Functional Programming

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UChicago CS 223

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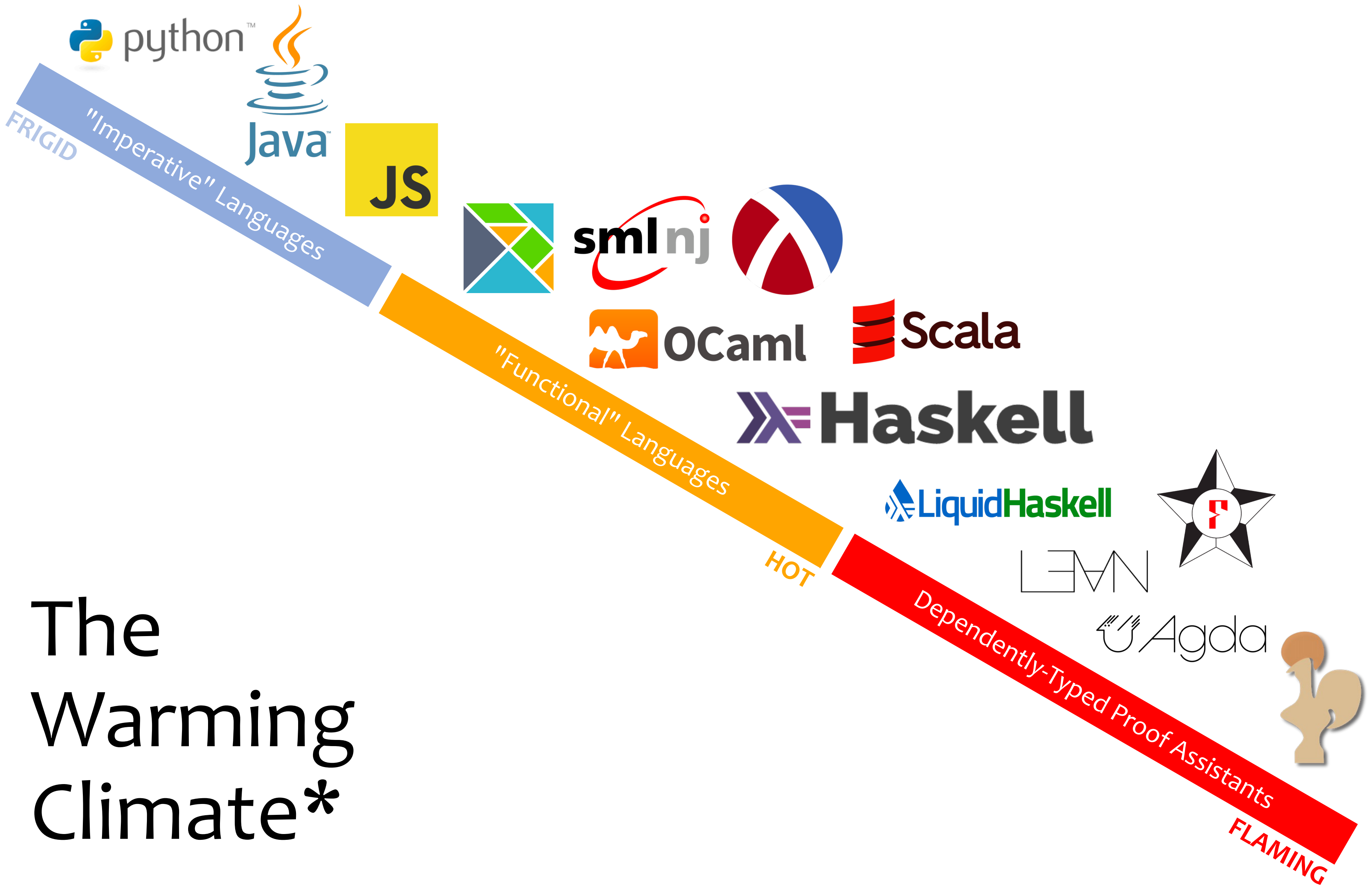
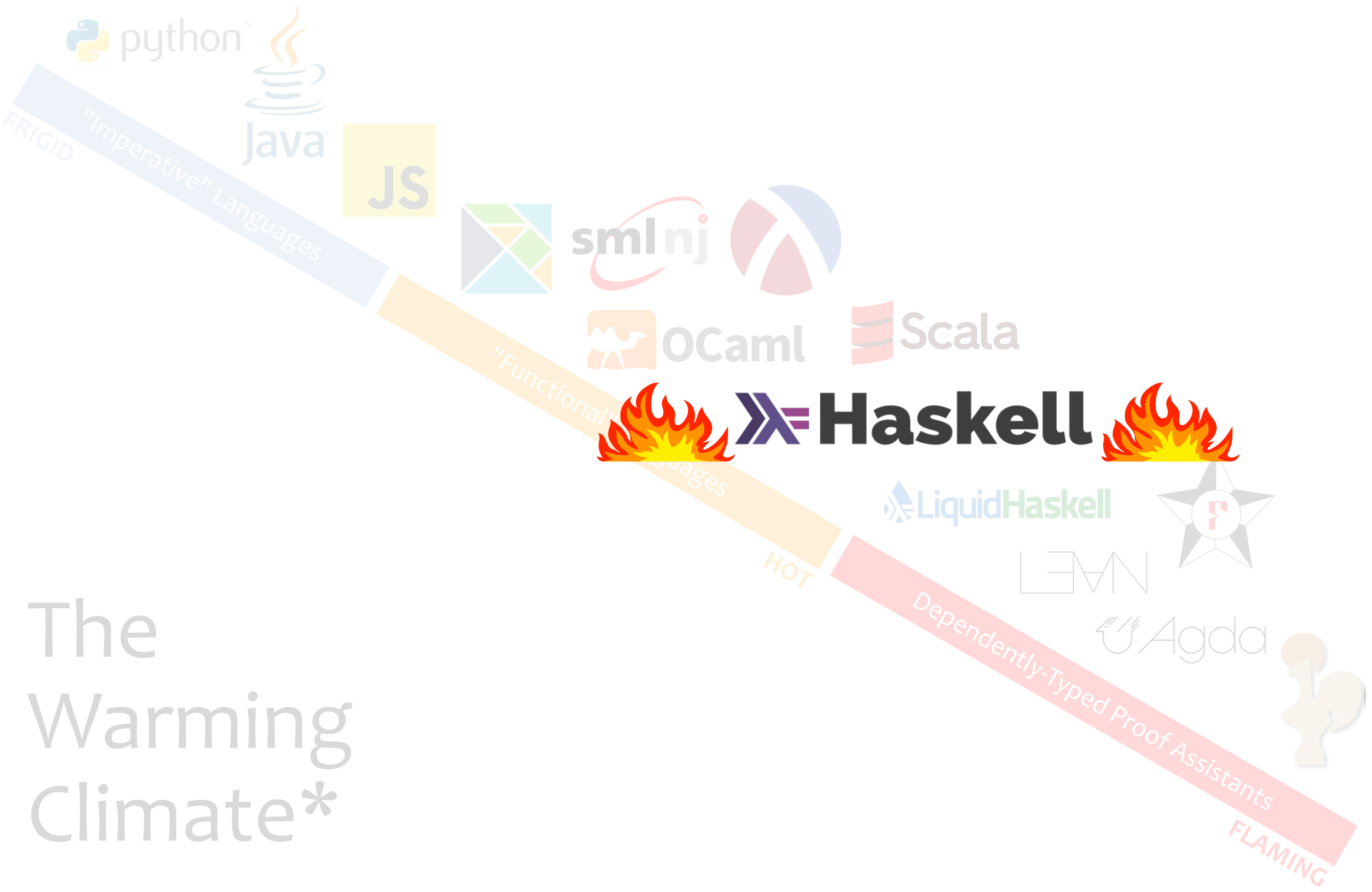


