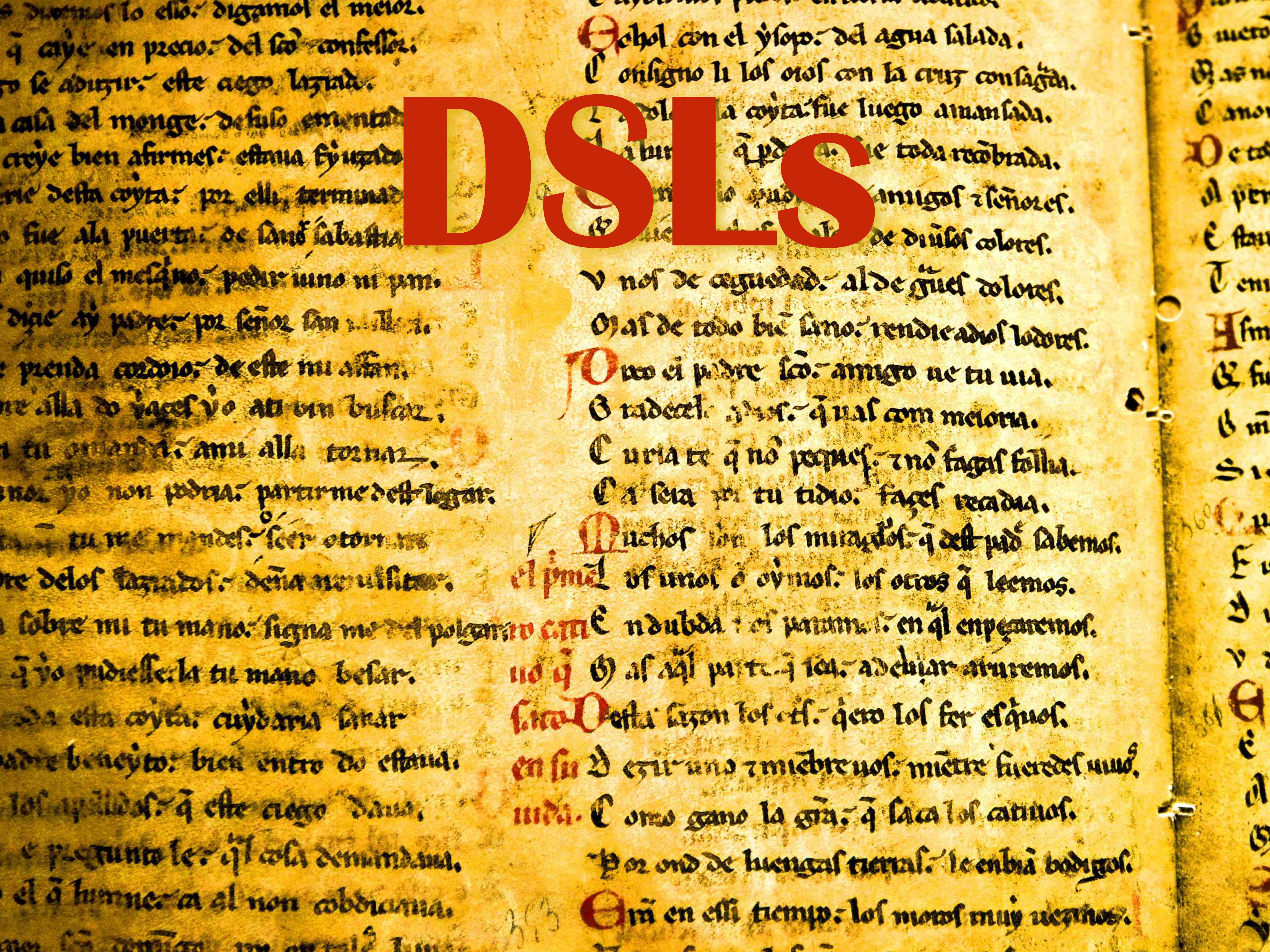
DSLs



DSL

=

Domain Specific

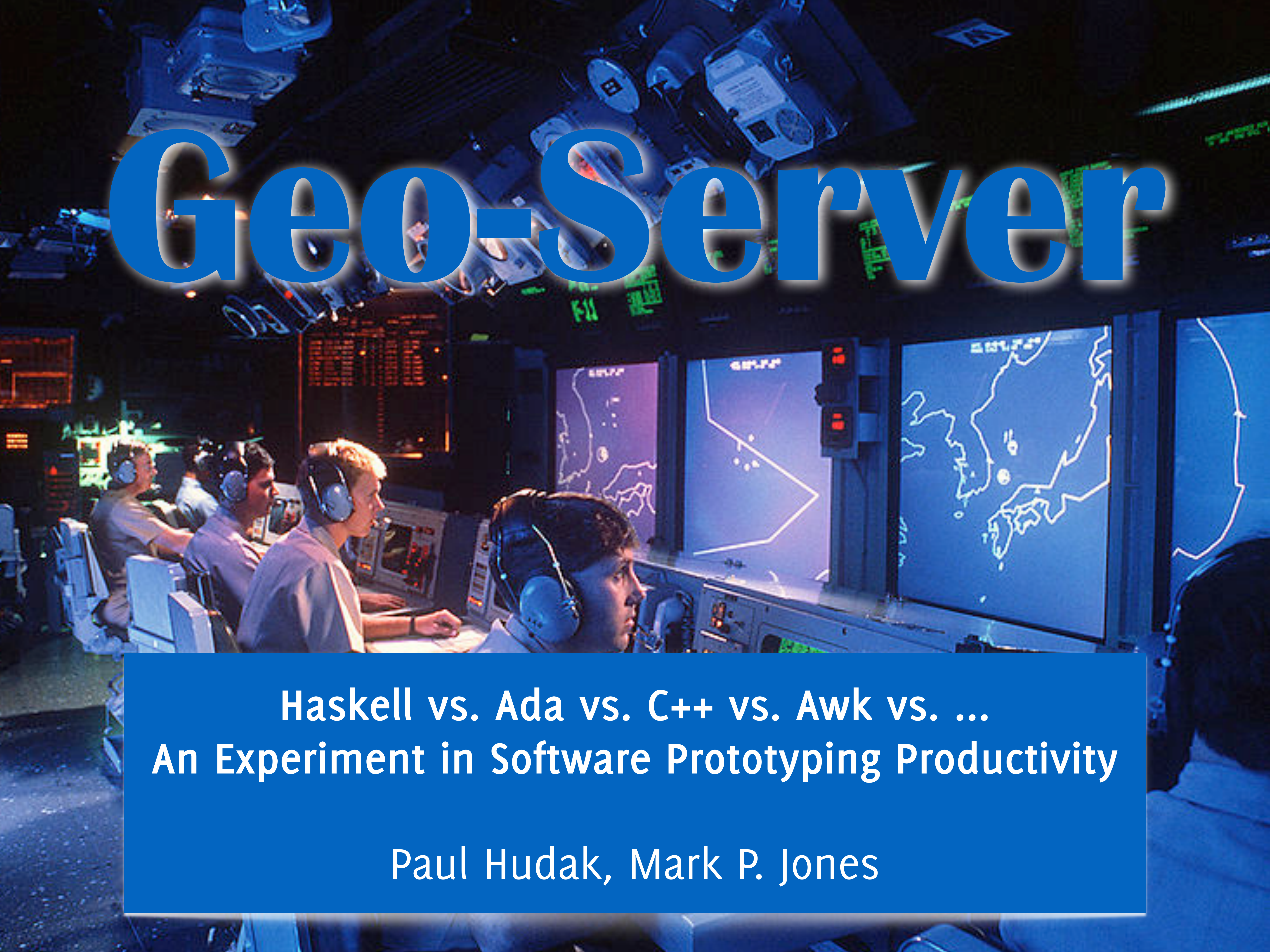
Language

DSL Approach

1. develop a language
2. solve problems with that language
3. $$$

Types of DSLs

- Stand-alone DSL
  HTML, Verilog, SQL, YACC, GraphViz, ...
- Embedded DSL (EDSL)
  embedded in a host language like
  Haskell as library
  (but also in Scala, Groovy, …)



Geo-Server

Haskell vs. Ada vs. C++ vs. Awk vs. ...
An Experiment in Software Prototyping Productivity

