Structured programming

- Sequence structure
  - order to perform actions
- Selection structure (conditional, branches)
  - what to do depending on a decision
- Repetition structure (iteration, loops)
  - do something many times

```
?Control #for help in R
```

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```
?Control #for help in R
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Selection structures

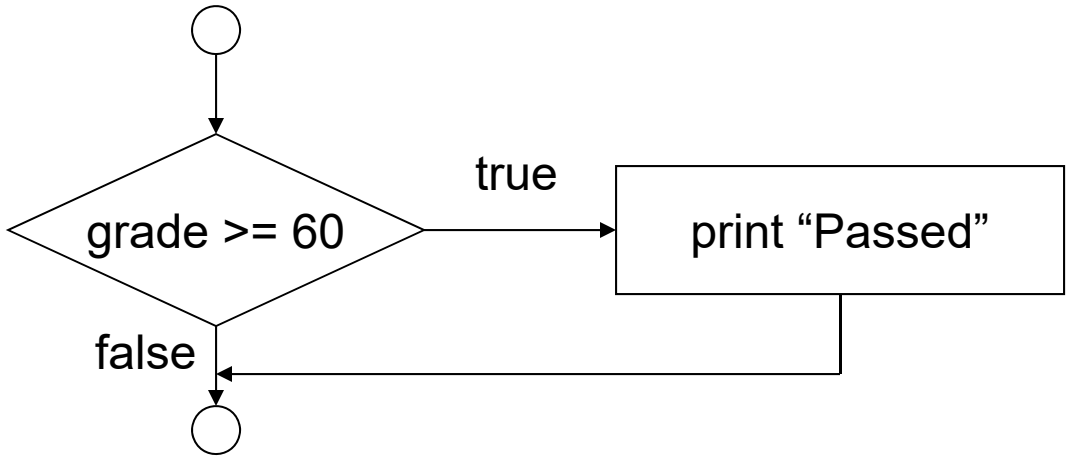
- Decisions: what to do if ...
- Pseudocode:

  If student's grade is greater than or equal to 60

      Print "Passed"

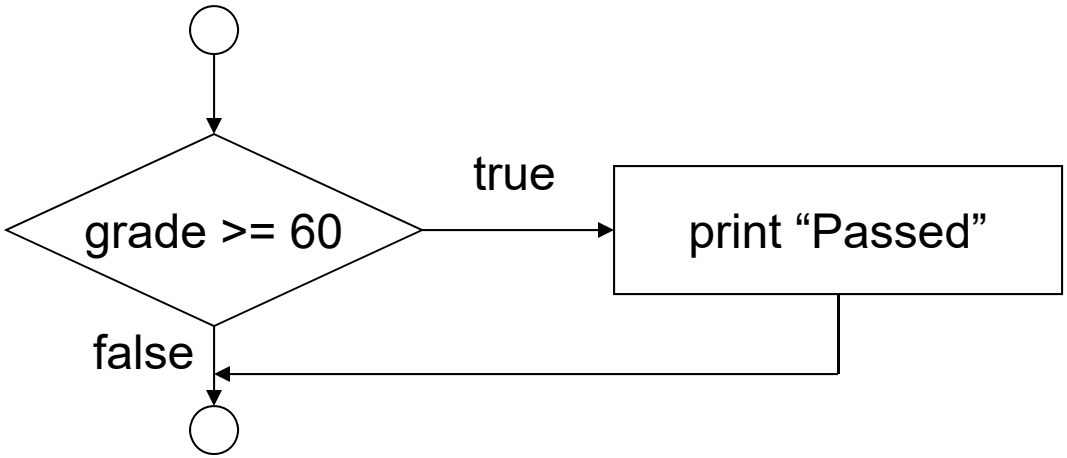
  indent (4 spaces)

- Flowchart:



R's if selection structure

```
if(condition) expression
```




```
student_grade <- 74

if(student_grade >= 60) print("Passed")
```

Predict: What is the output if you initialize the student's grade to be less than 60? Then try it.

