Universitetet i Oslo
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Reliable Systems
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INF 5110: Compiler construction

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Topic: Run-time environments (Chapter 7)

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Exercise 1 (Run-time environment) Draw a possible organization for the runtime environment of the following C program, for the following two situations. See corresponding figures from the lecture as inspiration (for example, the slide entitled "Stack gcd", approximately at slide 8.18):

1. after entry into block `A` in function `f`.
2. after entry into block `B` in function `g`.

```
1  int a[10];
2  char * s = "hello";
3
4  int f(int i, int b[])
5  { int j=i;
6   A:{ int i=j;
7       char c = b[i];
8       //...;
9     }
10    return 0;
11 }
12
13 void g(char * s)
14 { char c = s[0];
15  B:{ int a[5];
16      // ...;
17    }
18 }
19
20 main ()
21 { int x=1;
22   x = f(x,a);
23   g(s);
24   return 0;
25 }
```

Exercise 2 (Activation records (Pascal)) Draw the stack of activation reords for the following *Pascal* program, showing the *control* and *access* links, after the second call to procedure `c`. Describe how the variable `x` is accessed from within `c`.

```
program env;

procedure a;
var x: integer;

    procedure b;
        procedure c;
        begin
            x := 2;
            b;
        end;
    begin (* b *)
        c;
    end;

begin (* a *)
    b;
end;

begin (* main *)
    a;
end.
```

Exercise 3 (Access chaining vs. display) An alternative to access chaining in a language with local procedures is to keep the access links in an array *outside* the stack, *indexed* by the *nesting level*. This array is called the *display*. For example, the run-time stacks of the program `chain` and the corresponding stack picture on the slide entitled "access chaining" at approx. 8-36 fromx the lecture would now look as Figure 1 resp. Figure 2.

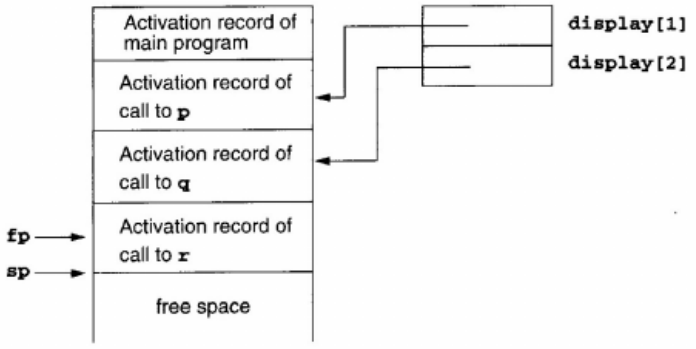


Figure 1: RTE with display (1)

1. Describe how a display can improve *efficiency* of nonlocal references from deeply nested procedures.

2. Redo Exercise 2 from this sheet, using a *display*.

Exercise 4 (Virtual function tables and memory layout for classes) Draw the memory layout of objects of the following C^{++} classes, together with the *virtual function tables*.

```
class A
{ public:
```

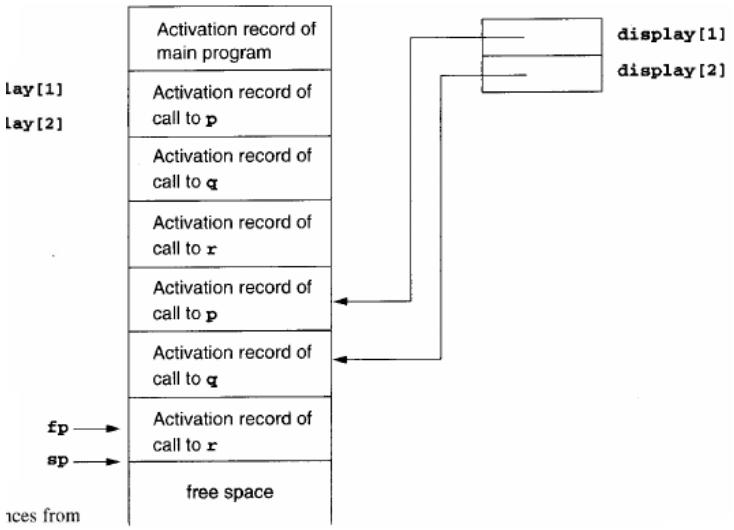


Figure 2: RTE with display (2)

```
3   int a;
4   virtual void f();
5   virtual void g();
6 };
7
8 class B : public A
9 { public:
10  int b;
11  virtual void f();
12  void h();
13 };
14
15
16 class C: public B
17 { public:
18  int c;
19  virtual void g();
20 }
```

Exercise 5 (Parameter passing) Give the output of the following program (written in C syntax) using the 4 parameter passing methods discussed in in the lecture.

```
1  #include <stdio.h>
2  int i = 0;
3
4  void p(int x, int y)
5  { x += 1;
6    i += 1;
7    y += 1;
8  }
9
10 main ()
11 { int a[2] = {1,1};
12   p(a[i],a[i]);
13   printf("%d %d\n",a[0], a[1]);
14   return 0;
15 }
```

Exercise 6 (Parameter passing) Give the output of the following program (written in C syntax) using the 4 parameter passing methods discussed in the lecture.

```c
#include <stdio.h>
int i = 0;

void swap (int x, int y)
{
  x = x + y;
  y = x - y;
  x = x - y;
}

main ()
{ int a[3] = {1,2,0};
  swap(i,a[i]);
  printf("%d %d %d %d\n",i,a[0], a[1],a[2]);
  return 0;
}
```