Bootstrapping a Smalltalk

G. Casaccio, S. Ducasse, L. Fabresse, J-B. Arnaud, B. van Ryseghem

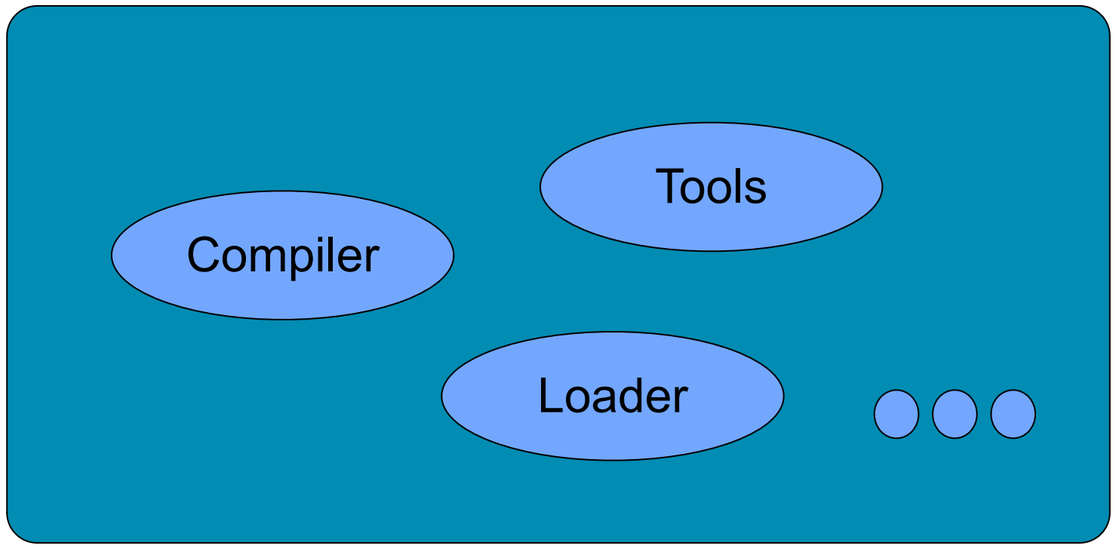
Presented by: M. Denker

What is Bootstrapping?

A process that builds
the minimal infrastructure of a language
that is reusable to define this language itself

