Computation Abstraction

Going beyond programming language glue, or what we've missed from FP for so long in mainstream

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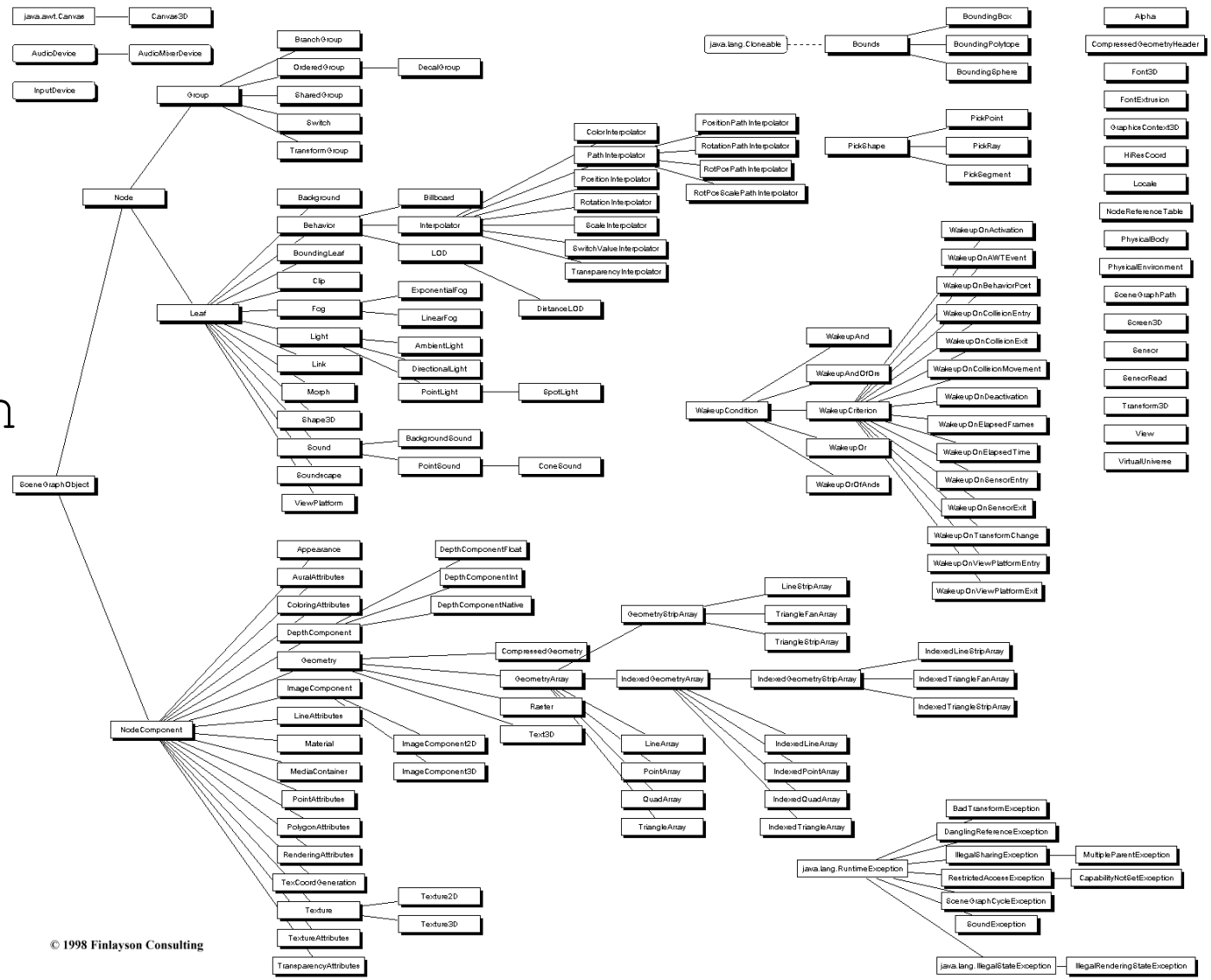
What has been abstraction for us in mainstream?

Hierarchical and Structural ~~O~~Abstr~~u~~action



What do we know about Computation Abstraction in mainstream?

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What do we know about Computation Abstraction in mainstream?

Did anyone mention Behavioral GOF Design Patterns?

What is Computation Abstraction?

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It is all about Glue!

