Non-determinism by design

A property of a computation which may have more than one result.

Non-determinism by interaction

A property of the operation environment which may lead to different sequences of concurrent stimuli.

References for this chapter

Non-determinism

[AdaRM2012]
ISO/IEC 8652:201x (E)

Selective waiting in Occam2

The programmer needs to understand the current language support: Ada, X10, Chapel, Fortress, Haskell, OCaml, …

NumberInBuffer < Size

Select function in POSIX

select

| @time < timeout =>
| @time = timeout =>
| @time > timeout =>

select-guarded-accept

if
| when
| do
| until
| guard

select-guarded-accept-else

select-guarded-accept-terminate

selective synchronization in Ada

Basic forms of selective synchronization

module SelectiveSynchronization

select

| while true loop
| guarded
| do
| delay
| accept
| terminate

selective synchronization in Ada

Module SelectiveSynchronization

select

| while true loop
| guarded
| do
| delay
| accept
| terminate

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Correctness of non-deterministic programs

- Partial correctness:
  \[ \text{P(I) \implies \text{terminates(P)}} \]

- Total correctness:
  \[ \text{P(I) \implies \text{terminates(P)}} \]

Safety properties

- \[ \text{P(O) \implies P(I)} \]
- \[ \text{Q(O) \implies P(I)} \]

Liveness properties

- \[ \text{Q(O) \implies Q(I)} \]

Sources of non-determinism

- Operating systems and network environments
- Communications software and hardware
- Schedulers
- Timers
- Events
- Processors

Correctness of non-deterministic programs

- Partial correctness:
  - Checking for termination

- Total correctness:
  - Checking for termination

Safety properties

- Sequentiality

Liveness properties

- Sequentiality

Presentation

- Non-deterministic programs
- Selective synchronization
- Conditional entry calls
- Timed entry calls
- Selective accepts

Summary

- Non-determinism by design:
  - Sequential programs
  - Synchronization

- Non-determinism by interactions:
  - Selective synchronization
  - Conditional entry calls
  - Timed entry calls

- Correctness of non-deterministic programs:
  - Sequential programs
  - Synchronization

Frame

- Message-based selective synchronization in Ada
- Operating systems and network environments
- Communications software and hardware
- Schedulers
- Timers
- Events
- Processors