Paul Hudak, Mark P. Jones

The Setup

- US Navy Experiment
- Study suitability of languages for rapid prototyping
- Languages: Haskell, Ada, Ada9X, C++, Awk, Rapide, Griffin, Proteus, Relational Lisp
- 1 expert programmer, small project

Problem

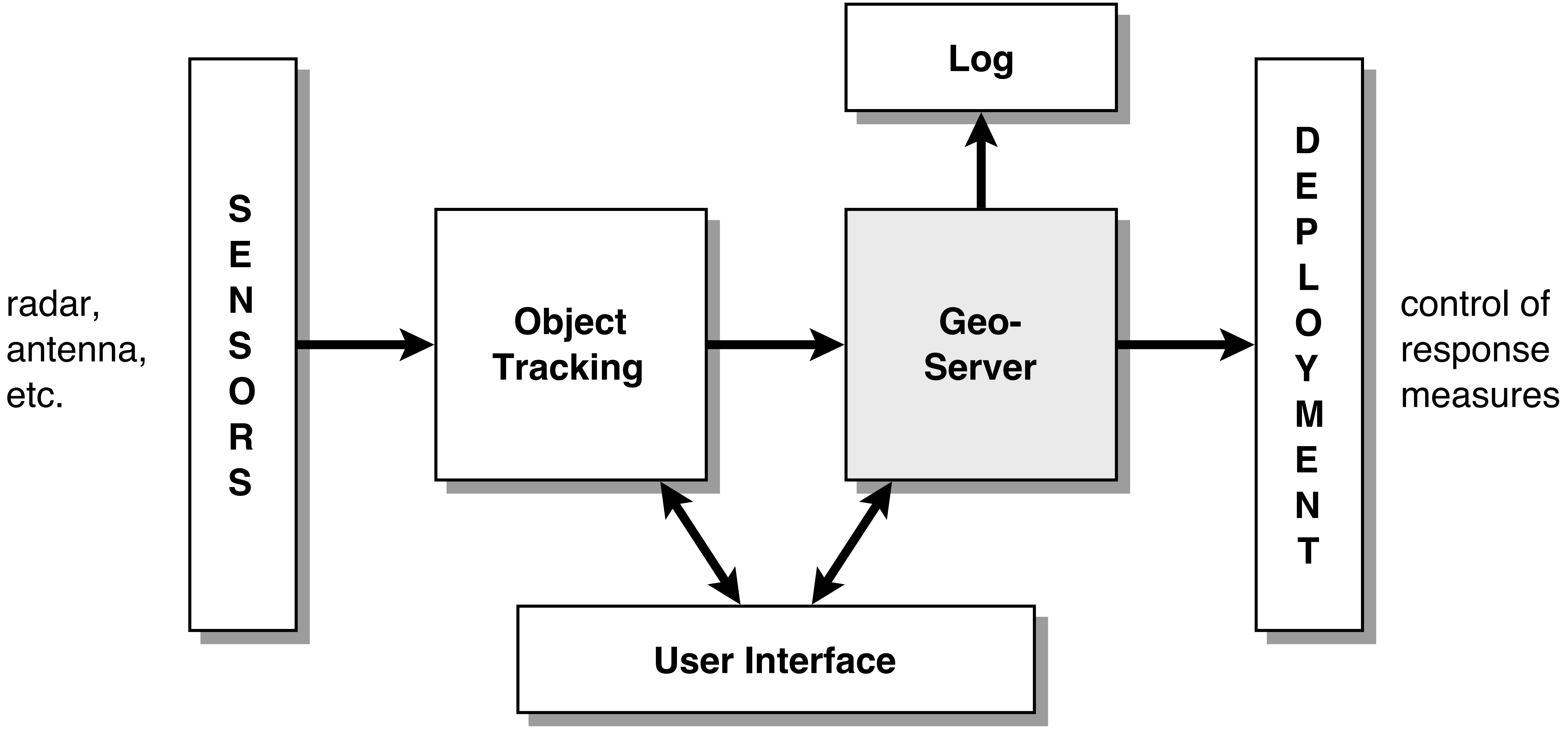


Figure 1: Simplified Aegis Weapons Systems Diagram

Geo-Server Input

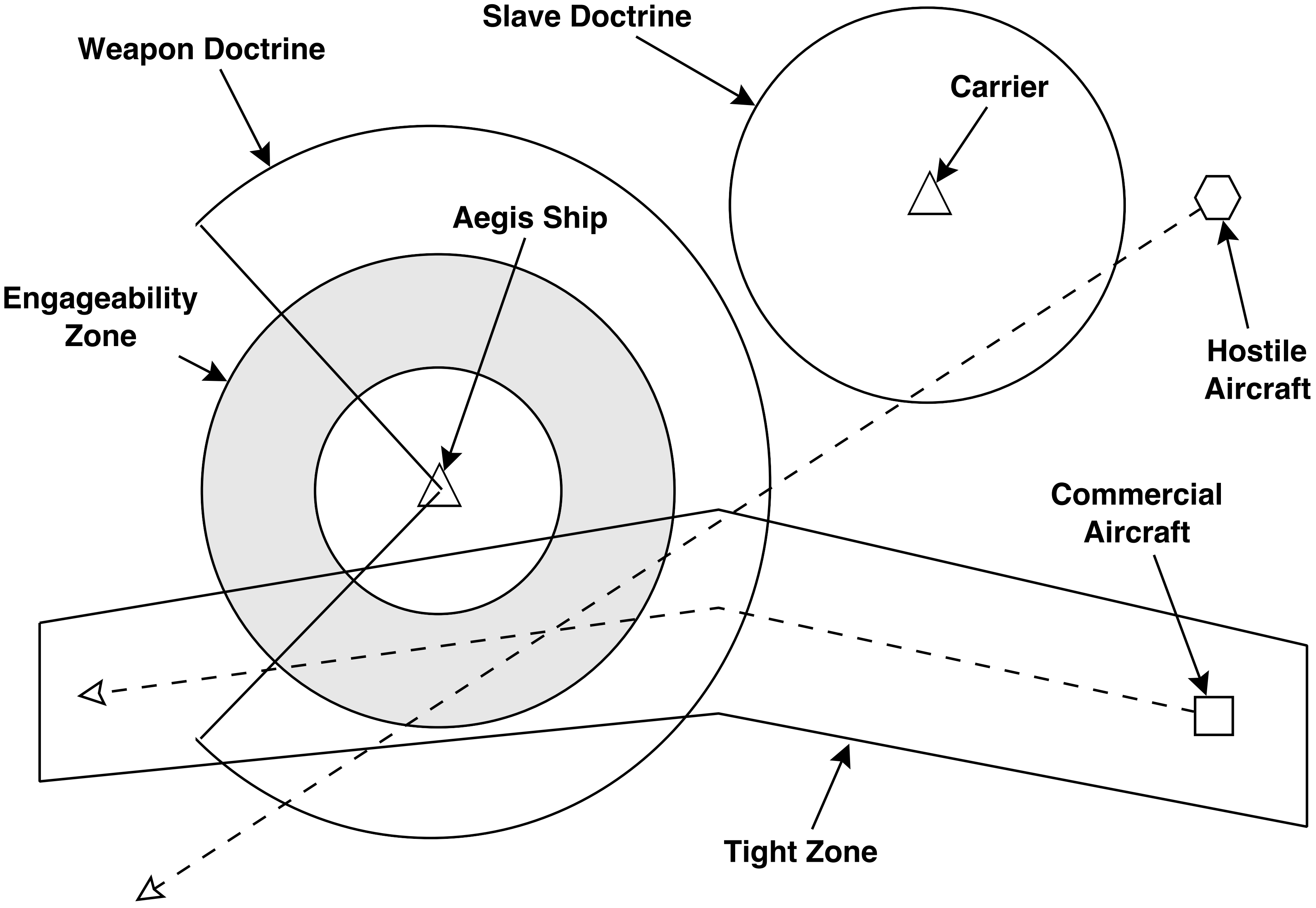


