Error Handling & D

Per Nordlöw

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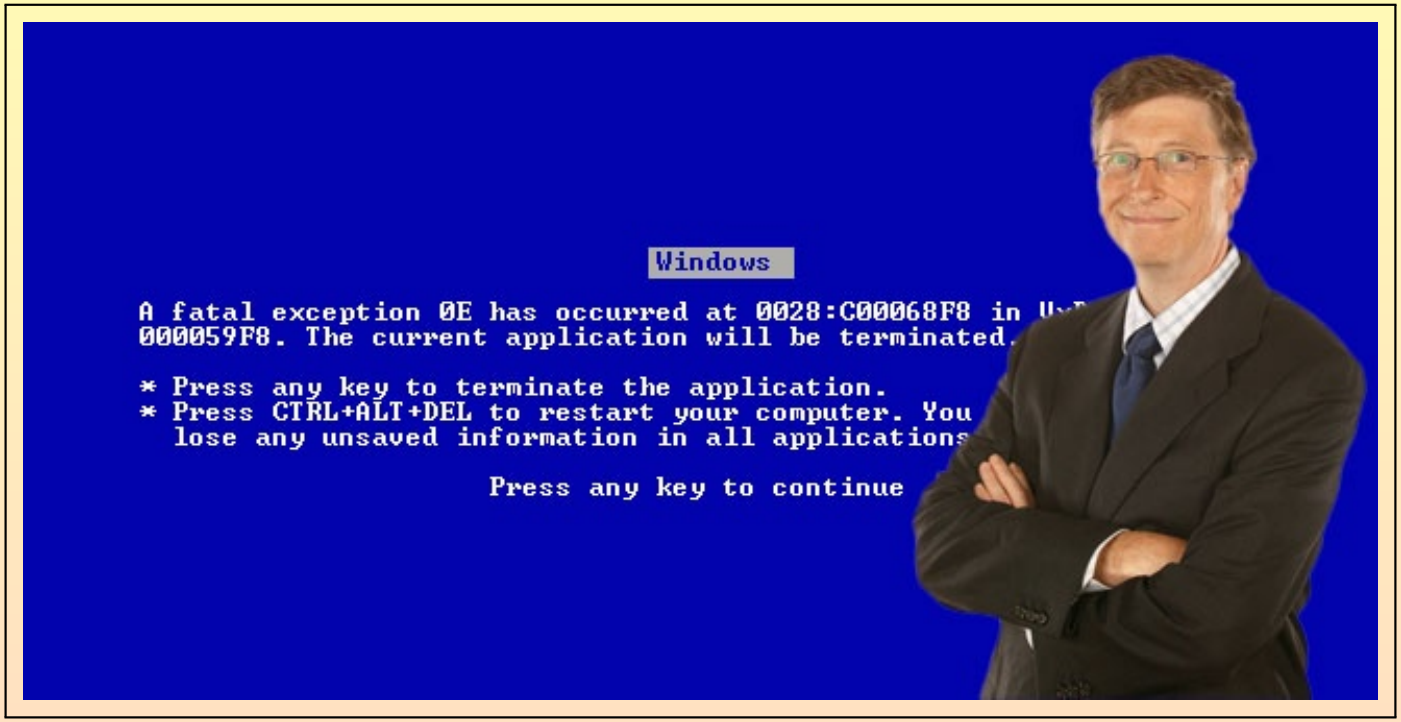
Trend: It's human to err!



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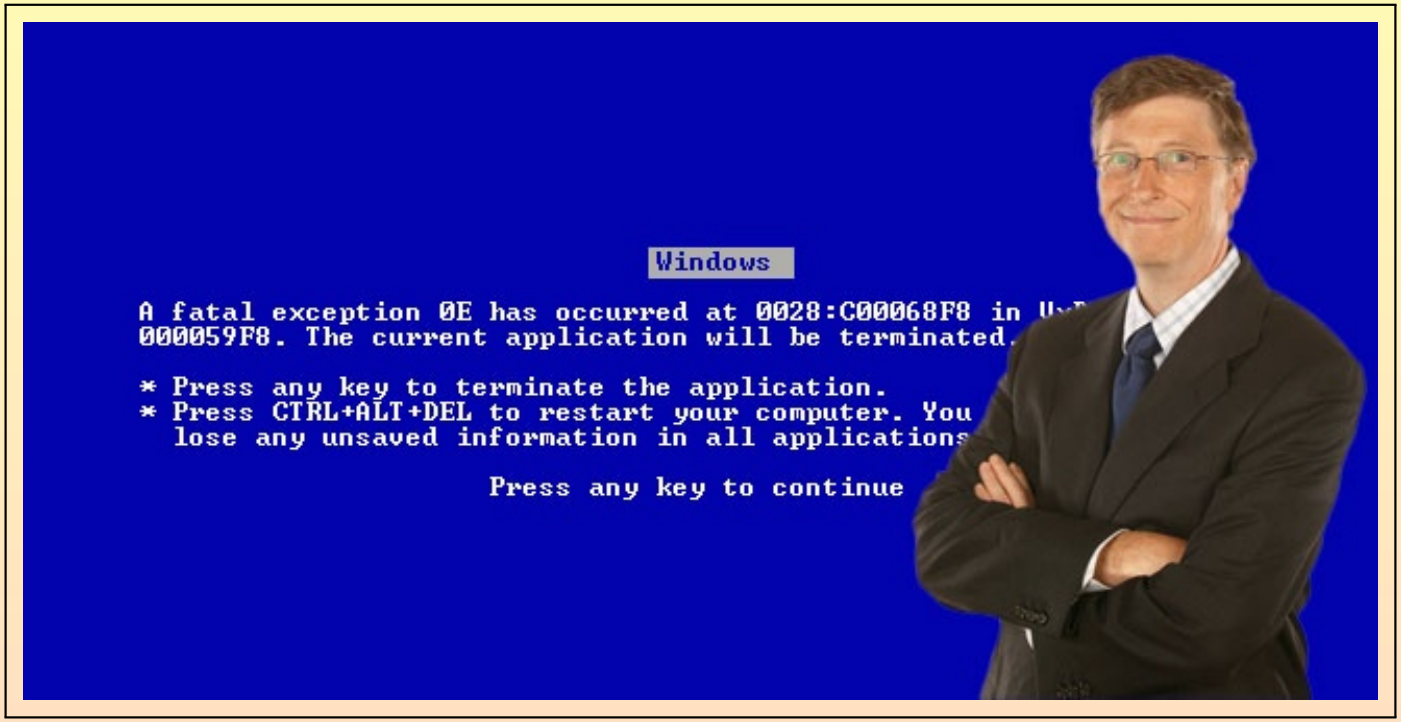

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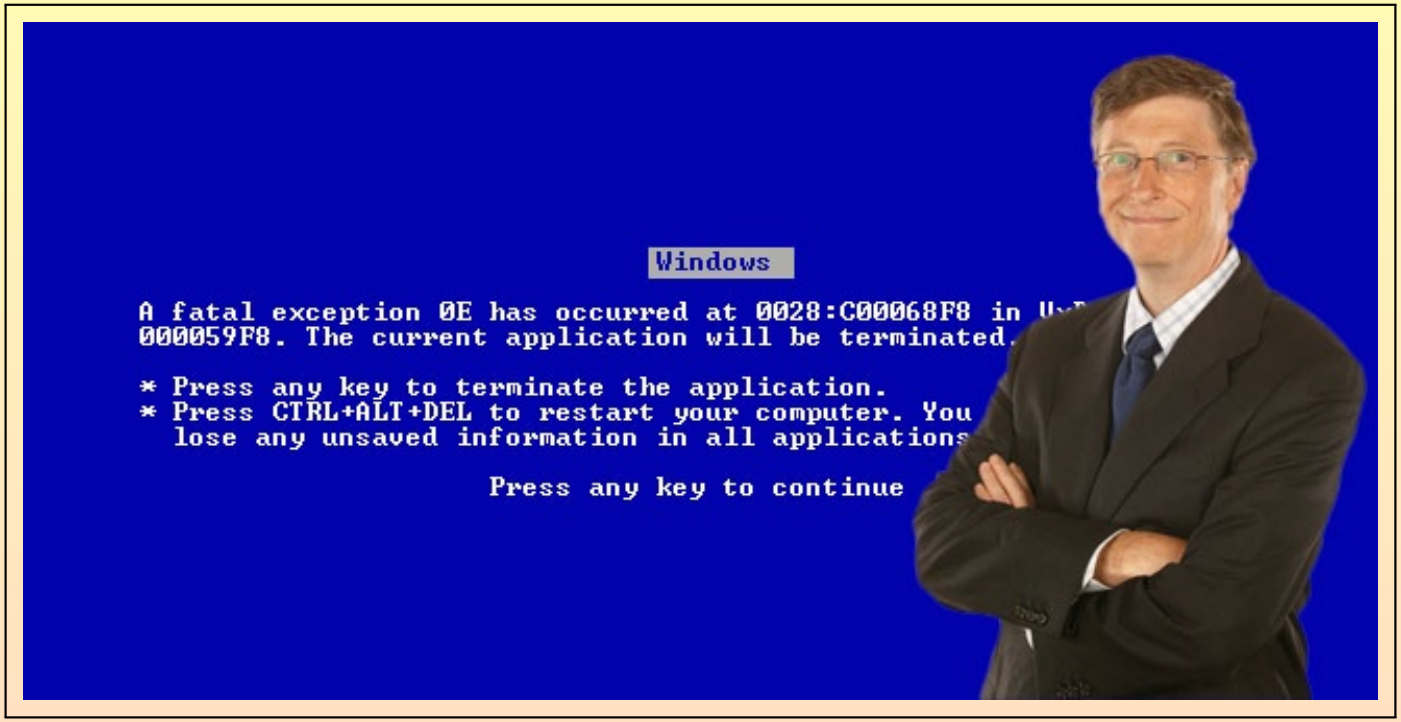

