Information-rich programming in F#

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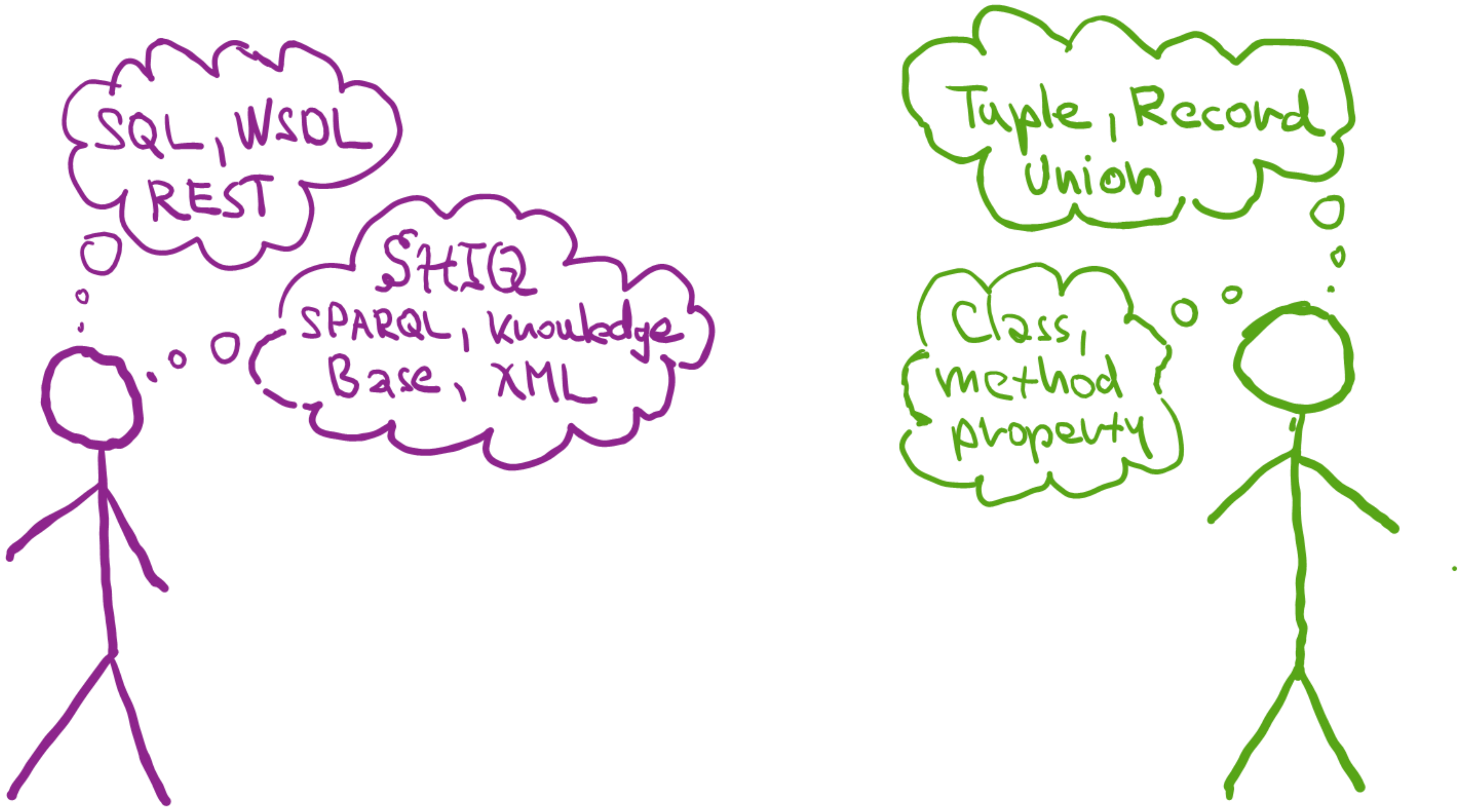
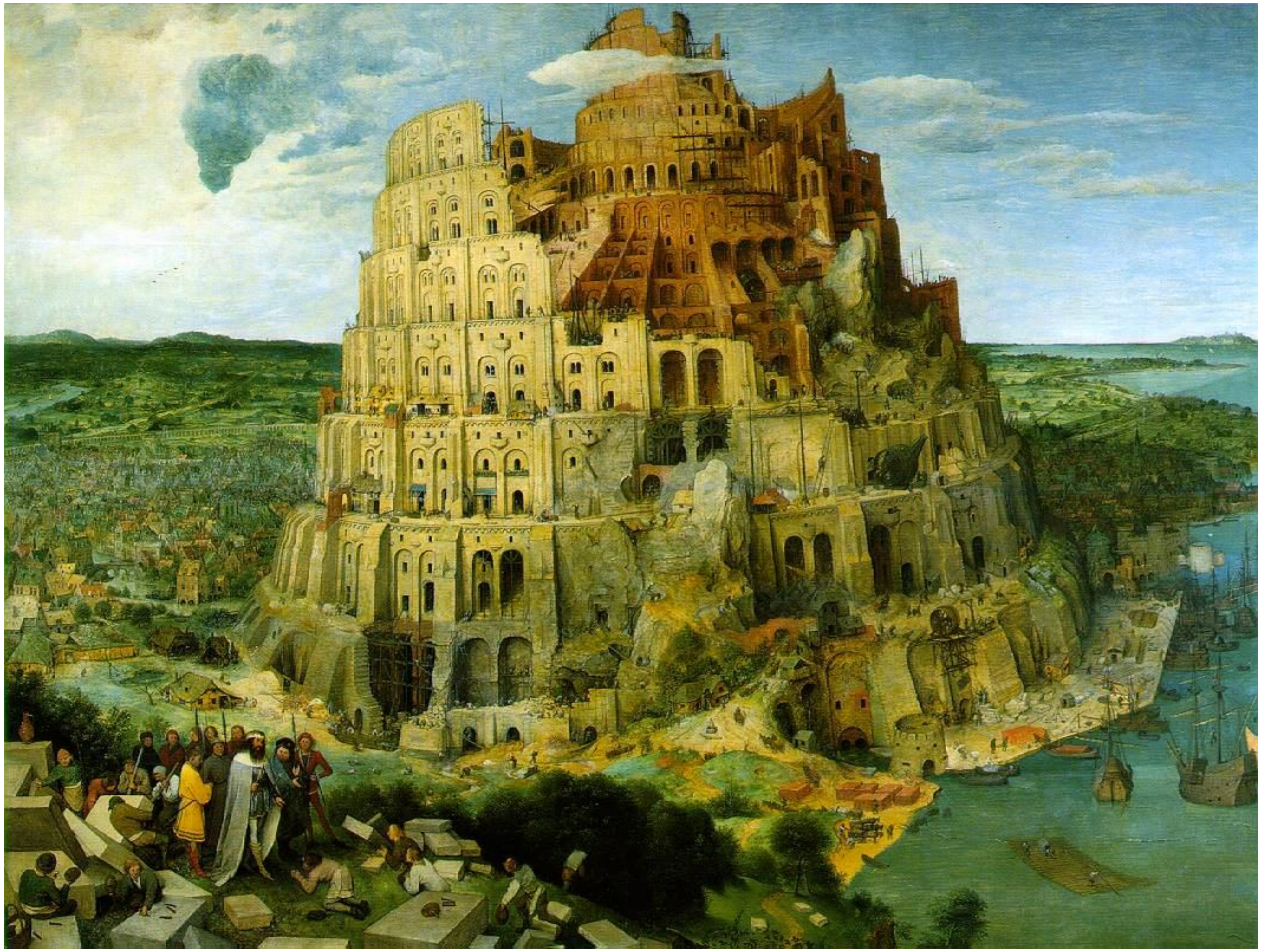