Figure 2: Geo-Server Input Data

Geo-Server Output

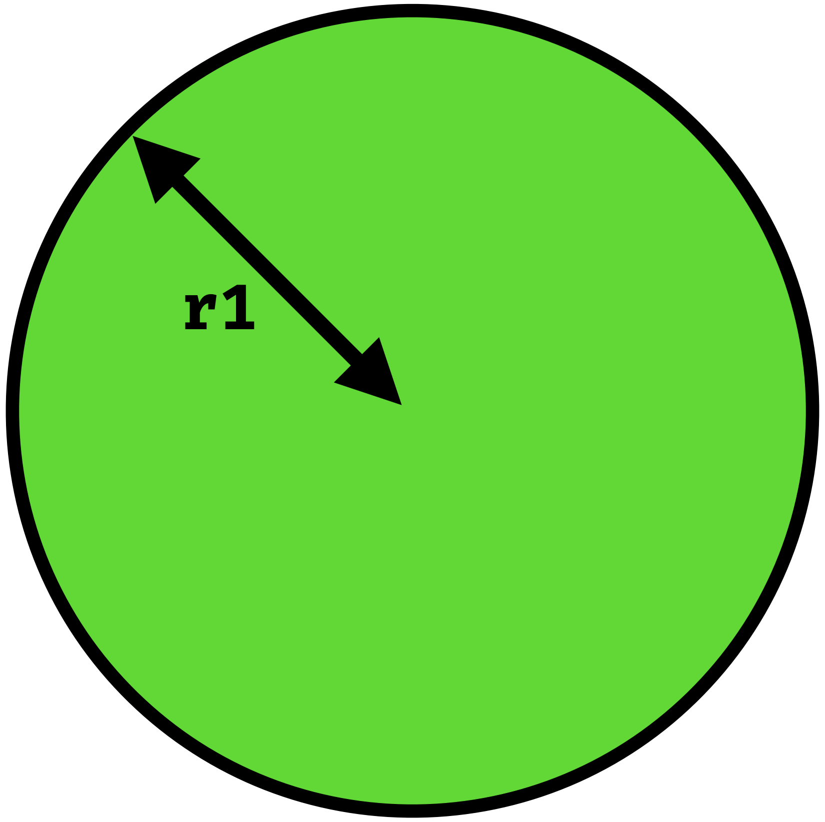
```
Time 0.0:
commercial aircraft: (38.0,25.0)
 -- In tight zone
hostile craft: (258.0,183.0)

Time 20.0:
commercial aircraft: (58.0,30.0)
 -- In tight zone
hostile craft: (239.0,164.0)

Time 40.0:
commercial aircraft: (100.0,43.0)
 -- In engageability zone
 -- In tight zone