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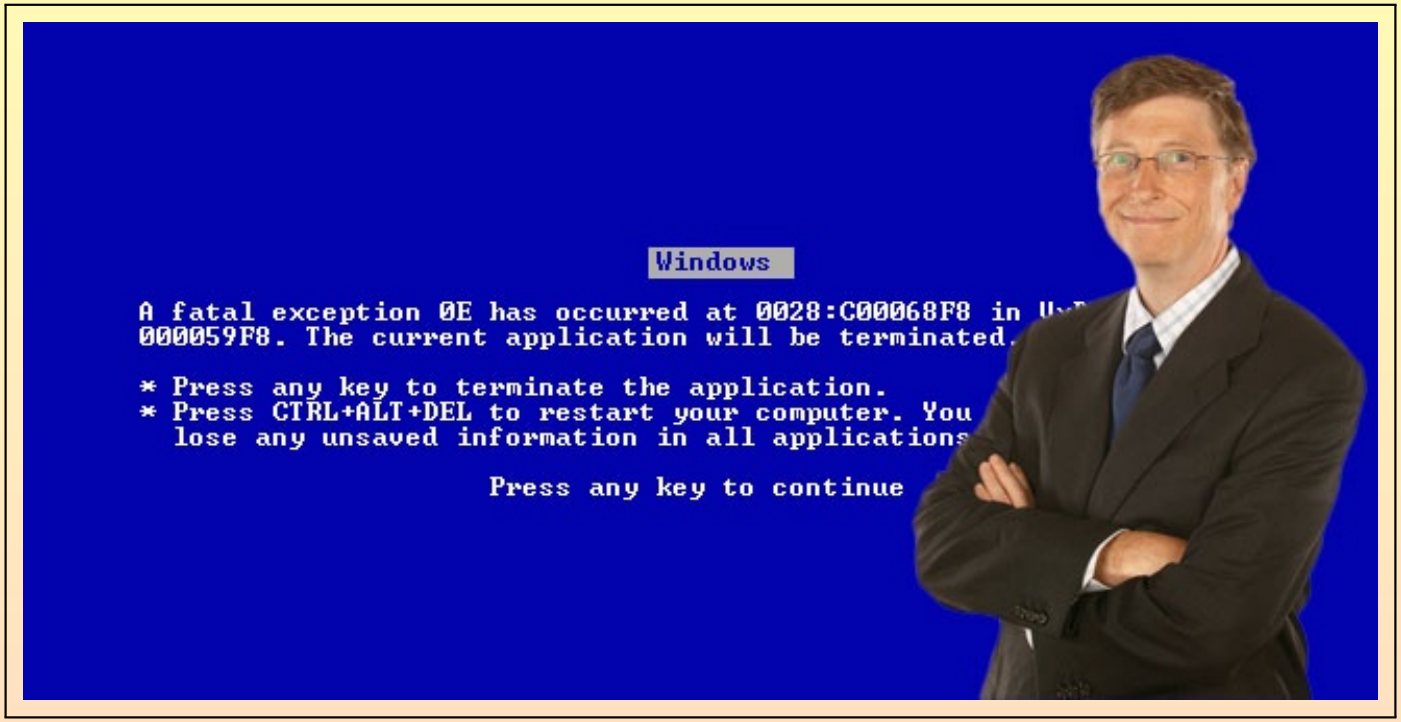

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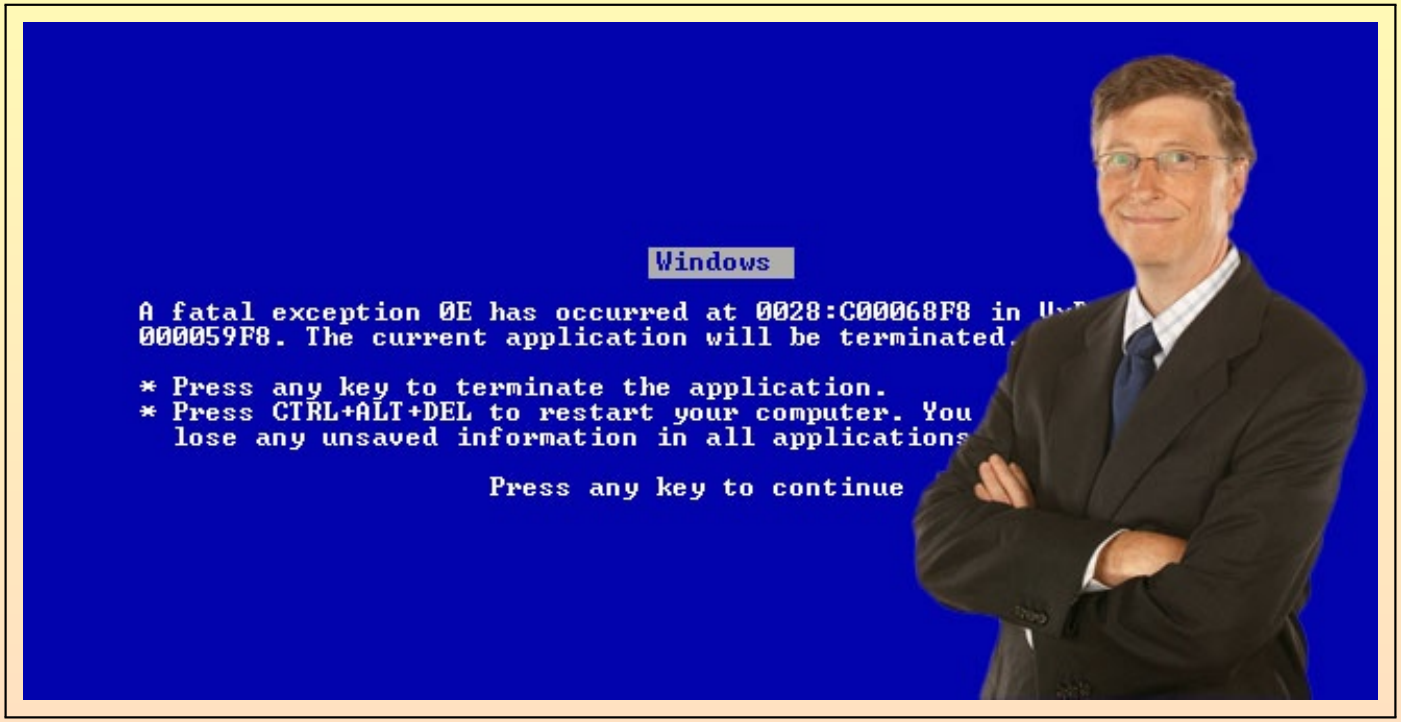

