A Walk on the Dart Side

A Quick Tour of

DART

Gilad Bracha

Joint Work with the Dart Team

Dart at 50,000 feet

Language for Web Programming

Sophisticated Web Applications need not be a tour de force

Google

Constraints

Instantly familiar to the mainstream programmer

Efficiently compile to Javascript

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Dart in a Nutshell

Purely Object-Oriented, optionally typed, class-based, single inheritance with actor-based concurrency

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So what's so interesting?

*Pure Object-Oriented, **optionally typed**, class-based, single inheritance with actor-based concurrency*

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Some Modest Innovations

Optional types

Built-in Factory Support

ADTs without types

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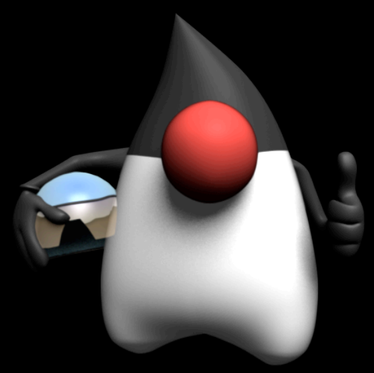
Mandatory Types



Optional Types

DART

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Mandatory Types

Static type system regarded as mandatory

Maltyped programs are illegal

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A Brief History of non-mandatory Types

Common Lisp

Scheme (soft typing)

Cecil

Erlang

Strongtalk

BabyJ

Gradual Typing

Google™

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Optional Types

Syntactically optional

Do not affect run-time semantics

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What does it look like?

Checked Mode

```
1  class Point {
2    Point(this.x, this.y);
3    var x, y;
4    operator +(other) => new Point(x + other.x, y + other.y);
5    scale(factor) => new Point(x * factor, y * factor);
6    distance() {
7      return Math.sqrt(x*x + y*y);
8    }
9  }
10
11 main() {
12   var a = new Point(10, 10);
13   var b = new Point(2, 3).scale(10);
14   print("distance=${(a+b).distance()}");
15 }
```

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Mandatory Types: Pros

In order of importance:

Machine-checkable documentation

Types provide conceptual framework

Early error detection

Performance advantages

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Mandatory Types: Cons

Expressiveness curtailed

Imposes workflow

Brittleness

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Optional Types:
Can we have our Cake and Eat it Too?

Documentation (for humans and machines- but not verifiable)

Types provide conceptual framework

Early error detection

Performance advantages (much attenuated)

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Optional Typing Precludes ...

Type-based overloading

Type based initialization, e.g.,

int i; *cannot mean* **var i: int = 0;**

Type classes, C# extension methods ...

