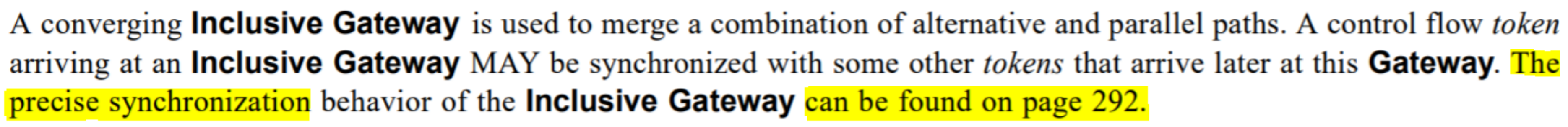
Immigration Course
on
Formal Methods

Academic year 2022/2023

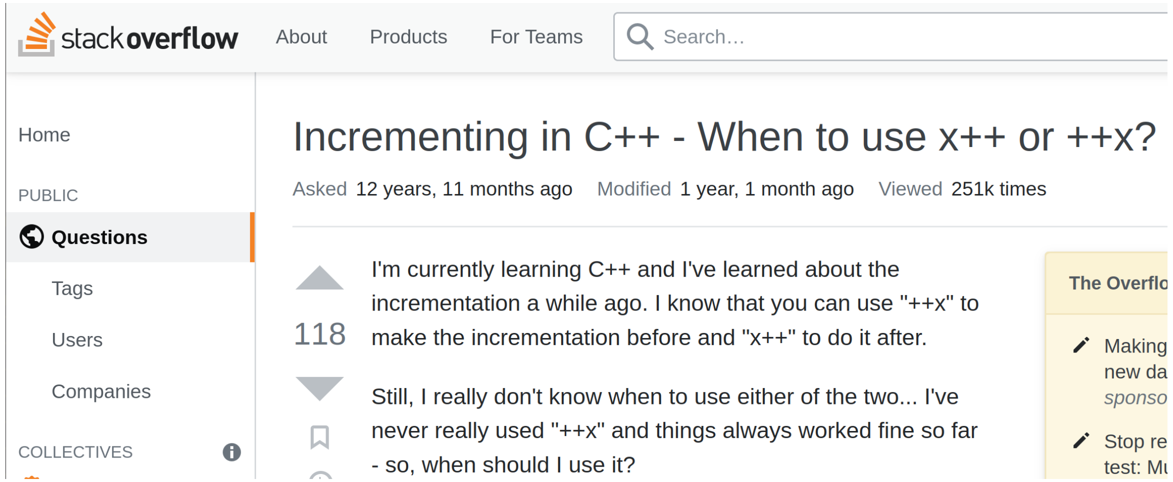
A couple of resasons to be rigorous



A converging **Inclusive Gateway** is used to merge a combination of alternative and parallel paths. A control flow *token* arriving at an **Inclusive Gateway** MAY be synchronized with some other *tokens* that arrive later at this **Gateway**. The precise synchronization behavior of the **Inclusive Gateway** can be found on page 292.

292 Business Process Model and Notation, v2.0

[https://www.omg.org/spec/BPMN/2.0/]



Incrementing in C++ - When to use x++ or ++x?