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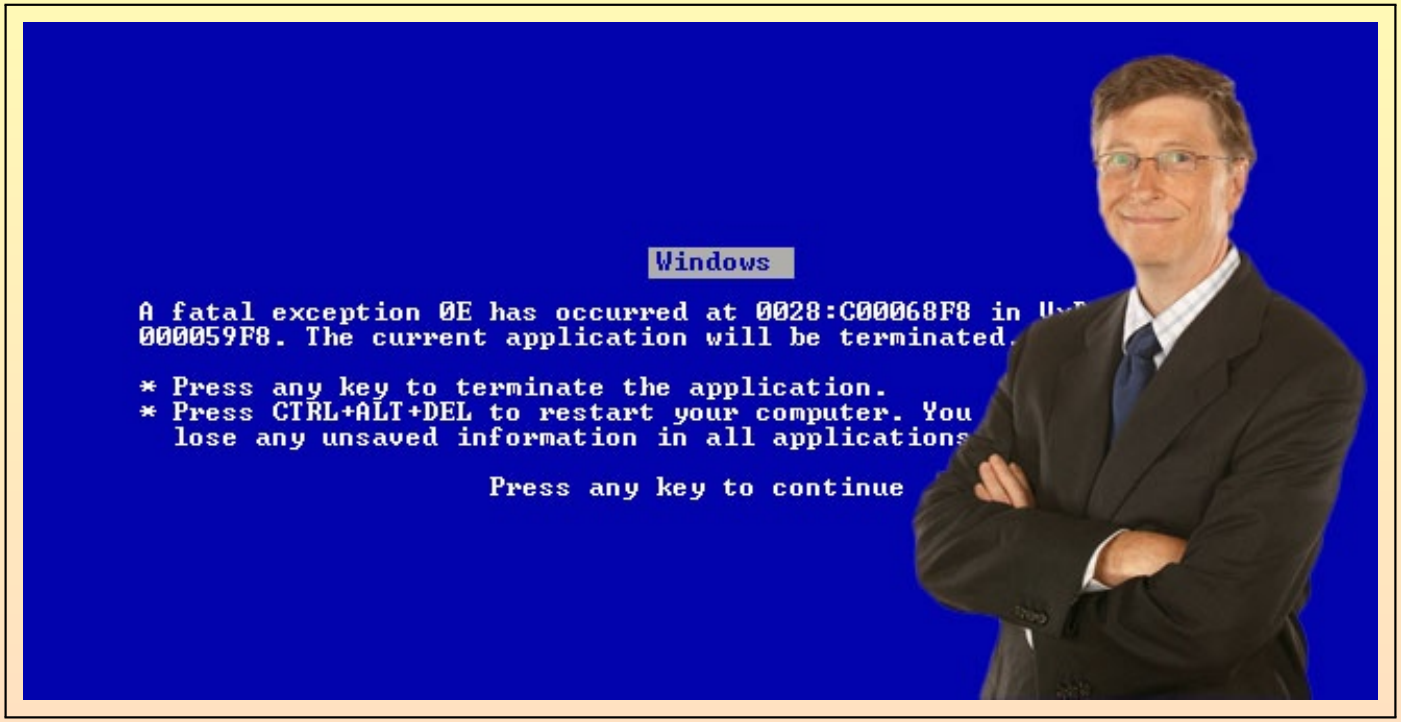

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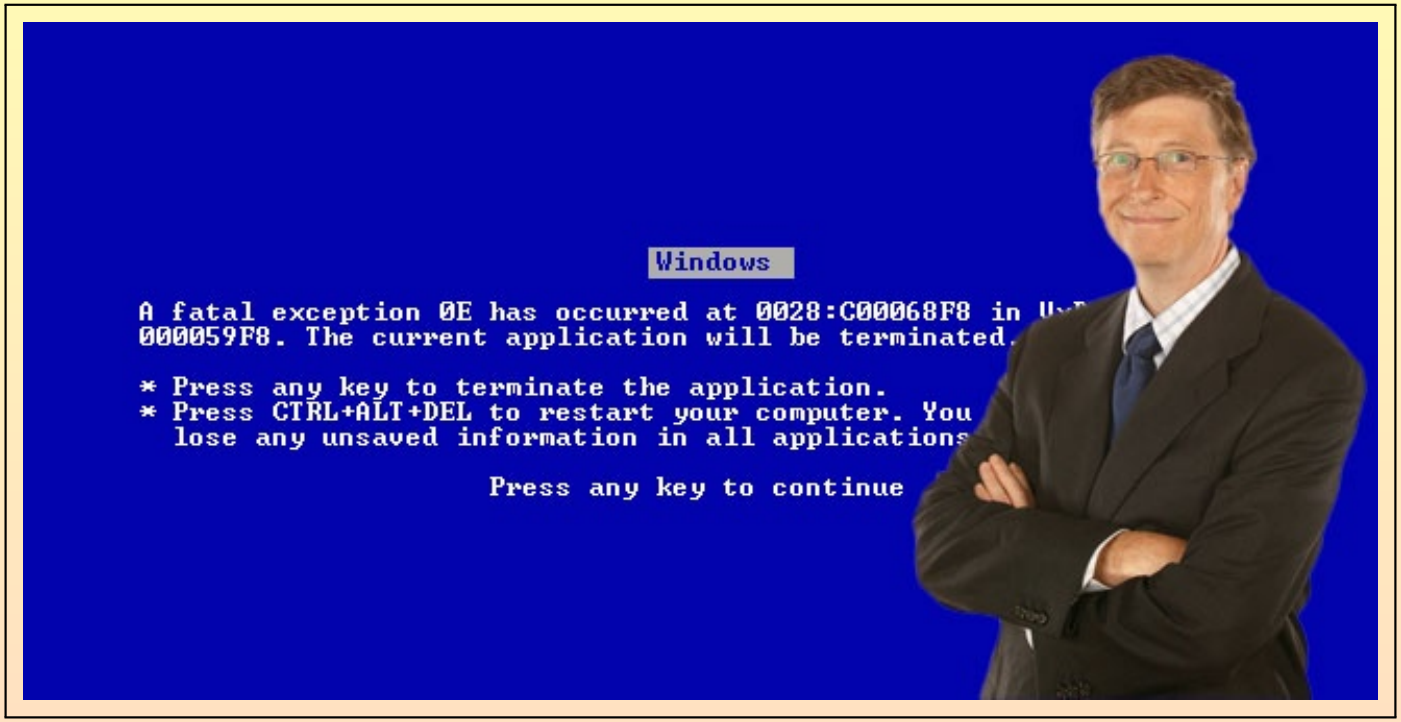

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- Trend: Static code inference can give guarantees on (concurrent) code!:
  Examples: Rust, Haskell, D, Scala, OCaml, F#, Julia partly C#

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  - Compiler generates nested try-catch expressions.

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- Units, Default-Value, Range, Saturation, Ownership, Access, etc

