Integrating Task Parallelism with Actors

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CCC Seminar Presentation

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Combine Task-Parallelism with the Actor's Paradigm

Parallel Programming Models

- Library based
  - Posix Threads
  - MPI
- Compiler indications
  - OpenMP
- Language based
  - Pig Latin
  - X10
  - Habanero Scala (HS) (Unified Model)
  - Habanero Java (HJ) (Unified Model)

TP with the Async-Finish-Model (AFM) in HJ

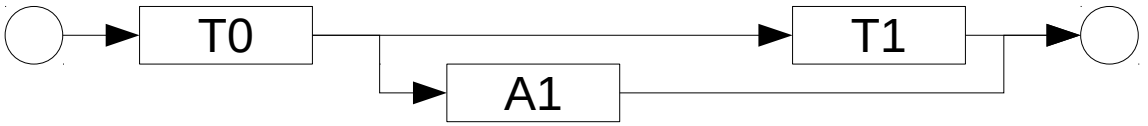
```
public class Foo{
	public static void main( String[] args)
	{

		System.out.println("T0");

		async big_computation()   // is called asynchronous as a task;

		System.out.println("T1");
	}

	static void big_computation(){
		System.out.println("A1");
	}
}
```



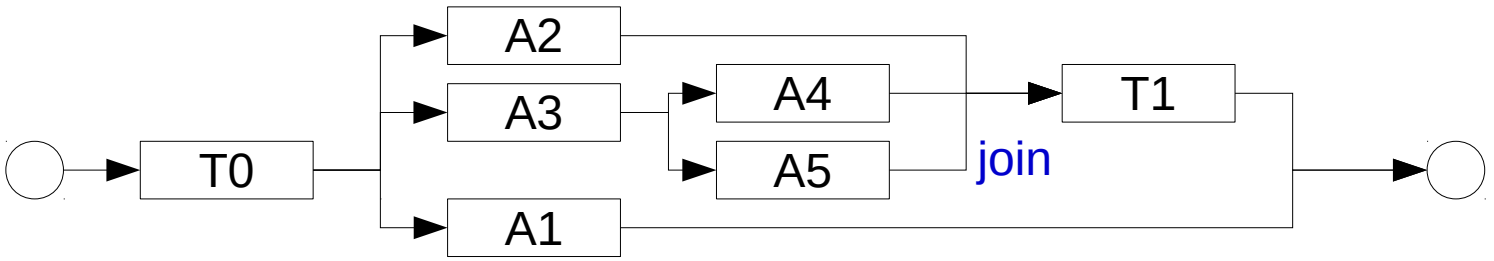
TP with the Async-Finish-Model (AFM) in HJ

```
public class Foo{
	public static void main( String[] args)
	{

		System.out.println("T0");
		async big_computation()   // is called asynchronous as a task;

		finish{
			async{
				System.out.println("A2");
			}
			async{
				System.out.println("A3");
				async System.out.println("A4");
				async System.out.println("A5");
			}
		}
		System.out.println("T1");
	}

	static void  big_computation(){
		System.out.println("A1");
	}
}
```



TP with the Async-Finish-Model (AFM) in HJ

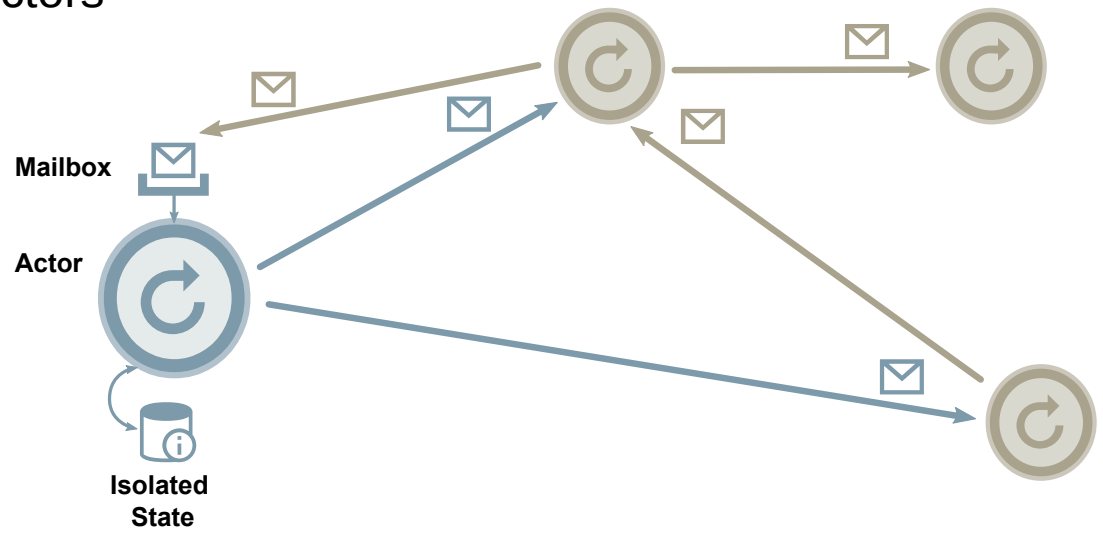
```
public class Foo{
	public static void main( String[] args)
	{
		var i = 0
		System.out.println("T0");
		async one_big_computation()   // is called asynchronous as a task;

		finish{
			async{
				System.out.println("A2");
			}
			async{
				System.out.println("A3");
				async System.out.println("A4");
				async System.out.println("A5");
			}
			finish{
				async i++;
				async i--;
			}
			System.out.println("A6 i="+i);
		}
		System.out.println("T1");
	}

	static void  one_big_computation(){
		System.out.println("A1");
	}
}
```