Asked 12 years, 11 months ago Modified 1 year, 1 month ago Viewed 251k times

118

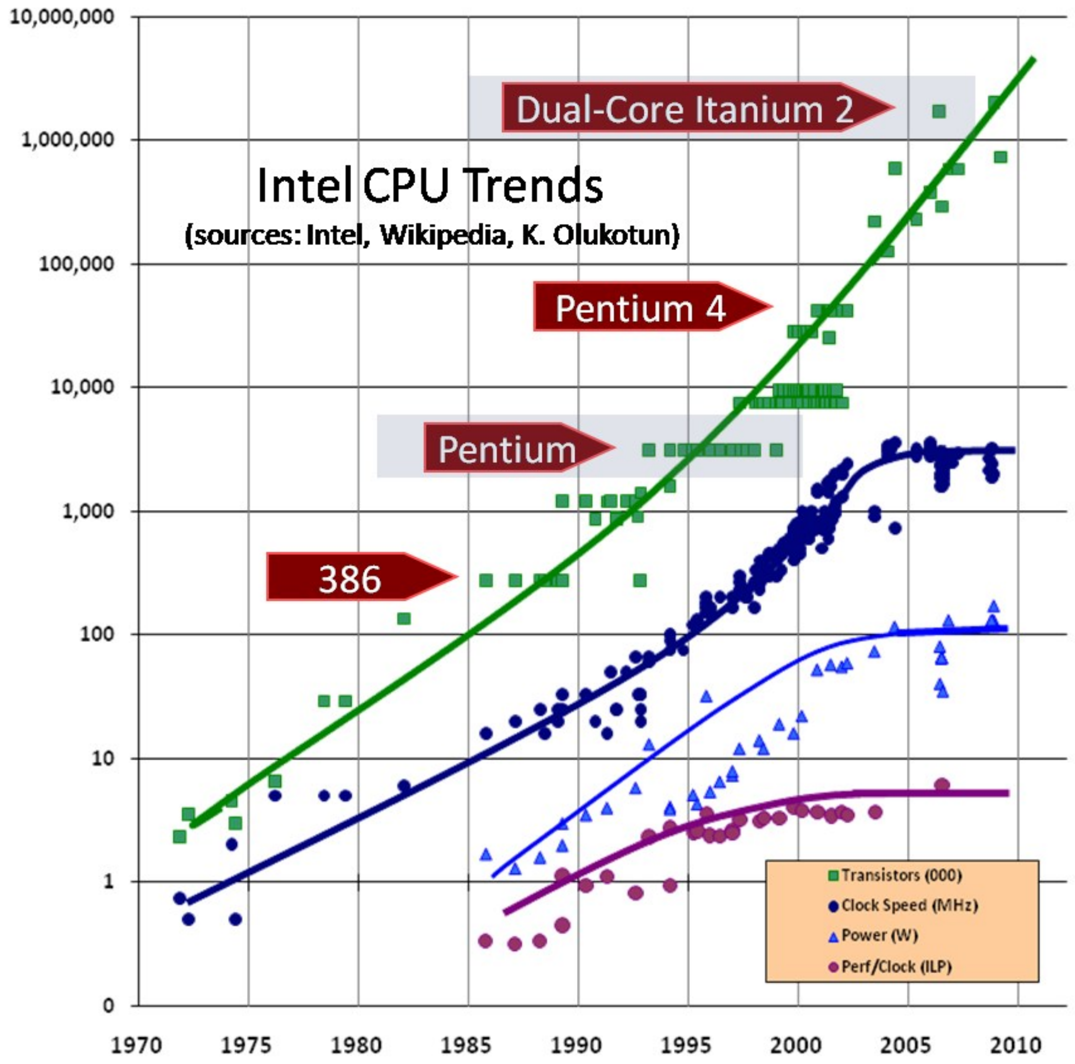
I'm currently learning C++ and I've learned about the incrementation a while ago. I know that you can use "++x" to make the incrementation before and "x++" to do it after.

Still, I really don't know when to use either of the two... I've never really used "++x" and things always worked fine so far - so, when should I use it?

[https://stackoverflow.com/questions/1812990/incrementing-in-c-when-to-use-x-or-x]

A reson to go concurrent

[http://www.extremetech.com/wp-content/uploads/2012/02/CPU-Scaling.jpg]



Job interviews and prime numbers

"On the first day of your new job, your boss asks you to find all primes between 1 and 10^10 (never mind why), using a parallel machine that supports ten concurrent threads. This machine is rented by the minute, so the longer your program takes, the more it costs. You want to make a good impression. What do you do?"

[Herlihy, Shavit: The Art of Multiprocessor Programming. Elsevier, 2012.]