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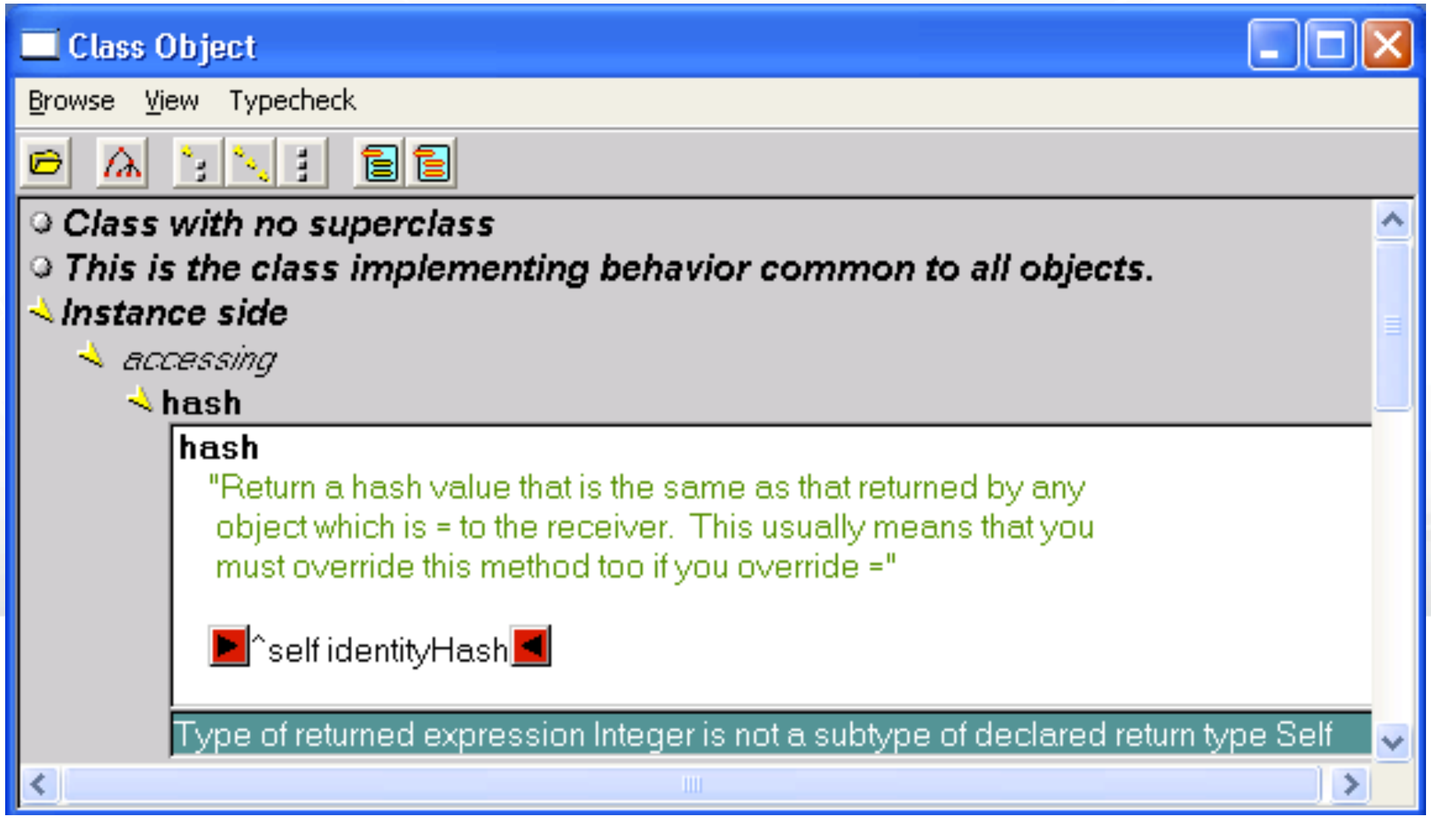
So what's actually new?

Didn't we have all this in Strongtalk in 1993?



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Type Assertion Support

*Dart's optional types are best thought of as a type assertion mechanism, **not** a static type system*

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Dart Types at Runtime

- *During development one can choose to validate types*
  - `T x = o;` ⟶ `assert(o === null || o is T);`
- *By default, type annotations have no effect and no cost*
- *Code runs free*

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Checked Mode

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Not your Grandfather's Type System

Not a type system at all -

rather a static analysis tool based on heuristics, coupled to a type assertion mechanism

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What about a real, sound, type system?

There is no privileged type system, but pluggable types are possible

For example, one can write a tool that interprets existing type annotations strictly

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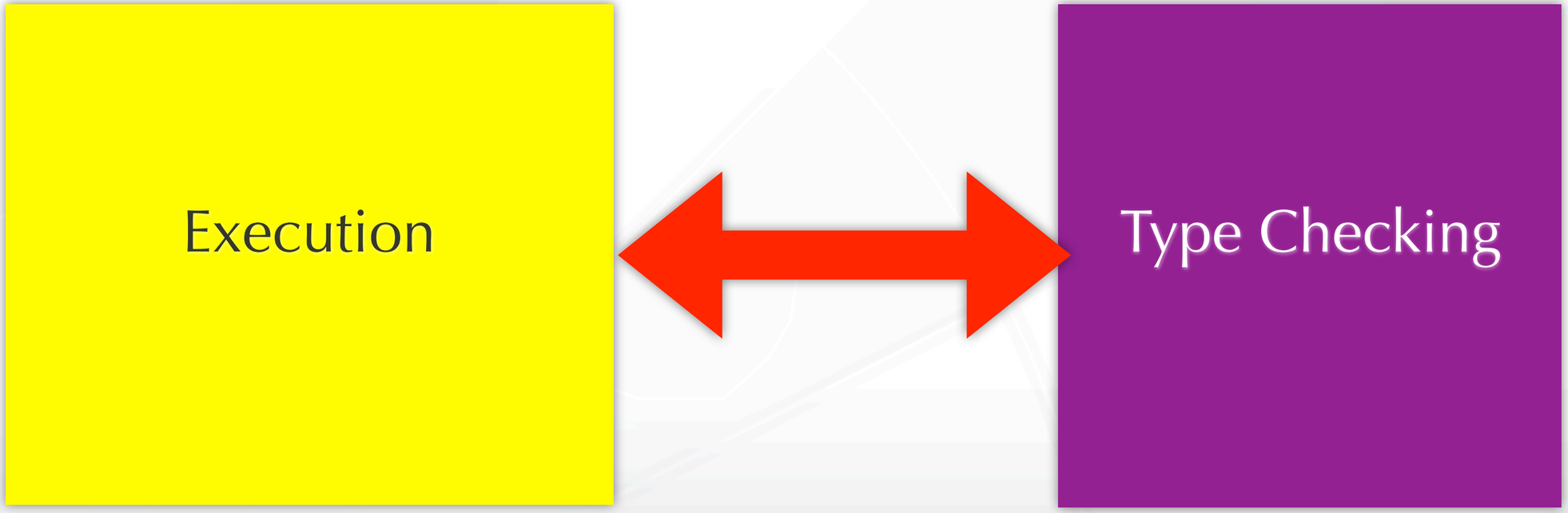
Runtime dependent on Type System



