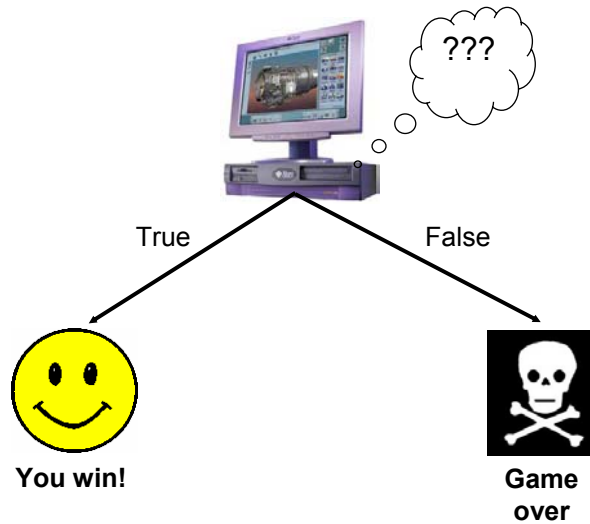


## Making Decisions In Pascal

In this section of notes you will learn how to have your Pascal programs choose between alternative courses of action

James Tam

## High Level View Of Decision Making For The Computer



James Tam

## Decision-Making In Pascal

Decisions are questions with answers that are either true or false (Boolean)

Decision making constructs in Pascal

- If-then
- If-then-else
- If, else-if
- Case-of

James Tam

## If-Then

Decision-making checking if particular condition is true

Format:

If (operand<sup>1</sup> relational operator operand<sup>1</sup>) then  
body;<sup>2</sup>  
additional statements;

Boolean expression

Indicates end of decision-making

Example:

```
if (age >= 18) then
    writeln('You are an adult');
    writeln('Tell me more about yourself');
```

1 Operands are referred to as expressions in Leestma and Nyhoff

2 The body of the if-then is referred to as a statement in Leestma and Nyhoff

James Tam

## Allowable Operands For Boolean Expressions

If (*operand* relational operator *operand*) then

Operands

- integer
- real
- boolean
- char
- const

James Tam

## Allowable Relational Operators For Boolean Expressions

If (operand relational operator operand) then

Pascal operator	Mathematical equivalent	Meaning
<	<	Less than
>	>	Greater than
=	=	Equal to
<=	≤	Less than or equal to
>=	≥	Greater than or equal to
◇	≠	Not equal to

James Tam

## If-Then (Simple Body)

Body of if-then consists of a single statement

Format:

```
if (Boolean expression) then
```

```
  s1;
```

← Body

```
s2;
```

↙ Indicates end of decision-making

Example (for full example look under  
</home/231/examples/decisions/simpleIfThen.p>):

```
if (x = 1) then
```

```
  writeln('Body of if');
```

```
writeln ('After body');
```

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## If-Then (Compound Body)

Body of if-then consists of multiple statements

Format:

```
if (Boolean expression) then
```

```
begin
```

```
  s1;
```

```
  s2;
```

```
  :
```

```
  sn;
```

← Body

```
end;
```

```
sn+1;
```

↙ Indicates end of decision-making

James Tam

## If-Then (Compound Body(2))

Example (for full example look under  
/home/231/examples/decisions/compoundIfThen.p):

```
if (x = 1) then
begin
    writeln('Body of if 1');
    writeln('Body of if 2');
end;
writeln('after if');
```

James Tam

## If-Then-Else

Decision-making with two conditions

One (and only one) condition will be true

Format:

```
if (operand relational operator operand) then
    body of 'if'
else
    body of 'else';
additional statements;
```

No semi-colon (indicates end of decision making!)

Semi-colon (decision making is complete)

James Tam

## If-Then-Else

Example:

```
if (age >= 18) then
    writeln('You are an adult')
else
    writeln('You are not an adult');
writeln('Tell me more about yourself');
```

James Tam

## If-Then-Else (Simple Body)

Body of if-then-else consists of a single statement

Format:

```
if (Boolean expression) then
    s1
else
    s2;
s3;
```

No semi-colon (indicates end of decision-making!)

Semi-colon (this is the end of the decision-making process!)