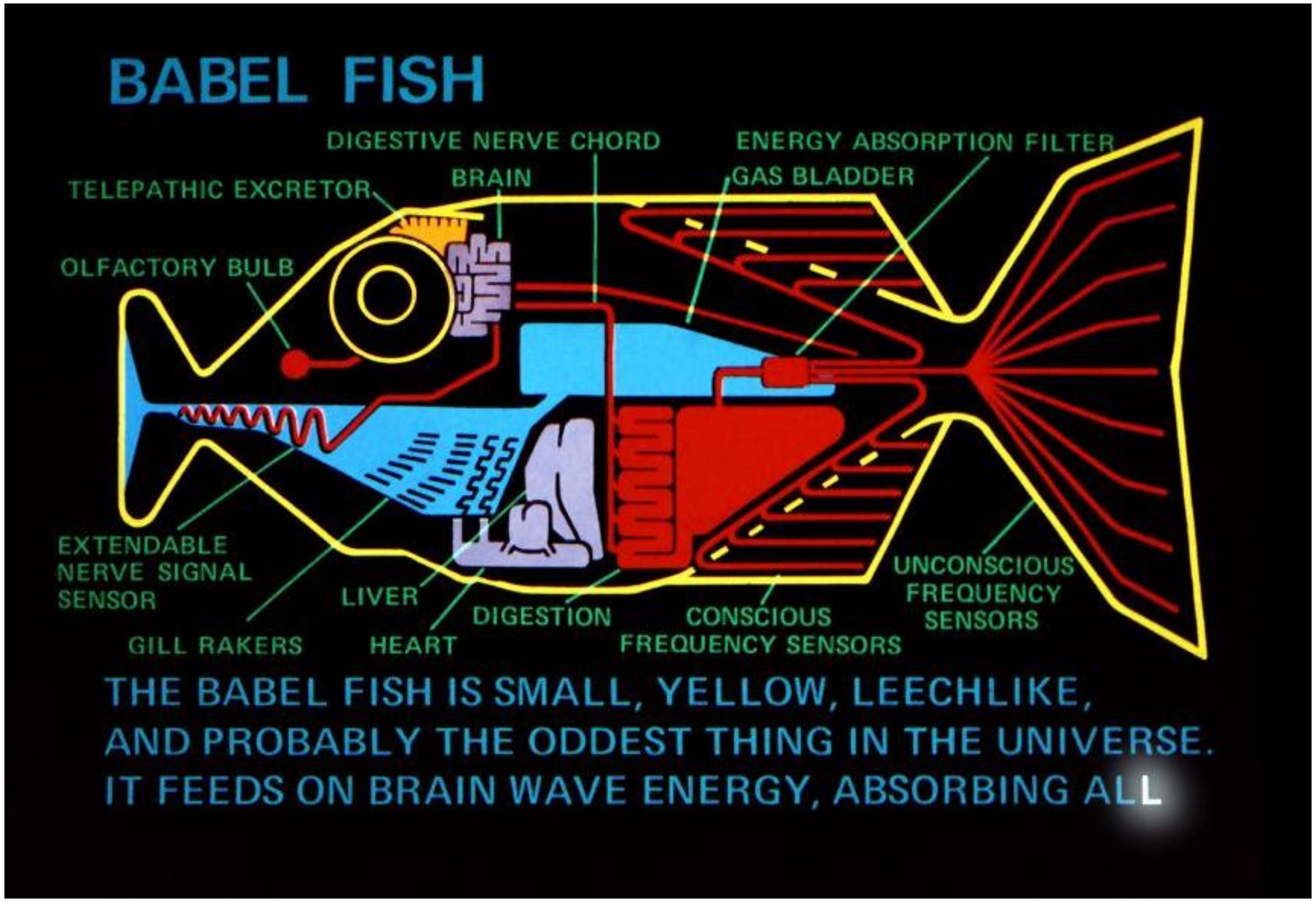
The confusion of languages