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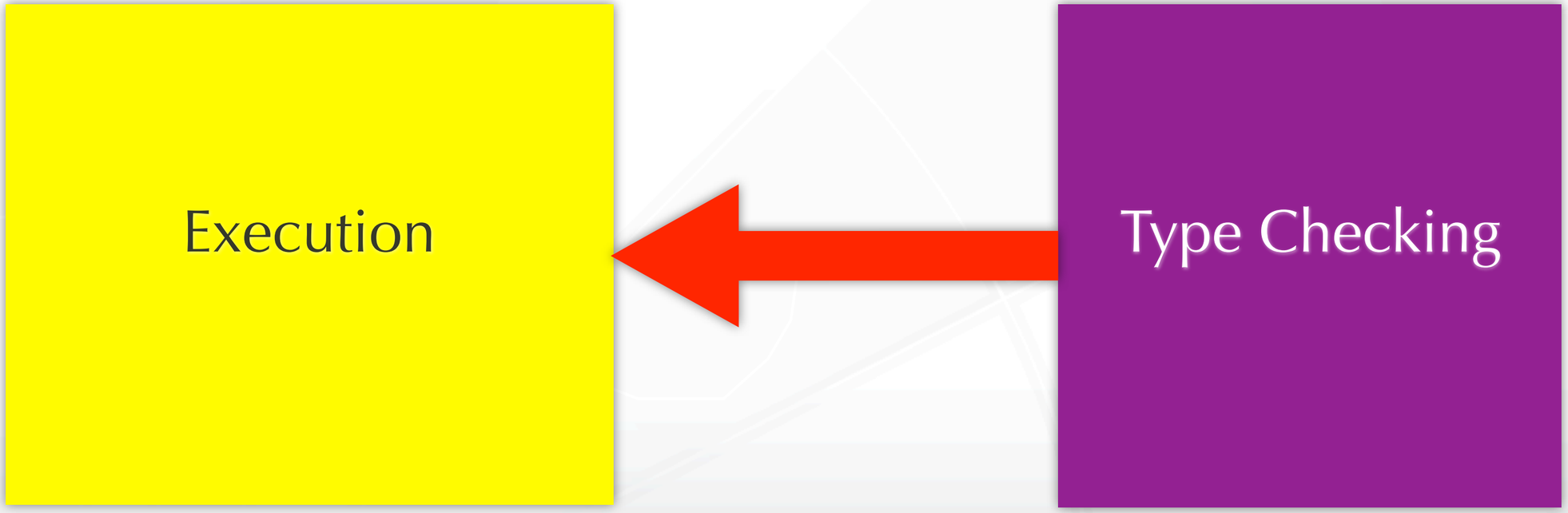
Runtime Independent of Type System



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What about type inference?

