Computer Languages

Activation records

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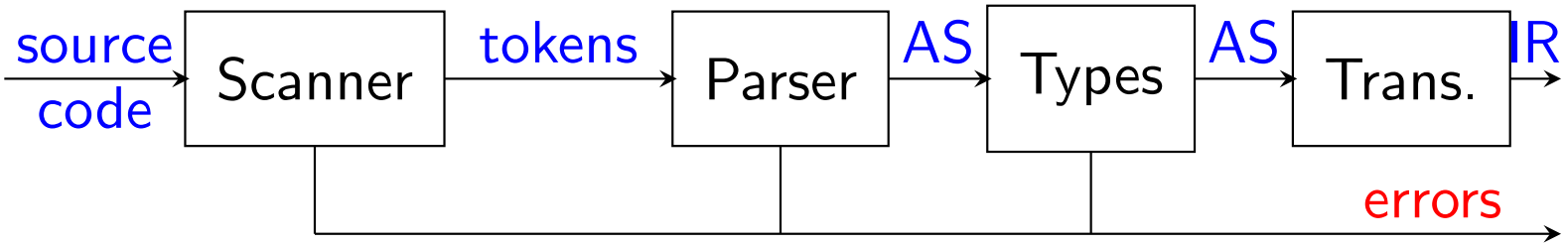
www2.hh.se/staff/jebe/languages

The Front End (analysis phase)



- The Scanner (lexical analyzer) transforms a sequence of characters (source code) into a sequence of tokens: a representation of the *lexemes* of the language.
- The Parser (syntactical analyzer) takes the sequence of tokens and generates a tree representation, the Abstract Syntax.
- This tree is analyzed by the type checker and is then used to generate the intermediate representation.

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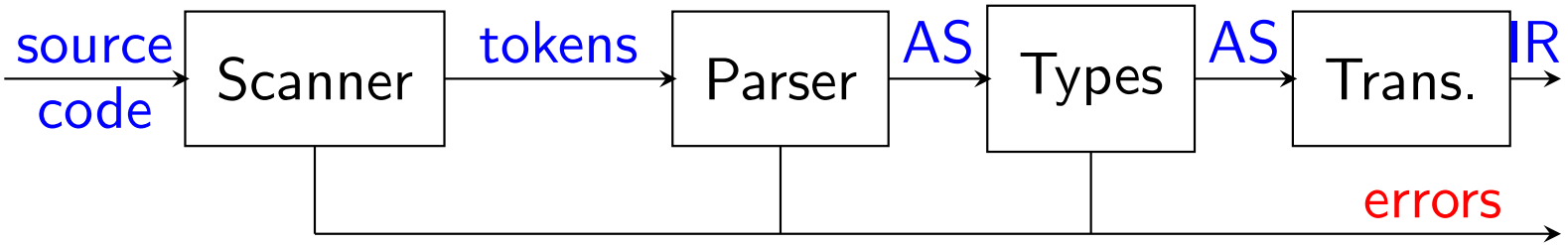

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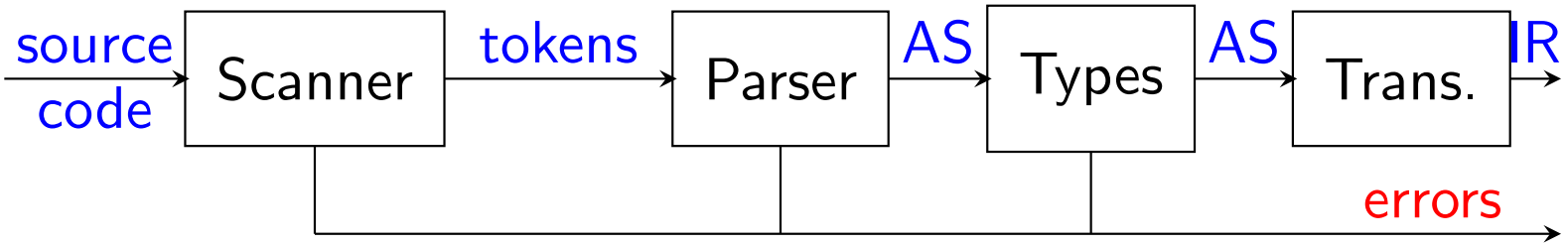