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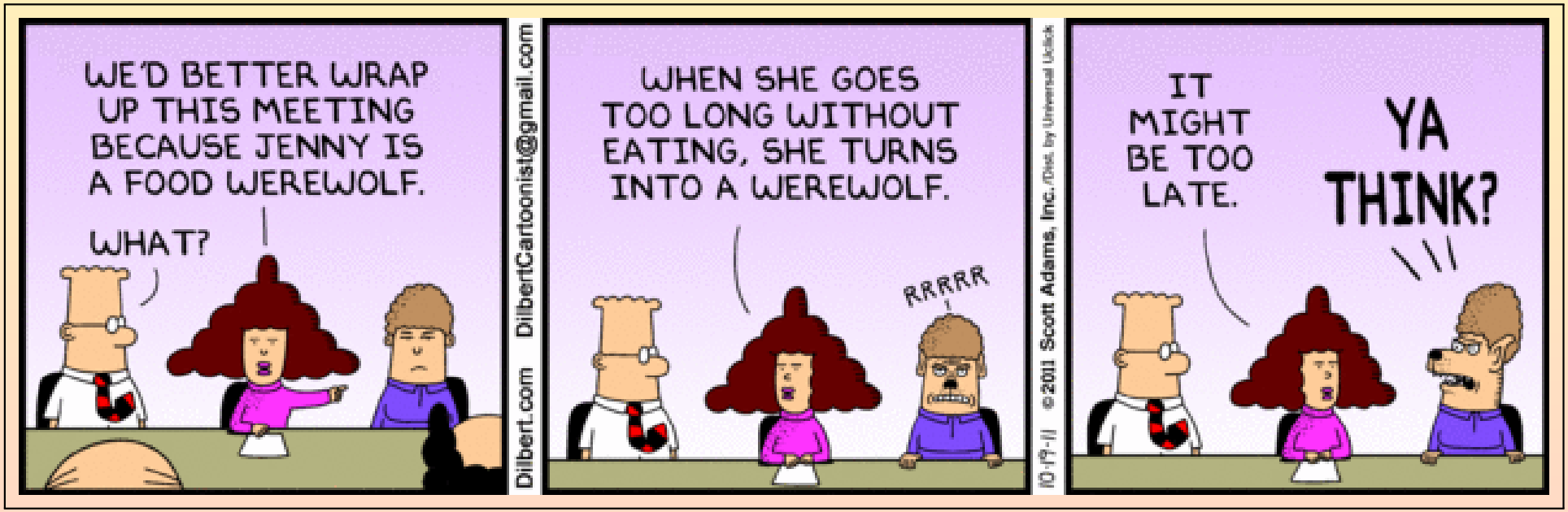
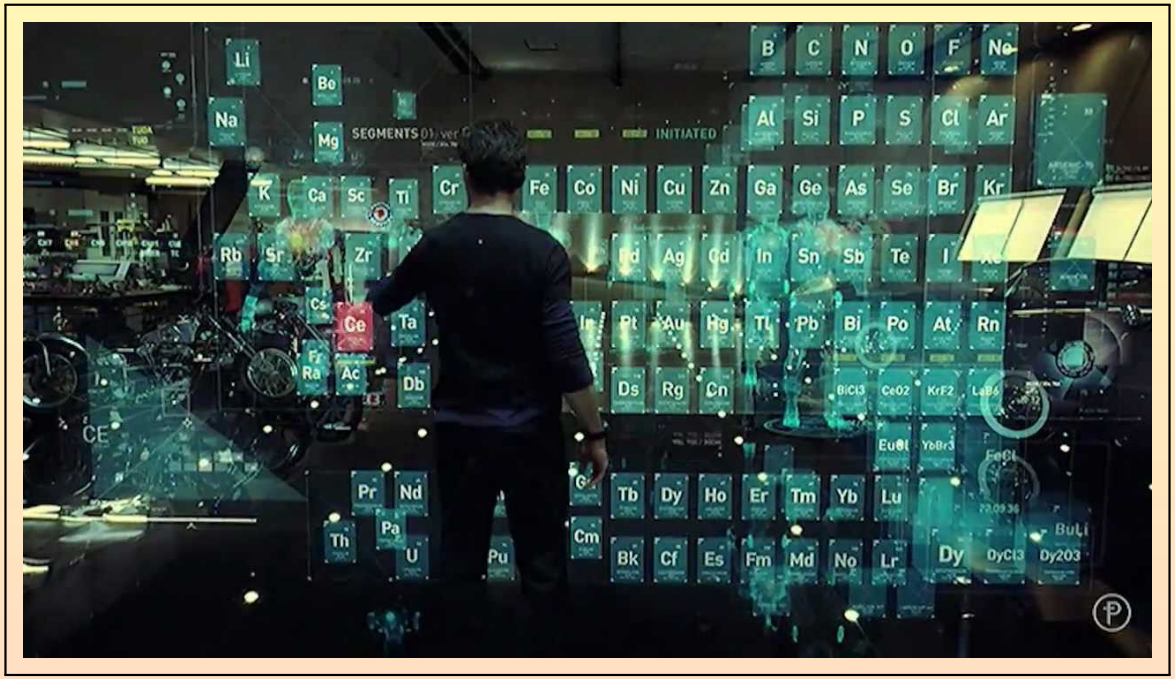
- Separate logic from presentation (CSS, LaTeX, Qt-XML)

Dinner!


WE'D BETTER WRAP UP THIS MEETING BECAUSE JENNY IS A FOOD WEREWOLF.
WHAT?
Dilbert.com DilbertCartoonist@gmail.com
WHEN SHE GOES TOO LONG WITHOUT EATING, SHE TURNS INTO A WEREWOLF.
RRRRR
10-19-11 ©2011 Scott Adams, Inc./Dist. by Universal Uclick
IT MIGHT BE TOO LATE.
YA THINK?

Iron Man like Systems and Interfaces?

How do we turn software engineers into Tony Starks? :)



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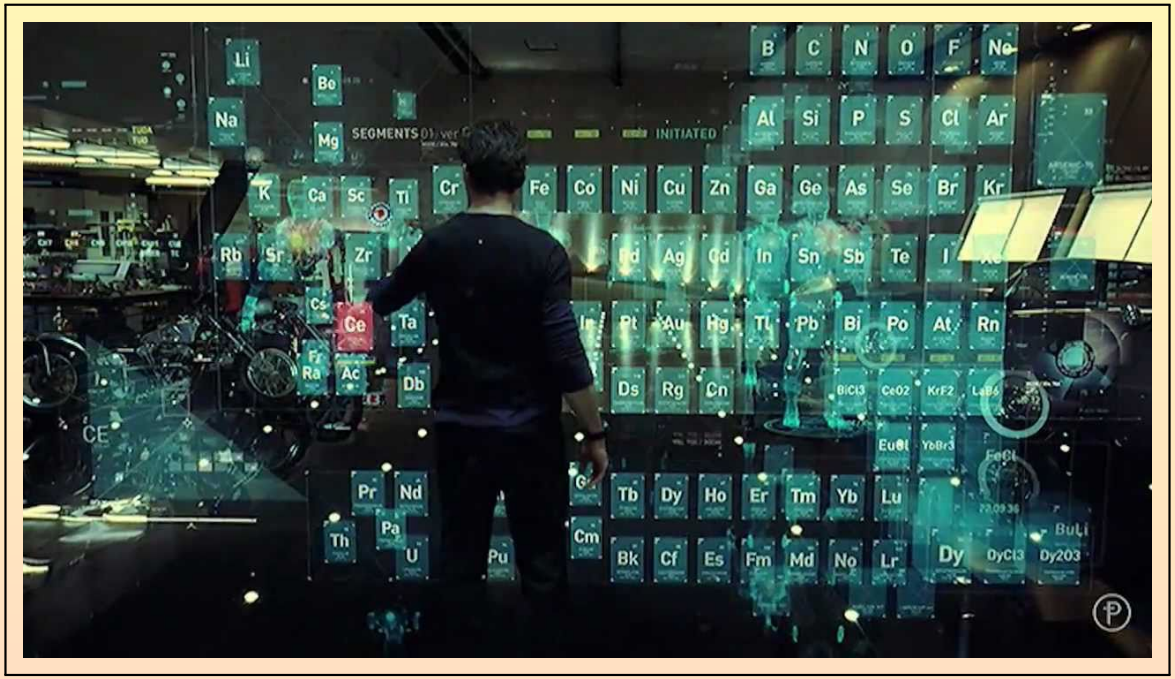

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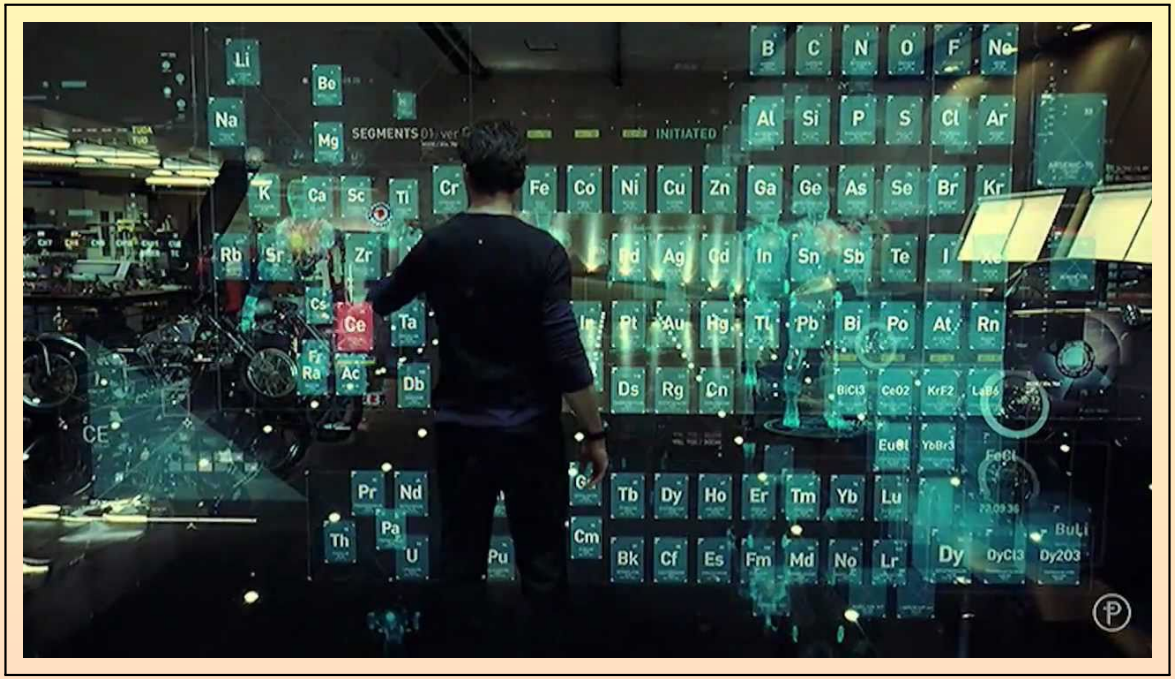