The confusion of languages



What is a type provider?


BABEL FISH
DIGESTIVE NERVE CHORD
ENERGY ABSORPTION FILTER
GAS BLADDER
BRAIN
TELEPATHIC EXCRETOR
OLFACTORY BULB
EXTENDABLE NERVE SIGNAL SENSOR
LIVER
DIGESTION
CONSCIOUS FREQUENCY SENSORS
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THE BABEL FISH IS SMALL, YELLOW, LEECHLIKE,
AND PROBABLY THE ODDEST THING IN THE UNIVERSE.
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DEMO: Accessing World Bank

Comparing **university enrollment rate** in **Czech Republic** and **OECD** countries

Problems with data access

Data is not types with members

Use dynamic languages?

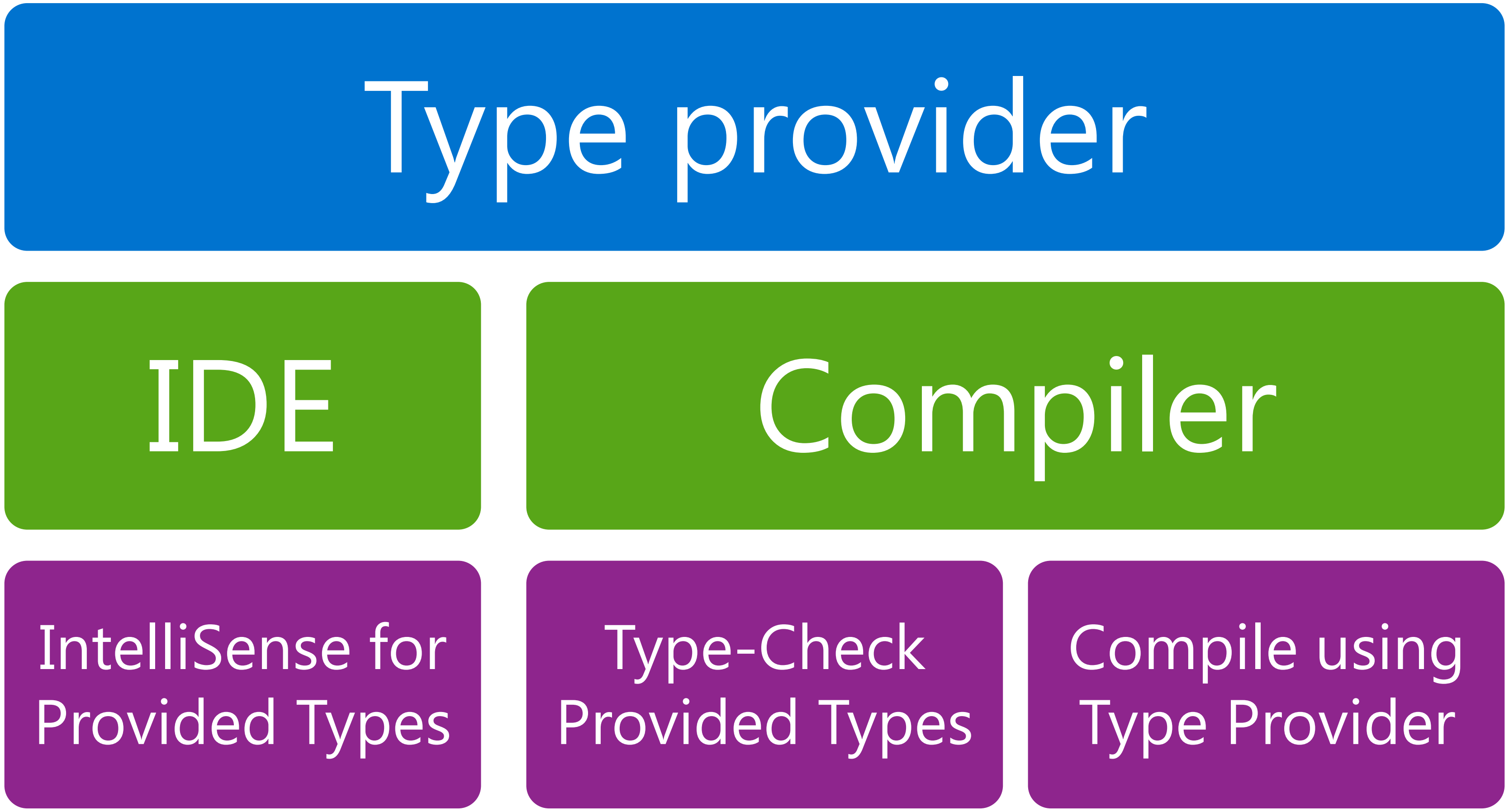
Need to know **names of properties**

Use code generation and static languages?

Enormous scale of data sources

Types need to be generated "on demand"

Components of a type provider


Type provider
IDE
Compiler
IntelliSense for Provided Types
Type-Check Provided Types
Compile using Type Provider

Research problems

Mapping data sources to types

    What is a type? What is a value?

Types are provided **on demand**

    Cannot generate all indicator types at once!

