# Representing method combinations

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# Context: The SICL project

https://github.com/robert-strandh/SICL
Several objectives:

- Create high-quality *modules* for implementors of Common Lisp systems.
- Improve existing techniques with respect to algorithms and data structures where possible.
- Improve readability and maintainability of code.
- Improve documentation.
- Ultimately, create a new implementation based on these modules.

# Generic function

A feature of object-oriented programming languages.

Can be thought of as a collection of *methods* sharing the same name.

In traditional languages, a generic function is not a first-class object.

In Common Lisp a generic function is an instance of a subclass of `function`, so it is a first-class object.

# Generic-function invocation

In traditional languages: `<arg1>.gf(<arg2>, ...)`

In Common Lisp `(gf <arg1> <arg2> ...)`

Because of subclassing, an invocation may result in several methods being *applicable*.

# Traditional generic-function invocation

In traditional languages, only the most specific applicable method is invoked.

Invoking less specific methods requires an explicit call, such as `super(...)`.

Explicit code is required to combine the results of the different applicable methods being called.

# Generic-function invocation in Common Lisp

The applicable methods are *combined* in some way.

The combination is expressed as a lambda expression called the *effective method*.

The effective method contains calls to the individual methods.

The compiler is called in order to turn the effective method into an *effective method function*.

When applied to the arguments of the invocation of the generic function, the effective method function calls the methods in the right order.

# compute-effective-method

This generic function has three parameters:

1. A generic-function metaobject
2. A method-combination metaobject
3. A list of method metaobjects

A call to this generic function returns an an effective method.

# Role of the method-combination metaobject

In `compute-effective-method`, the method-combination metaobject designates a *method-combination procedure*.

This procedure can be implemented in different ways:

- As a method on `compute-effective-method`, specialized to some method-combination class.
- As a function stored in the method-combination object.
- Any other way that will accomplish the task.

# Method combinations in the Common Lisp standard

A system class `method-combination` is defined.

Method-combination metaobjects must be *indirect instances* of this class.

A method-combination metaobject contains information about its *type* and the *arguments* used with that type.

# Example use of method combinations

```
(defgeneric foo (x)
  (:method-combination and :most-specific-last))
```

Here, `and` is the name of a method-combination *type* and `:most-specific-last` is an *argument* that this particular type accepts.

The applicable methods are combined with the `and` standard operator, and the arguments to the operator are the return values of the invocations of the applicable methods in the order of the least specific to most specific.

# define-method-combination

This operator defines a method-combination *type*

It has two *versions*: the *short* version and the *long* version.

# `define-method-combination` (short version)

`(define-method-combination` *name options*`)`

Options are unimportant for this presentation.

The short version defines a method-combination type that accepts an *optional argument* that can be `:most-specific-first` or `:most-specific-last`.

If no argument is given, it defaults to `:most-specific-first`.

# `define-method-combination` (long version)

`(define-method-combination` *name lambda-list* ... *body* `)`

The ... represent information that is not important to this presentation.

The *lambda-list* is an ordinary lambda list that specifies what *arguments* can be given after `:method-combination`.

# Scenarios

1. The user defines a method-combination type using `define-method-combination`, then uses that type in a `defgeneric` form, but makes a mistake in the arguments.
2. The user defines a method-combination type using the long version of `define-method-combination`, but makes a mistake in the lambda list. Then uses `defgeneric` with the intended arguments.
3. The user defines a method-combination type using the long version of `define-method-combination`, then uses `defgeneric` with acceptable arguments. Later, the user modifies the lambda list and redefines the method-combination type.

# Previous work

We investigated several FLOSS implementations:

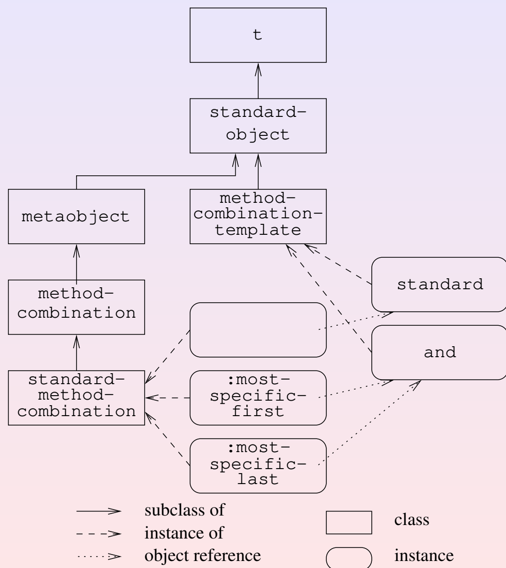
- Portable Common Loops (PCL). A mostly portable library used for adding CLOS to a pre-ANSI Common Lisp implementation.
- Steel Bank Common Lisp (SBCL)
- Clozure Common Lisp (CCL)
- Embedded Common Lisp (ECL)
- Clasp

Many of them fail several scenarios.

All of them sometimes fail to verify the validity of method-combination arguments early. Instead, the arguments are sometimes verified when `compute-effective-method` is called, resulting in cryptic error messages.

Details in the paper.

# Our technique



# Our technique

In this presentation, we cover only our technique for reporting incorrect method-combination arguments early.

Refer to the paper for the way we handle the other scenarios.

# Our technique

Recall the long version of `define-method-combination`:
`(define-method-combination` *name lambda-list* ... *body* `)`

The *lambda-list* is an ordinary lambda list that specifies what *arguments* can be given after `:method-combination`.

We translate the short version to the long version.

We analyze the *lambda-list* of the long version and extract all the parameters (say v1, ..., vn) that can be used in the *body*.

# Our technique

We construct a lambda expression as follows:

```
(lambda (...)  (list v1 ...  vn))
```

where (...) is the original lambda list.

We compile the lambda expression to obtain a function.

When this function is applied to the method-combination arguments, it returns a list of objects that can be used to identify a particular method-combination metaobject of a given type.

This list is used for recycling existing method-combination metaobjects.

# Our technique

In our `define-method-combination` forms, we include `&aux` parameters with expressions that verify the arguments.

Example of long version for method-combination type and:

```
(define-method-combination and
    (&optional (order :most-specific-first)
     &aux (ignore (unless (member order
                                  '(:most-specific-first
                                    :most-specific-last))
                       (error ...))))
 ...)
```

# Our technique

When our constructed function is applied to some incorrect method-combination arguments:

- It may fail because the arguments are incompatible with the parameters of the lambda list.
- It may fail because one or more `&aux` initialization forms call `error`.

In both cases, we handle the error and report incorrect arguments.

# Future work

The technique described here has been only partially incorporated into SICL. We are working on finishing this incorporation.

Our technique could benefit from some *weak* data structure to avoid memory leaks due to generic-function metaobjects being stored in our data structure. SICL does not yet have any such data structure. We plan to add it.

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# Thank you