Dagstuhl seminar 08372

Computer Science in Sport – Mission and Methods

Executive summary

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From September 7 to 10, 2008 about 30 experts from computer science and sport science (see Appendix B) met at the Leibniz-Zentrum für Informatik in Dagstuhl to discuss interdisciplinary issues in the area of computer science in sport. Five topics were selected for discussion (see Appendix A): doping, modeling and simulation, pervasive computing, robotics and sport technology. A total of 17 presentations dealt with selected projects and issues in the above-mentioned fields.

Doping – an individual decision or a social phenomenon?

Sociological theories disagree about the main causes of doping. On the one hand the victory code promotes pressure to exploit all (allowed and forbidden) means to increase sport performance. The particularities of an athlete's carrier add to this pressure on a 'one-way' street to doping after passing a 'point of no return'. On the other hand, as some athletes do not dope, there must be further moderators of doping involvement. Emrich and Pitsch discussed the doping phenomenon on the basis of sociological and economic models taking into account specific use and loss variables. Perl and Lames illustrated that statistical and

unconventional models of performance can detect conspicuous or suspicious developments or characteristic load-performance relationships indicating that something unusual must have happened in training.

The panel discussion dealt with the question: What can computer science in sport contribute to the prevention and detection of doping? Some interesting perspectives were offered:

- Advanced technology (e.g., GPS) can improve athlete tracking.

- Modeling and data analysis like data mining, machine learning, unconventional and conventional approaches can help to detect abnormal phenomena.

- New developments in pervasive computing like swallable and implantable sensors are ambivalent. They can be used either for advanced or more sophisticated doping analysis or for establishing more elaborated doping techniques.

Modeling and simulation – between reduction and abundance

In the modeling session, seven presentations were discussed dealing with a variety of topics:

- Basics of modeling (Perl)

- *Emerging actions and tactic solutions under constraints in training and competition* - Modeling of boxing movements based on the ecological approach to perception and action (Hristovski/ Balague)

- *Net-based process analysis in sport games* - Modeling creativity by integrating the PerPot model and Artificial Neural Networks (Grunz)

- Modeling in the area of Pathophysiology (Saupe)

- *Acquisition of performance parameters in race-bike training* - Modeling in cycling (Dahmen)

- *Use of Self Organizing Maps in Technique Analysis* - Modeling in biomechanics using Artificial Neural Networks (Bartlett)

- *Modelling and simulation: Some perspectives from sports science* (Mc Garry)

The presentations covered a wide range of applications. Furthermore, discussions showed that modeling in sport science raises some fundamental issues: Which models of computer science and mathematics are appropriate? Is a qualitative or quantitative, static or dynamic,

an implicit or explicit paradigm adequate? How can the properties of the original be formalized? Are the respective prerequisites of the models fulfilled by the original? Concerning the re-transfer of simulations to sport: What is the consequence of reduction and abundance, i.e. neglecting some features of the original and adding new features to the model? Models show many degrees of freedom, e.g., Neural Networks (number of neurons, topology, learning rule, learning rate etc.). In order to avoid the impression of arbitrariness, there should be standards – like in statistics – how to structure the modeling process and which parameters to document.

In many cases of modeling and simulation, a number of different proprietary and commercial solutions are usually available. There should be standards concerning formal and scientific quality (e.g., usability, visualisation) that have to be fulfilled by the respective systems.

Robotics – two directions of transfer: from humans to robots and back

In the robotics session five presentations were discussed:

- Basics and issues (Nebel)

- *Robotics: Some perspectives from sports science* (Mc Garry)

- *Robot Sport Competitions - Benchmarks for AI and Robotics* (Behnke)

- *When Robots Learn to Play Soccer* (Riedmiller)

- *Robot Plays Table-Soccer* (Zhang)

Both the presentations and the discussions showed that robotics is a promising interdisciplinary field where computer science and sport science can learn much from one another. This working field has made much progress in the last years.

