Introduction to Programming
Logical Expressions & Conditionals

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http://research.tamhsc.edu/pinformatics/

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Course URL:
http://pinformatics.tamhsc.edu/phpm672

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What we are going to learn

- Operators
  - Logical (~ / !), (& / and), (| / or)
  - Relational <, <=, ==, >, >
- Learn Conditional programming
  - if then else end
- Common Pitfalls

Relational Operators

Tests relationship between two objects

Name	Operators	Examples
Equivalence		
Equality	= (SAS) == (STATA)	5 == 5, x == y
Inequality	~= (SAS) != (STATA)	5 ~= 5, z == (x^2 + y^2)
Binary Operators		
Less Than	<	5 < 3
Less Than or Equal	<=	4 <= 4,
Greater Than or Equal	>=	7 >= 10
Greater Than	>	10 > 7

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Logical Operators

Boolean operators

Name	Operators	Examples
Unary Operators		
Logical Negation (NOT)	~ (SAS) / ! (STATA)	~ (3 == 5) = 1 (true)
Binary Operators		
Logical And (AND)	& / and (SAS)	T & T = 1 (true)
Logical Or (OR)	| / or (SAS)	F | T = 1 (true)

- Performs binary logic on two logical data type operands to return a logical result.

Boolean Logic

Truth Tables (1=T; 0=F)

x	y		NOT	AND	OR
			~ y	x & y	x | y
0	0		1	0	0
0	1		0	0	1
1	0		1	0	1
1	1		0	1	1

Logical Expressions

- Simple or complex expression whose final result is a single true/false logical result
- *Examples:* Given `x=3, y=4, z=5`
  - `x == 3`
  - `(x+y) < z`
  - Logical operators allow us to build up compound tests, piece by piece

Operator Precedence (Full)

Level	Operator
1 (highest)	Parentheses ( ) inner to outer
2	Transpose ′ , Power ^ ,
3	Unary plus +, Unary Minus -, logical negation ~
4	Multiplication *, Division /
5	Addition +, Subtraction –
6	Comparisons < , <=, > , >=, ==
7	Logical 'And' &
8(lowest)	Logical 'Or' |
	*** Left to right rule applies**

- `x & y | z = ? (put parenthesis)`

Boolean Logic

Truth Tables: `x & y | z`

x	y	z		x & y	(x&y)|z	(y|z)	x&(y|z)
0	0	0		0	0	0	0
0	0	1		0	1	1	0
0	1	0		0	0	1	0
0	1	1		0	1	1	0
1	0	0		0	0	0	0
1	0	1		0	1	1	1
1	1	0		1	1	1	1
1	1	1		1	1	1	1

Logical Data Types

- **Data Range**
  - Conceptually: Takes on only two Values
    - *true or false* (1 or 0)
  - Actually:
    - *false* ↔ *zero* (0)
    - *true* ↔ any non-zero value (1 or greater)
    - This difference can cause subtle bugs if you are not careful.
- **Storage**
  - Conceptually: Uses a single binary bit
  - Physically/Actually: Takes a single byte

Other Logical Objects

- Functions which return logical data types as their output
- Test functions (*is** functions)
  - Examples: *isfloat(), isvarname(), iskeyword()*
- String Comparison functions:
  - *strcmp(), strcmpi(), strncmp(), strncmpi()*

Motivation

- Step by Step Programming
  - All we have learned to do up to now…
  - Execute statements in order they occur
  - Single path through program script
- Conditional Programming
  - What if we only want to run the code only if some test is satisfied? (print if cond)
  - What if need to make a choice between 2 or more options?
  - How do we make the choice?

Example

SAS
• Initialize to default rate • If MS, assign higher rate

`rate=10;`
`if edu>3 then rate=12;`

`proc print data=fn(obs=10);`
`where gender='F';`

If-end Statement

Single conditional path

- **Syntax:**

```
if <test> then [do;]
   commands; * 1 or more;
[end;]
```

- **Tip:** For the <test>, use logical expressions that evaluate to a single *true/false* value.