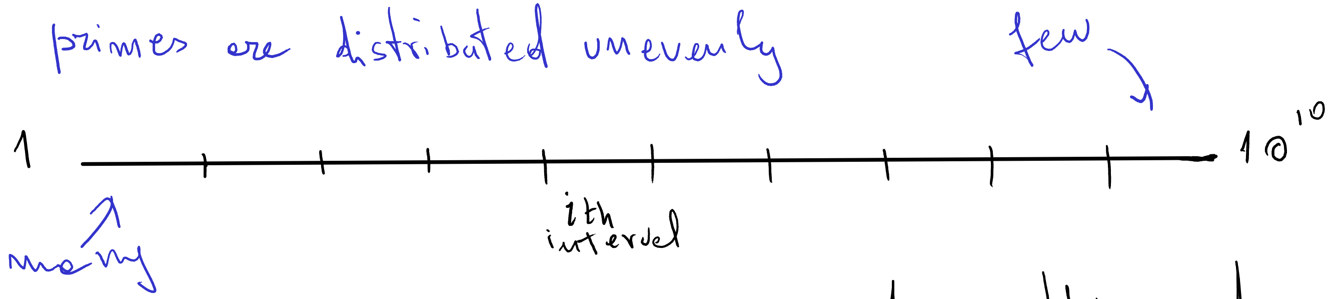
Example : Shared memory

Print all prime integer between 1 & 10^{10}

```
void primeSeq {
  for (j = 1, j<10^10; j++) {
    if (isPrime(j))
      print(j);
  }
}
```

