Garbage Collection in Ruby Extensions

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Ruby Extensions

make code written in C(++) accessible from Ruby code

Ruby Extensions

Reasons for using extensions:

- Execution speed
- Large existing code base
- Mandatory implementation language

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- Large existing code base
- Mandatory implementation language

Considerations:

- Security risk
- Stability risk
- Resource management

Garbage Collection

- frees the programmer from tracking object lifetimes
- inaccessible objects get deleted

```
x = Object.new
# possibly do something with x
x = nil
# the new object is inaccessible here
```

Object accessibility

"root set": Objects referenced by

- global variables
- local variables currently on the stack

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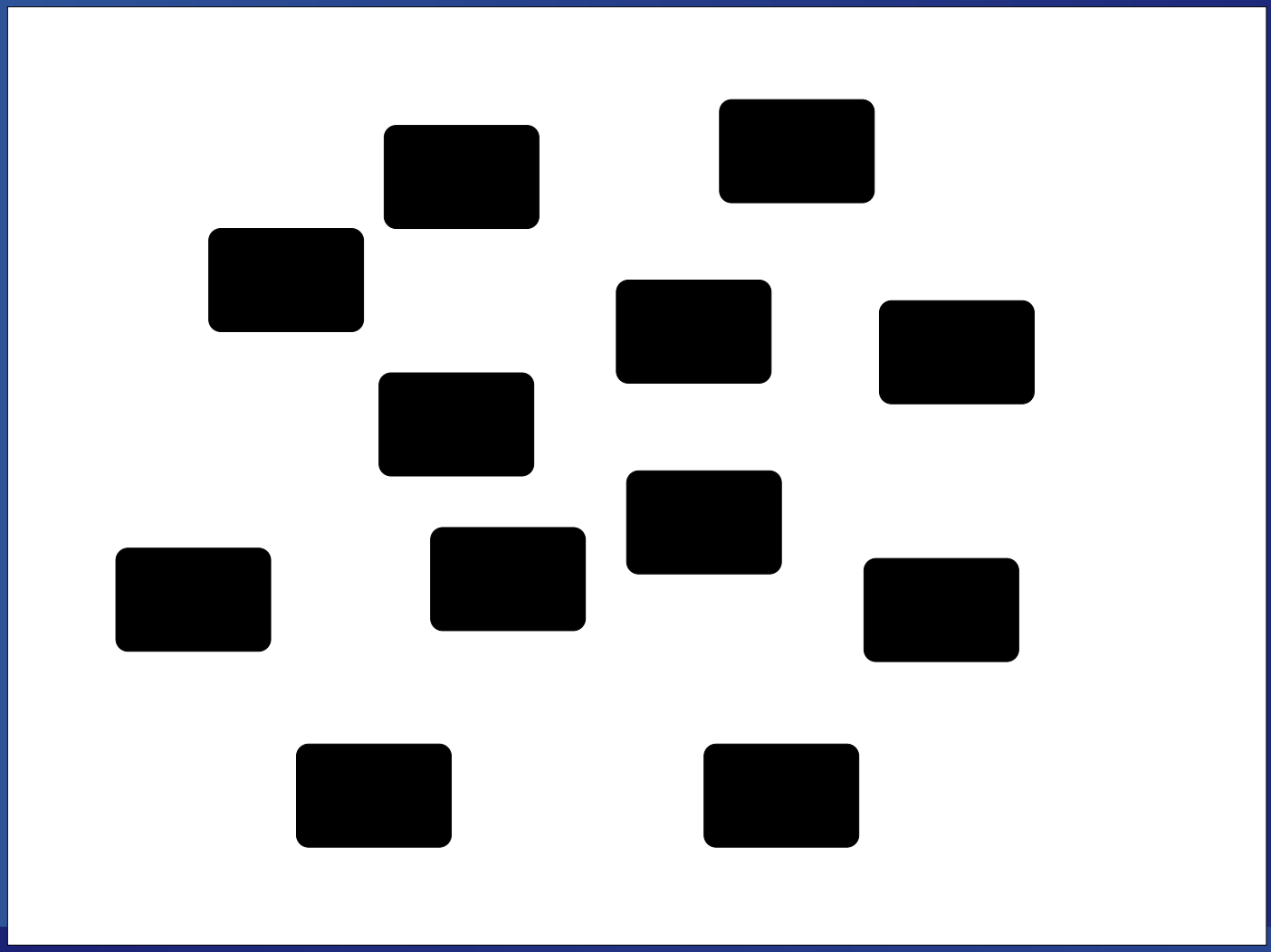
Reference paths: An object references