hostile craft: (210.0,136.0)
 -- In carrier slave doctrine
```

Haskell Solution

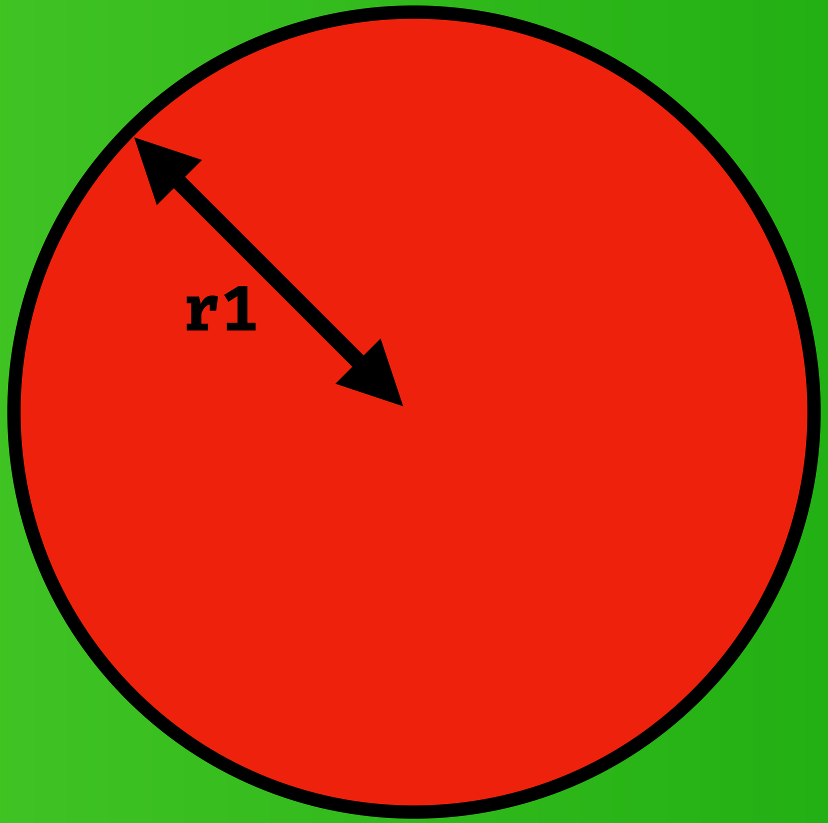
```haskell
type Region

inRegion :: Point  → Region → Bool
circle   :: Radius → Region
outside  :: Region → Region
(/\)     :: Region → Region → Region
```

```haskell
annulus :: Radius → Radius → Region
annulus r1 r2 = outside (circle r1) /\
                circle r2
```

