# 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*


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# 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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# Some Modest Innovations

*Optional types*

*ADTs without types*

*Built-in Factory Support*


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# Some Modest Innovations

***Optional types***

*ADTs without types*

*Built-in Factory Support*


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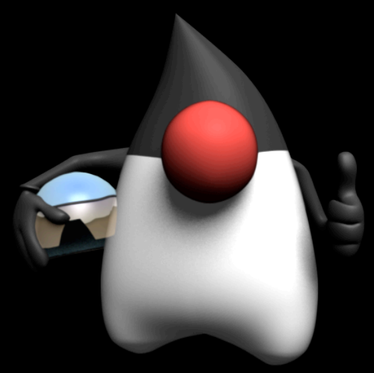
# Mandatory Types

# Optional Types

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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*


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# A Brief History of non-mandatory Types

*Common Lisp*

*Scheme (soft typing)*

*Cecil*

*Erlang*

***Strongtalk***

*BabyJ*

*Gradual Typing*


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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

```dart
class Point {
  Point(this.x, this.y);
  var x, y;
  operator +(other) => new Point(x + other.x, y + other.y);
  scale(factor) => new Point(x * factor, y * factor);
  distance() {
    return Math.sqrt(x*x + y*y);
  }
}

main() {
  var a = new Point(10, 10);
  var b = new Point(2, 3).scale(10);
  print("distance=${(a+b).distance()}");
}
```

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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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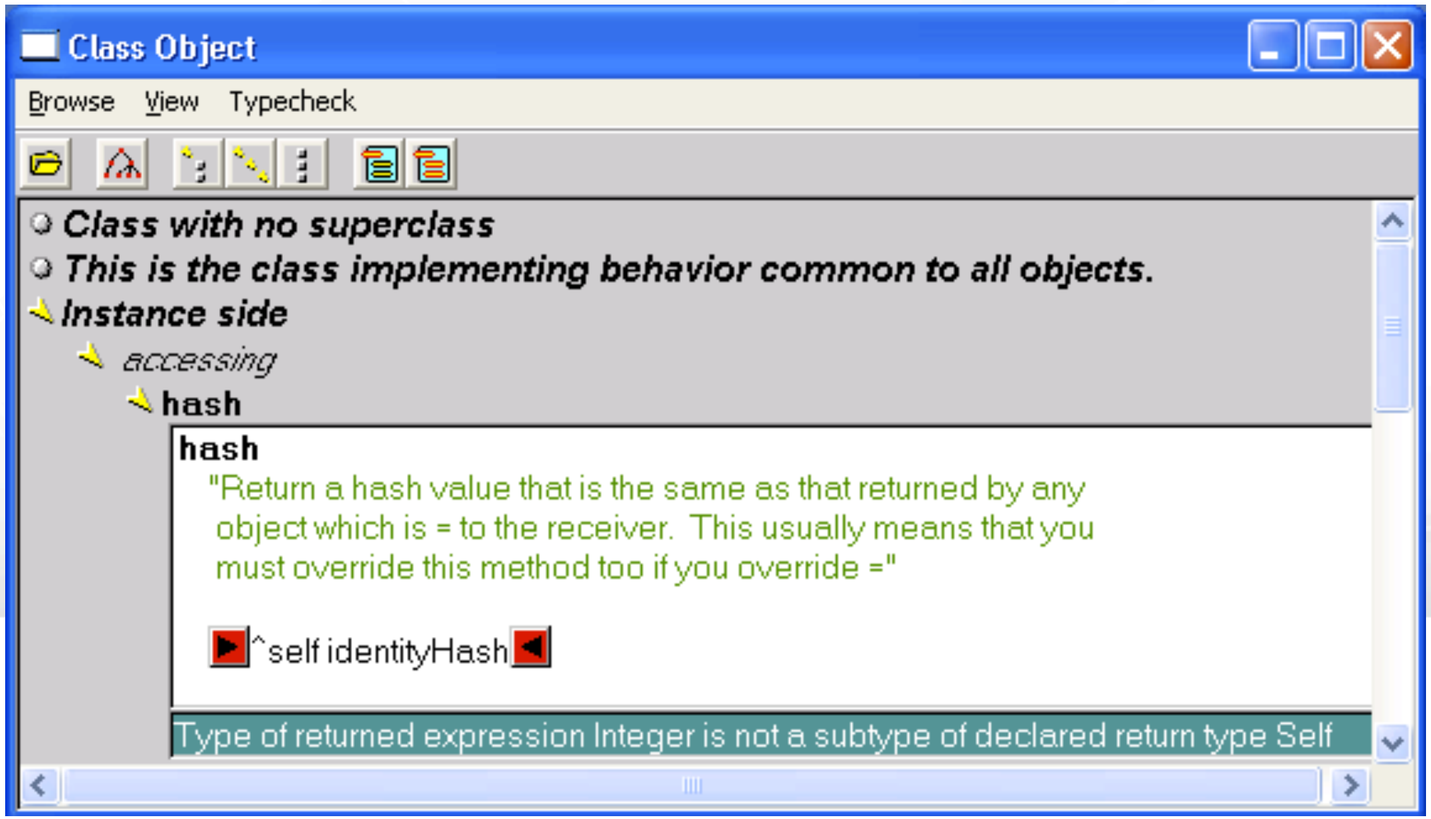
# So what's actually new?