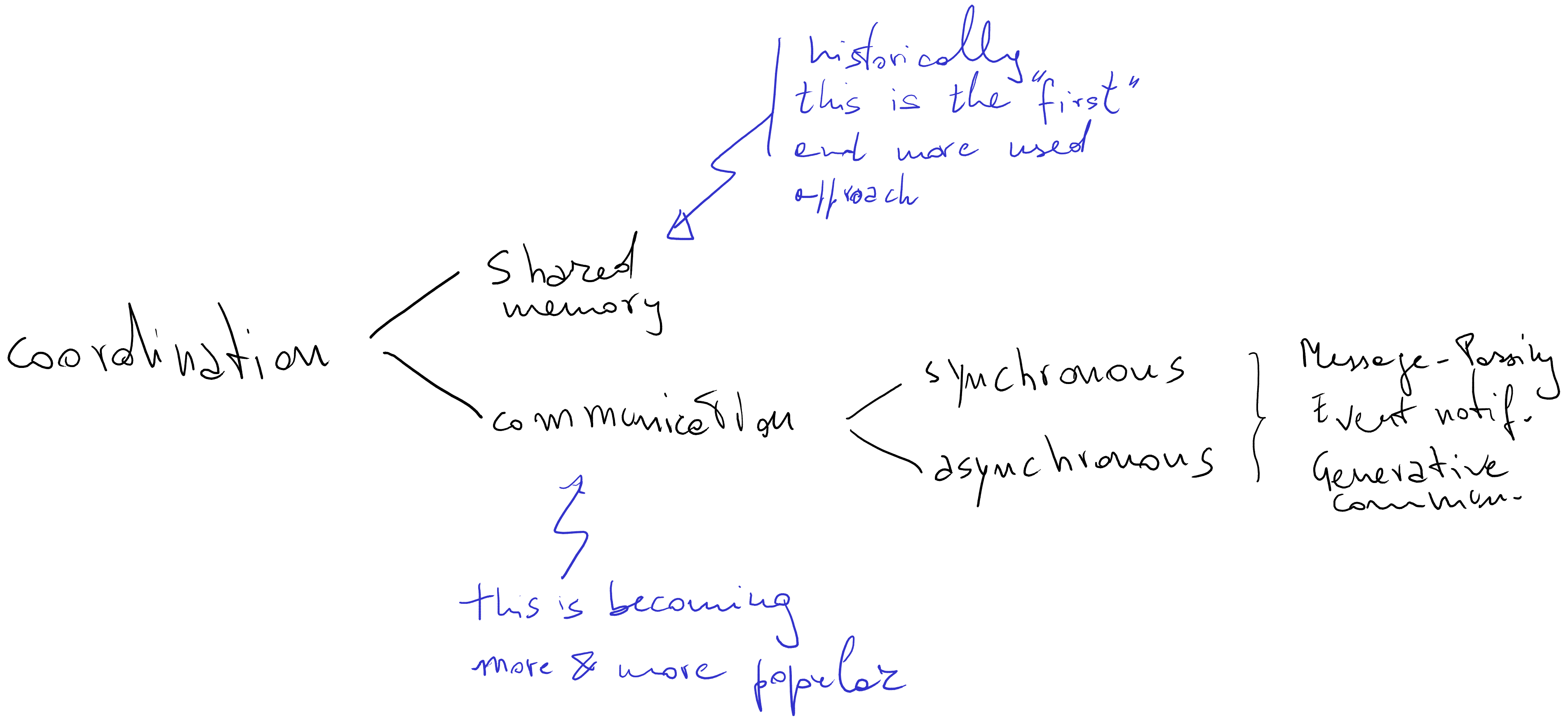
now let's try concurrently

Split the interval and launch a thread on each portion



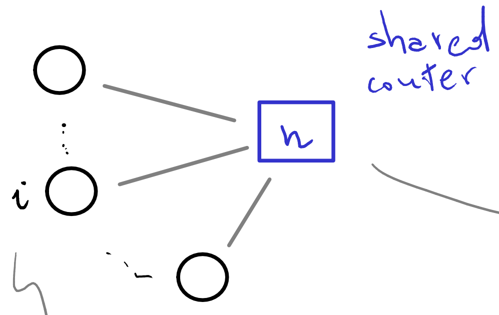
```
void primePrint(int i){ // i non-negative
  for (j = i*10^9+1, j<(i+1)*10^9; j++) {
    if (isPrime(j))
      print(j);
  }
}
```

- How good is this idea?
  - Uneven load
  - Is there an "optimal" split?


coordination
Shared memory
historically this is the "first" and more used approach
communication
this is becoming more & more popular
synchronous
asynchronous
Message-Passing
Event notif.
Generative commun.

Exercise 0

Find a better multi-threaded program for the primality test



```
void primePrint( Counter counter ) {
  long j = 0;
  while (j < 10^10) {
    j = counter.getAndIncrement();
    if (isPrime(j))
      print(j);
  }
}
```

RACES

THIS IS NOT GOOD!

```
public class Counter {
  private long value;
    synchronised
  public long getAndIncrement() {
    return value++;
  }
}
```

Say something bad about JAVA?

temp := value
value ++
return temp

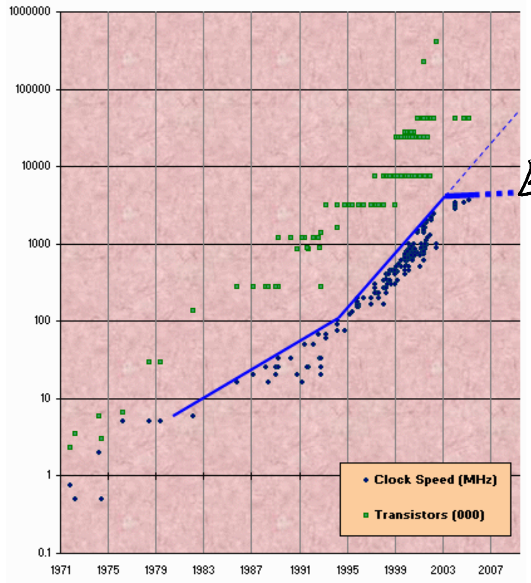
even better
WHY?

```
public long getAndIncrement() {
    synchronized {
      temp  = value;
      value = temp + 1;
    }
    return temp;
  }
}
```

REFLECT about why this solution is better than splitting

The art of multi-processor programming

$$\text{Hw} \xrightarrow{\text{Efficiency is no longer an hw thing}} \text{Sw}$$

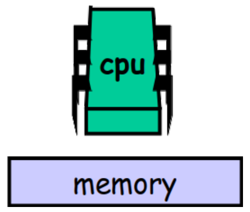


clock Speed

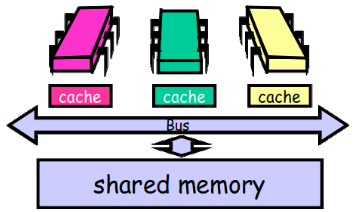
# transistors grows by a factor of 10 every 10 years

CPU speed is plateoing

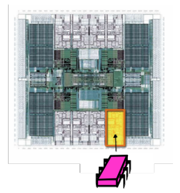
- programming constructs in ALL languages
  - "new" languages
    - Go
    - Scala
    - Elixir / Erlang
    - Ballerina
    - Concurnas
- supporting library, AKKA
- Modelling languages
  - BPEL
  - BPMN



uniprocessor



shared memory processor



multicore

Some terminology

Concurrency vs Parallelism

compose "independent" stuff

~

deal with a lot of stuff AT ONCE

GOAL: "good" composition

run stuff symultaneously

~

do a lot of stuff AT ONCE

GOAL: "good" execution

DESIGN!

PERFORMANCE

break down problems

&

Compose the pieces

Immmigration course on formal methods

Emilio Tuosto @ GSSI

Academic year 2020/2021

So far...