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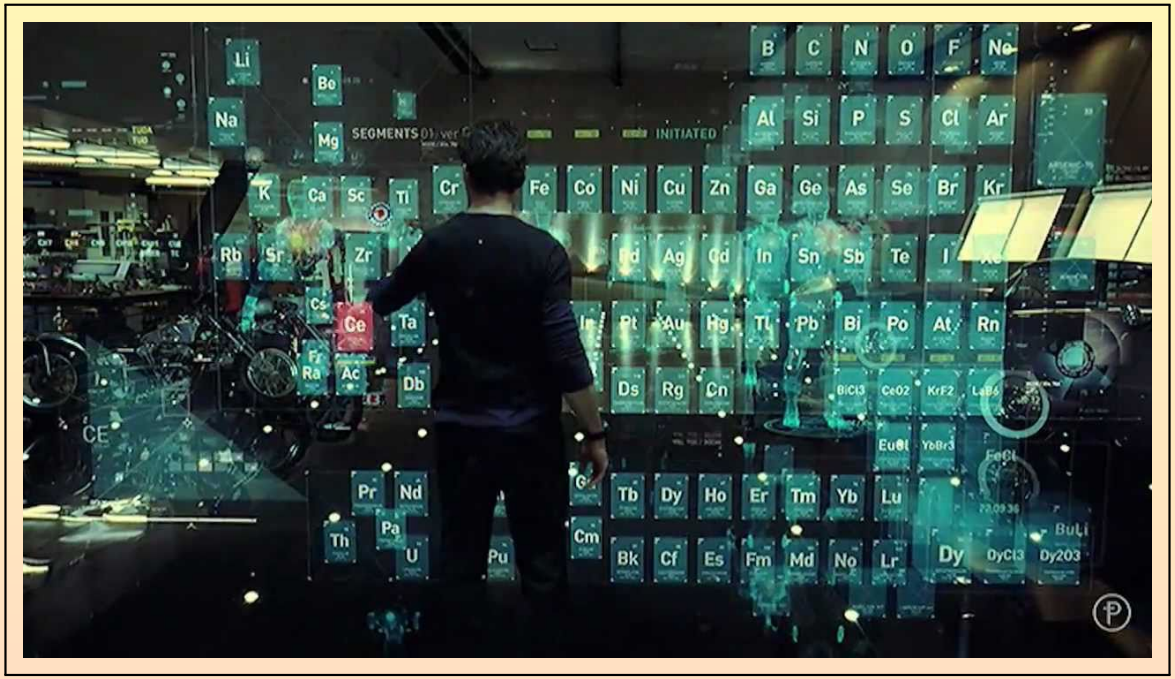

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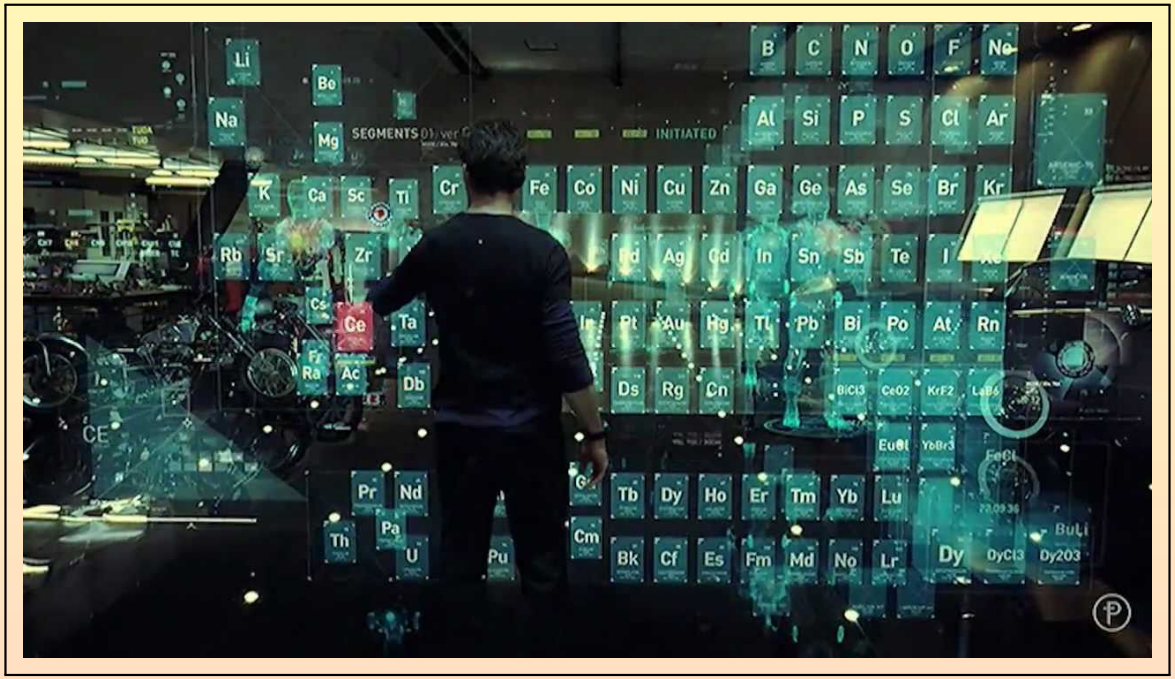

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- Either stick with it, or try to change it:

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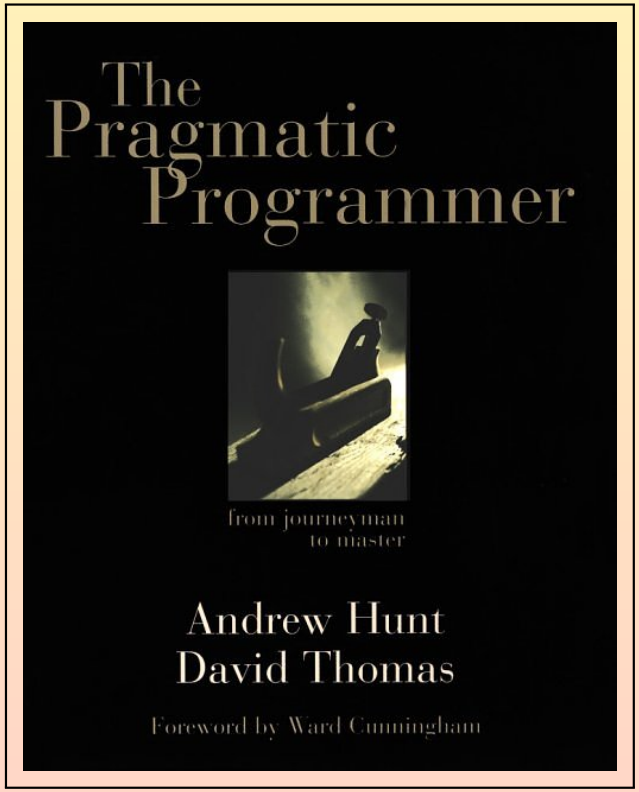

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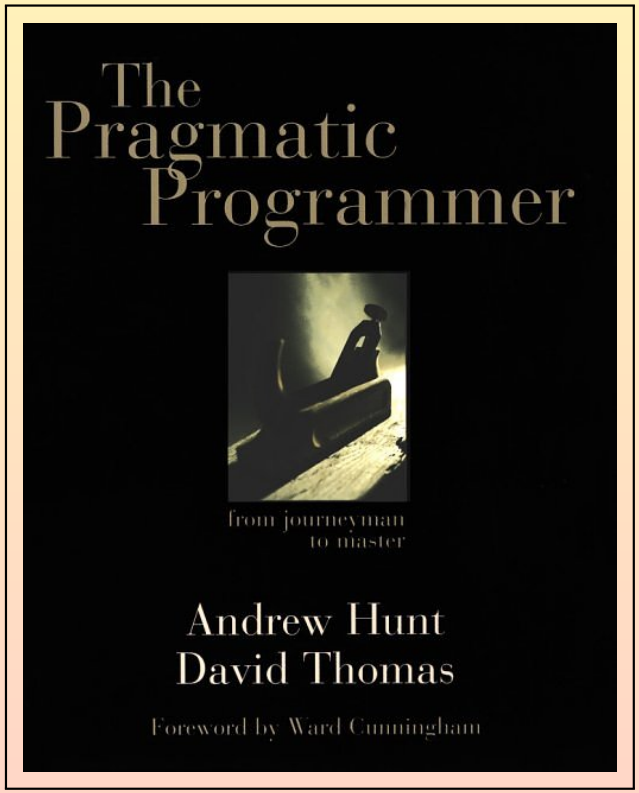