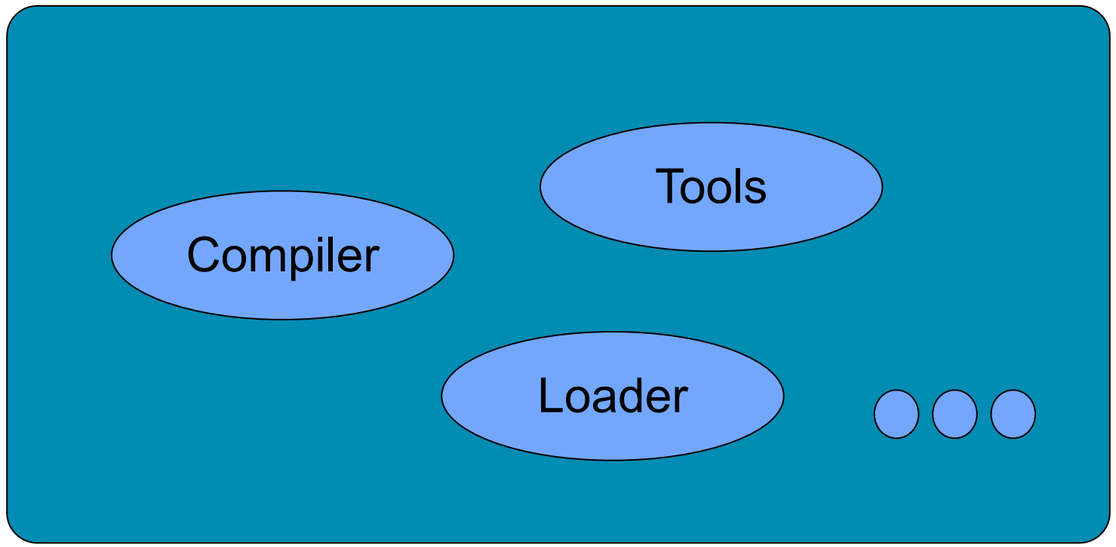
Example: Bootstrapping a language X

Language X



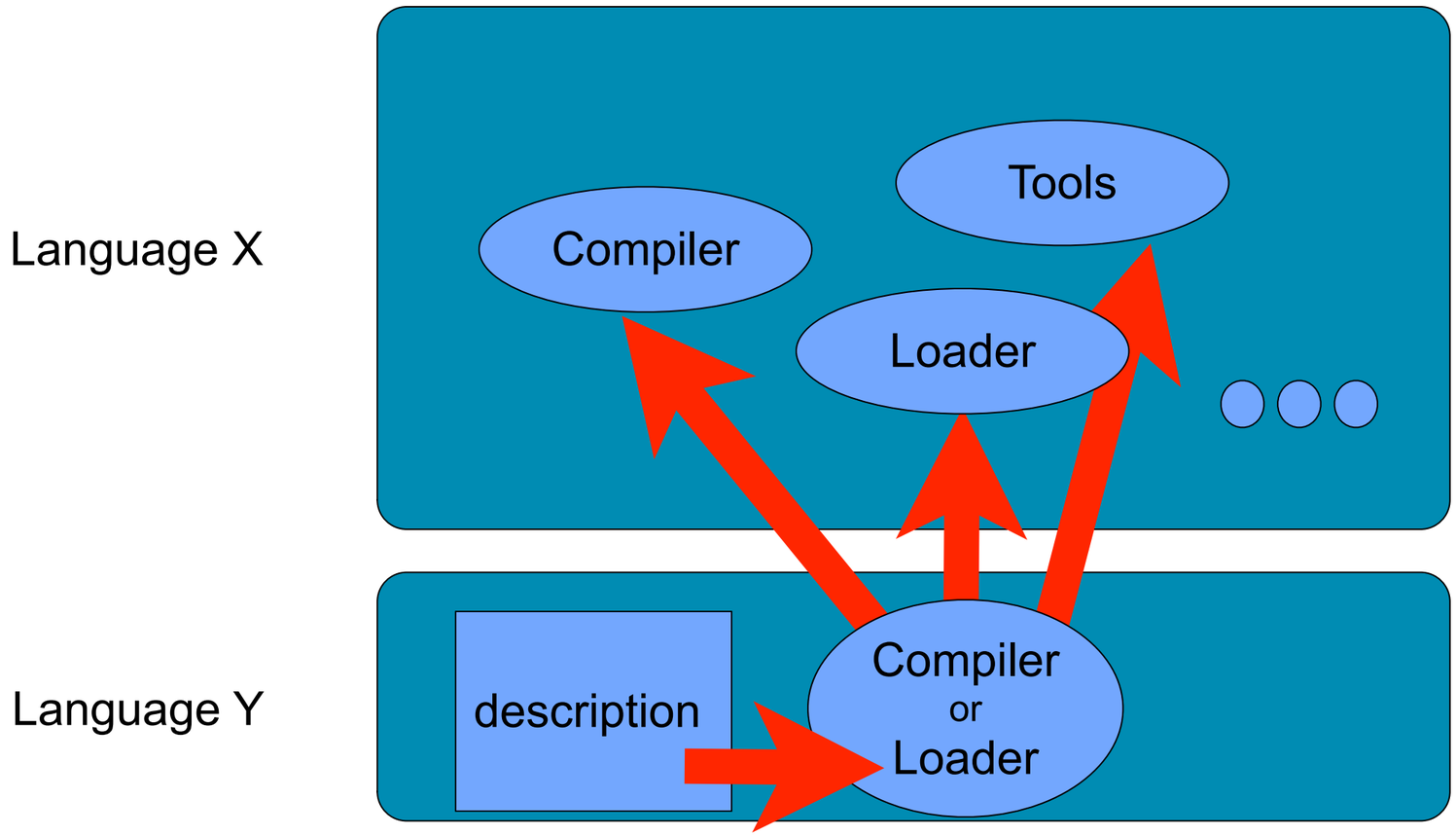
Example: Bootstrapping a language X

Language X



How to create/write all of this for language X?

