Individual memory about the 14^{th} Brainstorming Week on Membrane Computing

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Two weeks ago I didn't even know the existence about this branch of computing, right now I can ay a little bit more but I still know nothing. I think membrane computing is a science which is inspired in the cell (objects that pass trough the membranes). The most important and useful characteristic (especially in physics) is its maxim parallelism, it reduces the computation time because can operate lots of rules at the same time.

If we drew a comparison with quantum, we can identify the objects with the particles, and use the membranes as we want (e.g. as a device) with the appropriate rules. So we can solve a problem with N particles (N tends to infinite) more quickly than with conventional computing.

I have discovered an exciting world. I mean, when I decided to study physics was because of the particles. After learning computational physics I realized that I really like computing, but after this week in Sevilla I open my mind and I think that the possibilities of model with computers are unlimited, and I really want to learn more about it. And I want to link it with particles and quantum world.

I can sincerely say that this week has been one of the most important and amazing weeks in my life, not only for the knowledge, because I have realized what I really want to do in my life. I love learning and improve myself every day, and I can only reach this by working as a researcher. Also, the experience has been enriching for me. I met the most important researchers in this field, I could speak with them and asked questions, I also joked with some of them and I have learned a lot of important skills (especially work as a team, with people that I have never seen before).

In the morning sessions we had provocative presentations, where the researchers presents their projects and its difficulties to go on with it, all the assistants tried to help and to solve this problems. Some of this talks were interesting for me but other didn't because I couldn't understand anything.

One of the topics that I found really interesting is P-Systems with a quantum like-behaviour. How I found this? This began with our project (apply P-Systems to physics), it consists in simulate the Urainum 238 decay experiment. We use the simplest model, membranes (as a Stern-Gerlach device), objects (as a particles) and rules (as probabilities of being up or down). But, I was thinking that with this model the interactions are not considered, so I wanted to know if exists a model for it. By chance, we found a paper named P Systems with a Quantum-Like Behaviour: Background, Definition, and computational Power, before reading it I realized that the author is Alberto Leporati, one of the assistants to the brainstorming, so I asked him about this. This happened the last day so I had not got time to assimilate it and ask questions so now I am reading the paper and trying to understand it, I haven't finished it yet.

What I can understand for the moment is that, this systems is based on the exchange of a quantum of energy among two quantum systems, using the operator creation and annihilation. Each object have associated an amount of energy that can be use to transform objects using rules, which are realized trough linear operators. Its difficulty is avoiding undesired exchanges of energy among the objects, that yield the system to unintended states. I don't know how is visually this model and how it works but I find it useful in the way to model particles and their interactions.

I have been thinking about what P-systems can do in physics and I have some ideas, but I don't know if they are possible.

- Related with quantum behavior, I would like to develop a simulator of particles collision (simulate what occurs in the particles accelerators).
- Another idea that we develop in Sevilla is to use membrane computing for solving continuous problems. By constructing a net it's possible to approximate this problems to a discrete problems, so it's possible to solve with differential equations, for example standing distribution of temperatures (Poisson's equation). Because of membrane computing's maxim parallelism (lots of operations at the same time) it's possible to reduce the computing time. The problem is that in this model is not implemented the relative position (which is fundamental in physics). But I asked Sergiu Ivanov (one of the assistants) and he said that he is developing another model of P system, Automata P-System that may could be useful to solve this kinds of problems. If it's possible to implement the position, membrane computing can be very useful to simulate meteorological models.
- Another idea is related with quantum computer and cryptography. I don't know too much about quantum computer. I have read that the elementary units that compose these parts are two-level quantum system called qubits. The mathematical description of a single qubit is based on the two-dimensional complex Hilbert space C^2. Qubits are thus the quantum extension of the classical notion of bit, but whereas bits can only take two different values 0,1, qubits are

not confined to their two basis (pure) states, $|0\rangle$ and $|1\rangle$, but can also exist in states which are coherent superpositions. Performing a measurement of the state alters it. Indeed, performing a measurement on a qubit in the above superposition will return 0 or 1 with different probabilities. In cryptography it's necessary to do a lots of combinations to find the correct result. With the computation used until now it lasts a lot. But with membrane computing and its max parallelism it could be used as a quantum computer and reduce time of computing. I don't know how to do it yet, but with time and information maybe it's possible.