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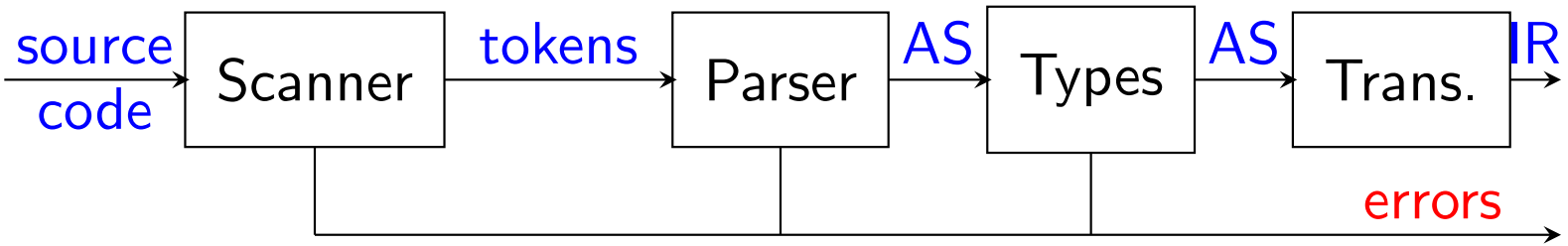

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The translation phase

- Lexical, syntactical and contextual analysis are phases of *all* language processors of *all* computer languages (which we have exemplified with *minijava*).
- The translation phase is more dependent on the kind of computer language being processed.
- For *programming languages* it is taking a step towards executable code.
- We will present some general techniques and abstractions for doing so.

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A meaningful *minijava*-fragment

```
class Visitor {
  Tree l ;
  Tree r ;
  public int visit(Tree n){
    int nti ;
    if (n.GetHas_Right()){
      r = n.GetRight() ;
      nti = r.accept(this) ; }
    else nti = 0 ;
    if (n.GetHas_Left()) {
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    return 0;
  }
}
```

Executable code is only in the body of a method!

What happens when a program that uses `Visitor` is executed?

Instances of `Visitor` will have their own values for `l` and `r`.

Activations of `visit` will have their own values for `n` and `nti`.

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...takes a lot of effort from the compiler

Code ...

- ... has to be translated into machine code that can be loaded to instruction memory. Labels are usually used to mark the first instruction of this code fragment.
- All variables used in the code have to be elaborated to the right relative address.

Data memory

- A frame of memory has to be designed so that on every activation of the method a reasonable portion of memory can be claimed!
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Stack of frames (*or activation records*)

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- The *caller* (the main program or some other function) provides the values for the arguments.
- When the *callee* terminates execution of its code, the *caller* resumes execution at the point that follows the invocation.
- A function terminates execution only after *all* the functions it calls in turn terminate.
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int f(int x){
   int y = x+x;
   if(y<10)
      return f(y);
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```

A call to **f(2)** will result in the following memory setup

When the last call to **f(8)** terminates returning **7**, the space allocated for this call can be *deallocated*.

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y{4}	y{8}	y{16}

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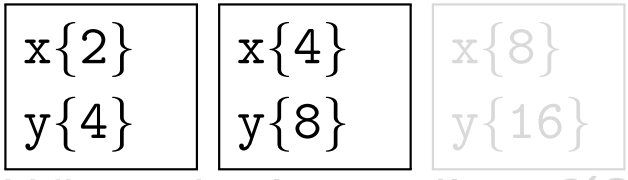