Example: Bootstrapping a language X



Example: Bootstrapping a language X

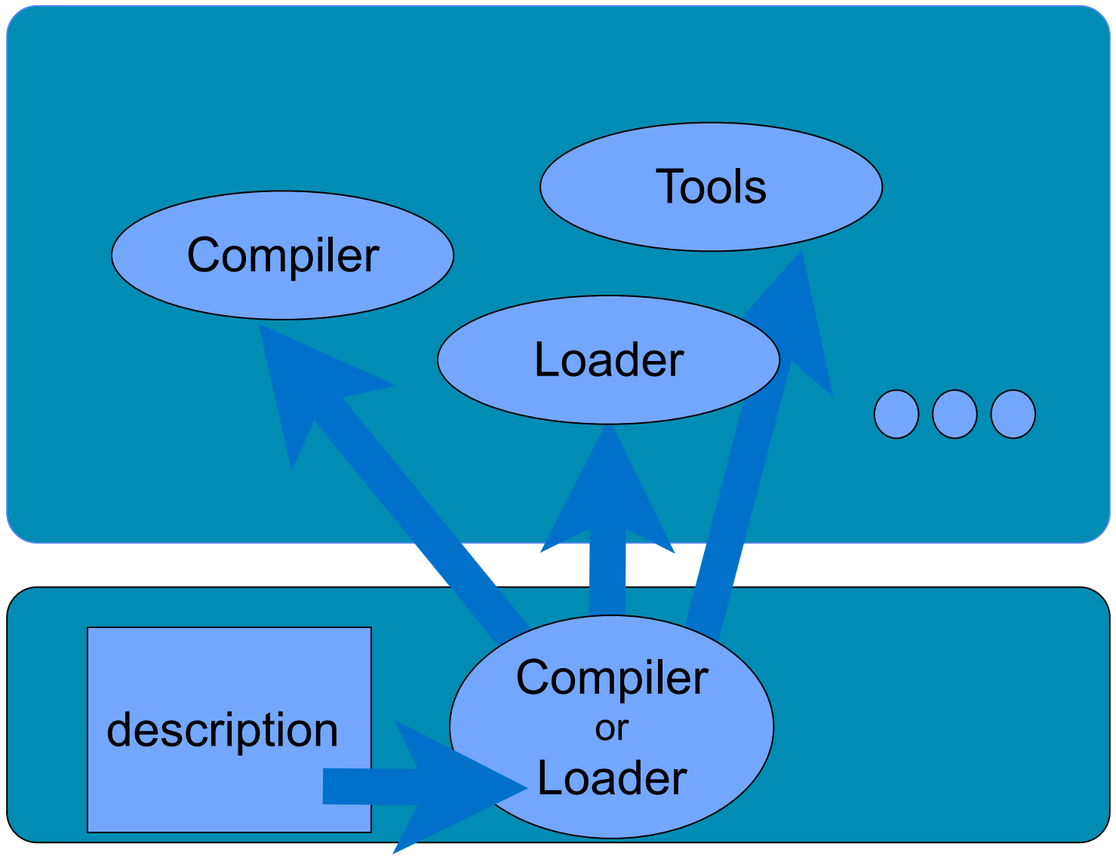
~~Language X~~

Resilient

≠

~~Language Y~~

Java



Example: Bootstrapping a language X

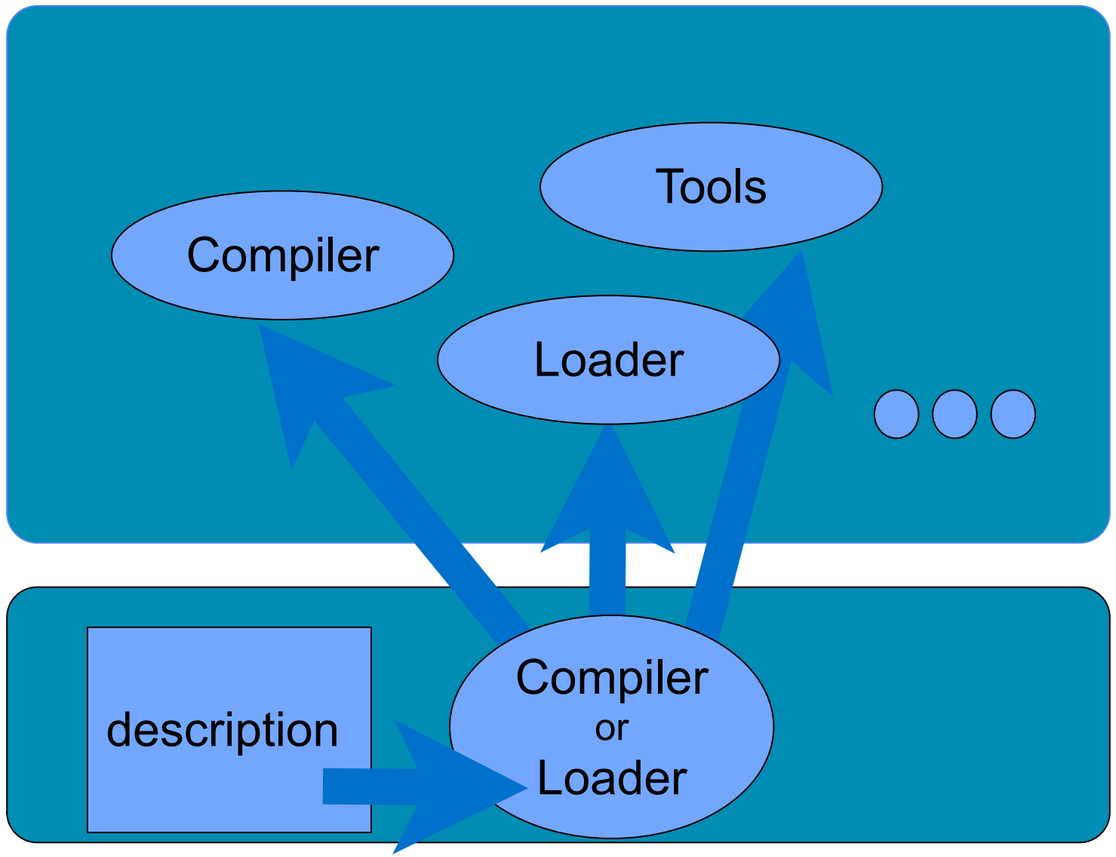
~~Language X~~

Squeak/Pharo

⊃

~~Language Y~~

Slang



Why Bootstrapping?