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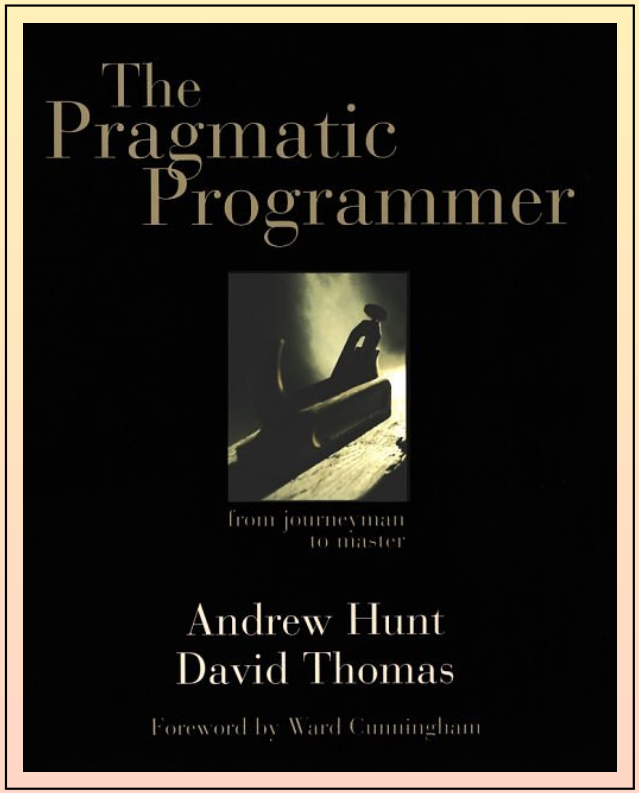

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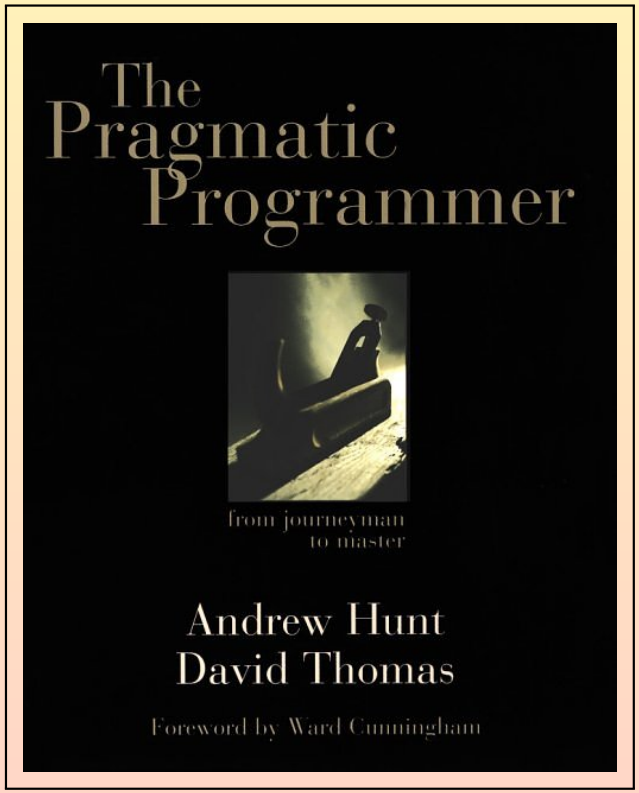

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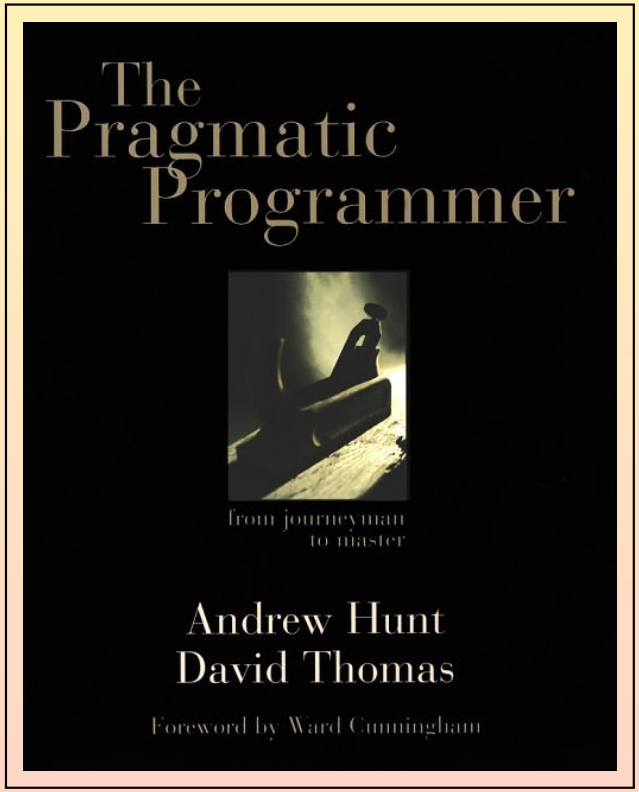

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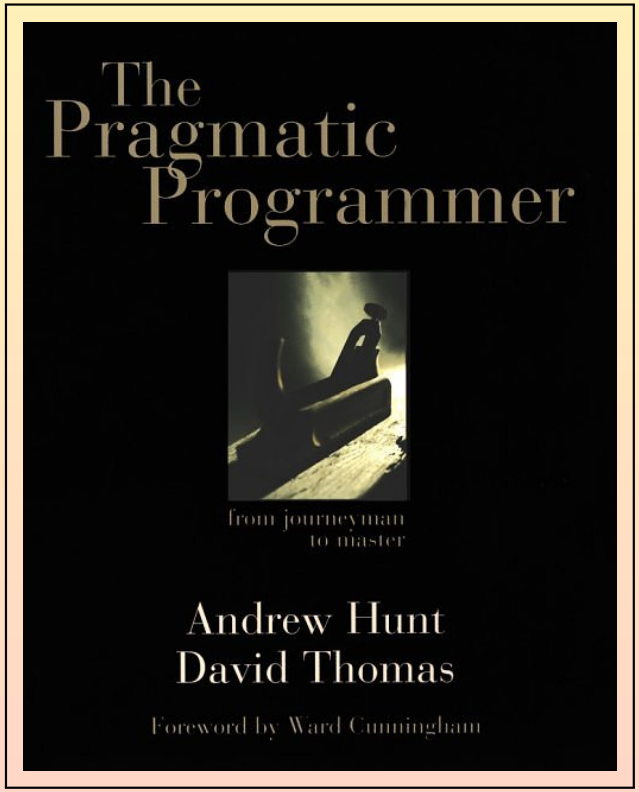

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- Gold is *not* everything that. . .— Big leaps are *not* made by the largest
- **Prestigeless Non-Company Controlled**: No more: *"Lets reinvent everything because we want to be different"*
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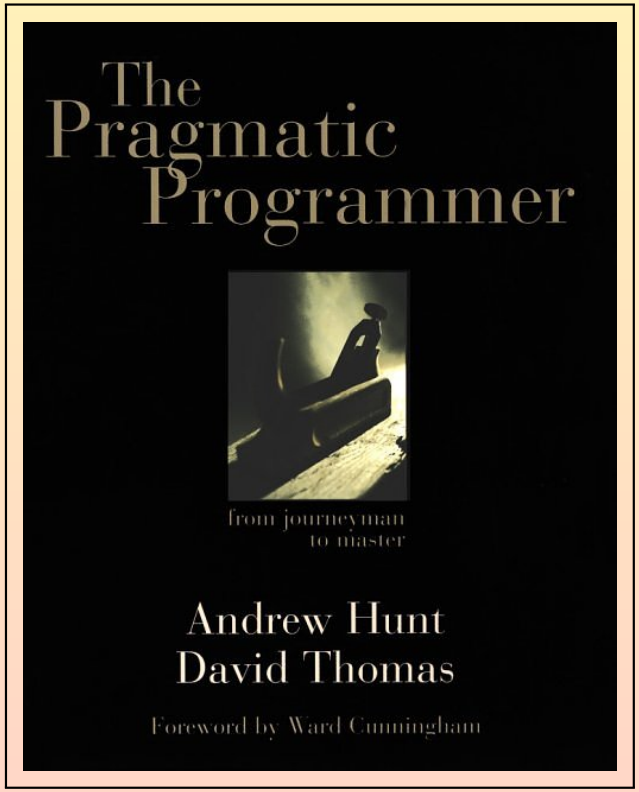