Good programming practice

- Use braces {}, spacing and indenting to identify control structures

```
student_grade <- 74
if ( student_grade >= 60 ) {
    print("Passed")
}
```

Class style

indent (4 spaces)

closing brace aligns with "i" in "if"

A variety of styles

```
student_grade <- 74
if (student_grade >= 60) {
  print("Passed")
}
```

Tidyverse style

```
student_grade <- 74
if ( student_grade >= 60 )
{
    print("Passed")
}
```

Another style

R: Explicit vs implicit printing

- Explicit

```
print("Passed")
print(v1)
```

- Implicit

```
"Passed"
v1
```

- Use explicit printing within braces

```
?"{" #see R help for why
```

Ecology examples

```
satiation <- 42
if ( satiation < 50 ) {
    print("Squirrel is hungry")
}
```

Ecology examples

```
hungry <- TRUE
if ( hungry ) {
    print("Squirrel is hungry")
}
```

Ecology examples

```
soil_moisture <- 0.08
if ( soil_moisture < 0.2 ) {
    print("Please water the plant")
}
```

Ecology examples

```
plant_stressed <- FALSE
soil_moisture <- 0.08
if ( soil_moisture < 0.2 ) {
    plant_stressed <- TRUE
}
```

Multiple line expressions

```
if ( condition ) {
    expression1
    expression2
    etc
}
```

This is a "block" of code

Multiple line expressions

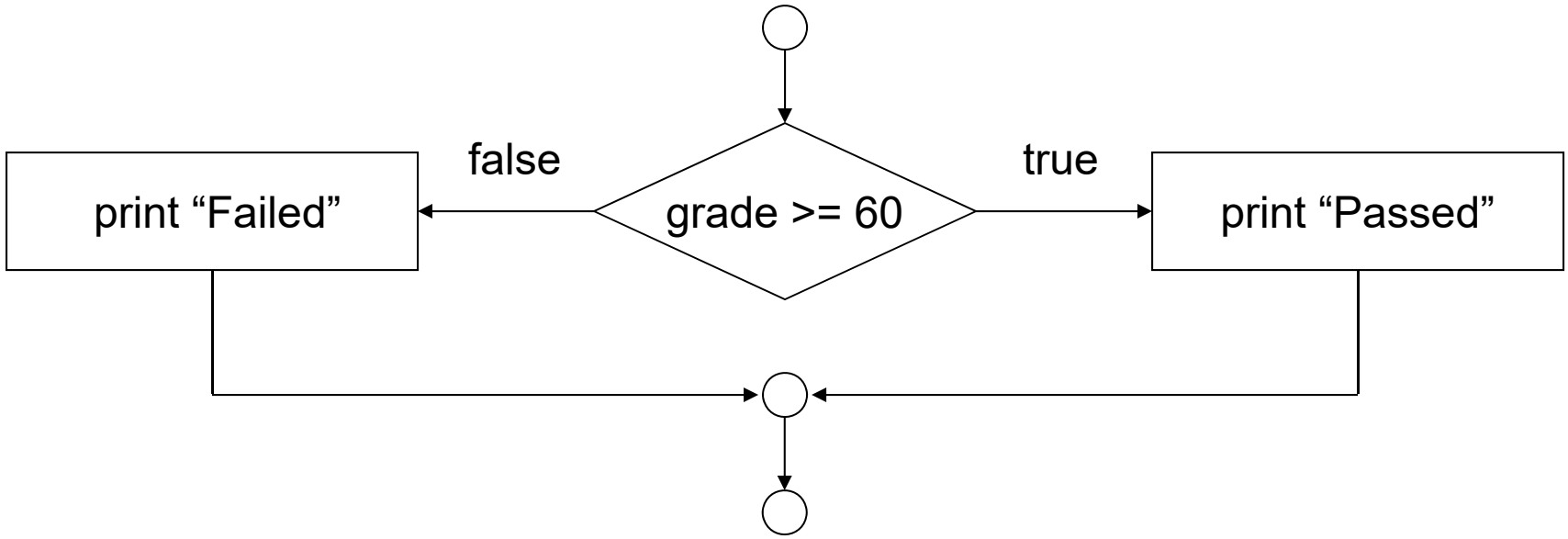
```
satiation <- 42
if ( satiation < 50 ) {
    print("Squirrel is hungry")
    satiation <- satiation + 10
    print("Squirrel ate 10 nuts")
    print(paste("Satiation:", satiation))
}
```