- its class
- its data members (via instance variables)
- specific references

Object accessibility



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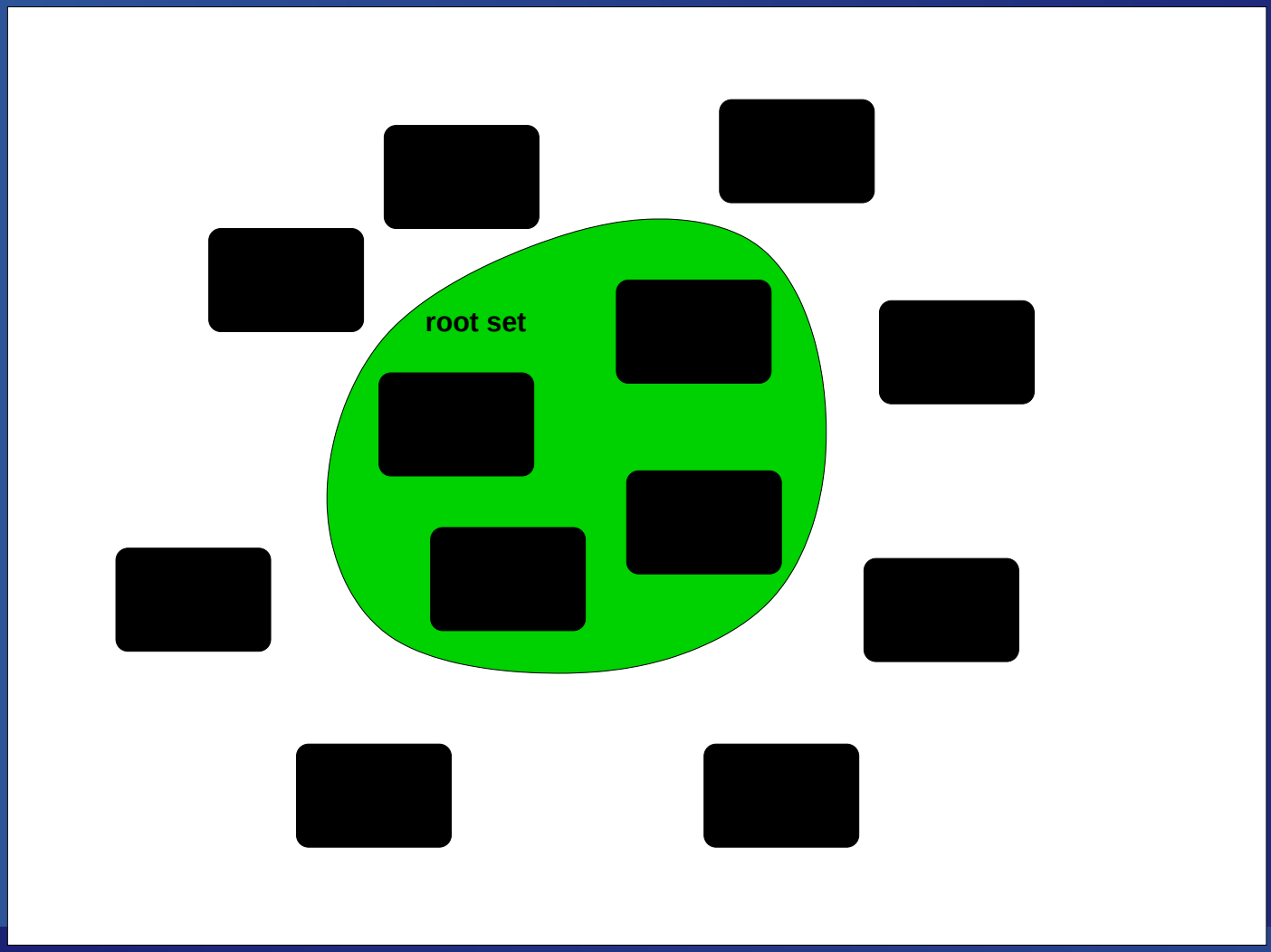