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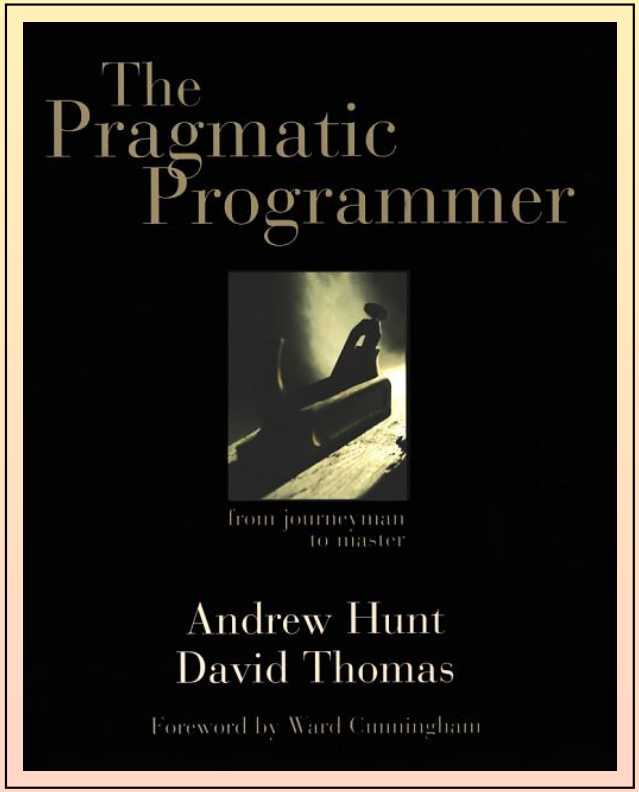

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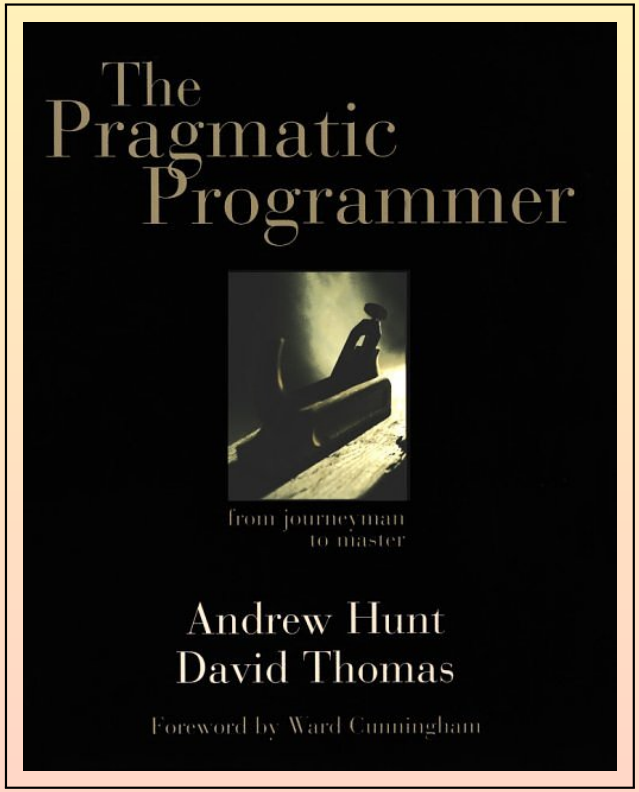

The Scientist and The Craftman — D's Magic Pair!

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- History and Development of Walter Bright and D is very similar to that of Linus Torvalds and Linux.

Heart of D: Reuseable Software

Walter Bright: How can we

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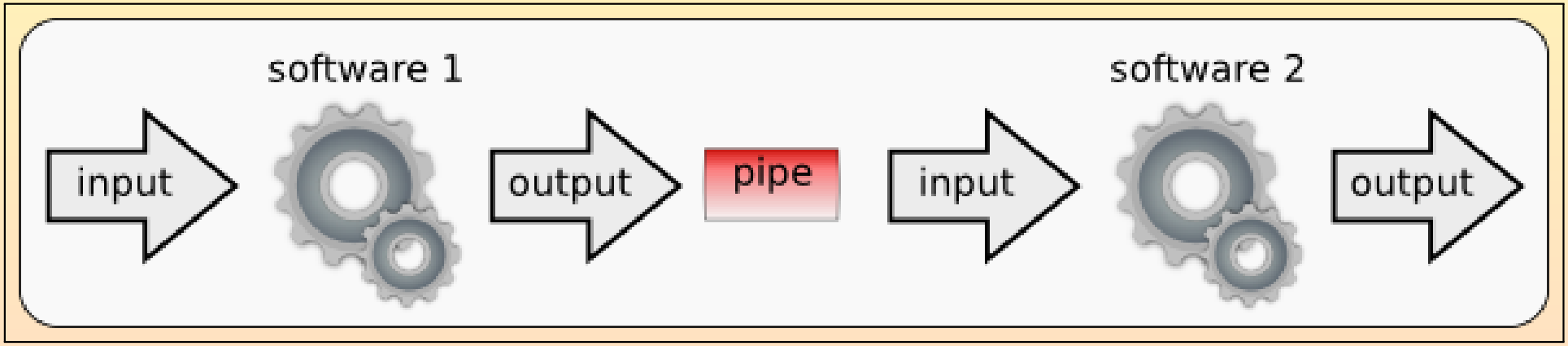
- Escape “Whirlpool Programming”?

Heart of D: Component Programming Pipeline



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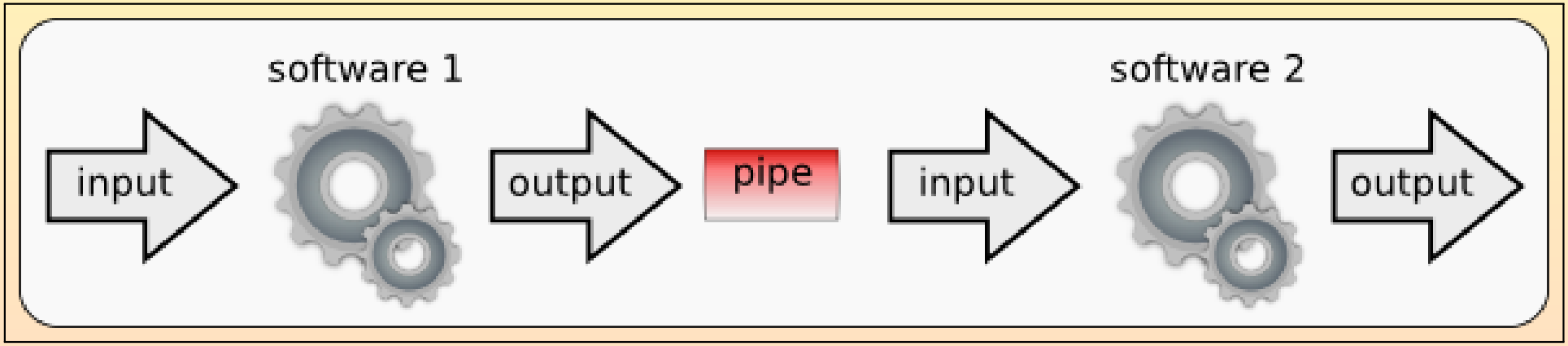

Successful model in

- As Western text: Left-to-right
- Proof of Concept: UNIX Commands & Pipes

Heart of D: Component Programming Example

"Read lines, sort em and print em back":

```
import std.stdio, std.algorithm, std.range, std.array;
void main(string args[]) {
    Stdin.
        byLine(KeepTerminator.yes).
        map!(a => a.idup).
        array.
        sort.
        copy(stdout.lockingTextWriter());
}
```

as fast as handwritten C with nested loops and with manual error-checking but way simpler and more flexible

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- Example: Check if a `range` is a **Palindrome**

```
bool isPalindrome(Range)(in Range x)
if (isBidirectionalRange!Range) {
    import std.algorithm: retro, equal;
    return x.retro.equal(x);
}
```

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- TODO: Visualizations of behaviour would be nice

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- **`lockstep`**: Iterates n ranges in lockstep, for use in a foreach loop. Similar to zip, except that lockstep is designed especially for foreach

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- **`dropOne`**: Creates the range that results from discarding the first elements from the given range.
- **`repeat`**: Creates a range that consists of a single element repeated n times, or an infinite range repeating that element indefinitely.
- **`cycle`**: Creates an infinite range that repeats the given forward range indefinitely. Look ma no types!:

```
import std.range;
auto b = [1,2,3,4]; // buffer
auto cb = b.cycle; // circular buffer
```

- **`zip`**: Given n ranges, creates a range that successively returns a tuple of all the first elements, a tuple of all the second elements, etc.
- **`lockstep`**: Iterates n ranges in lockstep, for use in a foreach loop. Similar to zip, except that lockstep is designed especially for foreach

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- Removes need for C++'s pointer member access operator: `->`

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- **Static** (Stack) Compile-Time Checked with *Value*-Semantics:

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int[2] a;
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ubyte[\$] b = [1,2,3]; // type given, length inferred (v2.066)
a[] = b[]; // mismatched array lengths, 2 and 3
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  GC-escapeable from function calls makes use easy and robust.