It is particularly interesting that despite different hardware and software concepts of motor control, motor learning, strategy and tactics share some features. In both areas concepts like perception, perceptual representation, levels and modes of control, memory, reinforcement learning, imitation, etc. are discussed. Furthermore, sport is an attractive realm for standardized benchmark testing in robotics.

Pervasive computing – technology meets human needs

In the pervasive computing session five presentations were discussed:

- Pervasive/Ubiquitous Computing in Sport - Basics and issues (Baca)

- *Analysis of Player Motion in Sport Matches* - Computer vision in game sport (Pers)

- *Using Signal Processing to Improve Engagement and Motivation in Sports and Fitness Games* - Emotion recognition (André)

- *3D Scene Reconstruction by Stereo Methods for Analysis and Visualization of Sports Scenes* (Gelautz)

- Selected issues of measuring technology (Hailes)

In pervasive computing a vast amount of different sensors and sensor technologies are used, ranging from visual representation to wireless physiological monitoring. There is a tendency to integrate many sensors and sensor fields. This poses the problem to choose the adequate sensors (e.g., for recognition of emotions where behavioral, physiological and cognitive indicators exist) and to establish an adequate fit of technology and practical requirements.

Pervasive computing offers many fascinating technological options for sport, particularly for learning, training and competition. However, the acquisition of sensor data is only the first step. The processing of sensor data poses great challenges, e.g., for recognition of situations, actions and particular states of the organism. Data processing has to detect and reveal the relevant structures and qualities in the sensor data.

Sport technology – the view of practice

In the sport technology session four presentations were discussed:

- Technology and archery (Edelmann-Nusser)

- *Sport Technology to Encourage Physical Activity in Adolescents* (Böhm)

- Technology, Computer Science, Coaching – Strategies and Concepts for Cooperation (Roemer & Link)

- *Motion Analysis of Volleyball Spikes* (Roemer)

- Sonification in Training of Top Level Athletes in Luge (Link)

The discussions addressed some general issues: Balancing the requirements of the applications field and the options offered by technology (push vs. pull) is a great challenge. Appropriate technological interventions in sport practice require an appropriate theoretic framework. Technological, psychological, sociological, pedagogical, biomechanical and physiological perspectives have to be integrated to develop a sustainable and maintainable solution for the problems in sport.

Fund-raising for interdisciplinary projects in computer science in sport is difficult because sport is considered only as an application field of computer science. Another issue is the placement of product in the market.

Mission statement

The discussion of the mission statement turned out to be problem. Introductory, the question for the author of such a statement was discussed. Since the participants of a Dagstuhl seminar do not form any formal group, it was finally agreed, not to work out a mission statement, but, moreover, a summary of opinions.

After this, some key aspects were collected:

- A network should be established for mutual exchange.

- A bidirectional exchange between computer science and sport science as well as joint publications should be promoted.

- More measures should be taken for recognizing computer science in sport as a real science.

- More focus should be put on the question of how to implement technology into practice (e. g. on design aspects).

- A platform for exchange (of ideas) should be established. It was proposed that this could be an issue of IACSS, the International Association of Computer Science in Sport – www.iacss.org).

- Standards and/or guidelines should be identified.

- Data sets for Benchmark tests should be provided to stimulate competition. Again, it was proposed that this could be an issue of IACSS.

Conclusions

The seminar proved that both sides (computer science and sport science) can profit from informal exchange. The participants emphasized that this was the salient outcome of the seminar. On the other hand, many issues have been addressed only shortly without having time to go into depth.

The evaluation of the seminar showed that the seminar

- inspired new ideas for further work (research, development or teaching),

- inspired joint projects, joint development, or joint publications,

- led to insights from neighboring fields or communities and

- identified new research directions.

The most important strengths of the seminar were open discussions, breadth of topics and participants, and quality of presentations. The seminar can be improved by reserving even more time for discussions and a more stringent organization of presentations and schedule.

Finally, there was a clear consensus of the participants to continue this kind of exchange.