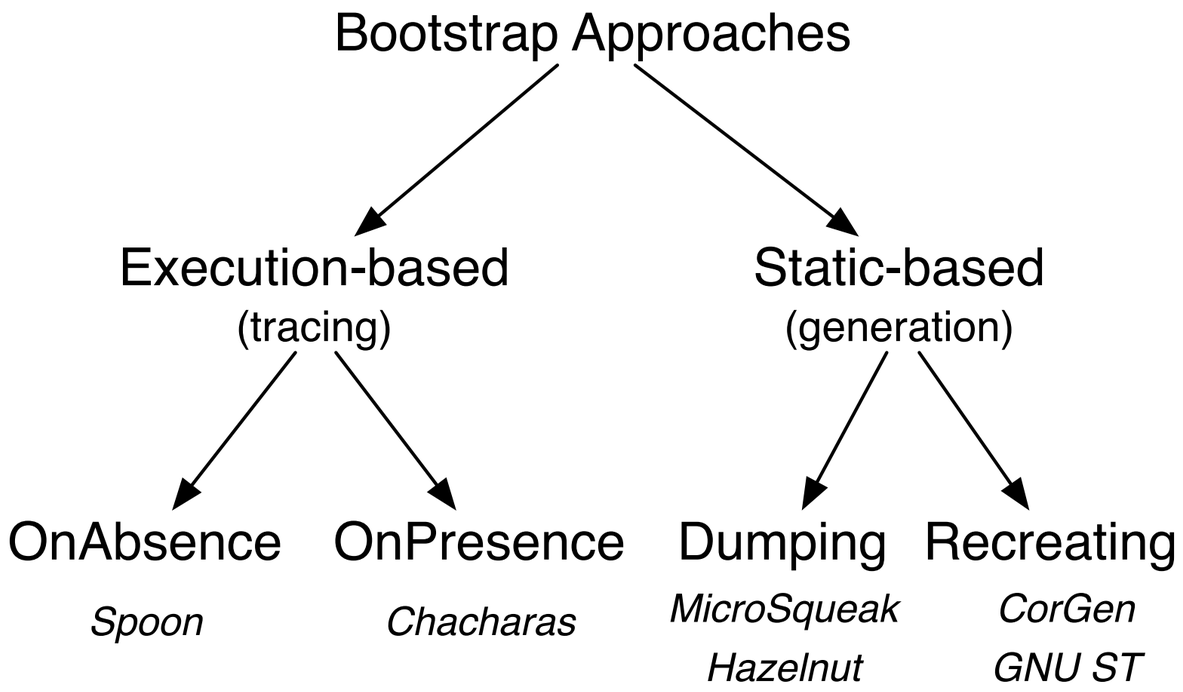
- Agile and explicit process

- Explicit malleability and evolution support

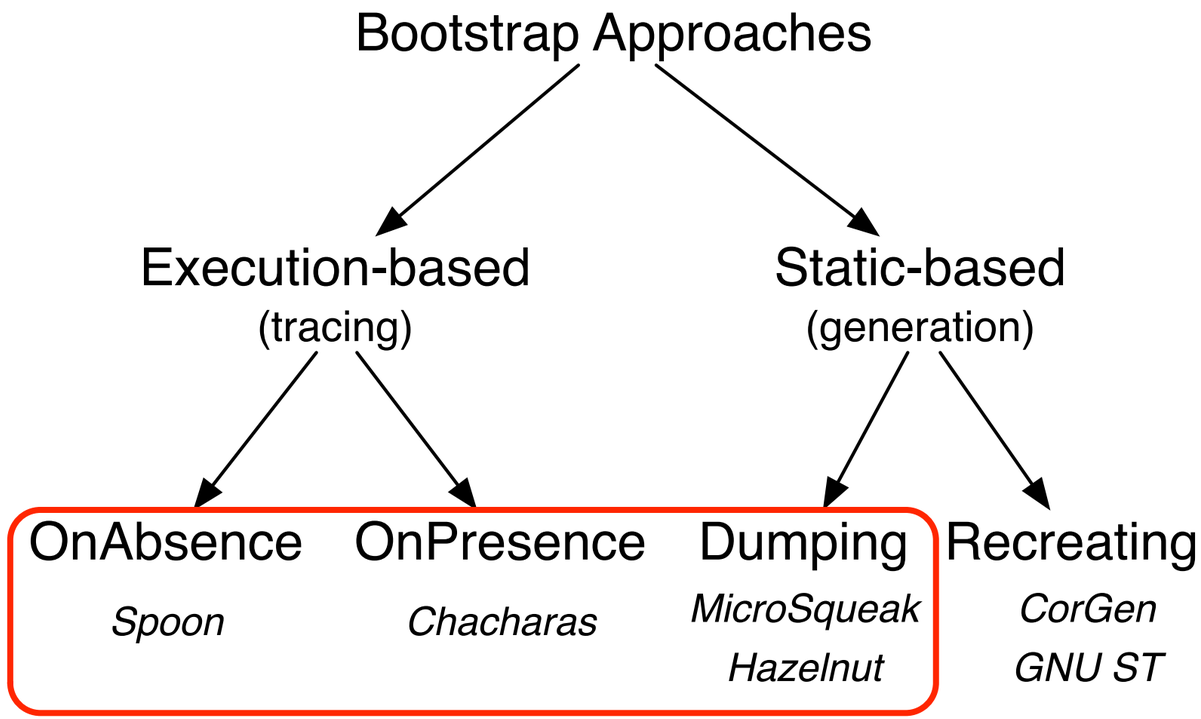
- Warranty of initial state