- An idea of FMs

Leonardo da Vinci

> “ Ma prima farò alcuna esperienza avanti ch’io più oltre proceda, perché mia intenzione è allegare prima l’esperienzia e poi colla ragione dimostrare. ”

eM’s (bad) translation

> “ Before proceeding further, I will first get some experiment, because my intention is to first understand the experiment and then to explain it with the intellect. ”

- Concurrency vs Parallelism
- Shared-memory

Message-passing

Pink Floyd

“Is there anybody out there?”

A glimpse of Erlang

```
ping(N, Pong_PID) ->
  Pong_PID ! {ping, self()},
  receive
    pong ->
      io:format("Ping received pong~n", [])
  end,
  ping(N - 1, Pong_PID).

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start() ->
  Pong_PID = spawn(example, pong, []),
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```

Semantics

- Message passing
- FIFO buffers [[mailboxes in Erlang's jargon]]
- Spawn of threads

Asynchrony by design

Erlang is an embodiment of the well-known actor model of Hewitt and Agha...dates back to '73!

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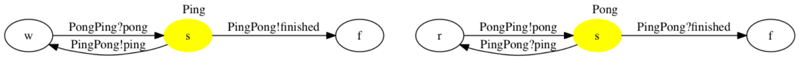
Friendlier representations

Local behaviour: communicating machines



CFSMs (Brand & Zafiropulo 1983!): FIFO buffers as well

Choregraphy: global graph

...“synchronous” distributed workflow (Deniélou and Yoshida 2012)

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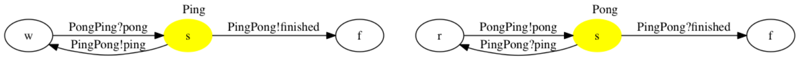

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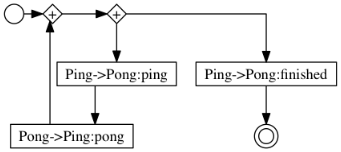

..."synchronous" distributed workflow (Deniélou and Yoshida 2012)

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Is this program correct?

A:

No!

Exercise:

find the bug

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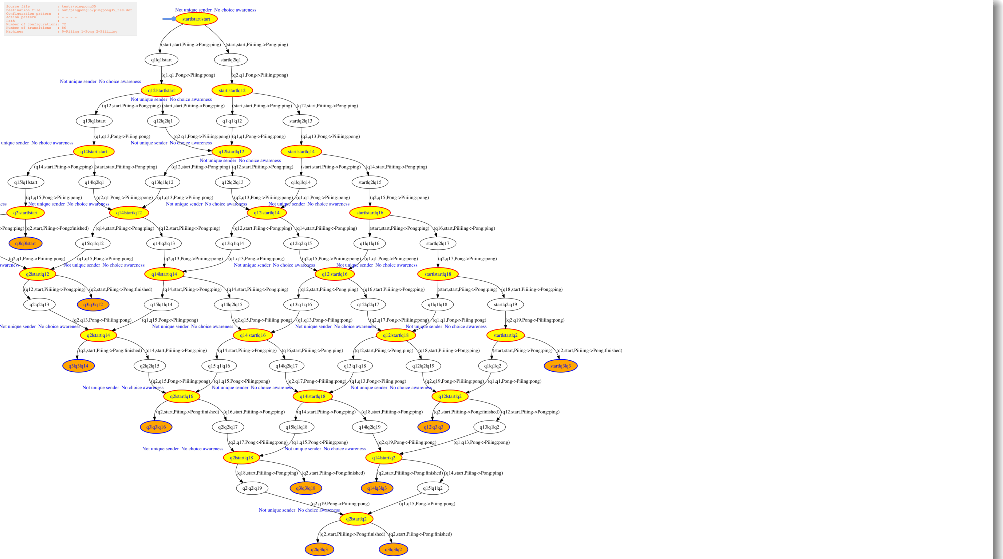
Send ping-pong to shell !!! ... I mean, use ChoSyn



```
Source file              : tests/pingpong35
Destination file         : out/pingpong35/pingpong35_ts0.dot
Configuration pattern    :
Action pattern           : - - - -
Path                     :
Number of configurations: 72
Number of transitions    : 86
Machines                 : 0=Piiing 1=Pong 2=Piiiiing
```