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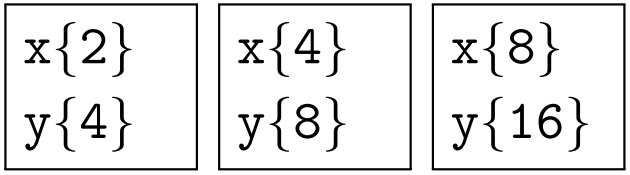

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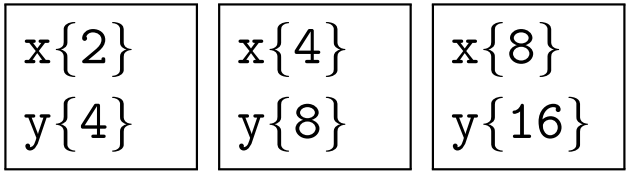

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Stack of frames

- Memory allocation for function calls will be organized as a *stack* of *frames*
- On calling a function a frame for the function will be pushed into the stack
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- The *structure* of frames is *machine dependent* (architectures prescribe a *standard layout*) but in any case what should be included in it can be calculated from the definition of the function

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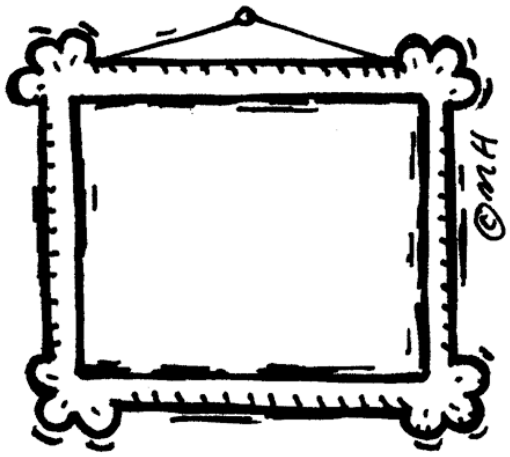
Typical processor frame



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	return address
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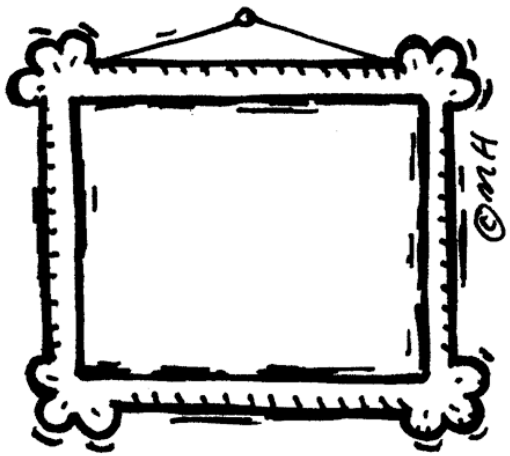

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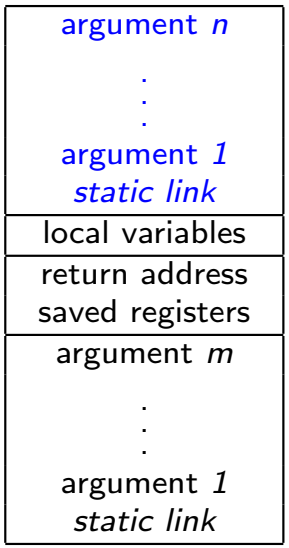
Typical Frame : registers, memory and parameter passing conventions



- Modern architectures include many registers to be used for parameters and local variables!
- So what should go in the frame?
  - A function that calls another function will *write over* the registers containing the parameters, it might need to *save* parameters that are still needed when the callee returns.
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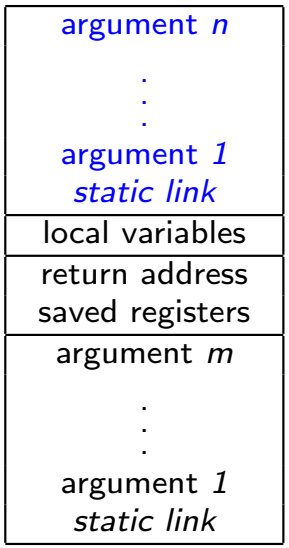

