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## Virtual Machines

3th reading exercise:

*Open, Reusable Object Model*

*(I. Piumarta, A. Warth, Los Angeles, CA, 2006/2007)*

Robert Schuppenies, Stefan Hüttenrauch, Tobias Queck

## Outline

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- Definitions
- Problems with common Object Models (OMs)
- Details of the implementation of the presented OM
- Extensibility – Flexibility – Usability

# Definitions

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- *Object Model*
  - “Description of the structural relationships among components of a [...] object including its metadata.” [1]
  - “Defines the structural relationships and dynamic interaction between a group of [...] objects.” [2]
  
- *Open*
  - Changeable and adaptable by the end user
  - Only few syntax and restrictions
  
- *Reusable*
  - Code reuse... what we all want

## Problems with common Object Models

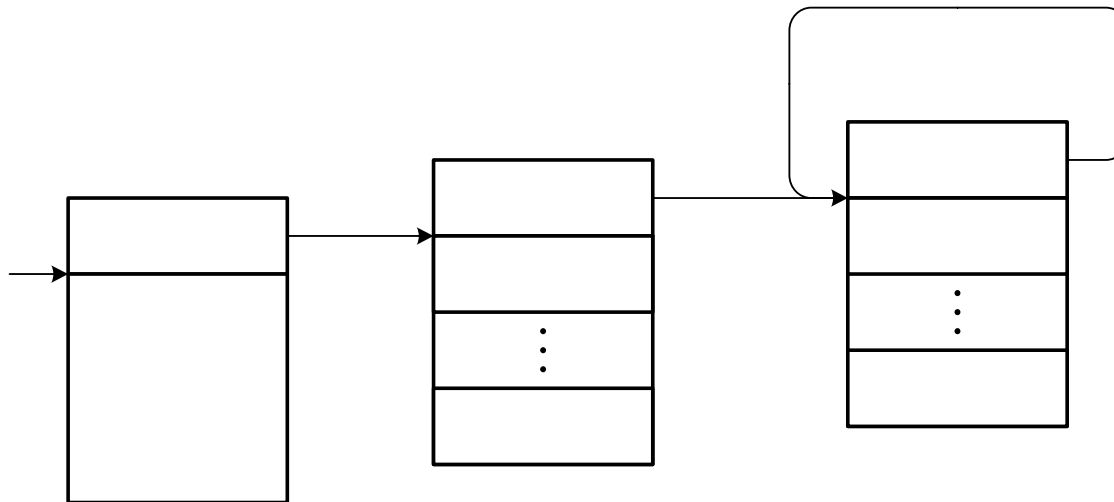
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- Problems with OMs
  - Implemented in language on lower level of abstraction
  - No customizing
  - Execution mechanisms cannot be changed
  - Static
  
- A way out
  - A more generic OM → that adds complexity
  - A different implementation of the Object Model

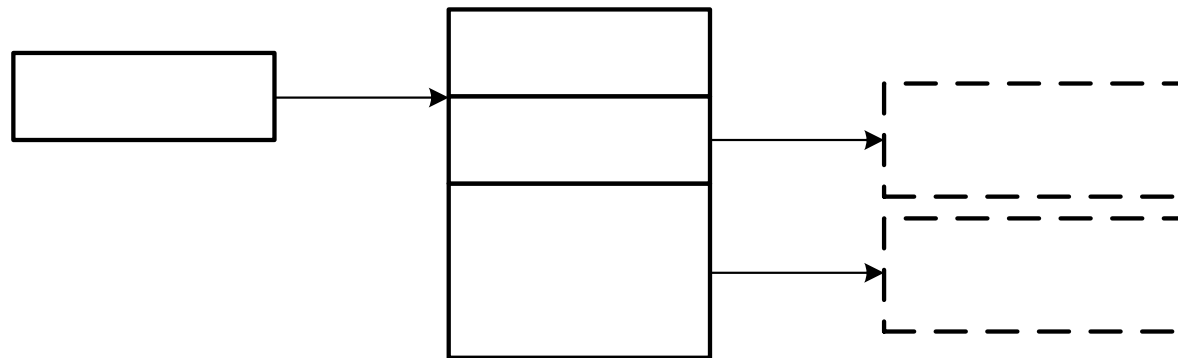
# Objects = state + behaviour

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- Nothing but objects
- Object = state + behaviour