James Tam

## If-Then-Else (Simple Body(2))

Example (for full example look under  
/home/231/examples/decisions/simpleIfThenElse.p):

```
if (x = 1) then
    writeln('body of if')
else
    writeln('body of else');
writeln('after if-then-else');
```

James Tam

## If-Then-Else (Compound Body)

Body of if-then-else consists of multiple statements

Format:

```
if (Boolean expression) then
begin
    s1;
    :
    sn;
end
else ← No semi-colon (marks end of decision-making!)
begin
    sn+1;
    :
    sn + m; ← Semi-colon (this is the end of the decision-making
end; ← process!)
sn + m + 1;
```

James Tam

## **If-Then (Compound Body(2))**

Example (for full example look under  
/home/231/examples/decisions/compoundIfThenElse.p):

```
if (x = 1) then
begin
    writeln('Body of if 1');
    writeln('Body of if 2');
end
else
begin
    writeln('Body of else 1');
    writeln('Body of else 2');
end;
writeln('after if-then-else');
```

James Tam

## **Decision-Making With Multiple Expressions**

Format:

```
if (Boolean expression) logical operator (Boolean expression) then
    body
```

Example:

```
if (x > 0) AND (y > 0) then
    writeln ('X is positive, Y is positive');
```

James Tam



## **Decision-Making With Multiple Expressions (2)**

Built-in logical operators in Pascal

NOT

AND

OR

XOR

(NAND and NOR can be constructed via NOT, AND & OR)

James Tam

## **Forming Compound Boolean Expressions With The “NOT” Operator**

Format:

```
if NOT (Boolean expression) then  
    body;
```

Example:

```
if NOT (x AND y) then  
  
if NOT (x OR y) then
```

For a complete example program look in Unix under  
`/home/231/examples/decisions/compoundNOT.p`

James Tam

## **Forming Compound Boolean Expressions With The “OR” Operator**

Format:

```
if (Boolean expression) OR (Boolean expression) then  
    body;
```

Example:

```
if (gpa > 3.7) OR (yearsJobExperience > 5) then  
    writeln('You are hired');
```

For a complete example program look in Unix under  
`/home/231/examples/decisions/compoundOR.p`

James Tam

## **Forming Compound Boolean Expressions With The “AND” Operator**

Format:

```
if (Boolean expression) AND (Boolean expression) then  
    body;
```

Example:

```
if (yearsOnJob <= 2) AND (isGoofOff = True) then  
    writeln('You are fired');
```

For a complete example program look in Unix under  
`/home/231/examples/decisions/compoundAND.p`

James Tam

## Forming Compound Boolean Expressions With The “XOR” Operator

Format:

```
if (Boolean expression) XOR (Boolean expression) then  
    body;
```

Example:

```
if (takesFirstJob = true) XOR (takesSecondJob = true) then  
    isEmployed := true;
```

James Tam

## Order Of The Operations

<u>Order</u>	<u>Operator</u>
1	NOT
2	* / DIV MOD AND
3	+ - OR
4	< > = <= >= <>

James Tam

## Why Bracket Boolean Expressions

Compound Boolean expressions

e.g., if  $x > 0$  AND  $y > 0$  then

James Tam

## Why Bracket Boolean Expressions

Compound Boolean expressions

e.g., if  $x > 0$  AND  $y > 0$  then

AND has highest priority so the 0 and y  
becomes operands for this operation

James Tam

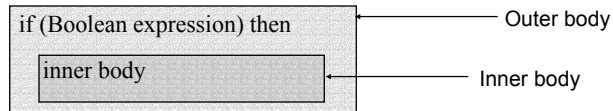
## Nested Decision Making

One decision is made inside another

Outer decisions must evaluate to true before inner decisions are even considered

Format:

```
if (Boolean expression) then
```



Example: (For complete example look in Unix under /home/231/examples/decisions/nesting.p)

```
if (num1 > 0) then
  if (num2 > 0) then
    writeln('Both numbers are positive');
```

James Tam

## Nested Decision Making: The Dangling Else

```
if (x > 0) then
```

```
if (y > 0) then
```

```
writeln('x is greater than zero, y is greater than zero')
```

```
else
```

```
writeln('x is greater than zero');
```

James Tam

## The Dangling Else Reformatted

```
if (x > 0) then
    if (y > 0) then
        writeln('x and y greater than zero')
    else
        writeln('x greater than zero');
```

James Tam

## Decision-Making With Multiple Alternatives

if-then

Checks one condition

if-then-else

Checks for one of two mutually exclusive conditions

Approaches for multiple alternatives

Multiple if's

Multiple else-if's

James Tam

## **Multiple If's: Non-Exclusive Conditions**

Any, all or none of the conditions may be true (independent)

Format:

```
if (Boolean expression 1) then
    body 1;
if (Boolean expression 2) then
    body 2;
:
statements after the conditions;
```

James Tam

## **Multiple If's: Non-Exclusive Conditions (Example)**

```
if (x > 0) then
    writeln('X is positive');
if (y > 0) then
    writeln('Y is positive');
if (z > 0) then
    writeln('Z is positive's);
```

James Tam

## Multiple If's: Mutually Exclusive Conditions

At most only one of many conditions can be true ←  
Can be implemented through multiple if's ← Inefficient combination!