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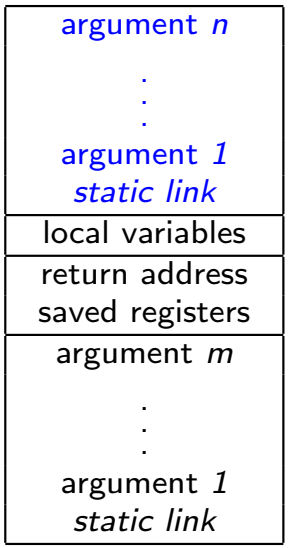

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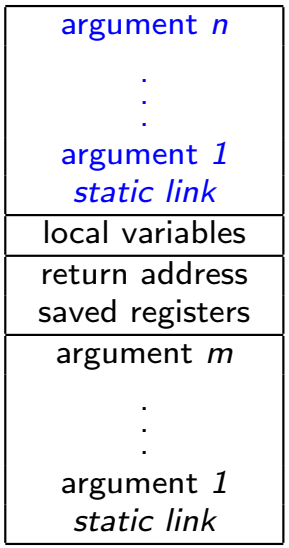

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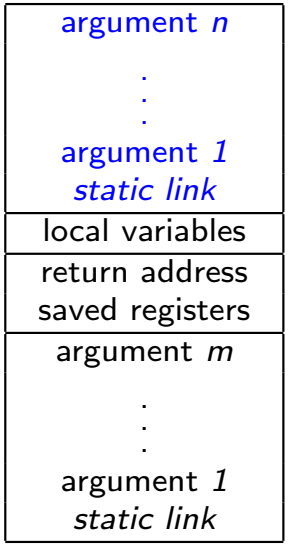

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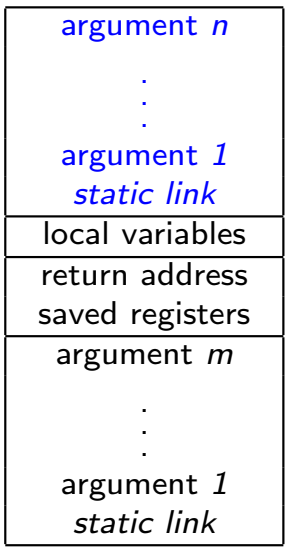
  - A function that calls another function will *write over* the registers containing the parameters, it might need to *save* parameters that are still needed when the callee returns.
  - Parameters that exceed the number of dedicated registers when the function has too many arguments.

Typical Frame: registers, memory and parameter passing



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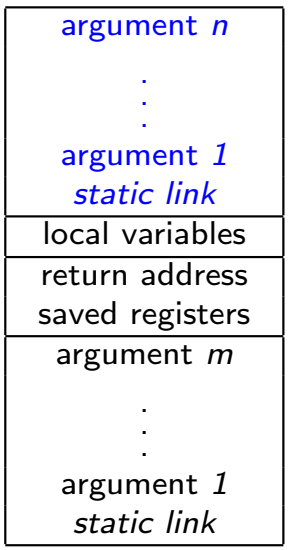

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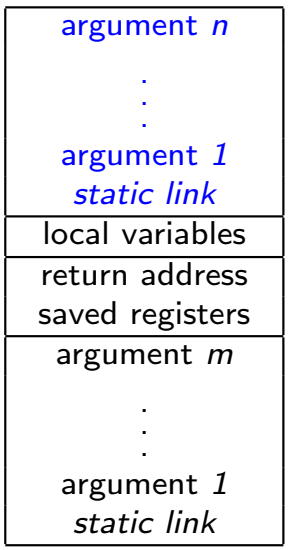