R’s selection structures

if	single selection structure
if/else	double selection structure
if/else if	multiple selection structure

if/else selection structure

```
if(condition) expr1 else expr2
```



if/else selection structure

```
if ( condition ) {
     expr1
} else {
     expr2
}
```

all lines between braces indented 4 spaces

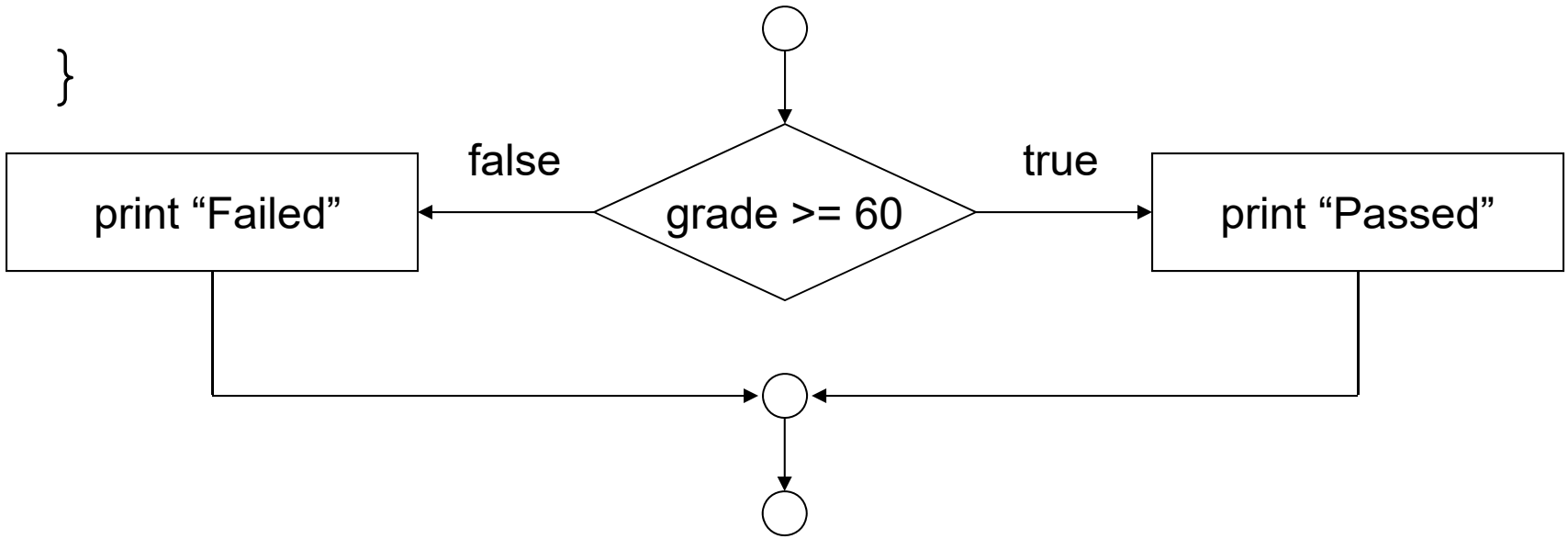
"} else" must be on same line

Good programming practice:
Always use braces, spacing, and indenting

if/else selection structure

```
if ( condition ) {
     expr1
} else {
     expr2
}
```

Exercise:
Modify the code from the student example above to print “Passed” or “Failed” depending on the student’s grade.