Simple Example

```
* One way;
rate=10;
if (edu > 3) then do;
   rate=12;
end;

* Another way;
rate=10;
if (edu > 3) then rate=12;
```

If-else-end statement

Two alternatives, if <true> else <false> end

- **Syntax:**

```
if <test> then [do;]
   commands1; * True;
end; else do;
   commands2; * False;
end;
```

Simple Example

```
* One way;
if (edu > 3) then do;
    rate=12;
end; else do;
    rate=10;
end;

* Another way;
if (edu > 3) then rate=12;
else rate=10;
```

If-elseif-else-end Conditional Execution

Multiple chained tests

```
if <Test1> then do;
  commands1; * T1 true;
end; else if <Test2> then do;
  commands2; * T2 true;
end; else if <Test3> then do;
  commands3; * T3 true;
end; else do;
  commands4; * all false;
end;
```

Example:

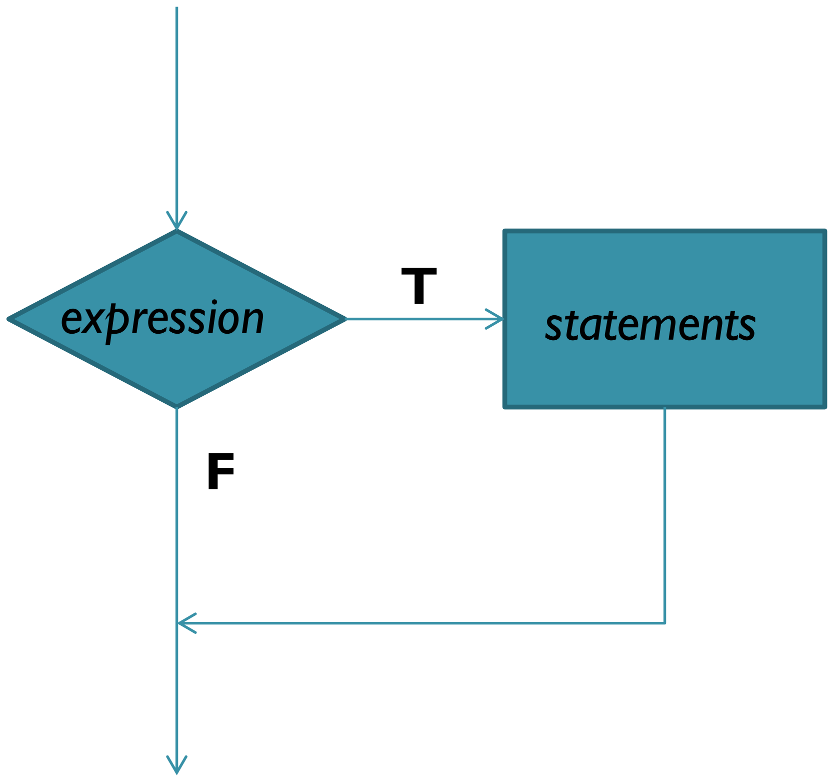
```
if (edu > 5) then do;
   rate=16;
end; else if (edu > 4) then do;
   rate=14;
end; else if (edu > 3) then do;
   rate=12;
end; else do;
   rate=10;
end;
```