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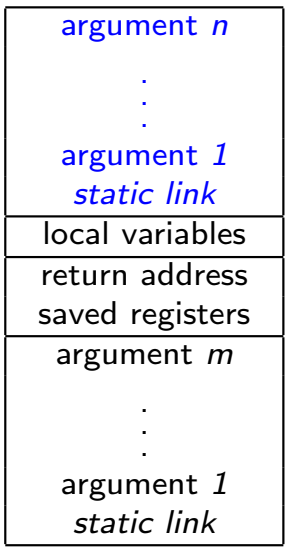

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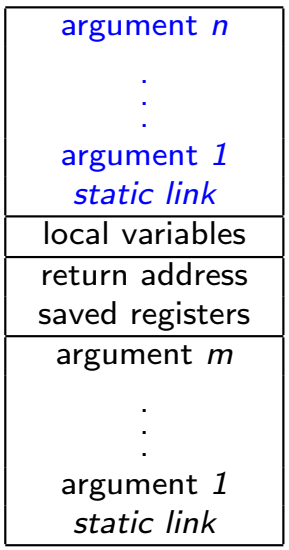

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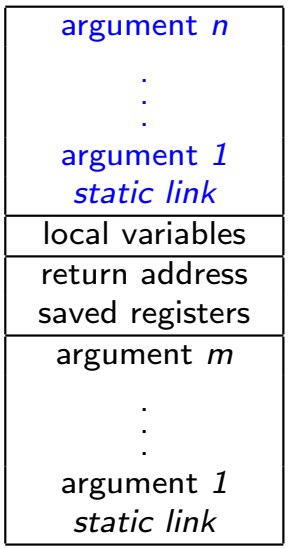

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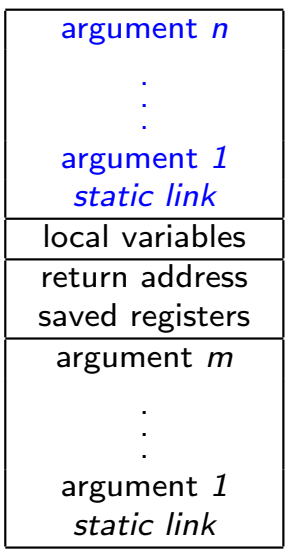

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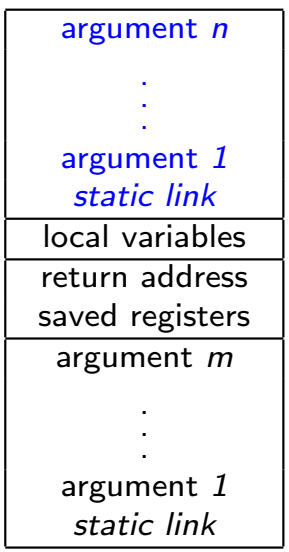

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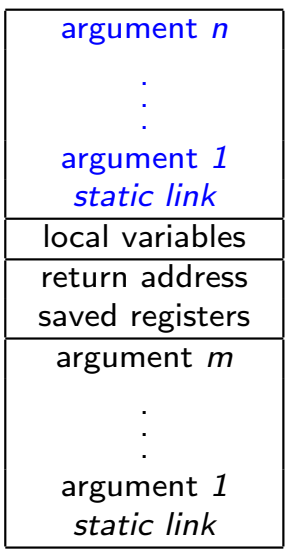

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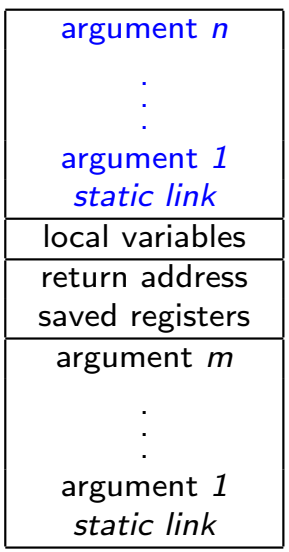

