The mirage of a general purpose robot and the combinatorial explosion

Thomas Brox, University of Freiburg

In 1973, Sir James Lighthill compiled a report for the British government about the status of artificial intelligence. The report was very pessimistic regarding the achievements of the field until then and also gave a very pessimistic prognosis on the achievements to be made in the future. The most important concern raised in the report was the combinatorial explosion, which would make it impossible to scale the methods of artificial intelligence up to the real world domain. While Lighthill was positive about computer science applied to specialized problems, such as airplane control, he criticized AI research to be restricted to toy problems and called the general purpose robot a mirage. As a result of his report, financial support for artificial intelligence in Britain was heavily cut.

40 years later, it is interesting to have a look at the state of the field and compare it to the prognosis of Lighthill. Which problems that he considered unsolvable have been solved and does this render his argument about the combinatorial explosion invalid? The issue of methodologies that do not scale up but work only on toy problems sounds all too familiar to us. Is progress to be attached to the exponential increase of computational capacity that allows us to linearly increase the size of the working domain, or has the field found ways to fight the combinatorial explosion? Are the heuristic approximations we invented to avoid the combinatorial explosion valid or do they necessarily restrict us to specialized domains requiring manual definition of priors, as claimed by Lighthill? Finally, is the combinatorial explosion a problem at all, or can we just rely on the exponential increase of computational capacity because even general purpose robots, and humans alike, act in a finite, quite restricted domain?

I will show excerpts of a debate that followed Lighthill's report and where Lighthill was opposed by three leading AI scientists of that time. I will expose the main arguments on both sides and put them in perspective to the current state of the field. I will raise the above questions and expect a lively discussion afterwards.