Actor Model

- A universal modular ACTOR formalism for artificial intelligence '73
  - Authors: Carl Hewitt, Peter Bishop, Richard Steiger
- Actors is a processes which communicate only via messages
  - Send / receive
  - Processes only one message at the time
  - Change of local state
  - Create new Actors



Source: http://berb.github.io/diploma-thesis/original/054_actors.html

Actor in HS

```
object Boo extends HabaneroApp {

        val printActor = new PrintActor()
        printActor.start()
        printActor ! "Hallo World"
        printActor ! True
}

class PrintActor extends HabaneroReactor{
        // Local State
        def behavior () = {
                case msg: Boolean => exit()
                case msg: String => println(msg)
        }
}
```

- How to detect when an Actor has finished ?

Actors in Scala

```
object ScalaActorApp extends App {
        val latch = new CountDownLatch ( 1 )
        val actor =  new PrintActor(latch)
        actor ! "Hello World"
        actor ! True
        latch.await ()
        println(”Actor terminated”)
}

class PrintActor(latch: CountDownLatch) extends Actor{
        def act() = {
                case msg: Boolean => {
                        // Lots of computation
                        latch.countDown()
                        exit()
                }
                case msg: String => println(msg)
        }
}
```

- What about Actors calling Actors ?
  - Is getting difficult when joining child actors

Actors in HS

- AFM + Actors = Unified Model
- (Child) Actors inherit the immediate enclosing Finish
- Enclosing Finish of actor is the Finish where actor.start() was performed

```
object ScalaActorApp extends App {
    val actor =  new PrintActor
    finish{
        actor.start()
        actor ! "Hello World"
        actor ! True
    }
    println(”Actor terminated”)
}

class PrintActor extends HabaneroReactor{

    def behavior() = {
        case msg: Boolean => exit()
        case msg: String => println(msg)
    }
}
```

AFM in Actors in HS

```
object Goo extends HabaneroApp {

    val printActor = new PrintActor()
    printActor.start()
    printActor ! "Hallo World"
}

class PrintActor extends HabaneroReactor{

    def behavior () = {
        case msg: String =>{
            finish{
                async stmt_1
                async stmt_1
                // parallel computation
                // with many asyncs
            }
            //  but ...
            async{
                // violation of the one message invariant
            }
        }
    }
}
```

One Message at a time Invariant

```
object Goo extends HabaneroApp {

        val printActor = new PrintActor()
        printActor.start()
        printActor ! "Hallo World"
}

class PrintActor extends HabaneroReactor{

        def behavior () = {
                case msg: String =>{
                        finish{
                                async stmt_1
                                async stmt_1
                                // parallel computation
                                // with many asyncs
                        }
                        pause() // no message will be processed
                        //new messages are still being received and kept in mailbox
                        async{
                                // do critical computation
                                resume() // we are save now! allow actor to process messages
                                // continue uncritical computation
                        }
                }
        }
}
```

Futures in HJ

Java version

```
1  Callable<ImageData> c1 = new Callable<ImageData>() {
2    public ImageData call() {return imageInfo.downloadImage(1);}};
3  FutureTask<Object> ft1 = new FutureTask<Object>(c1);
4  new Thread(ft1).start();
5  Callable<ImageData> c2 = new Callable<ImageData>() {
6    public ImageData call() {return imageInfo.downloadImage(2);}};
7  FutureTask<Object> ft2 = new FutureTask<Object>(c2);
8  new Thread(ft2).start();
9  . . .
10 renderImage(ft1.get());
11 renderImage(ft2.get());
```

HJ version

```
1  future<ImageData> ft1 = async<ImageData>{return imageInfo.downloadImage(1);};
2  future<ImageData> ft2 = async<ImageData>{return imageInfo.downloadImage(2);};
3  . . .
4  renderImage(ft1.get());
5  renderImage(ft2.get());
```

Source: https://wiki.rice.edu/confluence/display/PARPROG/COMP322
Lecture 27: Introduction to Java Threads
Autor: Vivek Sarkar

Data Driven Futures in HS

```
object Foo extends HabaneroApp {

    val (ddf_1 , ddf_2) = (ddf(), ddf())

    async{
        //long computation
        dff_1.put(4)
    }
    async{
        //small computation
        dff_2.put(6)
    }

    asyncAwait(ddf_1 , ddf_2){
        System.out.println(ddf_1.get() + ddf_2.get());
    }
}
```

asyncAwait can have a list of DDFs. It will wait until all values of all DDFs are available