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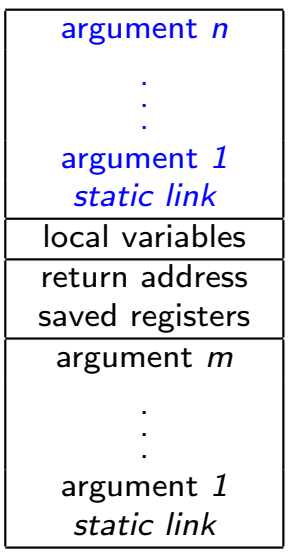

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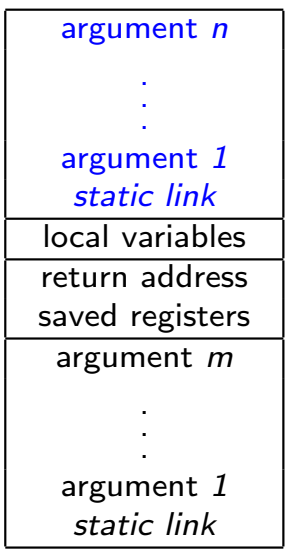

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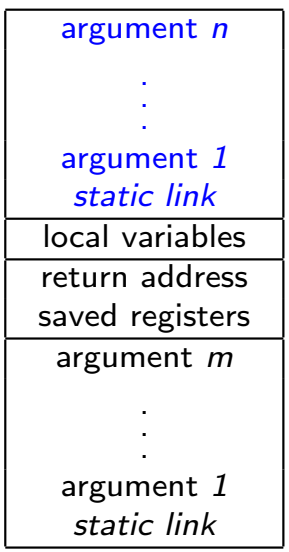

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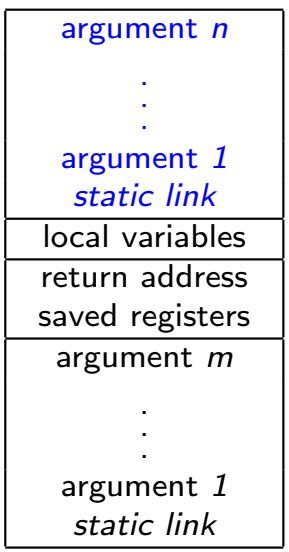

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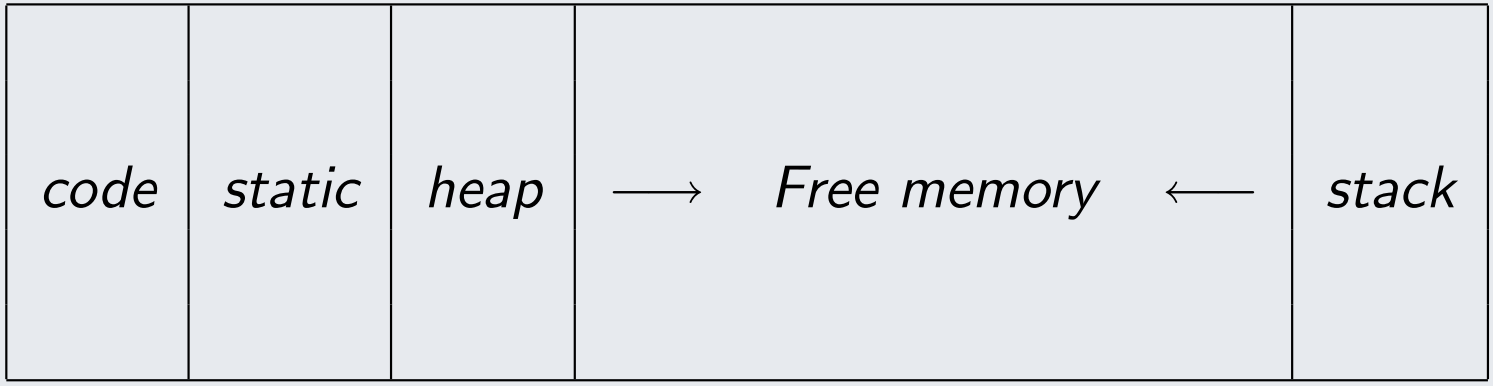

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