The Warming Climate*

*An incomplete and unscientific account



The Warming Climate*

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HOT Programming in Haskell

Higher Order Typed

Algebraic Datatypes

Higher-Order Functions

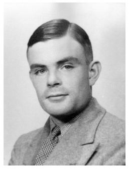
Separation of Church and State

Syntactic Concision

Lazy Evaluation

Haskell Curry
Combinatory logic
(1920s-30s)

Alonzo Church
λ-calculus
(1930s)


Alan Turing
Turing machines
(1930s)

CAUTION
VERY HOT ~~WATER~~
TYPE SYSTEM

A Silly Little I/O Loop

stdout stdin

```
Tell me a nice number: Haskell, woohoo!!!
Hmm, that doesn't seem like a number.
Tell me a nice number: CMSC 22300
Hmm, that doesn't seem like a number.
Tell me a nice number: cs223
Hmm, that doesn't seem like a number.
Tell me a nice number: 223
Yes, 223 is a nice number.
Tell me a nice number: -223
Yes, -223 is a nice number.
Tell me a nice number:
```

```haskell
main :: IO ()
main =
  do
    putStr "Tell me a nice number: "
    s <- getLine
    let i = read s :: Int
    putStrLn ("Yes, " ++ show i ++ " is a nice number.")
    main
```

```
main :: IO ()
main =
  do
    putStr "Tell me a nice number: "
    s <- getLine
    let i = read s :: Int
    putStrLn ("Yes, " ++ show i ++ " is a nice number.")
    main
```

```
main :: IO ()
main =
  do
    putStr "Tell me a nice number: "
    s <- getLine
    if all isDigit s then
      let i = read s :: Int in
      putStrLn ("Yes, " ++ show i ++ " is a nice number.")
    else
      putStrLn "Hmm, that doesn't seem like a number."
    main
```

```
main :: IO ()
main =
  do
    putStr "Tell me a nice number: "
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    if all isDigit s then
      let i = read s :: Int in
      putStrLn ("Yes, " ++ show i ++ " is a nice number.")
    else
      putStrLn "Hmm, that doesn't seem like a number."
    main
```

```haskell
main :: IO ()
main =
  do
    putStr "Tell me a nice number: "
    s <- getLine
    let i = readInt s
    if i /= -9999999999999
      then putStrLn ("Yes, " ++ show i ++ " is a nice number.")
      else putStrLn "Hmm, that doesn't seem like a number."
    main

readInt :: String -> Int
readInt s =
  if all isDigit s then
    read s
  else
    -9999999999999
```

```haskell
main :: IO ()
main =
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    s <- getLine
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    if i /= -9999999999999
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    main

readInt :: String -> Int
readInt s =
  if all isDigit s then
    read s
  else
    -9999999999999
```

```
main :: IO ()
main =
  do
    putStr "Tell me a nice number: "
    s <- getLine
    case readMaybeInt s of
      Just i  -> putStrLn ("Yes, " ++ show i ++ " is a nice number.")
      Nothing -> putStrLn "Hmm, that doesn't seem like a number."
    main

readMaybeInt :: String -> Maybe Int
readMaybeInt s =
  if all isDigit s then
    Just (read s)
  else
    Nothing
```

**Algebraic Datatypes (ADTs)
and Pattern Matching**

```
main :: IO ()
main =
  do
    putStr "Tell me a nice number: "
    s <- getLine
    case readMaybeInt s of
      Just i  -> putStrLn ("Yes, " ++ show i ++ " is a nice number.")
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    main

readMaybeInt :: String -> Maybe Int
readMaybeInt s =
  if all isDigit s then
    Just (read s)
  else
    Nothing
```

```haskell
main :: IO ()
main =
  do
    putStr "Tell me a nice number: "
    s <- getLine
    putStrLn (response s)
    main

response :: String -> String
response s =
  case readMaybeInt s of
    Just i  -> "Yes, " ++ show i ++ " is a nice number."
    Nothing -> "Hmm, that doesn't seem like a number."

readMaybeInt :: String -> Maybe Int
readMaybeInt s =
  if all isDigit s then
    Just (read s)
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```

```haskell
main :: IO ()
main =
  loop "Tell me a nice number: " response

loop :: String -> (String -> String) -> IO ()
loop prompt f =
  do
    putStr prompt
    s <- getLine
    putStrLn (f s)
    loop prompt f

response :: String -> String
response s =
  case readMaybeInt s of
    Just i  -> "Yes, " ++ show i ++ " is a nice number."
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readMaybeInt :: String -> Maybe Int
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```

Higher-Order Functions

v5

```haskell
main :: IO ()
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readMaybeInt :: String -> Maybe Int
readMaybeInt s =
  if all isDigit s then
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  else
    Nothing
```

Effectful Code

"State"

"Church"

Pure Functions

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response :: String -> String
response s =
  case readMaybeInt s of
    Just i  -> "Yes, " ++ show i ++ " is a nice number."
    Nothing -> "Hmm, that doesn't seem like a number."