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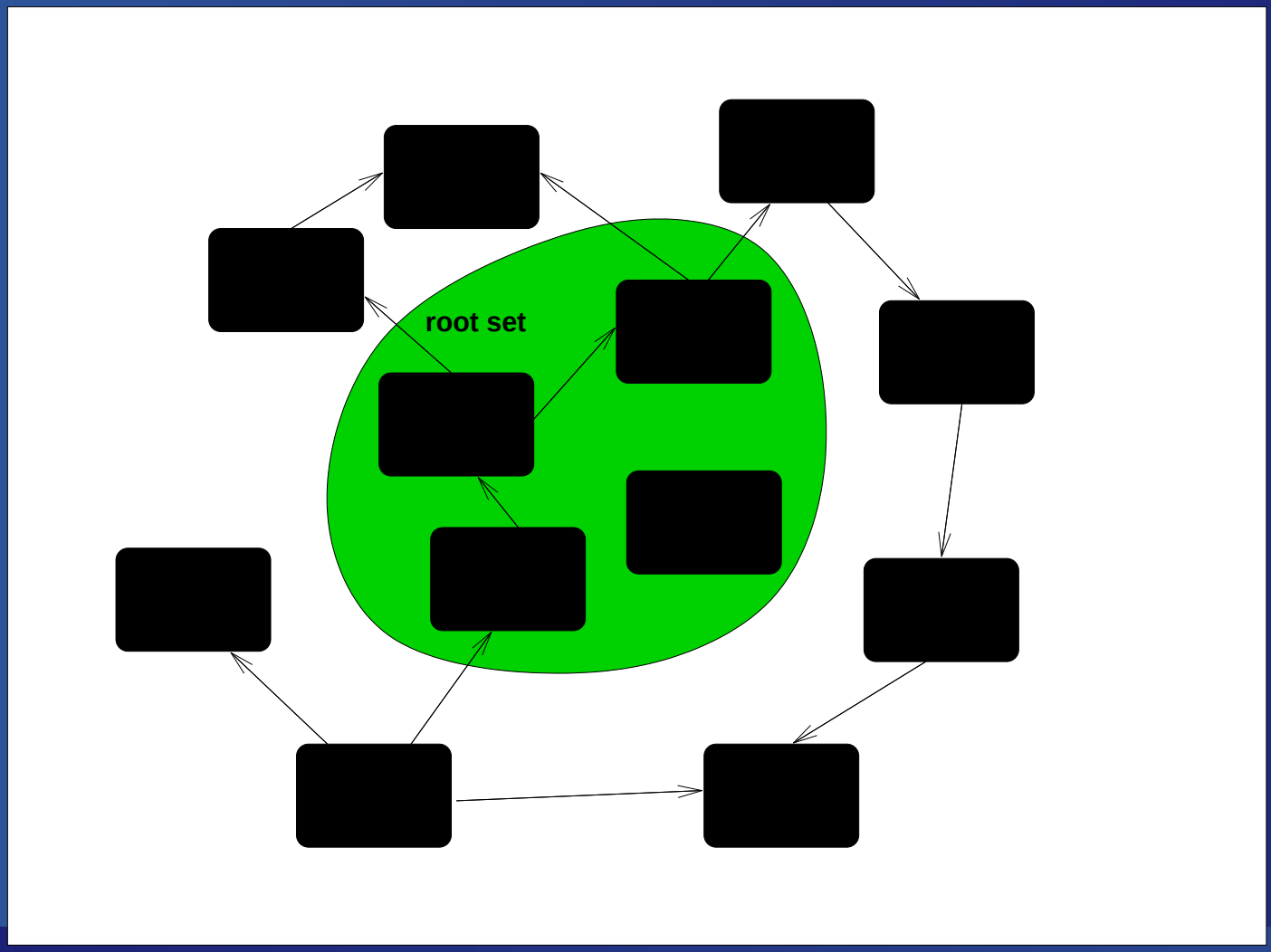