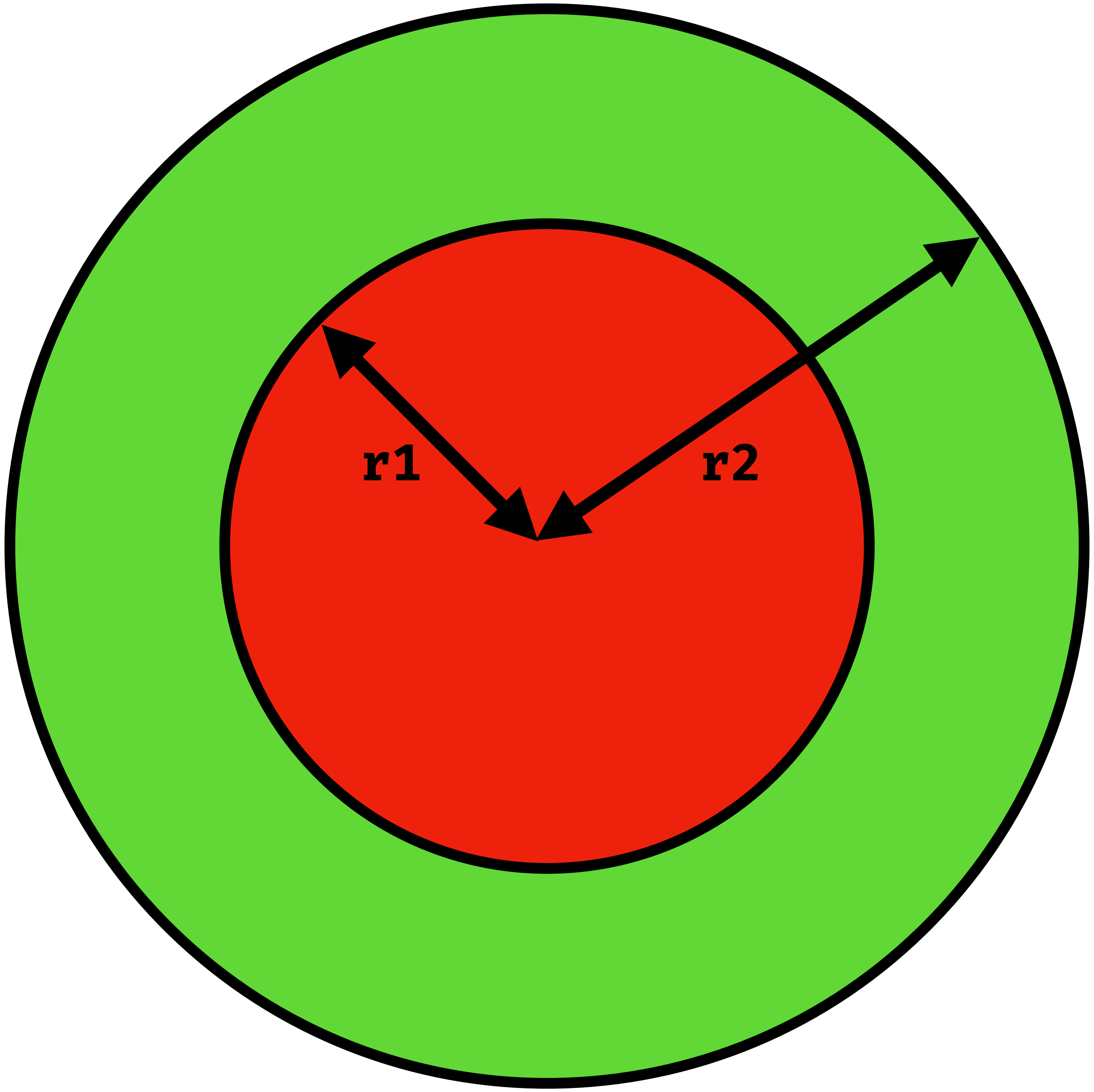
```
annulus r1 r2 =
  circle r1
```



```
annulus r1 r2 =
  outside (circle r1)
```



```
annulus r1 r2 =
 outside (circle r1)
 /\  circle r2
```