- Minimal self reference

Existing approaches

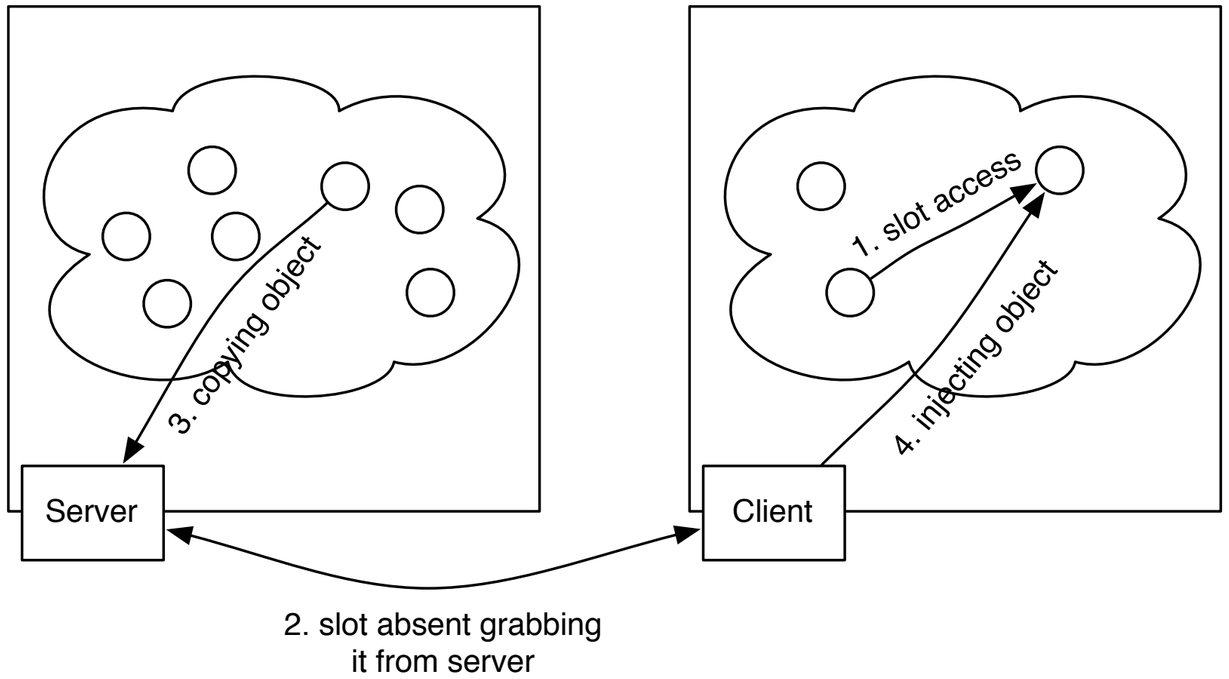


Existing approaches



Spoon

- Client / Server approach
- Client side starts as minimal