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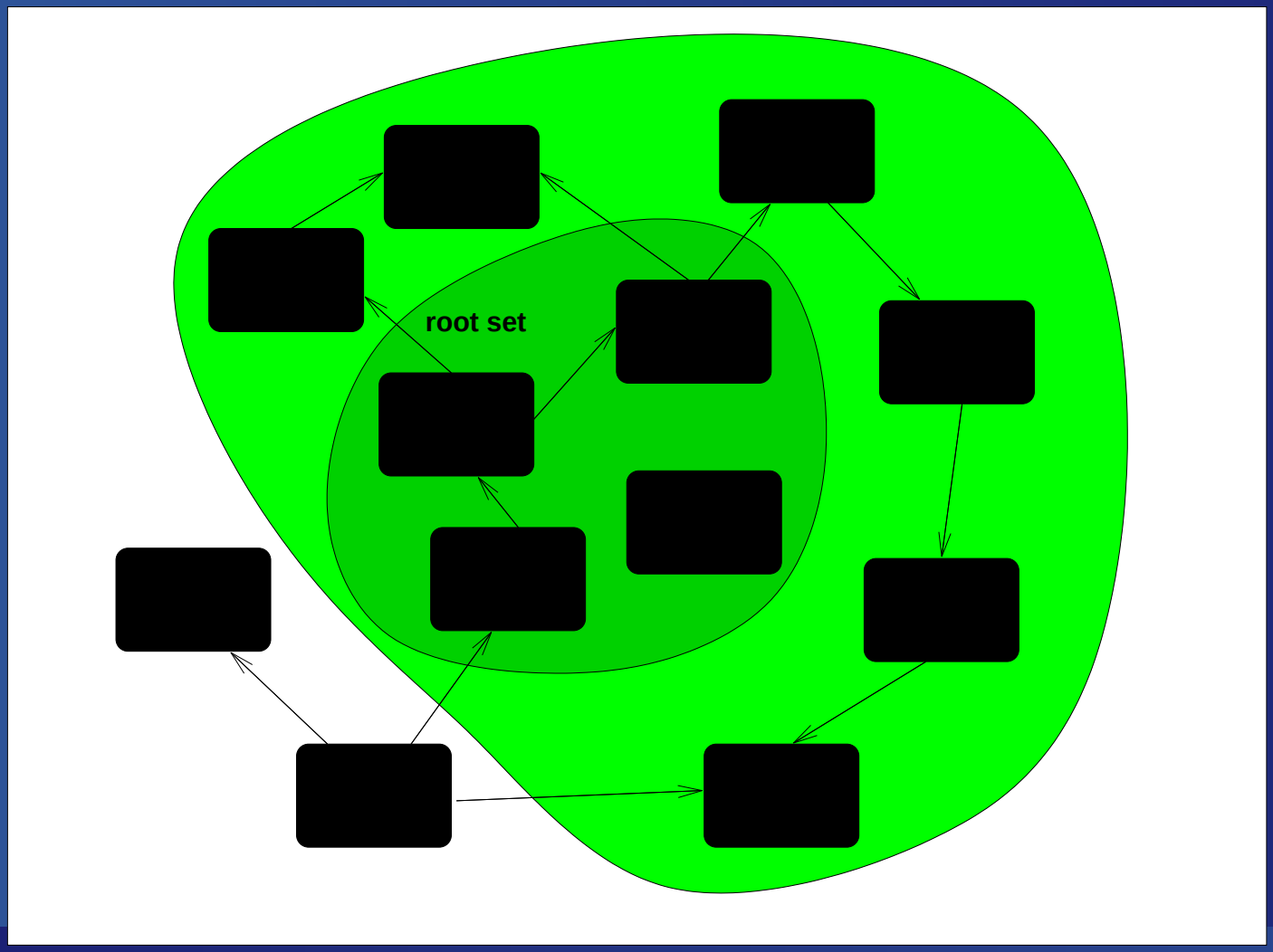