*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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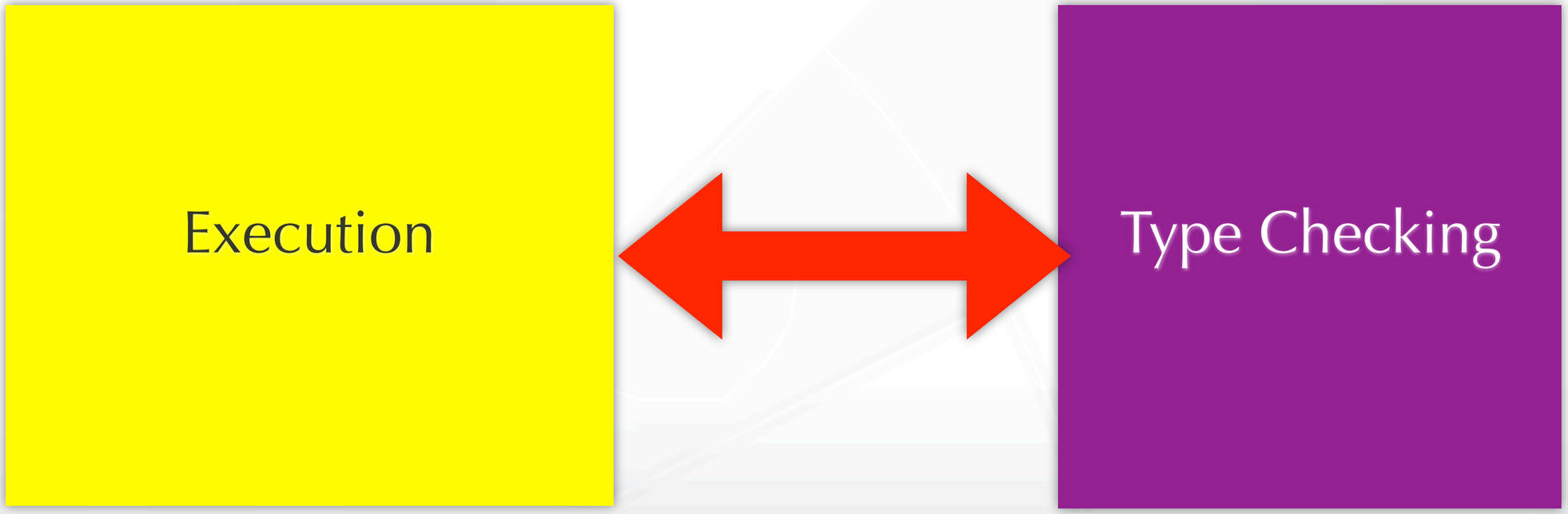
# Runtime dependent on Type System