Implementation

Shallow embedding

- ★ implement regions as Haskell functions
- ★ semantics: `inRegion`
- ★ no "interpretative overhead"

Shallow Embedding

```
type Region

p `inRegion`

circle d  = \p → distance (0,0) p =< d

outside r = \p → not (r p)

r1 /\ r2  = \p → r1 p && r2 p
```

```
func(p Point) bool {
  return distance((0,0),p) ≤ d
}
```

Study Results

Language	Lines of code	Lines of documentation	Development time (hours)
(1) Haskell	85	465	10
(2) Ada	767	714	23
(3) Ada9X	800	200	28
(4) C++	1105	130	–
(5) Awk/Nawk	250	150	–
(6) Rapide	157	0	54
(7) Griffin	251	0	34
(8) Proteus	293	79	26
(9) Relational Lisp	274	12	3
(10) Haskell	156	112	8

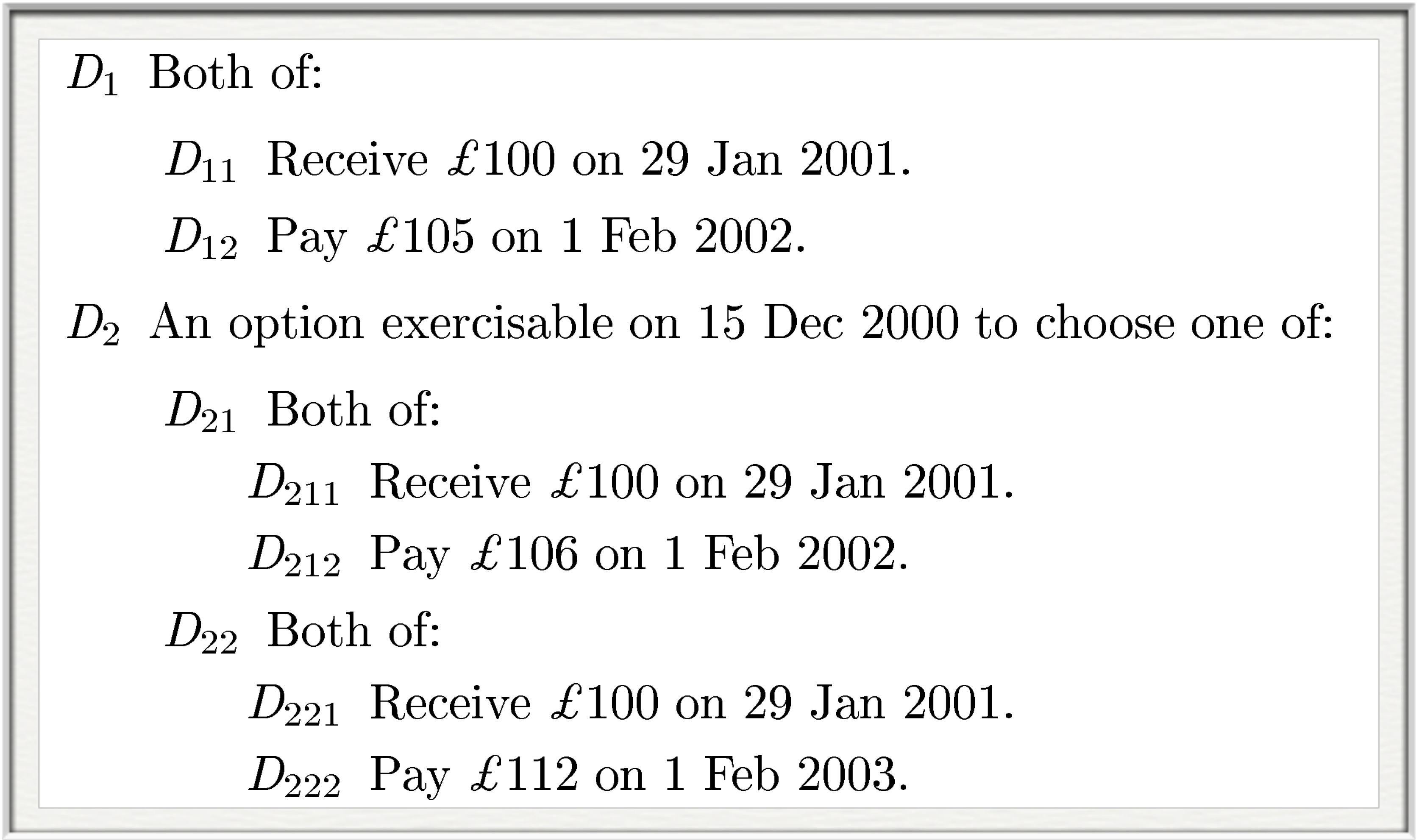
Financial Contracts

Composing contracts: an adventure in financial engineering

Simon Peyton Jones, Jean-Marc Eber, Julian Seward

Example Contract

The owner of the contract
has the right to choose on June 30 2000
between:



D_1 Both of:

- D_{11} Receive £100 on 29 Jan 2001.
- D_{12} Pay £105 on 1 Feb 2002.

D_2 An option exercisable on 15 Dec 2000 to choose one of:

- D_{21} Both of:
  - D_{211} Receive £100 on 29 Jan 2001.
  - D_{212} Pay £106 on 1 Feb 2002.
- D_{22} Both of:
  - D_{221} Receive £100 on 29 Jan 2001.
  - D_{222} Pay £112 on 1 Feb 2003.

Problems

- Inaccurate, non-uniform language
- Analysis and manipulation of contracts
  - calculate worth
  - simulate

Simple Contract

```