- Dynamic **Scoped** (Heap):

```
scoped auto a = [1,2];
```

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- Compare with C/C++11/C++14's Complexity: `T[]`, C99 VLA, `std::vector`, `std::array`, `std::valarray`, `std::dynarray`, etc.
- Safe by default (even in release mode): 90 % of (browser) security holes are memory overruns.

Pragmatic Array Slice Semantics

Eventhough this, at first sight, seem inconsisent this is *really* what we want in pattern (regexp) matching algorithms.

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static assert([].ptr != null);
static assert("ab"[$..$].ptr == null);
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- Zero-length slices are not null

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static assert("ab"[0..0] == []);
static assert("ab"[$..$] == []);
static assert("ab"[$..$] !is null);
static assert("ab"[$..$] == null);
static assert("ab"[0..0] == "ab"[$..$]);
static assert("ab"[0..0]); // contextual hit (BOL)
static assert("a\nb"[2..2]); // contextual hit (beginning of
    second line)
static assert("ab"[$..$]); // contextual hit (EOL)
```

Associative Arrays (Maps) Builtin & Done Right

No need for separate construction of map values:

```
string[][int] tags;
tags[13] ~= "Alice";
```

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- String Overview

Letter Type	*String Type*	*Code Length*	*Range Concept*	*Algorithms*
`char`, `wchar`	`string`, `wstring`	Variable	BiDirectional	Levenshtein Distance
`dchar`	`dstring`	Fixed	RandomAccess	Quick Sort

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- To date – not a single classic `for` loop

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- *Imperative (Blue)* Style (Side-Effects):

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foreach (elt; range) {
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foreach (elt; range.map!"a*a") {
    elt.doSideEffect;
}
```

- *Functional-Lambda* (White?) Style:

```
10.times!({ doSideEffect; });
```

Correctness: `unittest` builtin everywhere

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unittest { assert(something); }
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- and in places such as

```
const i = readInRunTime!ubyte;
const j = readInRunTime!ubyte;
const ij = i*j;
ushort y = ij; // no cast needed
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- *Contract*-Based Programming using

```
in {} out (result) {} body {}
```

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  - Code: pure, in, out, body, invariant, unittest + assert

Transactional Part 1: scope statement

Makes writing a *safe* cp in D a no-brainer:

```
import std.exception, std.file;
void main(string[] args)
{
    enforce(args.length == 3,
            "Usage: trcopy file1 file2");
    auto tmp = args[2] ~ ".messedup";
    scope(failure) {
        if (exists(tmp))
            remove(tmp);
    }
    copy(args[1], tmp);
    rename(tmp, args[2]);
}
```

Transactional Part 2: Exception-Safe Constructors

- D uses Copy-And-Swap Principle

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- C++ does not => Not Exception-Safe!

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- For larger projects **SCons** supports D

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- Multi-threading Unittesting will give further speedups

Compilation Speed Consequences 1

Enables use of new tools such as

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- Instant (1s) Syntactic and Semantic Analys for Project around 20k lines
- **Type-Rich Programming** finally becomes *practically* doable in *real* large projects, not just toy examples (such as in `Boost.Units`). Library error-messages can also be made understandable thanks to *alias*es and string template arguments. Having (physical) **unit analysis** checked by the compiler is another quantum leap code correctness.

Compilation Speed Consequences 2

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- Module-Executable-Hybrid Behaviour á lá Python, MATLAB, etc.

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- Better optimizations, safety checks, static analysis, etc

Safe Concurrency by default

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- Threads become *isolated* LWP

Safe Concurrency: Example

```
import std.concurrency: spawn;

alias T = string[];

void useArgs(const T x)
{
    import std.stdio: writeln;
    writeln("x: ", x);
}

void main(T args)
{
    useArgs(args); // ok to call in same thread
    auto f1 = spawn(&useArgs, args.idup); // ok
    auto f3 = spawn(&useArgs, args); // errors as: "Aliases to
        mutable thread-local data not allowed."
}
```

Message Passing

- Unique Feature: Messages are automatically dynamically typed and can be pattern matched on like in dynamic languages! Enabled by close interaction with compiler, type mangling (serialization) etc.

```
import std.concurrency;
void f(Tid tid)
{
    receive(
        (int i) { /* do something with i */ }
    );
    send(tid, true);
}
void main()
{
    auto tid = spawn(&f, thisTid); // async call f
    send(tid, 42);
    const ok = receiveOnly!(bool);
    assert(ok);
}
```

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- Example: Close to optimal speedup:

```
import std.algorithm, std.parallelism, std.range;
void main() {
    immutable n = 1_000_000_000;
    immutable delta = 1.0 / n;
    real getTerm(int i) {
        immutable x = ( i - 0.5 ) * delta;
        return delta / ( 1.0 + x * x ) ;
    }
    immutable pi = 4.0 * taskPool.reduce!"a+b"(
        std.algorithm.map!getTerm(iota(n))
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- NaNs propagate through system without bringing the system down but still indiciates something is wrong.

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- Upcoming Custom Allocators in Phobos: `std.allocator`

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- This reduces code bloat more than *any* other *imperative* (non Haskell-like) language

Expressiveness: Meta-Programming

Compile-Time-Function-Evaluation (CTFE) ,

realized by the Combo: (**`pure`** & **`immutable`**) + **`static if`**, enables

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  - `std.regex.ctRegex` fastest in the world!

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- Executed at Run-time:

```
auto a = f();
const c = f();
immutable i = f();
```

CTFE + Mixin Magic: Pegged

```
import pegged.peg;
import pegged.grammar;
pragma(lib, "pegged");

mixin(grammar(`
Arithmetic:
    Term     < Factor (Add / Sub)*
    Add      < "+" Factor
    Sub      < "-" Factor
    Factor   < Primary (Mul / Div)*
    Mul      < "*" Primary
    Div      < "/" Primary
    Primary  < Parens / Neg / Number / Variable
    Parens   < "(" Term ")"
    Neg      < "-" Primary
    Number   < ~([0-9]+)
    Variable <- identifier`));

void main(string[] args) {
    enum parseTree1 = Arithmetic("1 + 2 - (3*x-5)*6");
    assert(parseTree1.matches == ["1", "+", "2", "-",
           "(", "3", "*", "x", "-", "5", ")", "*", "6"]);
}
```

Concise and Uniform Syntax

```
ubyte someByte = 13;
string someString = "alpha";
auto someNumber = 42;
enum someConstant = 1;
const iPromiseToNeverChangeThisValue = 1;
immutable thisValueCanNeverBeChangedByAnyone = 1;
alias goodName = badName; // potentially many overloads
```

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- Consequence: Many github projects are one D file!

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- This makes it trivial to break out classes and functions into new separate files.

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Expressiveness: Type Construction

Haskell-Like Elegance in Type Construction:

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alias Pair(T) = Tuple!(T, T);
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- **Facebook**!: Andrei, Proof-of-Concept, Bounties
- **EMSI**: Economic Modeling Specialists Intl
- **STACK4**: Gameserver Backend written in D 2
- **SR Labs**: Eye Tracking Systems Integrator
- **Funatics Software GmbH**: MMO Game Developer
- **RandomStorm**: network security products and services

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- **Nested functions**: Capture scope of parent

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- **DCD**: D Completion Daemon: Server-Client! Frontends for Emacs, Vi, Sublime Text, etc.

Learning Curve & Cons

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- CTFE is slow for complex usage such as **Pegged**.

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- Strongly-Typed "Nullness" á lá Haskell's `Maybe`: `NotNull` or `@nullable`: No more "null-pointer-exceptions".

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Conclusion: Component Programming

Features come together in an elegant and concise harmonyReusable Software with native performance!

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- Flexibility: Fulfils more needs than any other language

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- Ask not..
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The End

Let's make the best candidate win!