Objects and references implementation

Regular object:

- `struct {long flags;...}`

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Direct Object:

- special VALUE

Mark and Sweep Garbage Collector

Mark phase

- Ruby iterates over all references defining the root set and calls `rb_gc_mark` on these references
- Objects receive marks and recursively call `rb_gc_mark` on all object references they know of

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Sweep phase

- Ruby iterates over all objects
- Objects that have not received a mark are deleted

Strategies for GC in Extensions

1. Do nothing
2. At least release the memory
3. Consider object relations
4. Revert to explicit resource management

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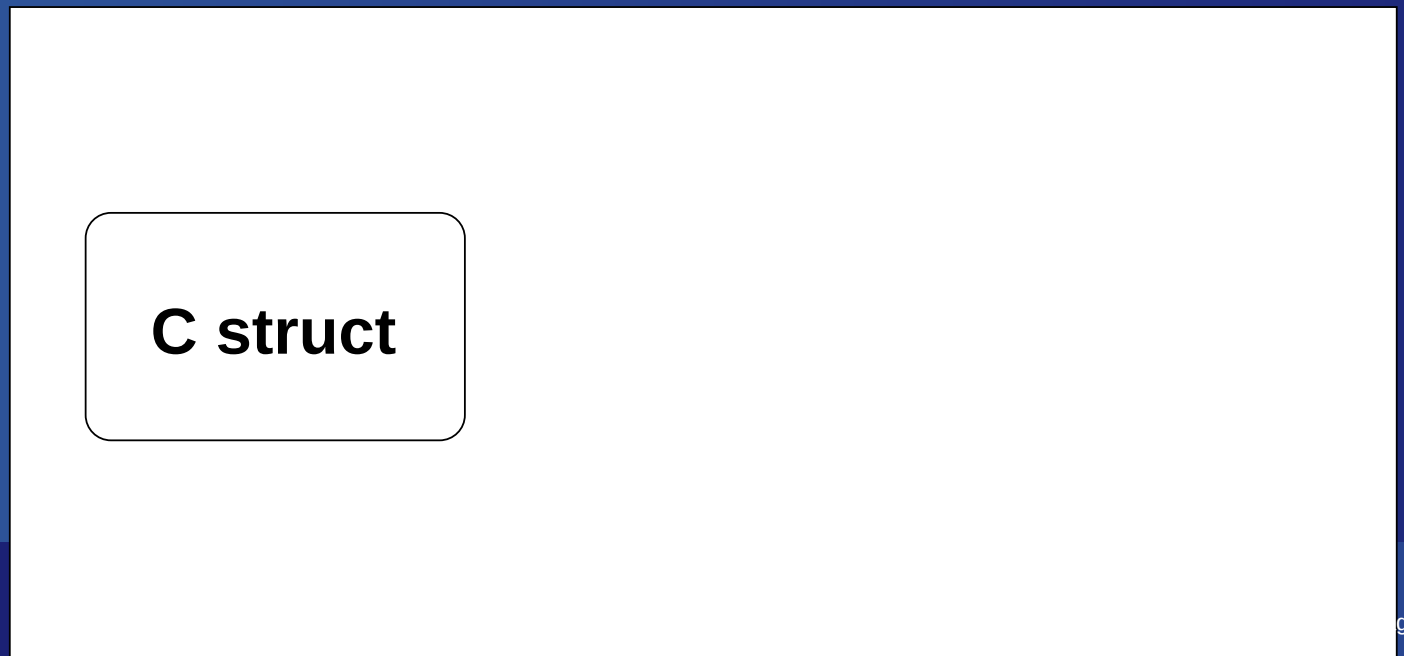