Type Inference relates to Type Checking as Type Checking to Execution

Type inference best left to tools

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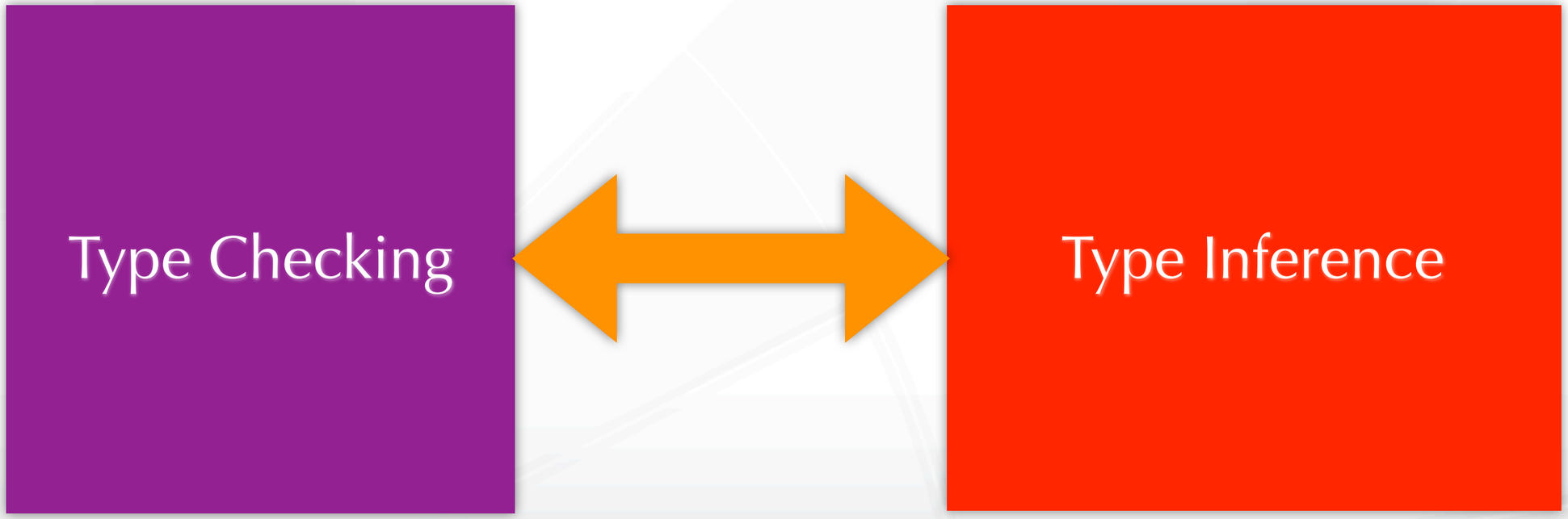
Type System dependent on Type Inference



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Type System Independent of Type Inference

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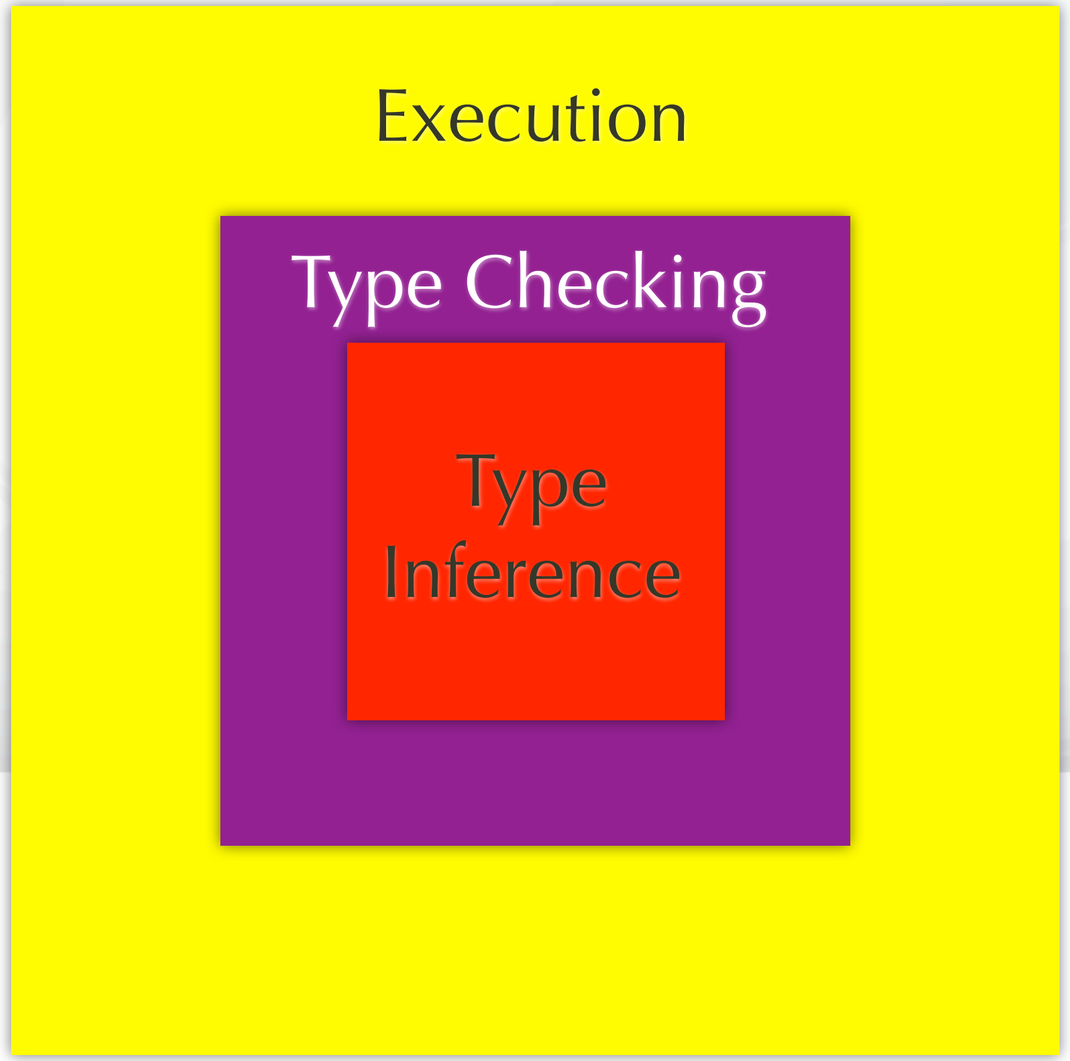
Don’t get Boxed-In