-- receive £100 on 13/02/2003
c1 :: Contract
c1 = zcb t1 100 GBP

-- zero coupon bond
zcb :: Date → Double → Currency → Contract

mkDate :: String → Date

t1 :: Date
t1 = mkDate “0800GMT 13 Feb 2003”
```

Composing Contracts

```
and :: Contract → Contract → Contract

c2,c3 :: Contract
c2 = zcb t2 200 GBP
c3 = c1 `and` c2

give :: Contract → Contract

andGive :: Contract → Contract → Contract
andGive c d = c `and` give d

c4 = c1 `andGive` c2
```

Haskell in Industry

Finance

ABN·AMRO

BARCLAYS CAPITAL

Deutsche Bank

CREDIT SUISSE

Telecom

QUALCOMM®

at&t

Alcatel·Lucent

Many Others

Google

intel®

The New York Times

f

Summary

Summary

✦ **Domain Specific**

✦**Language**

✦**Embedded**

Liked this material?

Functional Programming in Industry

https://dtai.cs.kuleuven.be/events/fpcourse/

Deep Embedding

```
type Region = R

data R = Circle Radius
       | Outside R
       |Intersect R R
```

```
circle  = Circle
outside = Outside
(/\)    = Intersect
```

```
p `inRegion` (Circle d)
  = distance (0,0) p =< d
p `inRegion` (Outside r)
  = not (p `inRegion` r)
p `inRegion` (Intersect r1 r2)
  = (p `inRegion` r1) && (p `inRegion` r2)
```

Smart Constructors

```
type Region = R

data R = Circle Radius
       | Outside R
       |Intersect R R
```

```
circle  = opt . Circle
outside = opt . Outside
(/\)    = …
```

```
opt :: R → R
opt (Intersect (Circle d1) (Circle d2))
  = Circle (max d1 d2)
...
opt r = r
```