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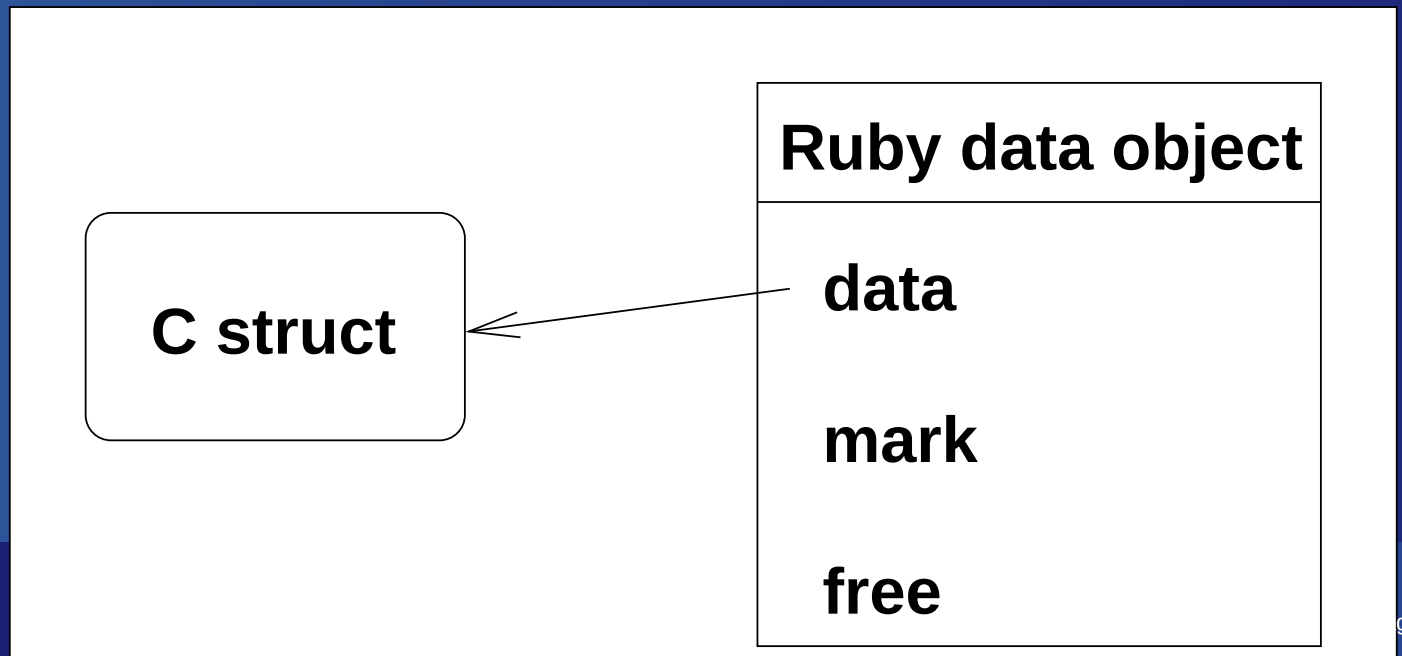

GC-strategy 1: Do nothing

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- The right strategy if you don't care for memory leaks
- Applicable for small programs
- Not applicable for libraries

GC-strategy 2: Release memory

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- Register `NULL` as the object's "mark" function and `free` as the object's "free" function
- But watch out for
  - multiple ruby objects wrapping the same C object
  - inter object relations

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multiple objects wrapping the same C object

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- use reference counting for C object if available
- or use some "user data" field in the C struct to point back to ruby object if available
- or have a hash-table that maps C pointers to ruby objects

GC-strategy 3: Object relations

```
x = Ext_Class_1.new(...)
x.learn_about(Ext_Class_2.new(...))
```

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x = Ext_Class_1.new(...)
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```

- use reference counting if available
- no need to provide a mark function then

GC-strategy 3: Object relations

```
x = Ext_Class_1.new(...)
x.learn_about(Ext_Class_2.new(...))
```

- otherwise unique mapping from C pointers to ruby wrapper objects is necessary
- class-specific mark functions have to be provided

GC-strategy 4: Explicit management

Sometimes garbage collection alone cannot determine the C object's lifetime.