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```
IDictionary<string,int> zipCodes= new Dictionary<string,int>{
            {"Paris",75}
        };
IDictionary<int, int> population = new Dictionary<int, int>{
            {75,100}
        };

int GetInterstingNumber(string cityName){
        var myCityCode= zipCodes[cityName];
       return ( population[myCityCode] *100 ) / TOTAL_POPULATION ;
}

void PrintIt(string[] args){
      Console.WriteLine("Paris has "+getInterstingNumber("Paris")+
                                "% of Population");
}
```

```
IDictionary<string,int> zipCodes= new Dictionary<string,int>{
            {"Paris",75}
        };
IDictionary<int, int> population = new Dictionary<int, int>{
            {75,100}
        };

int GetInterstingNumber(string cityName){
        var myCityCode= zipCodes[cityName];
       return ( population[myCityCode] * 100) / TOTAL_POPULATION ;
}

void PrintIt(string[] args){
      Console.WriteLine("Nancy has "+getInterstingNumber("Nancy")+
                                "% of Population");
}
```

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Welcome in the REAL WORLD

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```
IDictionary<string,int> zipCodes= new Dictionary<string,int>{
        {"Paris",75}
    };
IDictionary<int, int> population = new Dictionary<int, int>{
        {75,100}
    };

int GetInterstingNumber(string cityName){
    var myCityCode= zipCodes[cityName];
    return ( population[myCityCode] * 100 ) / TOTAL_POPULATION ;
}

void PrintIt(string[] args){
    Console.WriteLine("Nancy has "+getInterstingNumber("Nancy")+
                      "% of Populatin");
}
```

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```
static int? GetInterstingNumber(string cityName){

    int? myCityCode=null;
    try
      {
        myCityCode = zipCodes[cityName];
      }
    catch(KeyNotFoundException e)
      {
        myCityCode = null;
      }
    try
      {
        return (population[myCityCode.Value] * 100 / TOTAL_POPULATION);
      }
    catch (KeyNotFoundException e){ return null;}

    catch(/* .Value can produce an*/ InvalidOperationException e)
          {
              return null;
          }
}
```

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```
static int? GetInterstingNumber(string cityName){

    int? myCityCode=null;
    try
      {
        myCityCode = zipCodes[cityName];
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    catch(KeyNotFoundException e)
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      {
        return (population[myCityCode.Value] * 100 / TOTAL_POPULATION);
      }
    catch (KeyNotFoundException e){ return null;}

    catch(/* .Value can produce an*/ InvalidOperationException e)
          {
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}
```

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How does this default glue look like?

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How does this only possible glue look like?

- Errors are represented through an Exception System that by default cascades them up the call stack
- Exceptions short circuit (interrupt execution until they are "catched")
- Nulls by default produce errors that cascade up as exceptions
- These defaults can't be overridden but can be interrupted using some language syntax

What's wrong with our only possible glue?

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Mainly two types of problems:
one **P**RACTICAL and
one **C**onceptual

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Practical Problem:

- **Noise that disperses the main algorithm** declaration making readability a challenge

```
static int? GetInterstingNumber(string cityName){

    const int TOTAL_POPULATION=123;
    int? myCityCode=null;
    try
     {
        myCityCode = zipCodes[cityName];
     }
    catch(KeyNotFoundException e)
     {
        myCityCode = null;
     }
    try
     {
        return (population[myCityCode.Value] * 100 / TOTAL_POPULATION);
     }
    catch (KeyNotFoundException e){ return null;}

    catch(/* .Value can produce an*/ InvalidOperationException e)
          {
             return null;
          }
}
```

The special case handling is duplicated in two different places

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Conceptual Problem:

```
static int? GetInterstingNumber(string cityName){

    const int TOTAL_POPULATION=123;
    int? myCityCode=null;
    try
     {
        myCityCode = zipCodes[cityName];
     }
    catch(KeyNotFoundException e)
     {
        myCityCode = null;
     }
    try
     {
        return (population[myCityCode.Value] * 100 / TOTAL_POPULATION);
     }
    catch (KeyNotFoundException e){ return null;}

    catch(/* .Value can produce an*/ InvalidOperationException e)
          {
             return null;
          }
}
```

I can't abstract it and say for instance: *for any null you encounter in the algorithm stop and return null as a final answer.*

… and since I can't abstract the glue logic **I can't reuse it** in another algorithm definition across my application/**domain**.

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Some languages continue kindly trying
add more ways to approach these issues
but they still share the same problems
with the main glue

"Nancy has" + getInterstingNumber("Nancy")??"NA"+"% of Population"

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So how do we abstract “glue” or “computations”?

or as some call it “overriding the semicolon ;”

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We need computation abstraction tools!

Functional Languages contain naturally our needed tools (functions, functors, monads,…)

The good news is that some currently mainstream (C#) and other potentially mainstream (Scala, F#) programming languages have them in someway too!