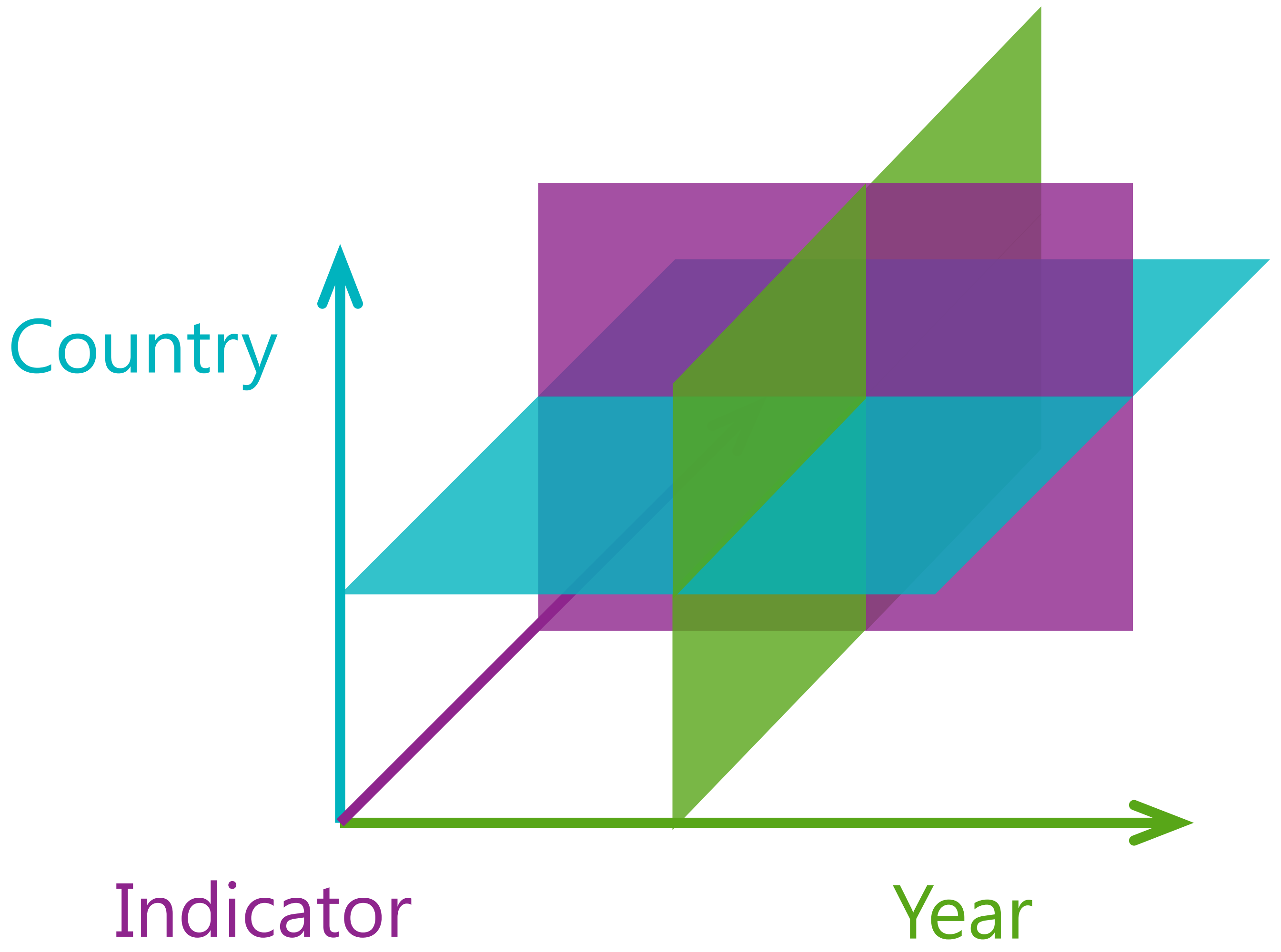
Representing **data source properties** as types

    Physical units, provenance, temporal properties

Adapting to **schema change**

    Type soundness is relative w.r.t. data source changes

Mapping data source to types



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Gamma, The Forgotten

Standard **typing judgments**

$$\Gamma \vdash e : \tau$$

Gamma on steroids

$$\Gamma = \ldots,\ \mathrm{WB.DataContext}$$

$$\mathrm{WB.DataContext} = \mathrm{Countries} : \mathrm{delay}(\ldots)$$

Country list

Reducing **delayed context**

$$\Gamma \vdash e : \tau \Rightarrow \Gamma'$$

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DEMO: XML Type Provider

Working with **XML data** and adapting to **schema change**

Related Work

Compile-time **meta-programming**

Types generated eagerly, not on demand

Dependently typed languages

Type-level computation in the IO monad??

