Concurrent Object Oriented Languages

Monitors

January 19, 2011

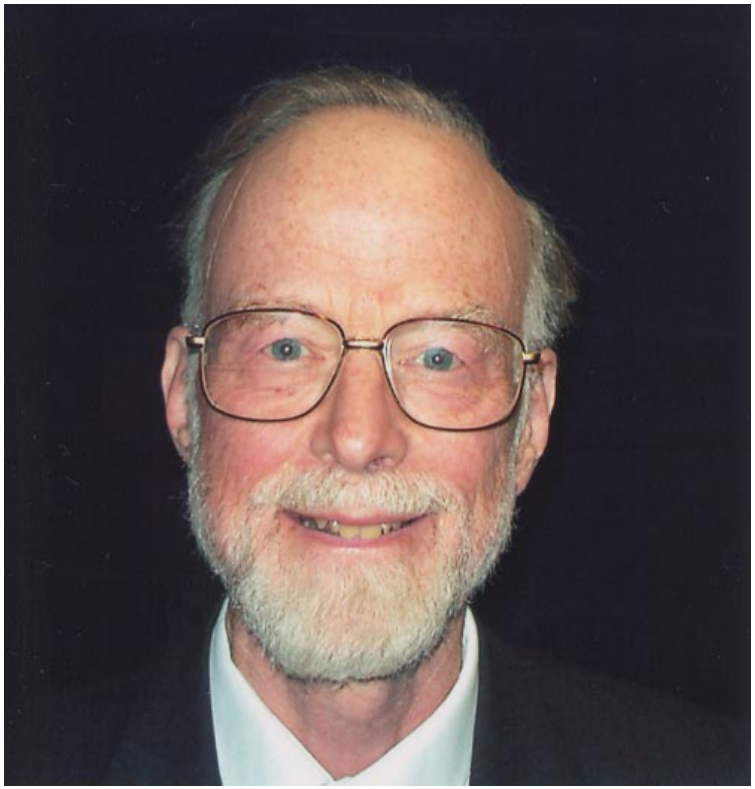
Monitors

Monitors were invented by Tony Hoare and Per Brinch Hansen.

C.A.R. Hoare. Monitors: an operating system structuring concept. *Communications of the ACM*, 17(10):549.557, October 1974.

sir Charles Antony Richard (Tony) Hoare

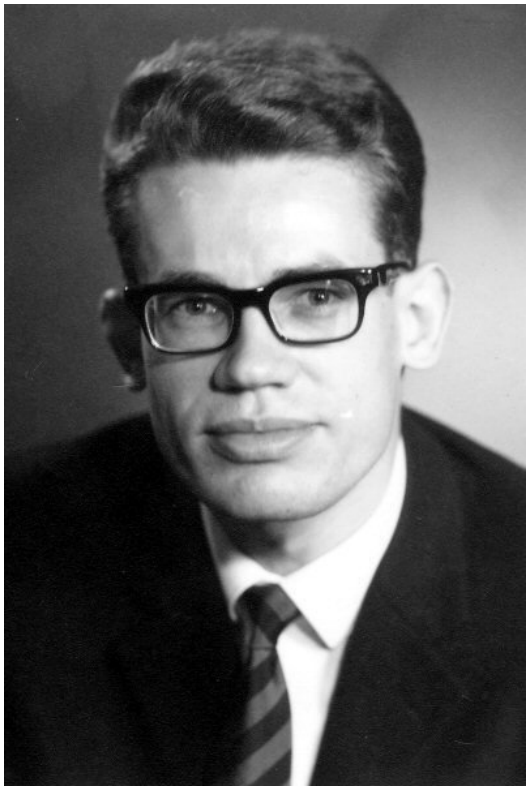
- Fellow of the Royal Society (1982)
- Fellow of the Royal Academy of Engineering (2005)
- Recipient of the Turing Award (1980)



Tony Hoare

Per Brinch Hansen

- IEEE Computer Pioneer Award (2002)



Per Brinch Hansen (1938–2007)

Monitors

A *monitor* consists of

- data: variables and initialization
- procedures

The variables can only be accessed within the monitor and, at any moment, at most one thread can be executing a procedure of a monitor. Hence, there cannot be any data races on the variables of a monitor.

A Simple Example

```
Counter : monitor
begin
  value : int;
  procedure increment(result number : int)
  begin
    value := value + 1;
    number := value;
  end
  procedure decrement(result number : int)
  begin
    value := value - 1;
    number := value;
  end
  value := 0;
end
```

Synchronization

A *condition variable* can be thought of as an event that has no value.

On a condition variable we preform the following operations.

- The wait operation
  - is issued inside a procedure of the monitor, and
  - causes the calling thread to be delayed.
- The signal operation
  - is issued inside a procedure of the monitor, and
  - causes exactly one of the waiting threads to be resumed (if there are no waiting program, the operation has no effect).

A Simple Example

```
Resource : monitor
begin

 procedure acquire()
 begin

 end
 procedure release()
 begin

 end

end
```

A Semaphore

```
Semaphore : monitor
begin

 procedure P()
 begin

 end
 procedure V()
 begin

 end

end
```

The Consumer-Producer Problem

```
BoundedBuffer : monitor
begin
    N : int;
    buffer : int[];
    next : int;
    size : int;
    procedure put(value : int)
    begin

    end
    procedure get(result value : int)
    begin

    end
    N := 10;
    next := 0;
    size := 0;
```

The Consumer-Producer Problem

```
procedure put(value : int)
begin
   buffer[next] := value;
   size := size + 1;
   next := (next + 1) mod N
end
```

The Consumer-Producer Problem

```
procedure get(result value : int)
begin
   value := buffer[(next − size) mod N];
   size := size − 1;
end
```

The Readers-Writers Problem

```
ReadersAndWriters : monitor
begin

  procedure startRead()
  begin

  end
  procedure stopRead()
  begin

  end
  procedure startWrite()
  begin

  end
  procedure stopWrite()
  begin
```

The Dining Philosophers Problem

```
Table : monitor
begin

 procedure getForks(int i)
 begin

 end
 procedure putForks(int i)
 begin

 end

end
```