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Interfaces

Every class induces an implicit interface

Interfaces are reified at runtime

Type tests are interface based

You can implement the interface of another class without subclassing it

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Generics

Reified

Covariant subtyping

```
print(new List<String>() is List<Object>);
print(new List<Object>() is List<String>);
print(new List<String>() is List<int>);
print(new List<String>() is List);
print(new List() is List<String>);
```

Yes, Virginia, it isn't sound

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Optional Types and Reified Types

Annotations do not affect semantics

Type arguments to constructors? Interfaces?

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Optional Types and Reified Types

Annotations do not affect semantics

Type arguments to constructors? Interfaces?

Type Arguments to constructors are optional, but are reified

Type tests are a dynamic construct that relies on reified interfaces

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Summary: Optional Types

- *Static checker provides warnings; tuned to be unobtrusive*
- *Type annotations have no effect except ...*
- *During development, you can check dynamic types against declarations*

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But is it Dynamic?

noSuchMethod

Mirrors & Debugging

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Some Modest Innovations

Optional types

ADTs without types

Built-in Factory Support

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Libraries and ADTs

A Library is a set of top-level classes, interfaces and functions

Libraries may be be mutually recursive

Libraries are units of encapsulation

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Libraries and ADTs

Library based privacy

- based on names

- _foo is private to the library

- naming and privacy are not orthogonal :-(

- privacy can be recognized context-free :-)

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Interfaces vs. ADTs

How to reconcile?

- interfaces based on externally visible behavior

- ADTs based on implementation

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Interfaces vs. ADTs

What happens when we implement an interface with private members?

```
// in library 1

class A { var _foo = 0;}

foo(A a) => a._foo;

// in library 2

class B implements A {int get _foo()=> 42;}

foo(new B());
```

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Interfaces vs. ADTs

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Interfaces vs. ADTs

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foo(A a) => a._foo; // Warning?

// in library 2

class B implements A {int get _foo()=> 42;}

foo(new B());
```

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Interfaces vs. ADTs

```
class B implements A {

  int get _foo()=> 42;

  noSuchMethod(msg){

    msg.name = '_foo' ?msg.sendTo(this): super.noSuchMethod(msg);

  }

}
```

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Some Modest Innovations

Optional types

ADTs without types

Built-in Factory Support

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Factories

Constructors without tears

Use caches, return other types of objects

Instance creation expressions based on interfaces

Minimize need for Dependency Injection

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Factories

Checked Mode

```
1  interface Person factory PersonFactory {
2    Person(name);
3    final name;
4  }
5
6  class PersonFactory {
7    factory Person(name) {
8      if (name == null) return const Ghost();
9      return new RealPerson(name);
10   }
11 }
12
13 class RealPerson implements Person {
14   RealPerson(this.name);
15   final name;
16 }
17
18 class Ghost implements Person {
19   const Ghost();
20   get name() => "ghost";
21 }
22
23 main() {
24   print(new Person("gilad") is RealPerson);
25   print(new Person(null) is Ghost);
26 }
```

DART

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Dart is not Done

- *Mixins?*
- *Reflection*
- *High level actor semantics: await? Erlang-style pattern matching? Promise-pipelining?*
- *Class nesting? First class libraries? Non-nullable types?*
- *Metadata? Pluggable types?*

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Q & A

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