Chapter 12 -- Runtime Support (Storage)

- Static allocation (global)
  - Each variable gets a static location
  - name, address
  - (name, data area, offset ... fortran)

- Stack allocation (local variables)
  - Activation Record -- managing the stack

Procedure P (a:integer)
  var b: boolean;
  c: array [1:10] of integer;
  begin
    ...
  end;

- Parameters: a
- Local Vars: b, c
- Other Info: return addr, ...
Stack allocation / variable location

Access to variable in Activation Record

□ Usually some reference point in AR, Frame Pointer (FP)
□ Some kind of offset from the reference point

Specifics are machine dependent

<table>
<thead>
<tr>
<th>VAX (A very old machine)</th>
<th>HC (For ATL/1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW c</td>
<td>HIGH c</td>
</tr>
<tr>
<td>b</td>
<td>b</td>
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<tr>
<td>FP --&gt; Ret/Reg</td>
<td>FP --&gt; Ret/Reg</td>
</tr>
<tr>
<td>AP --&gt; 1/ptr</td>
<td>a</td>
</tr>
<tr>
<td>a</td>
<td>LOW</td>
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</tbody>
</table>

a: special access via AP
b: -4 relative to FP
c: -44 relative to FP


Dynamic arrays & Static variables

Dynamic Arrays

- Size known only after procedure entry
- Fixed entry in AR (usually pointer and size)
- Variable size entry pushed on AR at run time

Static / Own Variables

- Static (C), Own (algol)
- Allocate in global Data
Variable Access, local & non-local

Program P;
  Var a;

Procedure R;
  Var b;

Procedure S;
  Var c;
  begin
    a <-- b+c;
  end;

begin
  end

begin
  end

Local:  c
Global:  a
Not local, not global:  b
Display: Draw picture
Static Chains: Draw picture
hc and display

- 16 display registers (Fixed)
- One for each static level

- load 1, value => load address d[l] + value

- call l, spaddr
  - push d[l]
  - push return-addr
  - d[l] <-- SP
  - PC <-- spaddr

- exit l, n
  - SP <-- d[l]
  - PC <-- Pop()
  - d[l] <-- Pop()
  - SP -= n
Static Chains

A non-local access method

- No display
- Each AR has pointer to enclosing static AR
- Access to non-local variables are via static pointers.
- Follow pointers to AR of variable.
- May save pointers to each AR on the way
- Advantages?
- Disadvantages?
Heap Allocation

- Dynamic memory allocation (not heap data structure)
- Not stored on the runtime stack.
- Explicit versions
  - Pascal, Ada, New
- Implicit
  - Snobol, Java

Total Memory Layout
- Traditional -- i386/ns32k/...
- HC