# Lecture Notes in Computer Science

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# Concurrency: Theory, Language, and Architecture

UK/Japan Workshop
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Proceedings

**Volume Editors**

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# Foreword

Japan's period as a closed society terminated abruptly in 1868, and Japan has played an increasingly important role in the world of business and technology. But communication between Japan and Europe on scientific matters, including Computer Science, is still quite limited. Japanese researchers are well read in the international literature, but barriers of language and culture have restricted their participation at a more personal level, and meant that Europeans are often unaware of Japanese work and unsure how to conduct themselves in personal encounters with Japanese whom they meet at a conference, or who may visit their workplace.

The situation is improving as many Japanese spend time abroad, and some Europeans visit Japan. Particularly it has been noticeable over the last ten years that many more Japanese researchers are able to converse in English with some facility. Sadly our efforts to learn Japanese and understand Japanese social conventions have been much less intensive.

This series of Japan-UK workshops, the first at Sendai in 1987 and the second at Oxford in 1989, is in some sense the fruit of almost twenty years of growing friendship between Professor Ito and myself, since 1967 when he was doing a PhD at Stanford with John McCarthy and I was a young lecturer in "Machine Intelligence" at Edinburgh.

It seemed to me that, beside the technical outcome of exchanging research results, we should try to get a group of Japanese and British researchers to feel comfortable together and begin the long process of sharing the unspoken assumptions about what is worth finding out - assumptions which underly all our research efforts. This was made easier by the warmth and generosity of Japanese hospitality at Sendai, a welcome which, with the help of Bill McColl, we tried to repay in some small measure at Oxford.

The first workshop was on Logic, Proof and Specification; there were no published proceedings, but the list of participants and talks is included at the end of this volume. The second Workshop on Concurrency gave rise to this volume. The first section reflects the UK concentration on the theory of concurrency with just one Japanese contribution, and the second emphasises the strong Japanese interest in the object oriented approach to programming and in particular to concurrent programming. The third section on architectures and VLSI is more evenly matched with contributions from a variety of researchers in both countries. The abstracts at the end of the book cover some other talks which were not submitted for publication.

We hope to continue this series and further encourage amiable conversation amongst this community of researchers.

Edinburgh University, January 1991                                                    Rod Burstall

# Preface

Concurrency has grown into one of the most active and prolific research areas in Computer Science. The second UK/Japan Workshop in Computer Science was held at Wadham College, Oxford, September 25-27, 1989, and focused its topics on Concurrency to exchange ideas emerging in the two countries. The workshop was organized by Rodney M. Burstall, Takayasu Ito, and Akinori Yonezawa with the help of William F. McColl (Oxford) for local arrangements at Oxford. At the workshop, 18 UK and 13 Japanese talks were given on various topics in concurrency, ranging from theories and languages to architectures and applications.

This volume, which contains the papers based on the research works presented at the workshop, is organized into four parts. Part I contains the papers on theoretical aspects of concurrency which reflect the flourishing research activities in UK, and Part II contains the papers on object-orientation and concurrent languages which reflect major research activities on concurrency in Japan. Part III contains a number of papers on parallel architectures and VLSI logic. Part IV gives an overview of the workshop including the abstracts of the talks and the list of the participants. The Appendix gives a brief report of the first UK/Japan Workshop in Computer Science, held at Sendai, Japan, July 6-9, 1987. The major topics of the first workshop, which was organized by R. M. Burstall and T. Ito, were Logic, Proof, and Specification in Computer Science. The idea of holding the Workshop on Concurrency was one of the major outcomes at this workshop.

This second UK/Japan Workshop at Oxford was sponsored by SERC (Science and Engineering Research Council of the British Government) and JSPS (Japanese Society for the Promotion of Science). It was held with the great help of Oxford people. In particular, we would like to express our cordial thanks to W. F. McColl of Oxford Computing Laboratory for his efforts on local arrangements of the workshop held at Wadham College. Also our special thanks go to Eleanor Kerse who served as the conference secretary during the workshop.

For the publication of this proceedings, we thank Hans Wössner of Springer-Verlag for his assistance and encouragement. Finally, we thank all those who helped organize the workshop and made this publication possible.

Hongo, Tokyo

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