- On each slot access if the target object is missing, fetch and copy it from the server



Chacharas

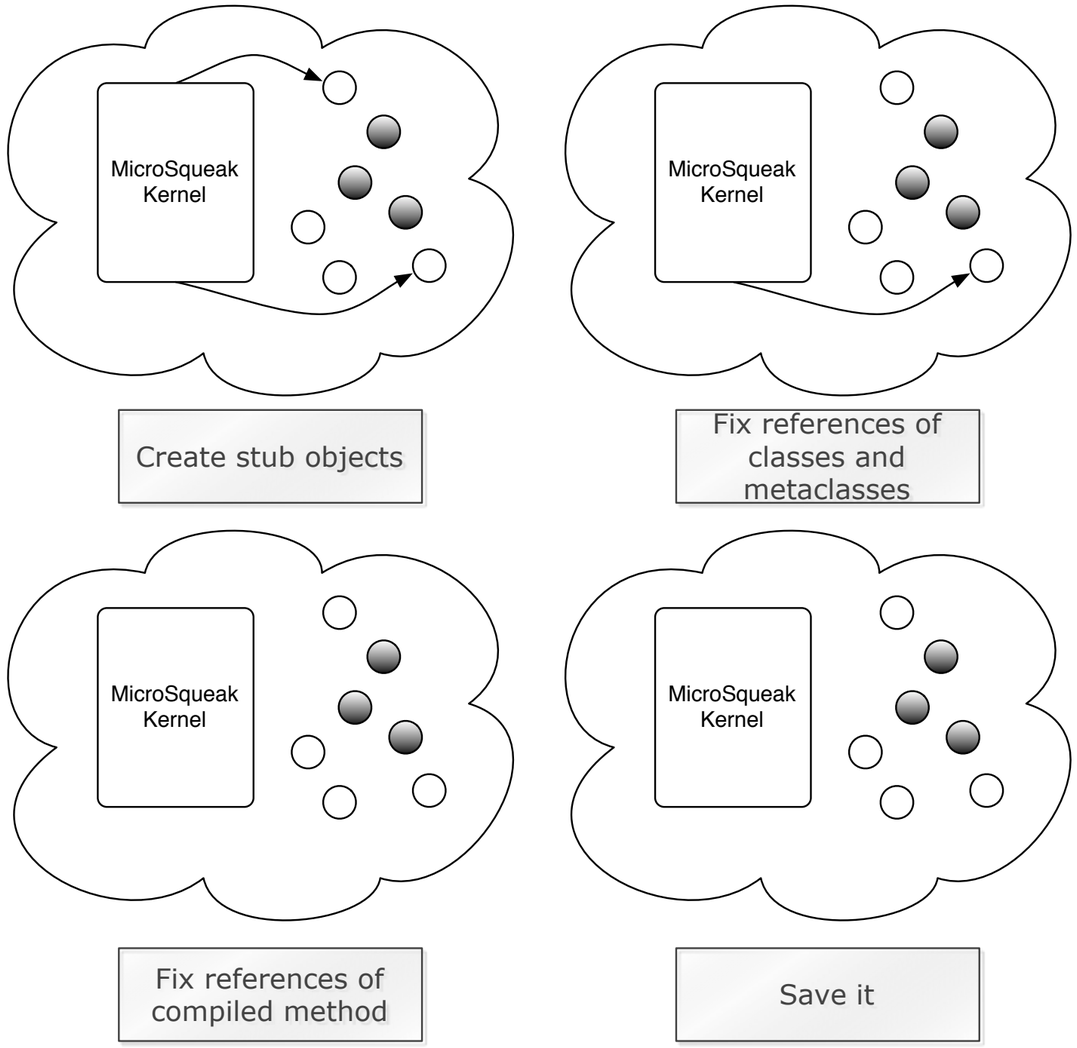
Same approach as Spoon but:

- Analyze a server side execution

- All reached objects are copied on the client

MicroSqueak

1 - A kernel is loaded from files into a namespace



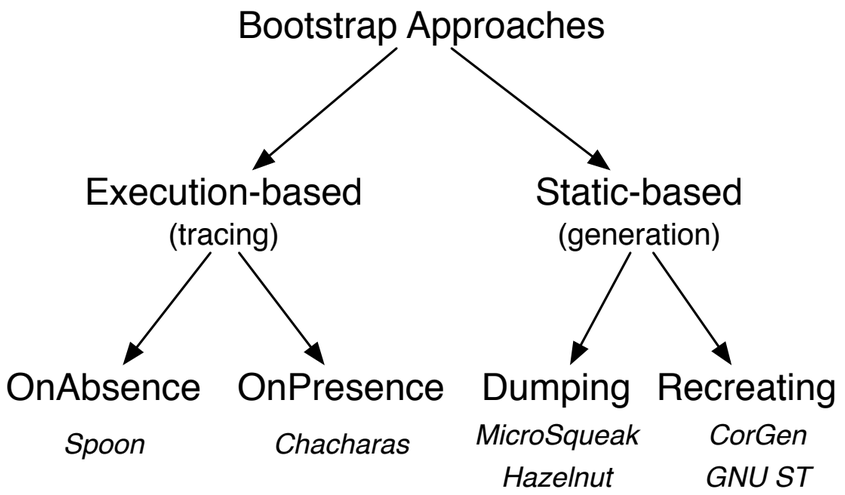
Hazelnut

Same approach as MicroSqueak but:

- does not rely on a specific list of class that are manually edited

- takes a list of classes as input and recursively copy classes into a new namespace

Discussion



Execution-based approaches:

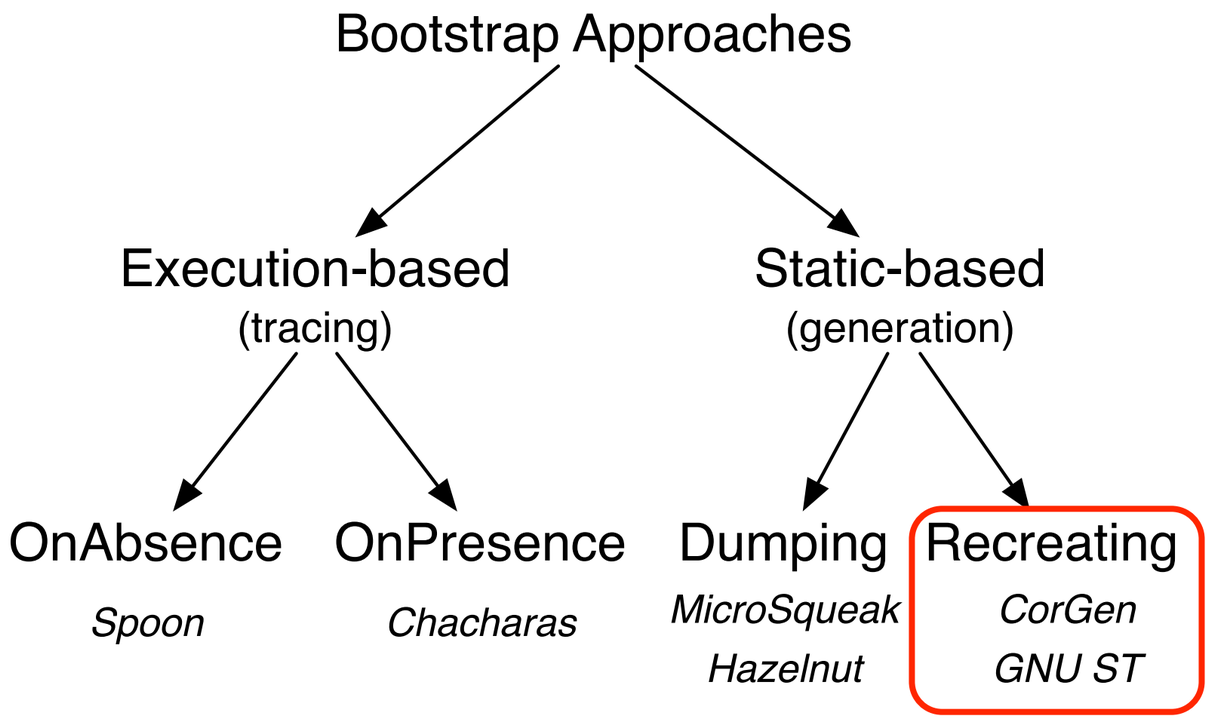
- difficult to control which objects will be selected for the bootstrapped image
- reflection breaks tracing
- not suitable for interactive programs