Combining control structures

- Stacking
  - one after another
- Nesting
  - one inside another

Stacked selection structures

```
if ( exam >= 50 ) {
    print("Passed")
}
if ( !(exam >= 50) ) {
    print("Failed")
}
```

if

else

This shows that an if/else structure can be built from the fundamental if structure. We would not do this in practice. We would use an if/else structure instead.

Stacked selection structures

```
plant_stressed <- FALSE
soil_moisture <- 0.35
solar_radiation <- 2000
if ( soil_moisture < 0.2 ) {
    plant_stressed <- TRUE
}
if ( solar_radiation > 1600 ) {
    plant_stressed <- TRUE
}
if ( plant_stressed ) {
    print("Plant is stressed")
}
```

Nested selection structures

```
if ( exam >= 70 ) {
     if ( exam < 90 ) {
          grade <- "B"
     }
}
```

What does this do?
Consider different values for exam

Nested selection structures

- nested if/else structures
- creates an if/else if multiple selection structure

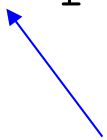
```
if ( cond1 ) {
    expr1
} else {
    if ( cond2 ) {
        expr2
    } else {
        expr3
    }
}
```

But don't write it this way.

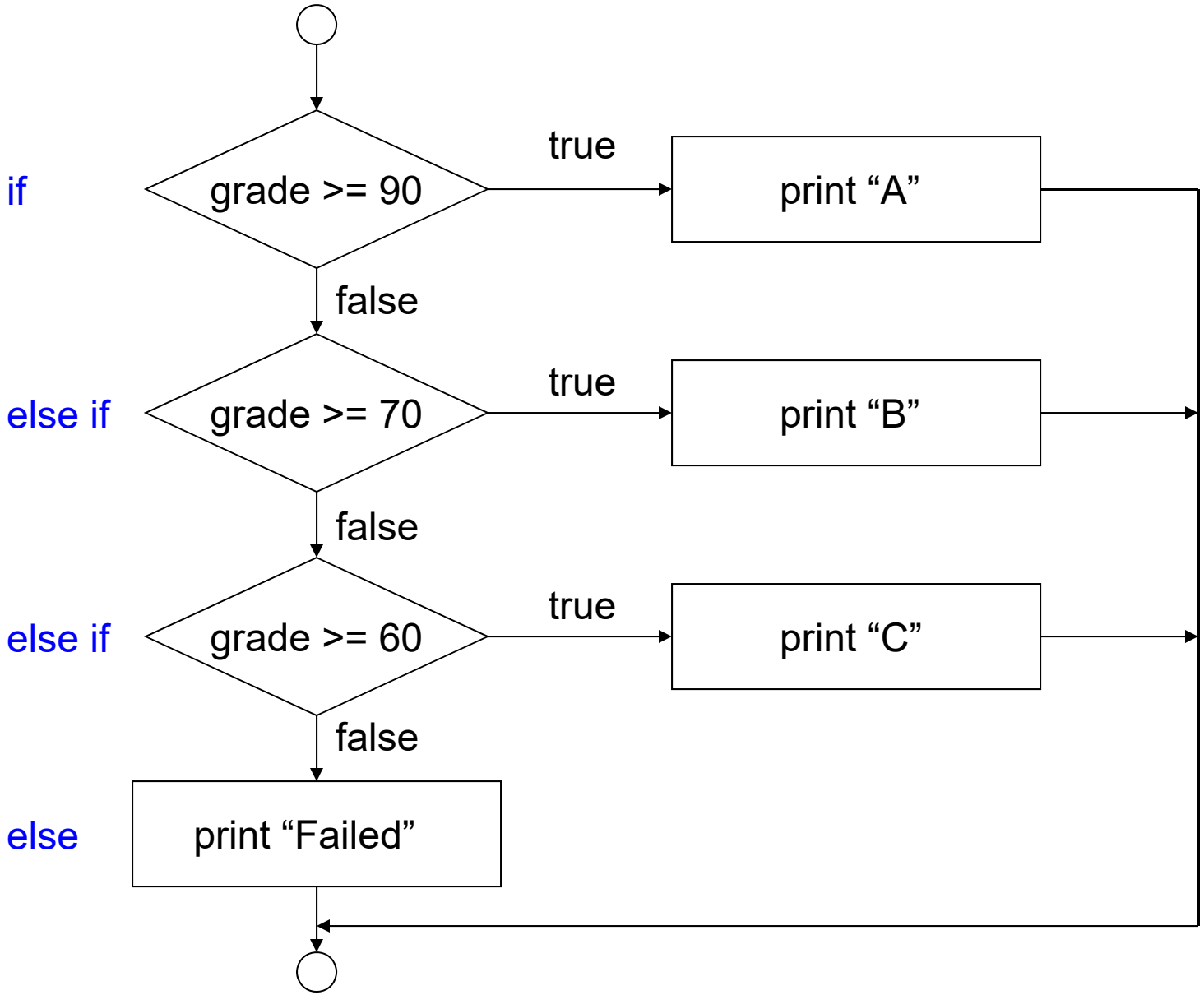
Nested selection structures

- nested if/else structures
- creates an if/else if multiple selection structure

```
if ( cond1 ) {
    expr1
} else if ( cond2 ) {
    expr2
} else {
    expr3
}
```

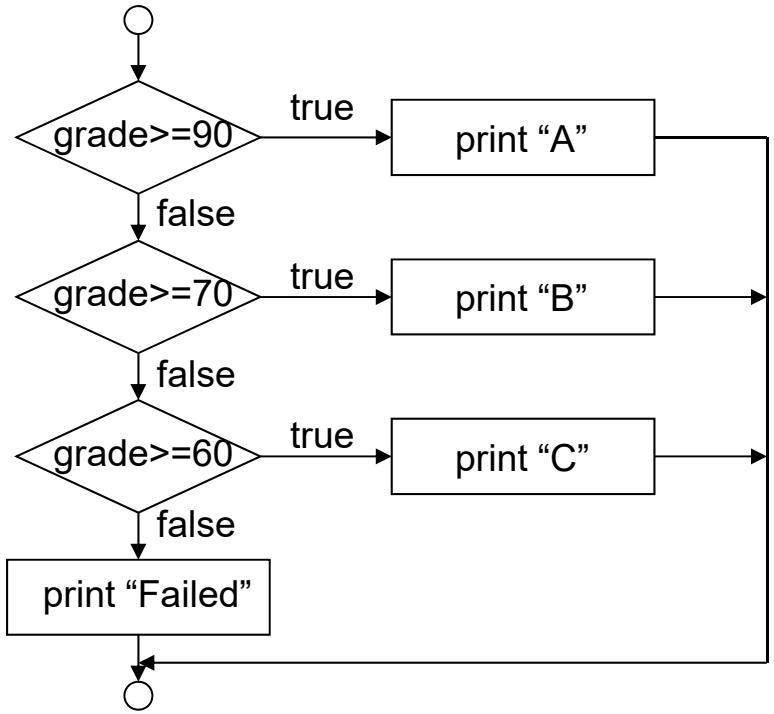


all lines between braces indented 4 spaces


if
grade >= 90
true
print “A”
false
else if
grade >= 70
true
print “B”
false
else if
grade >= 60
true
print “C”
false
else
print “Failed”

if/else if selection structure

```
if ( cond1 ) {
    expr1
} else if ( cond2 ) {
    expr2
} else if ( cond3 ) {
    expr3
} else {
    expr4
}
```



Exercise:
Modify the code from the student example to print “A”, “B”, “C”, or “Failed” depending on the student’s grade.