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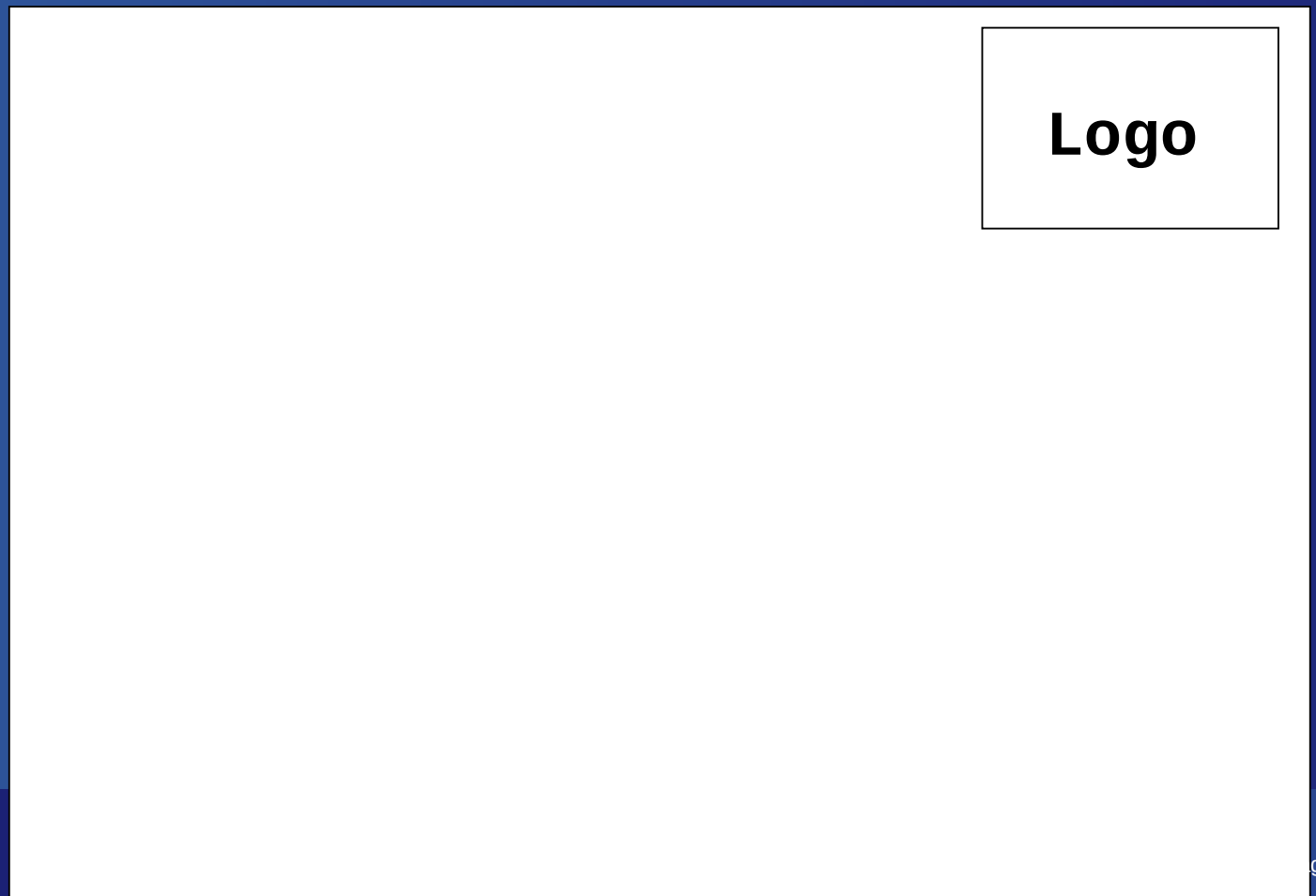

Using SWIG

1. Do nothing
2. Use `%newobject`
3. Use `%typemaps`, `%markfunc` and `%freefunc`
   - Tip: Call the same `ruby_wrapper_for_klass(klass, bool create)` from within the `%typemaps` and the `%markfunctions`

Common Misconceptions

- Not trusting the Garbage Collector, desire to register objects as globals.

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- Not trusting the Garbage Collector, desire to register objects as globals.
- Misunderstandings of the purpose of the mark and sweep phases and functions.

Summary

- Quick and dirty programs do not require any GC support from an extension
- Correct GC support in extensions requires either a reference counting framework inside the C library or a reverse mapping of C pointers to ruby objects

Thank you