CS 342/358. Advanced Programming Languages:

Concurrent Object-Oriented Programming Languages

John C. Mitchell

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Course Description

This course will examine issues in the design of concurrent object-oriented programming languages. An immediate issue in the design of concurrent object-oriented languages is the relation between objects and processes. Processes and objects are both relatively complex entities that are used to structure the control and data flow of computation. A reasonable starting point in language design is to expect some form of connection between the two constructs. In addition, it seems difficult to avoid design considerations that involve interactions between obejcts and processes. For example, messages to objects might be serialized, or allowed to arrive in parallel.

The main goals of the course are to understand the design space of concurrent object-oriented languages, explore some of the trade-offs, and become familiar with some of experiments that have been carried out by previous researchers. Some of the main design possibilities are listed below:

- process generation and termination
  - synonymous with object creation and termination
  - separate mechanisms
  - atomicity considerations
- communication
  - shared variables
  - channels

- message send
- broadcast
- possibility of failure

- synchronization
  - synchronous communication
  - separate mechanism

Preliminary Reading List

General

[AWY93] Agha, Wegner and Yonezawa (eds.), Research Directions in concurrent object-oriented programming, Mit Press 1993.

[Ecoop91] Proc. of the ECOOP'91 Workshop on object-based concurrent computing, LNCS 612.

Implemented languages

POOL

[Ame89] P. America. Issue in the design of a parallel object-oriented language. In *Formal Aspects of Computing*, 1, 366-411, 1989.

[AB+86] P. America, J. de Bakker, J. Kok and J. Rutten. Operational Semantics of a Parallel Object-Oriented Language. In *Proc. of POPL'86*, (1986), 194-208.

ABCL

[Yon90] A. Yonezawa. ABCL: An object-oriented concurrent system. *MIT Press*, Cambridge, Mass., 1990.

Obliq

[Car95] L. Cardelli. A language with distributed scope. In *Computing Systems*, 8(1):27–59, 1995.

Formal aspects

Process Algeba approach

[KY94] N. Kobayashi and A. Yonezawa. Type theoretic foundations for object-oriented concurrent programming. In *Proc. of OOPSLA'94*, 1994. (actually a longer and better version titled "Towards foundations of concurrent object oriented programming: Types and language design" can be found on Yonezawa's www page http://web.yl.is.s.u-tokyo.ac.jp/)

[PT94] B. Pierce and D. Turner. Concurrent objects in a process calculus. In *Proc. of Theory and Practice of Parallel Programming*, 1994.

[Vas94] V. T. Vasconcelos. Typed concurrent objects. In *Proc. ECOOP'94*, 1994.

[Nie92] O. Nierstrasz. Towards an object calculus. in *Proc. of the ECOOP'91 Workshop on Object-Based Concurrent Computing*, 1992.

Actor language approach

[Agh86] G. Agha. Actors: a model of concurrent computation in distributed systems. *MIT Press*, Cambridge, Mass., 1986.

[Agh90] G. Agha. Concurrent object-oriented programming. In *Communication ACM* 33(9), 1990.

[AMS95] G. Agha, I. Mason, S. Smith, and C. Talcott. Towards a theory of actor computation. In *Proc. of CONCUR'92*, 1992.

Functional object-oriented approach

[DF96] P. Di Blasio and K. Fisher. A calculus for concurrent objects.

Other research topics

Inheritance and concurrency

[MY93] S. Matsuoka and A. Yonezawa. Analysis of inheritance anomaly in object-oriented concurrent programming languages. In *Research Directions in Concurrent Object-Oriented Programming*, MIT Press, 1993.

[MY93] T. Watanabe and A. Yonezawa. Reflection in an object-oriented concurrent language. In *Sigplan Notices*, Sep 1988, pp. 305-315.

Static Analysis

[Nie93] O. Nierstrasz. Regular types for active objects. in *Proc. of OOPSLA'93*, 1993.

[MY93] N. Kobayashi, M. Nakade and A. Yonezawa. Static Analysis of communication for asynchronous concurrent programming languages. In Yonezawa's www page http://web.yl.is.s.u-tokyo.ac.jp/.