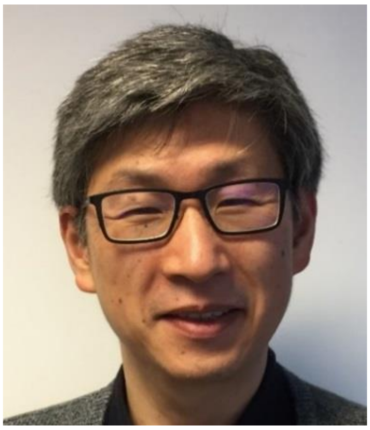
# Invited Speaker 5

Invited Speech Title：**Harnessing over a Million CPU Cores to Solve a Single Hard Mixed Integer Programming Problem on a Supercomputer**



**Dr. Yuji Shinano** is Researcher, Zuse Institute Berlin, Germany

**CV:**

1997 PhD Engineering, Tokyo University of Science, Japan
1994 MS Engineering, Tokyo University of Science, Japan
1992 BS Engineering, Tokyo University of Science, Japan

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**Appointments**

2010/04 – present Researcher, Zuse Institute Berlin, Germany
2010/10– present Guest Associate Professor, The Institute of Statistical Mathematics, Japan
2009/03 – 2009/12 Visiting Zuse Institute Berlin for Sabbatical leave
2004 – 2010/03 Associate Professor, Tokyo University of Agriculture and Technology, Japan
1999 – 2004 Assistant Professor, Tokyo University of Agriculture and Technology, Japan
1997 – 1999 Research Assistant, Tokyo University of Science, Japan
1994 – 1997 Research Fellow of the Japan Society for the Promotion of Science, Japan

**Recent Publications**


1. Y. Shinano, T. Achterberg, T. Berthold, S. Heinz, T. Koch. ParaSCIP: a parallel extension of SCIP. Competence in High Performance Computing 2010, Christian Bischof, Heinz-Gerd Hegering, Wolfgang Nagel, Gabriel Wittum (Eds.), pp. 135–148, 2012.
2. T. Koch, T. Ralphs, Y. Shinano. Could we use a million cores to solve an integer program? Mathematical Methods of Operations Research, 76(1):67–93, 2012.
3. Y. Shinano, T. Achterberg, T. Berthold, S. Heinz, T. Koch, M.Winkler. Solving hard MIPLIB2003 problems with ParaSCIP on supercomputers: An update. in Proceedings of the 2014 IEEE International Parallel & Distributed Processing Symposium Workshops, IPDPSW'14, (Washington, DC, USA), pp. 1552–1561, IEEE Computer Society, 2014.
4. G. Gamrath, T. Koch, S. J. Maher, D. Rehfeldt, Y. Shinano. SCIP-Jack - A solver for STP and variants with parallelization extensions. Math. Prog. Comp. pp.1 – 66, 2016.
5. Y. Shinano, T. Achterberg, T. Berthold, S. Heinz, T. Koch, M. Winkler: Solving open MIP instances with ParaSCIP on supercomputers using up to 80,000 cores.

In: 2016 IEEE International Parallel and Distributed Processing Symposium (IPDPS), pp. 770–779. IEEE Computer Society, Los Alamitos, CA, USA, 2016.

6. Y. Shinano, S. Heinz, S.Vigerske, M.Winkler. FiberSCIP - A shared memory parallelization of SCIP. accepted for publication in INFORMS Journal on Computing, 2017.

**Research Interests and Expertise**

My research expertise is in the field of mathematical optimization programming problems and parallel computing. I am interested in the application of parallel computing to solve very hard discrete optimization problem instances in the real-world.

Currently I am involved in the development of the SCIP Optimization Suite at the Zuse Institute Berlin. I am the developer of UG which is a software framework to parallelize state-of-the-art MIP solvers and is a package in the SCIP Optimization suite.

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Abstract:

Mixed integer programming (MIP) is a general form to model combinatorial optimization problems and has many industrial applications. The performance of MIP solvers, software packages to solve MIPs, has improved tremendously in the last two decades and these solvers have been used to solve many real-word problems. However, against the backdrop of modern computer technology, parallelization is of pivotal importance. In this way, ParaSCIP is the most successful parallel MIP solver in terms of solving previously unsolvable instances from the well-known benchmark instance set MIPLIB by using supercomputers. It solved two instances from MIPLIB2003 and 12 from MIPLIB2010 for the first time to optimality by using up to 80,000 cores of supercomputers. Additionally, a specialized version of ParaSCIP for solving Steiner tree problems called SCIP-Jack solved three open instances from the Steiner tree test benchmark set PUC. ParaSCIP has been developed by using the Ubiquity Generator (UG) framework, which is a general software package to parallelize any state-of-the-art branch-and-bound based solvers. The UG framework is currently being used to develop ParaXpress, a distributed memory parallelization of the commercial MIP solver Xpress. Moreover, it is being used to parallelize PIPS-SBB, a solver for stochastic MIPs. Since Xpress is a multi-threaded solver and ParaSCIP can run at least 80,000 processes in parallel for solving a single MIP, ParaXpress could handle over a million CPU cores. Furthermore, the parallelization of PIPS-SBB by the UG framework has the potential to also handle over a million CPU cores. In this talk, a ground design of the UG framework and its latest extensions to harness over a million CPU cores will be presented and preliminary computational results will be provided.