readMaybeInt :: String -> Maybe Int
readMaybeInt ""       = Nothing
readMaybeInt ('-':s) = case readMaybeInt s of
                          Just i  -> Just (-1 * i)
                          Nothing -> Nothing
readMaybeInt s        = if all isDigit s
                          then Just (read s)
                          else Nothing
```

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main :: IO ()
main =
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                          else Nothing
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  do
    putStr prompt ;
    s <- getLine ;
    putStrLn (f s) ;
    loop prompt f ;

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readMaybeInt :: String -> Maybe Int
readMaybeInt ""       = Nothing
readMaybeInt ('-':s) = do
                          i <- readMaybeInt s ;
                          return (-1 * i) ;
readMaybeInt s        = do
                          guard (all isDigit s) ;
                          return (read s) ;
```

“Programmable Semicolons”

```
main :: IO ()
main =
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loop prompt f =
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readMaybeInt ('-':s) = do
                          i <- readMaybeInt s
                          return (-1 * i)
readMaybeInt s        = do
                          guard (all isDigit s)
                          return (read s)
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readMaybeInt :: String -> Maybe Int
readMaybeInt ""       = Nothing
readMaybeInt ('-':s) = (\i -> -1 * i) <$> readMaybeInt s
readMaybeInt s        = guard (all isDigit s) >> return (read s)
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Operator Overloading++

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```
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main =
  loop "Tell me a nice number: " response

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    putStrLn =<< f <$> getLine
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import Data.Char
import Control.Monad

main :: IO ()
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```

HOT Programming in Haskell

Higher Order Typed

Primary Big Ideas

Algebraic Datatypes

Higher-Order Functions

Separation of Church and State

Secondary

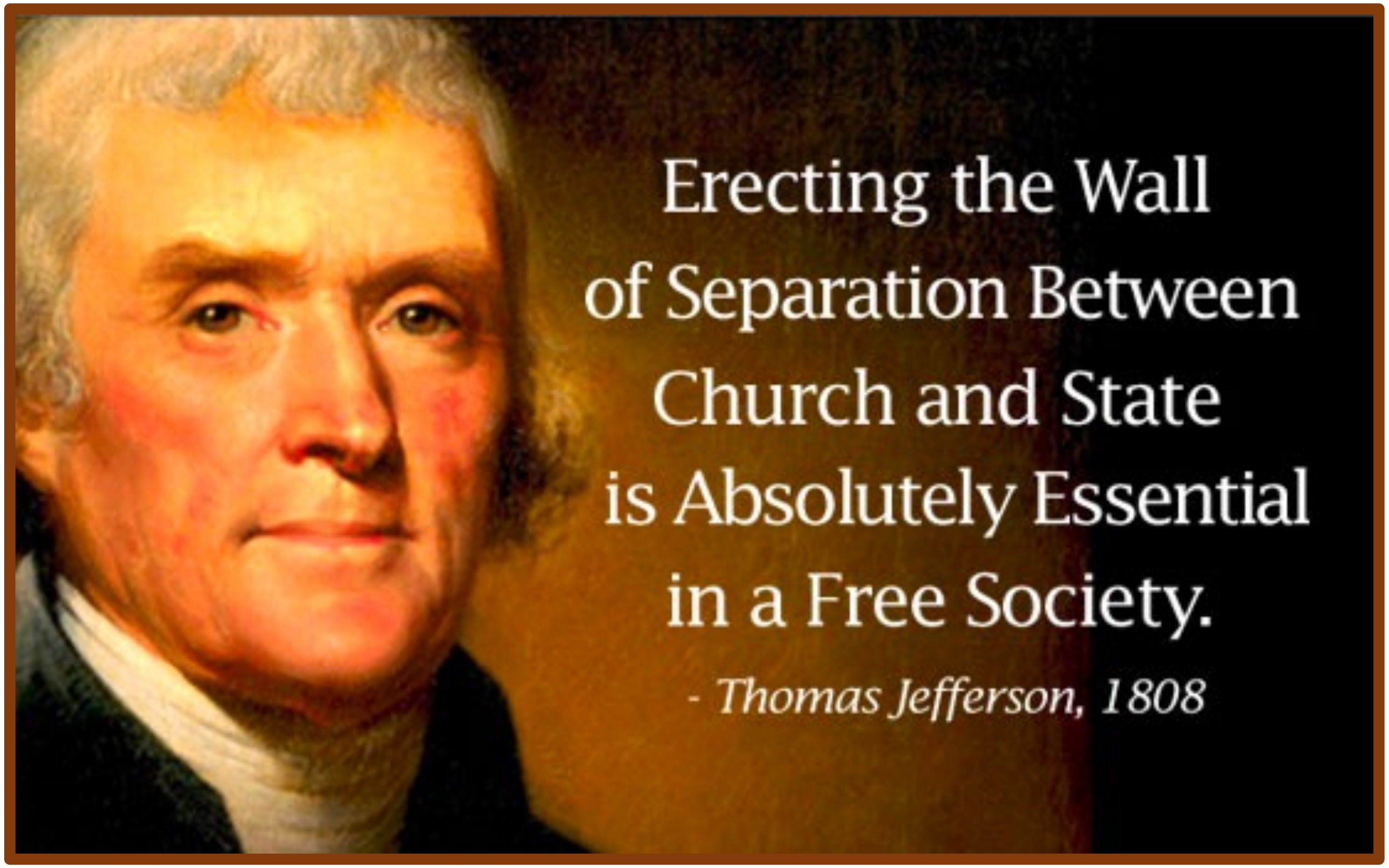
Syntactic Concision

(double-edged sword)

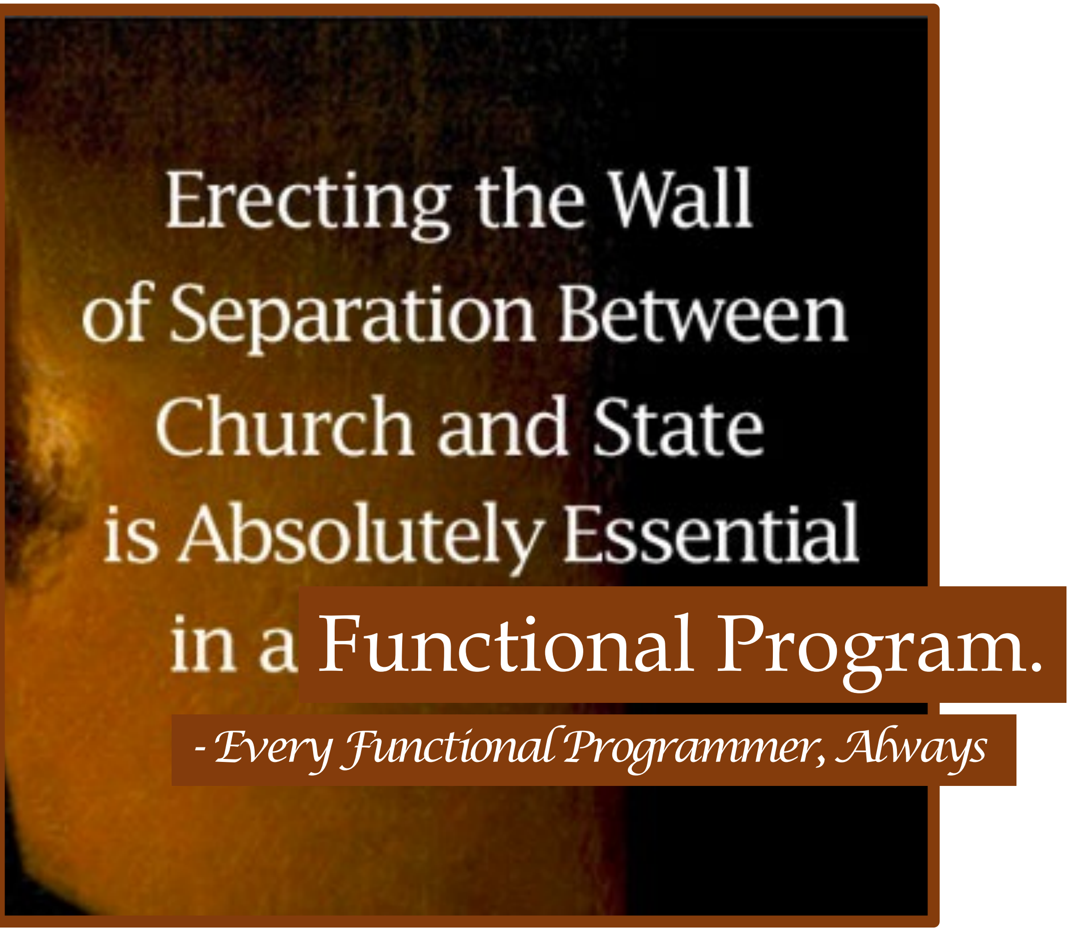
Lazy Evaluation

(ditto)

Separation of Church and State



Separation of Church and State



Erecting the Wall
of Separation Between
Church and State
is Absolutely Essential
in a Functional Program.

- Every Functional Programmer, Always

Disclaimer: This is not an authentic quote from Phil Wadler
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