Multi-stage computations

Focus on performance vs. data access

For more information

Upcoming technical report

Don Syme, et al. Strongly-Typed Language Support for an Information-Rich World

Workshop on related topics

Data Driven Functional Programming Workshop, **Co-located with POPL 2013**

Summary

Mismatch between **data** and **types**

- Type providers bridge the gap
- Development-time, compile-time & run-time

Interesting future questions

- Relative type safety and schema change
- Capturing meta-data with types

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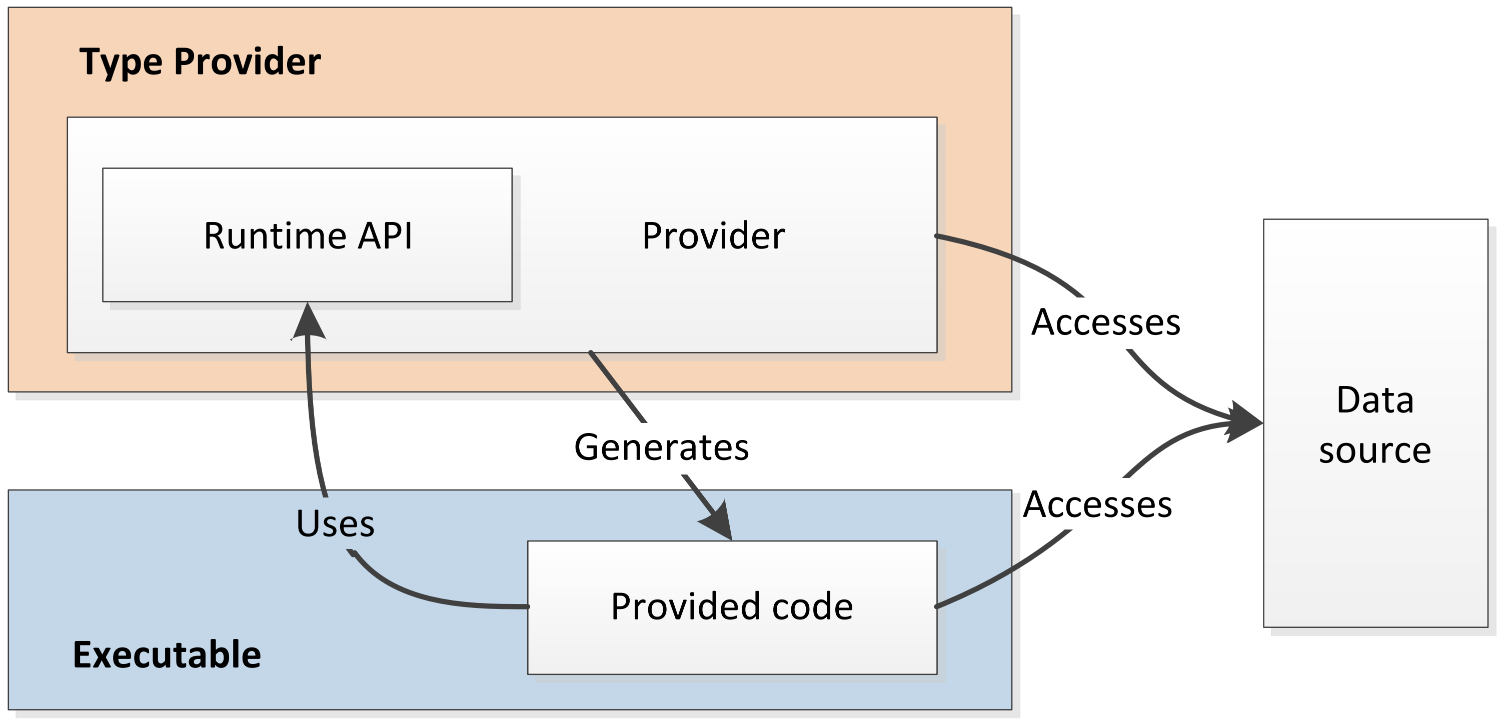
DEMO: FreeBase Type Provider