Abstracting the glue with nulls (None) in F# would be:

```
let getInterestingNumber
   (cities:Map<string,int>) (population:Map<int,int>)
   (cityName:string) :int Option=
     maybe{ let! zipCode= cities.TryFind cityName
            let! cityPopulation= population.TryFind zipCode
            return cityPopulation * 100 / TOTAL_POPULATION }
```

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The glue implementation with null (None) propagation looks like:

```
module Maybe=
    let succeed x = Some(x)
    let fail = None
    let bind p rest =
        match p with
            | None -> fail
            | Some r -> rest r
    let delay f = f()

    type MaybeBuilder() =
        member b.Return(x) = succeed x
        member b.Bind(p, rest) = bind p rest
        member b.Delay(f) = delay f
        member b.Let(p,rest) = rest p

    let maybe = MaybeBuilder()
```

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What about a glue implementation that collects errors and goes on?

```
let plusOneWithError ints= (Error "First Error",List.map ((+)1) ints)
let plus2WithAnotherError ints=(Error "2nd Error",List.map ((+)2) ints)
let twiceWithNoError ints= (NoError,List.map (( *)2) ints )

let answer= collectingErrors { let! l1= plusOneWithError [1;2;3]
                               let! l2= plusTwoWithAnotherError l1
                               let! l3= twiceWithNoError l2
                               return l3 }
```

```
val final : Error * int list =
  (ErrorList [Error "First Error"; Error "Second Error"], [8; 10; 12])
```

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In Scala you can Abstract Computation too:

```
for{ i <- Some(1)
     val j = i +1 } yield j )
```

Evaluates to Some(2)

```
def map[B](f: A => B): Option[B]=
                o match{case None => None
                                case Some(a) => Some f(a)}


def flatMap[B](f: A => Option[B]): Option[B]=
                          o match{case None => None
                                        case Some(a) => f(a)}
```

What about C#, a current mainstream language?

Heard of LinQ of course!

```
IEnumerable<double> result=from i in Enumerable.Range(0,100)
                           select 1.0/i;
```

there is an error of division by zero there!

```
IEnumerable<double> result=from i in Enumerable.Range(0,100)
   .IgnoringErrors()
                           select 1.0/i;
```

Non problem. Since we abstracted computation, we can use a more tolerant implementation of the glue!

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What about C#, a current mainstream language?

Implementing asynchronous programming glue using Computation Abstraction in the Reactive Programming Framework:

```
// Create mouse drag
 var mouseDrag = from md in this.GetMouseDown()
                 from mm in this.GetMouseMove()
                                    .Until(this.GetMouseUp())
                 select mm;
// Subscribe
 var handler = mouseDrag.Subscribe( e =>

  PublishMouseDrag(e.EventArgs.Location));
```

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In Scala Error propagating glue without exceptions:

```
def throwError(i:Int):ThrowsError[Int]=
                        Error("I don't like " +i+ "!");

for{i <- throwError(2)
    val j = i + 1}  yield j )
```

Evaluates to Error(I don't like 2!)

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```
case class ThrowsError[A] (e:Either[Error,A]){

        def map[B](f: A => B): ThrowsError[B]= ThrowsError(e.right.map(f))
        def flatMap[B](f: A => ThrowsError[B]): ThrowsError[B]=
                                        ThrowsError(e.right.flatMap(a=>f(a).e))
  }
```

Asynchronous Worflows in F#

```
let asynctask =
     async { let req = WebRequest.Create(url)
             let! response = req.GetResponseAsync()
             let stream =
response.GetResponseStream()              let
streamreader =
               new System.IO.StreamReader(stream)
                  return streamreader.ReadToEnd() }
```

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What did I show so far?

Defined glue for:

- Nulls
- Errors that propagate (better exceptions)
- Custom glue that doesn’t short circuit (collectErrors)
- Events and asynchronous programming
- A lot is already available (Lists, Streams, Channels, State, Enviorement…)
- Easily add your own (implementing map, bind(flatMap))
- Combine them!

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Reuse and combine

Monad Transformers

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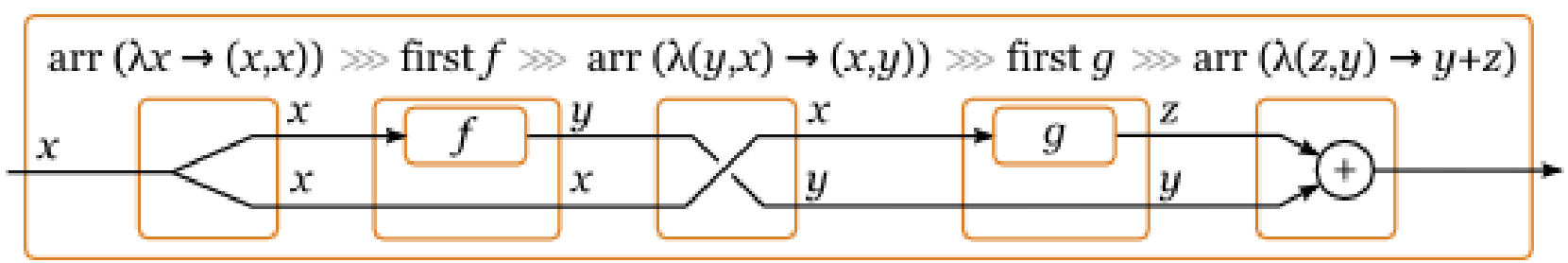
Showed Computation Abstraction

Functors, Applicative Functors, Monads, Comands

Still there are others!

Like Arrows for more control over your computation:



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Release Your Algorithms from plumping code

Let them Express themselves!

Q?

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