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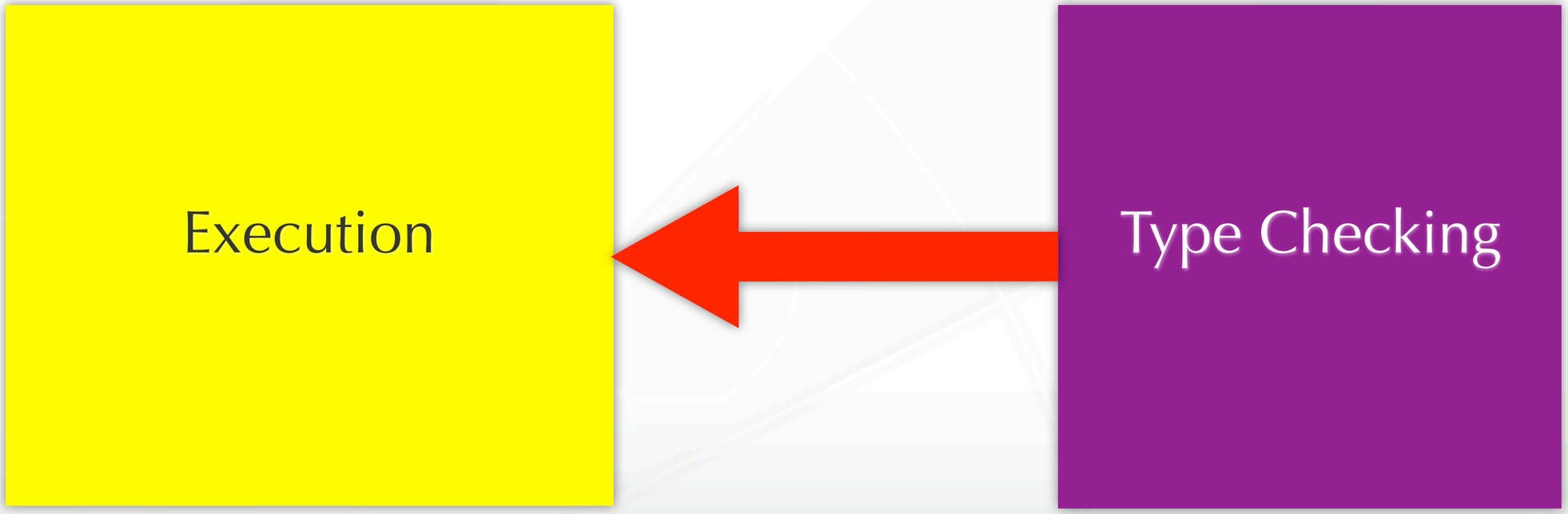
# Runtime Independent of Type System

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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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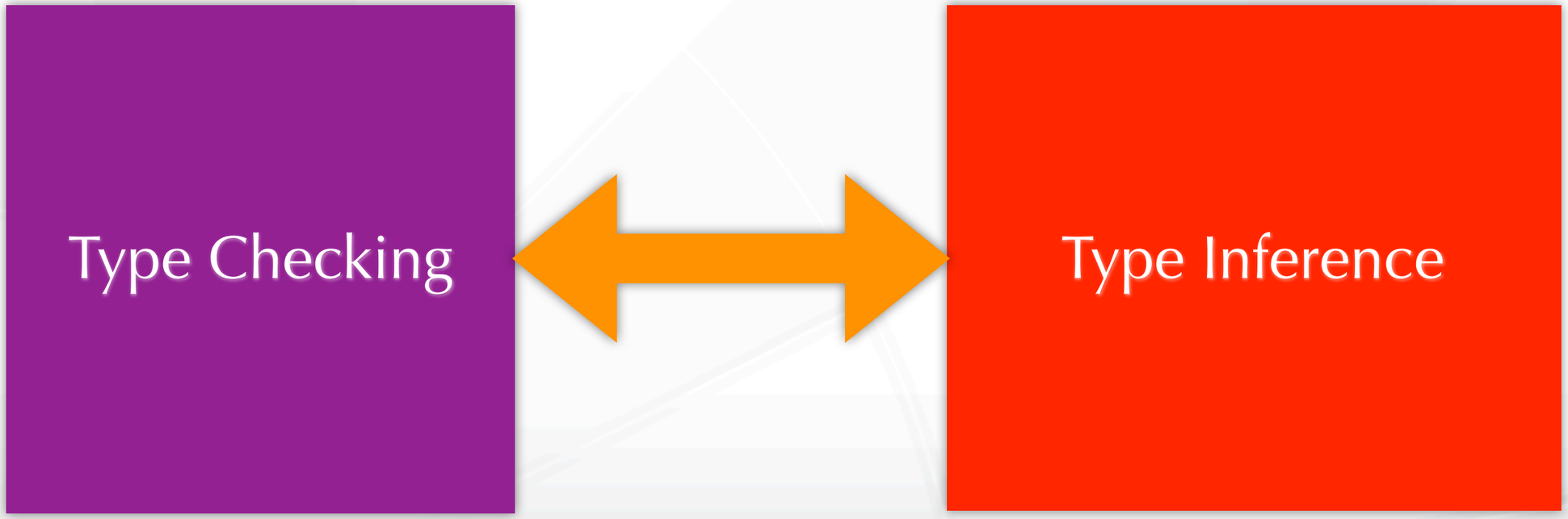
# Type System dependent on Type Inference