Example (for full example look in Unix under  
/home/231/examples/decisions/inefficientDecisionMaking.p)

```
if (gpa = 4) then
    letter := 'A';
if (gpa = 3) then
    letter := 'B';
if (gpa = 2) then
    letter := 'C';
if (gpa = 1) then
    letter := 'D';
if (gpa = 0) then
    letter := 'F';
```

James Tam

## Multiple If, Else-If's: Mutually Exclusive Conditions

Format:

```
if (Boolean expression 1) then
    body 1
else if (Boolean expression 2) then
    body 2
    :
else
    body n;
statements after the conditions;
```

James Tam



## Multiple If, Else-If's: Mutually Exclusive Conditions (Example)

Example (for full example look in Unix under /home/231/examples/decisions/ifElseIf.p)

```
if (gpa = 4) then
    letter := 'A'
else if (gpa = 3) then
    letter := 'B'
else if (gpa = 2) then
    letter := 'C'
else if (gpa = 1) then
    letter := 'D'
else if (gpa = 0) then
    letter := 'F'
else
    writeln('GPA must be one of 4, 3, 2, 1 or 0');
```

Watch your semi-colons!

James Tam

## Case Statements

An alternative to the if, else-if (at most only one of many conditions can be true)

Format (integer):

```
case (expression) of
```

```
    i1:
        body;
```

```
    i2:
        body;
```

```
    :
```

```
    in:
        body;
```

```
else
```

```
    body;
```

```
end; (* case *)
```

Expression (variable, constant, arithmetic) must evaluate to an integer

James Tam

## Case Statements: Integer Example

Example (look for complete example in Unix under /home/231/examples/decisions/caseOf1.p):

```
case (gpa) of
  4:
    writeln('You got an A');
  3:
    writeln('You got a 'B');
  2:
    writeln('You got a C');
  1:
    writeln('You got a D');
  0:
    writeln('You got an F');
```

James Tam

## Case Statements: Integer Example (2)

```
else
  writeln('GPA must be one of 4, 3, 2, 1 or 0');
end; (* case *)
```

James Tam

## Case Statements: Characters

Format (char):

```
Case (expression) of
    'c1':
        body;
    'c2':
        body;
    :
    'cn':
        body;
else
    body;
end; (* case *)
```

Expression (variable, constant, arithmetic) must evaluate to a character

James Tam

## Case Statements: Character Example

Example (look for complete example in Unix under  
`/home/231/examples/decisions/caseOf2.p`):

```
case (letter) of
    'A':
        writeln('GPA = 4');
    'B':
        writeln('GPA = 3');
    'C':
        writeln('GPA = 2');
    'D':
        writeln('GPA = 1');
    'F':
        writeln('GPA = 0');
```

James Tam

## **Case Statements: Character Example (2)**

```
else
    writeln("Letter grade must be one of an "A", "B", "C", "D" or "F");
end; (* case *)
```

James Tam

## **Testing Decision Making Constructs**

Make sure that the body of each decision making construct executes when it should.

Test:

- 1) Obvious true cases
- 2) Obvious false cases
- 3) Boundary cases

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## Testing Decisions: An Example

```
program testDecisions (input, output);
begin
    var num : integer;
    write('Enter a value for num: ');
    readln(num);
    if (num >= 0) then
        writeln('Num is non-negative: ', num)
    else
        writeln('Num is negative: ', num);
end.
```

James Tam

## You Should Now Know

What are the four decision making constructs available in Pascal:

- If-then
- If-then-else
- If, else-if
- Case-of
- How does each one work
- When should each one be used

How to evaluate decision making constructs:

- Tracing the execution of simple decision making constructs
- Where are semi-colons needed in decision making constructs and why
- How to evaluate nested decision making constructs

James Tam

## **You Should Now Know (2)**

How the bodies of the decision making construct are defined:

- What is the body of decision making construct
- What is the difference between decision making constructs with simple bodies and those with compound bodies

What is an operand

What is a relational operator

What is a Boolean expression

How multiple expressions are evaluated and how the different logical operators work

How to test decision making constructs