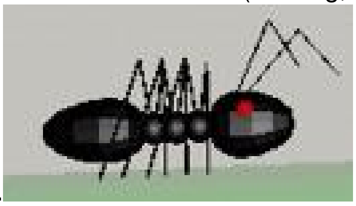
Overview of the Ants

This is an application of the DBC/DBN theories. A computer program simulates behavior of ants (walking, looking for food, making paths between anthill and location of food) on cellular level. 

For those interested in our work, the ants provide visualization of the results. The run time simulation of ants is fun to look at, and with the drag and drop options you can push the ants (and the underlying model) to their limits. Each ant is ultimately seeking for food. While doing that, the ant creates a path, which can lead them back home. The paths are not visible by a naked eye, and therefore tools must be used. In the simulation there is a button - "show path". Once you click on it, you can see the paths. When an ant gets on some already existing path, it follows the path and walks considerably faster. However, the ant must avoid collisions with other ants or unfriendly objects, so it uses the tentacles to explore the area ahead. If it finds an obstacle, the ant has to go back. There are several implementation of the ant, which can be seen live.

Let's take a look

For those not interested in problematic of simulation in the biological field the story ends more or less here. Why should I be interested? Why did the authors spend a considerable amount of time on the simulative software? The ultimate target is clear: Those, who can adequately describe and simulate, are able to predict as well. And those who predict can in fact see the future. And who can see the future may be able to alter it, to their benefit. The goal is big, which is good, because we are not interested in small achievements. The first step lying ahead is to decide: What methodology is the best to use for the simulation? It does not have to be specifically for the ants, but for all biological events in general. The project Ants can be seen as a sandbox, where different methodologies and approaches to the problematic can be compared.

The first idea is to use an already existing proven methodology. Physics use ordinary or partial differential equations for centuries. They come up with a formula to describe a system. Then the calculus provides them many tools to solve the equations analytically or numerically. At the end they have the solution, which predicts the future of the system given initial parameters. So, our first idea could be to describe the Ants by a mathematical formula.

The second idea is to use another already existing, but younger methodology. Computer scientists use discrete simulations for decades. The trend has started in 60's with language Simula, which has introduced very popular object oriented programming. The programmers come up with a set of objects, which describe a system. Each of the objects has different data and algorithmic representation. Powerful computers and languages provide scientists many tools to run the simulation faster, than they would in the real world. At the end, they show the state of the system at the given time in the future. So, our second idea could be to describe the Ants algorithmically.

The third idea is to create a new methodology, specifically designed to simulate biological processes. It shall be based on the empathic approach and as the essential building block we'll use Digital Biological Cell. The new methodology

- Inherits the idea of the same mathematical formula for all simulated objects from physics (DBC)
- Inherits the idea of computer based simulation from computer scientists
- Brings an interface, which will allow to simulate many different biological processes together and therefore to build the simulations on top of each other
- Allows to run the simulation on cellular level and get the results on higher layer (tissue or organism)

A researcher comes up with a DBC compatible model. Again, the computers will provide many tools to run the simulation faster, than it would run in the real world. At the end, it shows the state of a tissue or organism reflecting given multiple processes at the given time in the future. So, our third idea could be to describe the Ants cellularilly.

Let's go back to our Ant's sandbox and compare the methodologies. It is time consuming to describe the Ants by a mathematical formula for its complexity. However, some of the ants are implemented algorithmically and some others are implemented cellularilly. When you run the simulations, you can compare the visual results of both implementations. They seem identical. Delivering the same result, both methodologies seem to be equal. Also the effort to create the program is comparable. However, the cellular approach has the considerable advantages:

- It implicitly delivers framework for various simulations and their combinations. Also combinations, which were unknown at time of the model creation.
- It is closer to the biological reality and therefore the model can be easily inspired by or compared to an experimental research. There is pretty straightforward relationship between DBC implementation and real biological cell. As a result the inter-cell relationship is comparable in real world and the simulation.
- It can naturally explain various biological observations on tissue level. For example the Ants revealed why it is simpler for sensations from the right sensors to be processed in the left hemisphere (and vice versa).
- The behavior, which is easier to implement cellularilly, is usually the observed behavior. As an example variable speed for the ant comes naturally simpler to implement cellularilly, than constant speed, which is simpler to implement algorithmically.

The conclusion is, that biological process deserves a new methodology. The immediate results may seem similar to other methodologies, but future extensions are easier to implement cellularilly. Instead of having separate algorithms or formulas for each aspect, the cellular implementation brings unifying model for all of them.