

# §12.1-12.5: Pointers

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CMPT14x  
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- *Wed **Lab08** ok late*

# Review last time (Py tut §9.2)

- Namespaces
- Scope
  - New names add to **local** scope
  - Names **outside** local scope are **read-only**
    - ◆ Assigning to them makes a **local copy**
  - **global** command
- **Backtracking**: Knight's Tour
- *Lab09 (cplx), HW10 (knight), Lab10 (M2)*

# What's on for today (12.1-12.5)

- **Pointers** (in Modula-2 and C)
  - **Creating** pointers, **dereferencing** pointers
  - Assignment **compatibility**
  - Pointer **arithmetic**
  - **NIL** (in C: **NULL**)
- **Static** vs. **dynamic** allocation of memory
  - **Activation** records
  - **Stack**, stack pointer
- **Dynamic** variables: **NEW()**, **DISPOSE()**

# Pointers

- Values are stored in **locations** in memory
- These locations are accessed by their addresses, which **point** to a spot in memory
- A **pointer** is a variable whose **value** is a memory address:

```
VAR
```

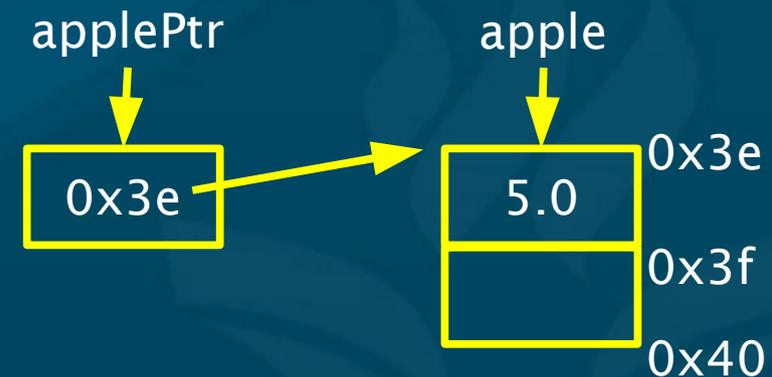
```
applePtr : POINTER TO REAL;
```

```
apple : REAL;
```

```
BEGIN
```

```
apple := 5.0;
```

```
applePtr := SYSTEM.ADR (apple);
```



# Dereferencing pointers

- The last example shows how to **make** a pointer:

VAR

```
applePtr : POINTER TO REAL;
```

```
apple : REAL;
```

BEGIN

```
apple := 5.0;
```

```
applePtr := SYSTEM.ADR (apple);
```

In C:

```
float apple;
```

```
float* applePtr;
```

```
apple = 5.0;
```

```
applePtr = &apple;
```

- How do we **get** at the memory pointed to?

```
applePtr^ := 4.0; (* same as apple := 4.0 *)
```

- ◆ (C syntax: \*applePtr)

- The “hat” operator  $\wedge$  is called the **dereferencing** operator

# Operations on pointers

- Different pointer types are **not** compatible
  - But can always **cast** from one type to another:  

```
float* applePtr;  
int* pearPtr;  
applePtr = (float*) pearPtr;
```
- **NIL** points to nothing at all
  - Handy for **initializing** pointers: `ptr1 := NIL;`
  - **Dereferencing** `NIL` raises `sysException`
  - In C, use **NULL** (which is just 0)

# Pointers and C arrays

- An **array** in C is really just a **pointer** to a location in memory that stores **consecutive** entries of the array:

```
float appleSizes[4];  
appleSizes[0] = 2.5;
```

- **Indexing** into the array is really done by **adding** to the pointer to the head of the array:

```
appleSizes[2]
```

- ◆ Is the same as:

```
*(appleSizes + 2)
```

# Pointers and call-by-reference

- Pointers are how **call-by-reference** is done in C:

```
int increment (int* x) {           /* takes a pointer to an int */
    *x = *x + 1;
    return *x;
}
```

```
int x;
```

```
x = 5;
```

```
increment (&x);                 /* pass a pointer to x */
```

- In **C++**, can specify in the **function** definition:

```
int increment (int &x) {         /* call-by-reference */
```

```
    x = x + 1; ....
```

```
increment (x);
```

# Static vs. dynamic memory

- **Static** variables are allocated at the **beginning** of the program run
  - Their size in memory is **fixed** at compile-time
  - Variables named in **declaration** section
- **Dynamic** variables are allocated **during** the running of a program
  - May also be **deallocated** during program
  - Size need **not** be predetermined
  - Reference them via **pointers**

# Dynamic variables

- You can make your own **dynamically** allocated variables, using **NEW()** and **DISPOSE()**:

**VAR**

**applePtr** : POINTER TO REAL;

**BEGIN**

**NEW** (**applePtr**);

- ◆ **Allocates** memory for a REAL, and stores the address in **applePtr**

**DISPOSE** (**applePtr**);

- ◆ **Deallocates** the memory, and sets **applePtr** to NIL
- Dynamic variables are in the **heap**:
  - ◆ Open space for program to allocate/deallocate
- If heap is **full**, **NEW** sets pointer to NIL

# A caution about pointers

- Pointers are a **powerful** tool and a quick way to **shoot** yourself in the foot:

```
VAR
```

```
    applePtr : POINTER TO REAL;
```

```
BEGIN
```

```
    applePtr^ := 5.0;      (* yipes! *)
```

- **Uninitialized** pointer could point to anywhere in memory: **dereferencing** it can potentially modify any accessible memory!
  - ◆ Can **crash** older Windows; **core dump** in Unix

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- **Static** vs. **dynamic** allocation of memory
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  - **Stack**, stack pointer
- **Dynamic** variables: **NEW()**, **DISPOSE()**

# TODO

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- **Lab09** due next week:
  - Complex number library
- **HW10** due Mon:
  - Hand-simulation of Knight's tour
- **Midterm** next Wed 22Nov:
  - M2 chs9-10
  - Py ch10-14