Conditional Execution

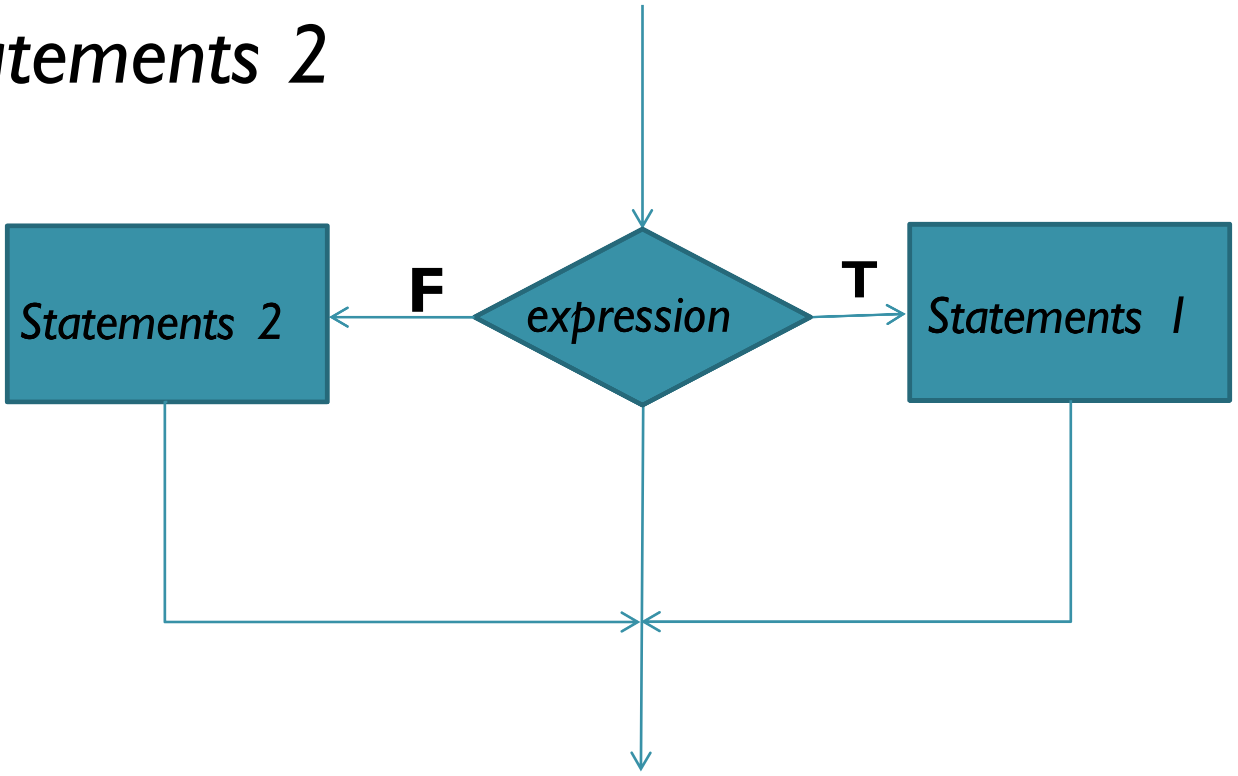
Nested conditions

```
if <Test1> then do;
   if <Test2> then do;
      commands1; * T1,T2 both true;
   end; else do;
      commands2; * T1=1, T2=0;
   end;
end; else do;
   if <Test3> then do;
      commands3; * T1=0, T3=1;
   end; else do;
      commands4; * T1,T3 both false;
   end;
end;
```