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# Type System Independent of Type Inference


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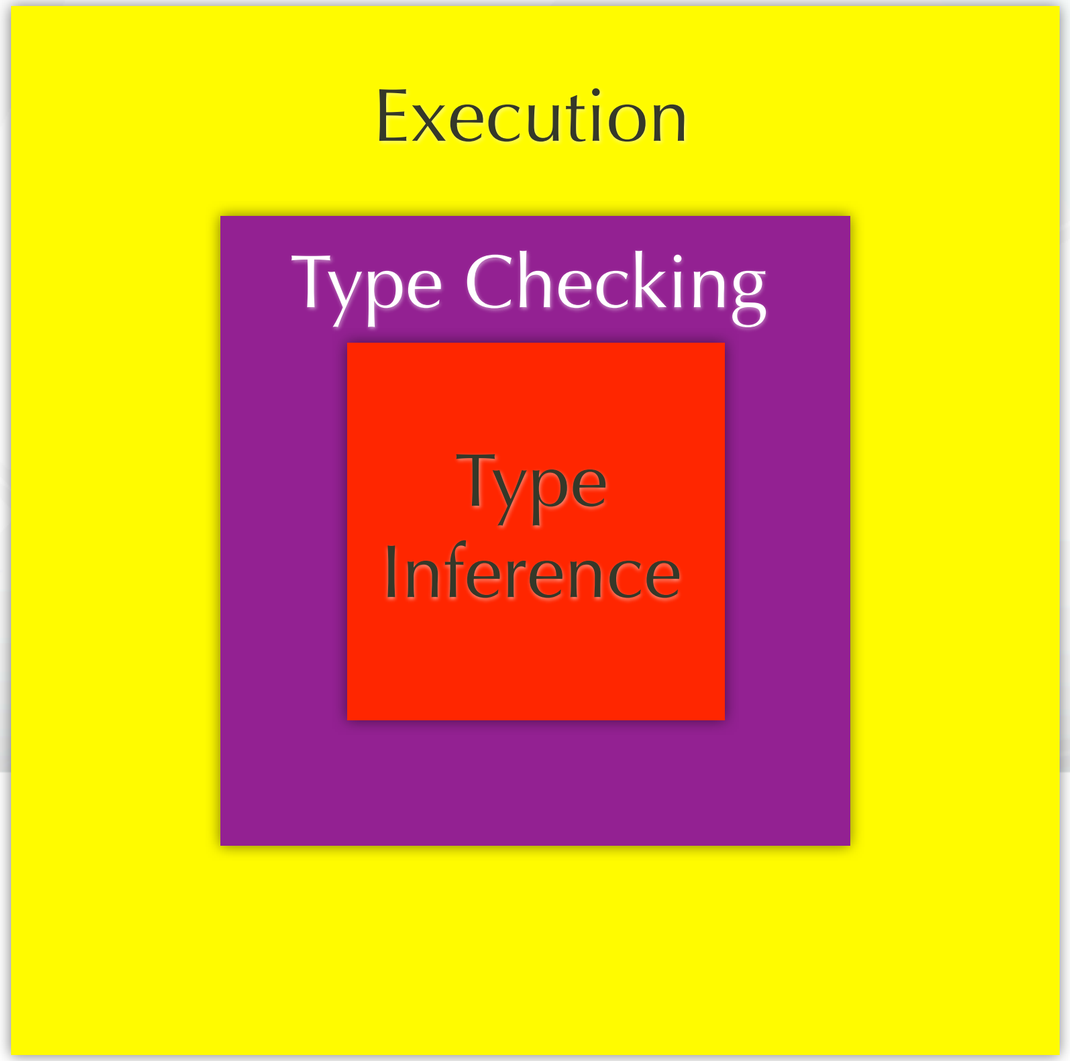
# Don’t get Boxed-In

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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 :-)*

# 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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// in library 1

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foo(A a) => a._foo

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# Interfaces vs. ADTs

*What happens when we implement an interface with private members?*

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// in library 1

class A { var _foo = 0;}

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 }
```

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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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