+ suitable to compute the minimal runtime required by a program

Static-based approaches:

+ easier to control the result of a static generation
+ suitable for deep changes in a system (new object format, ...)
- hard to specify / write / maintain

Our approach



CorGen

1. Creation of the stub objects for literal objects: nil, true, false, characters
2. Definition of classes and metaclasses
3. Method compilation
4. Creation of process and special object array
5. Image serialization.

```
Bootstrap>>bootstrap [

    self
        instantiateSmalltalkObjects;

        importClassesFromSources;
        processClasses;
        setupSmalltalkObjects;
        saveImage]
```

Stubs Creation

```
Bootstrap>>instantiateSmalltalkObjects [
   self
         instantiateNilGst;
         instantiateTrueGst;
         instantiateFalseGst;
         instantiateCharactersTable; "build all the characters"
         instantiateEnvironment "create System Dictionary"]
```

Classes/Metaclasses creation

```
Bootstrap>>processClasses [
    "fill the class stubs with real classes"
    self
        "create classes and add them to System Dictionary"
        createClasses;

        "compile and install CompileMethods"
        compileMethods ]
```

Compile Methods

- Methods either taken from the model or the source files

- Use a compiler parametrized by an environment and a symbol table

- Deep changes may be applied (change bytecode set, other optimization, ...)

Initializing the System

```
Bootstrap>>setupSmalltalkObjects [
    self setupCharacter; "insert references to the Character table"
        setupSymbol; "insert references to the Symbol table"
        setupProcessor "create Processor and install it" ]

Bootstrap>>setupProcessor [ | processorGst |
    processGst := self createProcess.
    processorGst := GstProcessorScheduler new.
    processorGst scheduler: nilGst;
    processes: self buildProcessList;
    activeProcess: processGst;
    idleTasks: nilGst. ]
```

Initializing the System

```
Bootstrap>>createProcess [
        | processGst |
        (processGst := GstProcess new)
                nextLink: nilGst;
                suspendedContext: self createInitContext;
                priority: 4;
                myList: nilGst;
                name: GstString new;
                interrupts: nilGst;
                interruptLock: nilGst ]
```

Saving the Image

- Comply with image file format:
  - Image header
  - Special object array

- Serialize objects according to their shape (CompiledMethods, ...)

- Avoid object duplication during serializing

The Result

A 54 classes Smalltalk Kernel:

Kernel (15 classes): Behavior, BlockClosure, BlockContext, Boolean, Class, ClassDescription, ContextPart, False, Metaclass, MethodContext, MethodInfo, Object, ProcessorScheduler, True, UndefinedObject.

Collection (27 classes): Array, ArrayedCollection, Bag, BindingDictionary, ByteArray, CharacterArray, Collection, CompiledBlock, CompiledCode, CompiledMethod, Dictionary, HashedCollection, IdentityDictionary, Iterable, Link, LinkedList, LookupTable, MethodDictionary, OrderedCollection, Process, Semaphore, SequenceableCollection, Set, String, Symbol, SystemDictionary, WeakSet.

Magnitude (12 classes): Association, Character, Float, Fraction, Integer, LookupKey, Magnitude, MethodInfo, Number, SmallInteger, VariableBinding, HomedAssociation.

Related Work

- Lisp : using image such Smalltalk, the bootstrap is done by migrate the current image, using a cross-compiler include in the host image.

- Ruby : the kernel is load and initialize by the VM some low level initialization is done in C, all the other is done by ruby processing. After all the module is load separately by the Virtual Machine.

- Python : the Python virtual machine is initialized. Some classes stubs are created and initialized in the virtual machine. (close of the ruby bootstrap)

Conclusion and Future Work

Pros and Cons:

- Execution-based bootstrapping (tracing) such as Hazelnut
- Static-based bootstrapping (declarative) such as CoreGen

Future work: Boostrapping Pharo

- use an execution-based approach as an intermediate solution
- reach a static-based bootstrap that can easily be maintained and co-evolve with the system

THANKS

Bootstrapping a Smalltalk

G. Casaccio, S. Ducasse, L. Fabresse, J-B. Arnaud, B. van Ryseghem

Presented by: M. Denker