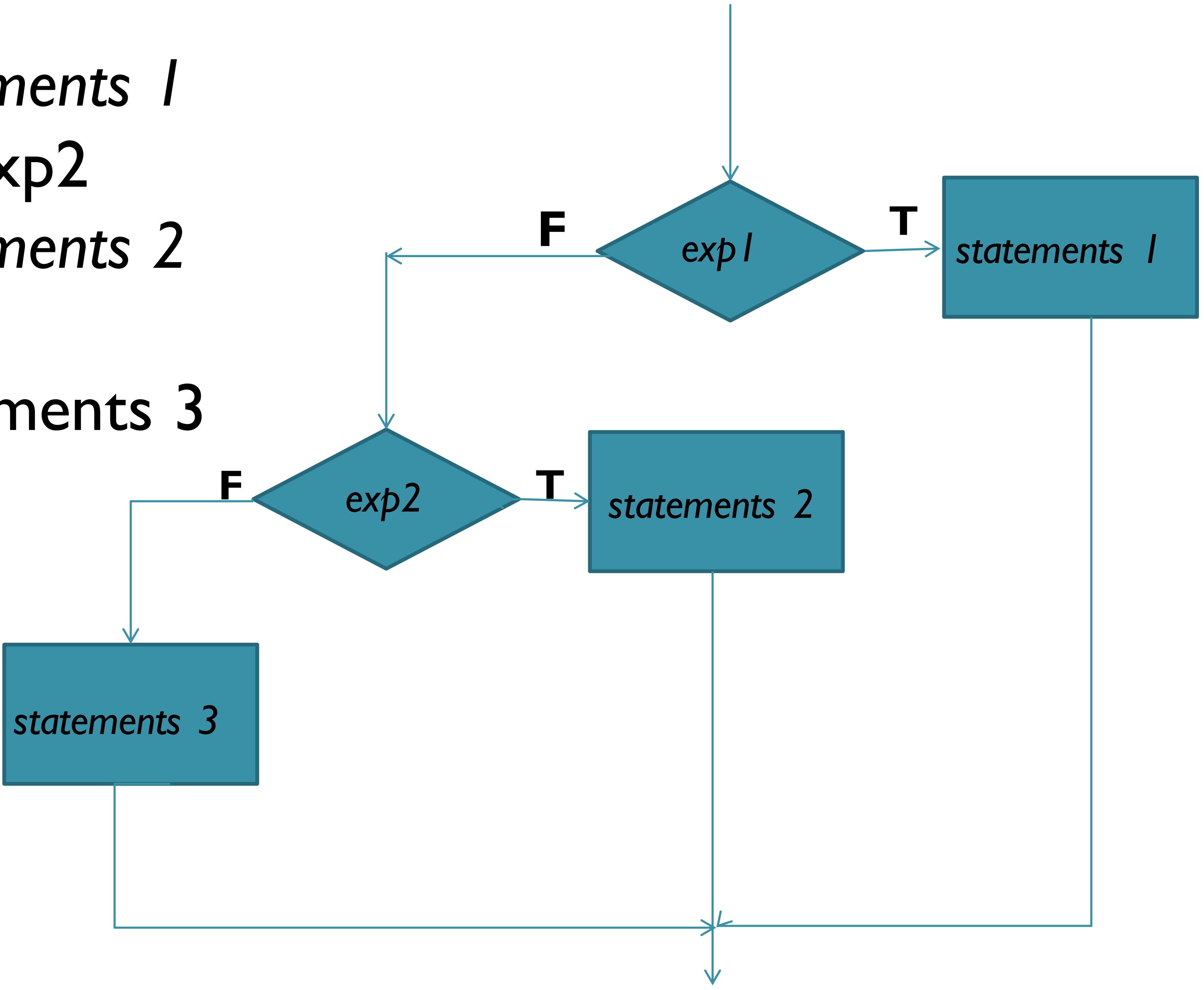
```
if expression
    statements
end
```



```
if *expression*
    *statements 1*
else
    *statements 2*
end
```

