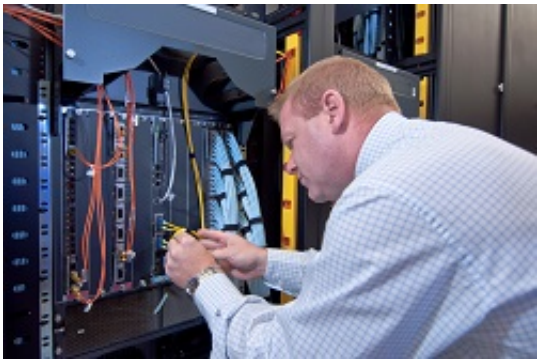
How game theory can lead to energy efficient solutions

April 25 2016



EU researchers have applied game theory in order to develop new ways of efficiently controlling complex systems such as heating and power.

The EU-funded CASSTING project has pioneered an effective new approach to understanding and shaping what are known as collective adaptive systems. These complex systems typically consist of numerous autonomous units, which can interact in a variety of ways. Examples include the ecosystem; the brain; manufacturing businesses; and the internet.

By developing mathematical methods for identifying how optimal efficiencies might be achieved, researchers hope to be able to design better ordered systems and ultimately boost Europe's high tech industry.

Sectors that could potentially benefit include robotics, high tech appliances and medical diagnostics.

The CASSTING project team began by characterising collective adaptive systems through the prism of game theory. This branch of mathematics has been successfully applied in various domains including economics, social sciences, biology, political sciences, engineering and computer science.

Game theory attempts to model strategic situations where several individuals are interacting, and tries to predict what decisions individuals will take in a given situation, assuming rationality. This theory views components as players, their behaviour as strategies and specifications as winning conditions.

The project's overall objective has been to find ways of arranging components in such a way that will produce the best results through the application of this mathematical theory. This of course is easier said than done. Collective adaptive systems contain components that interact continuously with each other and with their environments, and which may work collaboratively or in an adversarial capacity. Components of collective adaptive systems can also adapt over time and even disappear, if one thinks about how the ecosystem behaves.

Nonetheless, the application of game theory has helped the CASSTING project team to develop new algorithmic analysis methods for predicting the behaviour of complex systems. One project case study involved the development of a complex system for floor heating. Several novel ideas were put forward in order to provide fully automatic communication with the hardware components of the floor heating system.

An adaptive, online synthesis algorithm was developed capable of computing repeatedly optimal strategies for the near-future. The tool

was then built and demonstrated. The results showed that the tool could control the house considerably better than conventional heating controllers.

Another case study involved the analysis of a block of houses equipped with solar panels connected to the electricity network. Each household consumes and produces energy, which they can therefore buy and sell. Game theory was applied to represent this situation: each household is a player whose actions consist of selling, buying, and consuming energy. Algorithms were developed to find good consumption and trading behaviours for each household in different contexts.

The challenge now is to develop algorithms and programmable components for other complex systems. This will create new opportunities for complex systems involved in, say, home automation, smart housing and efficient industrial manufacturing.

More information: For further information please visit the CASSTING project website: www.cassting-project.eu/

Provided by CORDIS