Working with **chemistry data**
and **units of measure**

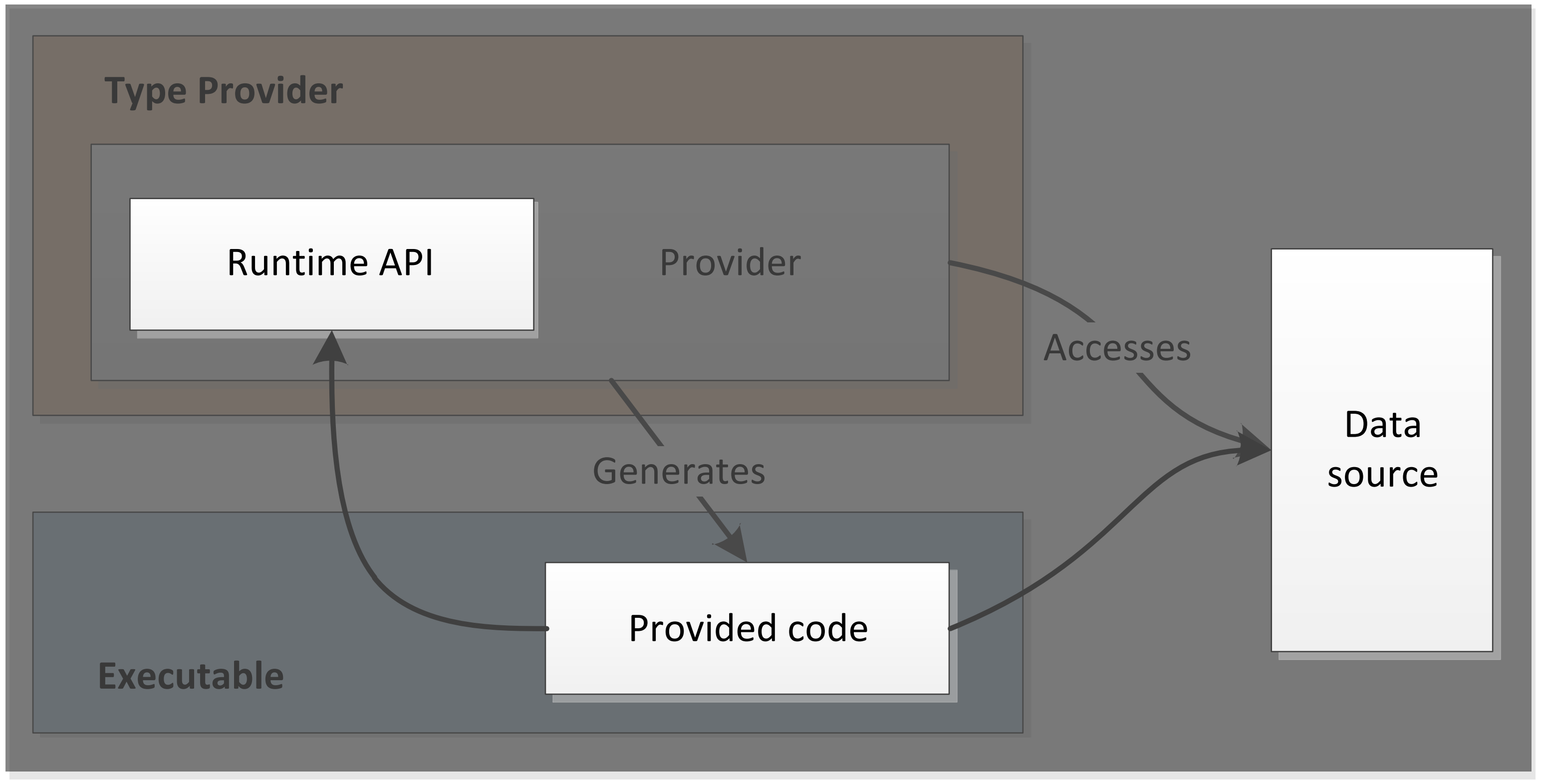
Structure of a Simple Provider

```
[<TypeProvider>]
type SampleTypeProvider(config: TypeProviderConfig) =
  inherit TypeProviderForNamespaces()

  // Define new type Samples.GeneratedType
  let thisAssembly = Assembly.GetExecutingAssembly()
  let providedType = ProvidedTypeDefinition( ... )
  do
    // Add property 'Hello' that just returns a string
    ProvidedProperty
      ( "Hello", typeof<string>, IsStatic = true,
        GetterCode = fun args -> <@@ Runtime.lookup "Hello" @@>)
    |> providedType.AddMember

    // Register the type with the compiler
    this.AddNamespace(namespaceName, [ providedType ])
```

Compile-Time vs. Run-time



Compile-Time vs. Run-time



Queries in F#

Can be turned to **quotations**

```
query { for movie in netflix.Titles do
        where (movie.Name.Contains(search))
        select movie }
```

Extensible query language

```
query { for index in Numbers do
        reverse
        takeWhile index > 10 }
```