COMPUTER EXPERIMENT - SIMILARITIES AND DIFFERENCES

Vladimir Ristić and Mirko Radulović

Faculty of Science, P.O. Box 60, 34000 Kragujevac, Yugoslavia

(Received April 23, 2001)

ABSTRAC. It was shown that though there are various differences between thought and computer experiment, there are also some similarities. Computer simulations, as representations of computer experiments, are shown to have the same proving ability as thought experiments. Both are using previous knowledge collected by the science in question, and extending it to new problems.

INTRODUCTION

In this paper we are trying to emphasize the similarities between thought experiments and computer simulations (as the most often representantion of computer experiment); also, we shall try, through some logical steps, to extend the proving ability of thought experiments to the computer simulations, by showing that same arguments which show proving ability of thought experiments apply to the computer experiments.

This is shown by using one simple thought experiment (the one with an elevator, from General Relativity [1]) and one simple simulation (simulation of self-avoiding walks on fractals [3]). Comparing the to we are trying to shed some light on the problem.

ONE SIMPLE THOUGHT EXPERIMENT

First we shall try to formulate a working definition of thought experiment, with the help of Einstein's thought experiment with elevator:

Let us imagine an elevator in space, removed from influences of all gravitational mass, which moves with some acceleration. If acceleration is constant and equals g, man inside the elevator will feel like he is under Earth gravitational field. Conversely, in elevator that falls freely in Earth's gravitational field, acceleration downwards completely nullifies influence of this field, thereby neutralizing the effect of gravitation.

We can say that aforementioned thought experiment uses real objects (objects which are realizable, or which can be made as such) and puts them in unrealizable relations, or in realizable relations, but which are more obvious and simpler if described by thought experiment [1].

So, what we have here is the thought experiment that uses well known concepts collected from innumerous real experiments regarding physical bodies in the gravitational field of Earth, and extends them to the case never before realized, thus accomplishing to give us a deeper insight into physical phenomena at hand.

AN EXAMPLE OF A COMPUTER SIMULATION

What is a computer simulation? According to [2], it is a model of a real process (not necessarily physical) that has been realized on a computer. Model is abstraction of reality in sense that it can not circumvent all of its aspects, so it is simplified and idealised picture of reality. Thing relevant for our consideration is the fact that model is not only a simplified picture of a real system (which as such contains objects and attributes of a real system), but also it has in itself incorporated certain assumptions about validity conditions.

On the other hand, it is commonly known that computer experiments use programming languages in order to develop models that are used for simulation. Also they are using concepts that are already verified by experience and that are combined in a new fashion in order to throw light on some new problem. In order to emphasize this, we shall give here a short segment of computer simulation, which deals with simulating self-avoiding walks on fractals. The simulation has been written in programming language Fortran.

```
      GRP=P5-P0
      WRITE(7,1110)GRP
1110  FORMAT(' p* - po='F8.5)
      GRN=(GRP/P0)*ODSTN**2
      WRITE(7,1120)ODPR
1120  FORMAT(' ERROR FOR <N> ='F8.4)
      SRN1=SRN+GRN
      WRITE(7,1130)SRN1
1130  FORMAT(' <N(p*)>='F8.4)
      ZET1=ALOG(REAL(B))/ALOG(SRN1)
      WRITE(7,1140)ZET1
1140  FORMAT('CRITICAL EXPONENT IN POINT p* NI='F8.5)
```

```
      DZET1=(ZET1*ODPR)/(SRN1*ALOG(SRN1))
      WRITE(7,1150)DZET1
1150  FORMAT(' ERROR FOR NI ='F8.5)
      WRITE(*,*)' END OF PROGRAM'
      STOP
      END
```

Here we see our main argument in making case for proving ability of computer, as well as thought experiments, and that one is: when we are creating computer simulations, with it goes inclusion of all the results of all previous experiments into starting parts of simulation. For instance, let us observe physical quantity such as *critical exponent*, which stems from theoretical physics, where it was strictly defined. This analogy between computer experiments and thought experiments in physics follows from similarity that stems from the fact that in thought experiments, as well as in computer experiments, one uses documented results of great number of, earlier conducted, real experiments, which have become part of the scientific inheritance. Both of them are combining these results in order to give a new insight into reality.

It is the same with computer simulation of this experiment, at least from the point of view of starting assumptions, which bring together results of innumerous previous experiments. Form that these results have is that of physical formulas, as can be seen in our aforementioned computer simulation example, where they follow from statistical physics.

Naturally, there are numerous differences between the two, mainly at the level of complexity. In thought experiments in order to achieve the leaps of insight into the problem at hand we ignore all irrelevant details, and reasoning from, in such way obtained scenarios, we obtain the conclusions that would otherwise be impossible to reach. Conversely, in computer simulations we have exactly the opposite property – they absolutely "force" us to concentrate on every detail, and therefore have the benefit of making visible the assumptions that we might not have realized we were making.

Nevertheless, we still think that a strong case can be made for extending proving ability of thought experiment to the computer experiment. Both are using well known concepts obtained from real experiments, and extending them to cases that have never been realised before.

CONCLUSION

So, we showed – on the example of Einstein's thought experiment with an elevator – that same arguments by which once proving ability of thought experiments was established can be applied to computer experiments also, because of their similarity in one important fact – that of a starting assumptions which authors of both computer and thought experiments make, and which follow from all previous knowledge accumulated from numerous experiments in form of theorems, lemmas and formulas.

References:

[1] V. Babović, V. Ristić and D. Todorović, *Thought Experiment in Physics*, Collection of Scientific Papers of Faculty of Science Kragujevac, 4 (1983) (in Serbian)

[2] B. Radenković, M. Stanojević and A. Marković, *Computer Simulation*, Faculty of Organizational Sciences, Belgrade (1999) (in Serbian)

[3] S. Milošević, I. Živić, *Self-avoiding walks on fractals studied by the Monte Carlo renormalization group*, J. Phys. A: Math. Gen. 24, L833-L838 (1991)