# Objects = state + behaviour, cont.



Closure object

behaviour

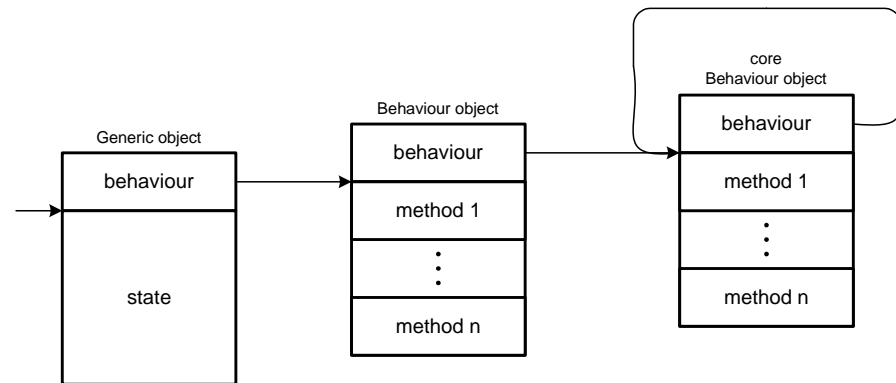
method name

method  
implementation

# Let's see some code: prototypes

```
class struct_object(object):
    ...
    self._vt = {}
```

```
class struct_vtable(object):
    ...
    self._vt = {}
    ...
    self.keys = []
    self.values = []
    self.parent = None
```

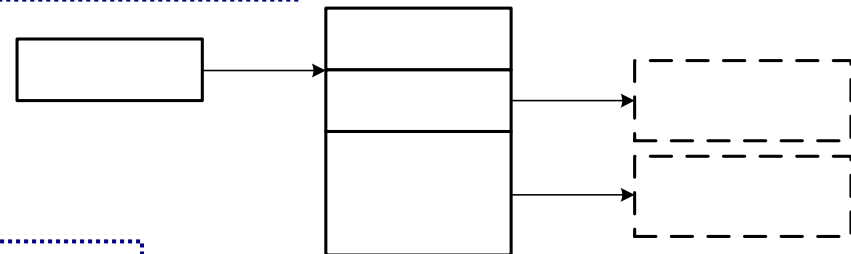
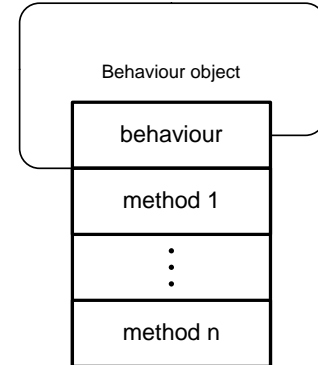


```
class struct_closure(object):
    self._vt = {}
    self.method = None
    self.data = None
```

```
class struct_symbol(object):
    ..
    self._vt = {}
    self.string = None
```

# .. code: methods

```
def vtable_addMethod(closure, self, symbol, method):
    ...
def vtable_lookup(closure, self, symbol):
    ...
def vtable_allocate(closure, self, size):
    ...
def vtable_delegated(closure, self):
    ...
```



```
def symbol_intern(closure, self, string):
    ...
```

```
def closure_new(method, data):
    ...
```



.. code: bindings

```
def send(object, messageName, *args):  
    ...  
def bind(object, messageName):  
    ...
```

## .. code: bootstrapping

```
global SymbolList
global vtable_vt, object_vt, symbol_vt, closure_vt
global s_lookup, s_addMethod, s_allocate, s_delegated

vtable_vt = vtable_delegated(0,0)
vtable_vt._vt["-1"] = vtable_vt

object_vt = vtable_delegated(0,0)
object_vt._vt["-1"] = vtable_vt
vtable_vt.parent = object_vt

symbol_vt = vtable_delegated(0,object_vt)
closure_vt = vtable_delegated(0,object_vt)

SymbolList = vtable_delegated(0,0)

s_lookup    = symbol_intern(0, 0, "lookup")
s_addMethod = symbol_intern(0, 0, "addMethod")
s_allocate   = symbol_intern(0, 0, "allocate")
s_delegated  = symbol_intern(0, 0, "delegated")

vtable_addMethod(0, vtable_vt, s_lookup, vtable_lookup)
vtable_addMethod(0, vtable_vt, s_addMethod, vtable_addMethod)

send(vtable_vt, s_addMethod, s_allocate, vtable_allocate)
send(vtable_vt, s_addMethod, s_delegated, vtable_delegated)
```

## Flexibility examples

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- Adding data types
  - Creating a vtable
  - Putting functionality into the vtable
- Converting single inheritance to multiple inheritance
  - Modify the semantics of message sending
  - Redefine lookup
    - Convert single parent vtable to parent list
    - Look for method in all parents
  - Taking state of parents into account

## Evaluation

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- Compact implementation
- Benchmarks
  - Overhead of dynamic dispatch nearly factor 2
  - Object based primitives
    - Slower without cache (0.6) but faster with cache (2)
- Traits
- Limitations
  - Model relies on method cache
  - Implementation of bind and send

Questions & Answers



## References

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- [1] <http://www.cs.cornell.edu/wya/DigLib/MS1999/glossary.html>
- [2] <http://www.haley.com/helpcenter/glossary.html>
- [3] [www.st.informatik.tu-darmstadt.de/database/seminars/data/SWTrends\\_Reflection\\_Radic.pdf?id=179](http://www.st.informatik.tu-darmstadt.de/database/seminars/data/SWTrends_Reflection_Radic.pdf?id=179)