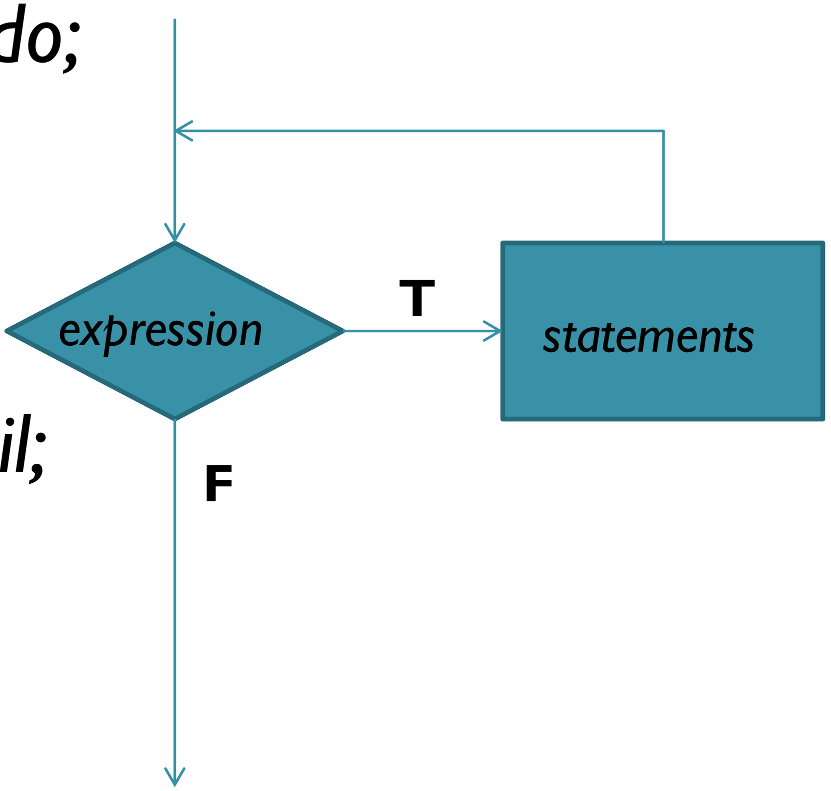


```
if exp1
    statements 1
else if exp2
    statements 2
else
    statements 3
end
```



```
while (expression) do;
    statements;
end;

do (expression) until;
    statements;
end;
```



Common Pitfalls

- Using = instead of == and vice versa.
  - SAS: same, STATA: different
  - `if x = 5 …` **% Error, use `if x == 5`**
  - `x == [2 3]` **% Error, use `x = [2 3]`**
- Confusing `&` (`and`) and `|`(`or`)
- Inserting an extra space in a 2 character relational operator
  - `if x < = y` **% Error, note extra space**
  - `if x <= y` **% Correct**

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Common Pitfalls, cont.

- Using multiple comparisons properly
  - `10 <= x <= 100` % Error (OK in SAS)
  - `(10 <= x) & (x <= 100)` % Correct
- Forgetting the quotes when working with characters or strings
  - `if letter == y` % Error
  - `if letter == “y”` % Correct
- Comparing characters / strings (be careful)
  - `'c' < 'Z'` % OK, compatible sizes
  - `'cat' < 'catch'` % Error, size problem
  - `strcmp('cat', 'catch')` % Use strcmp

Common Pitfalls, cont.

using if … end instead of if … else .. end

```
if (error)
  disp(errMsg);
end
…   %Continue
```

```
if (error)
    disp(errMsg);
else
    …   %Continue
end
```

- Despite detecting an error, we continue on to execute the rest of the script or function

- We only execute the rest of the script or function, if we are error free.

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Logical Expressions & Conditional Programming

Reminder

- Practice using conditional logic
  - Learn logical operators ~, &, |,
  - Learn relational operators <, <=, ==, >, >=
  - Logical expressions
  - If statement
- Practice writing conditional code
- Do the online modules

Learn to fish

- Reading: READ sections in the recommended book & modules I give you before class
- Give you good problems (lab & assignment) to learn to fish on your own
  - Lab: Read my code
  - Assignment: Now write your code
- Available when you get stuck
- Top (problem) down(data) vs bottom up
  - Need to iterate

Before we start

- I will do more coding in class so you can see how coding is done
  - Remember this is just ONE way of doing it. I have very old habits from when computers were very different. So pick and choose what you think works for you
- LAB: I will share code I write, so you learn to read code
- Assignment: now try to write code to do similar things with your own data
- Computing environment is important (by assign 2)
  - You need to figure out stable environment.
  - Programming is very difficult and time consuming if you don't have your work environment set up, even for me.
  - Laptops? Desktops? Lab machine (usb)?