COMPSCI 101

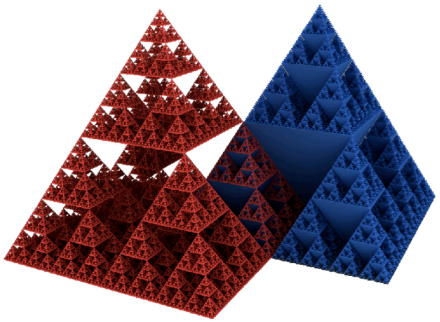
Principles of Programming

Lecture 10

Deskchecking

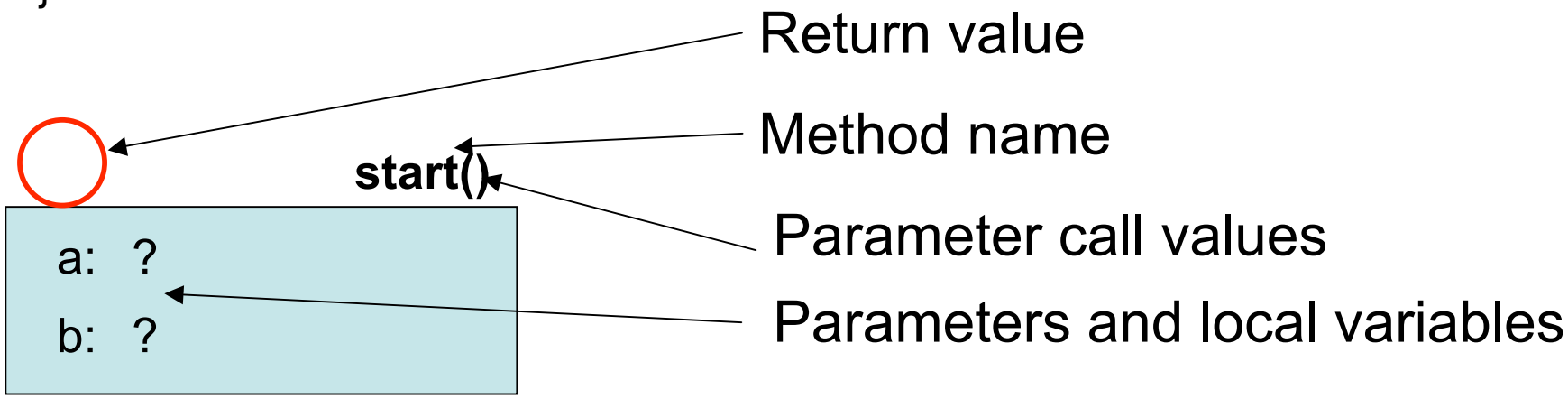
&

Boolean expressions



Tracing code: Method Call Box

```
public void start() {
    int a, b;
    a = 5;
    a = multiplyBy4(a);
    System.out.println(a);
}
```

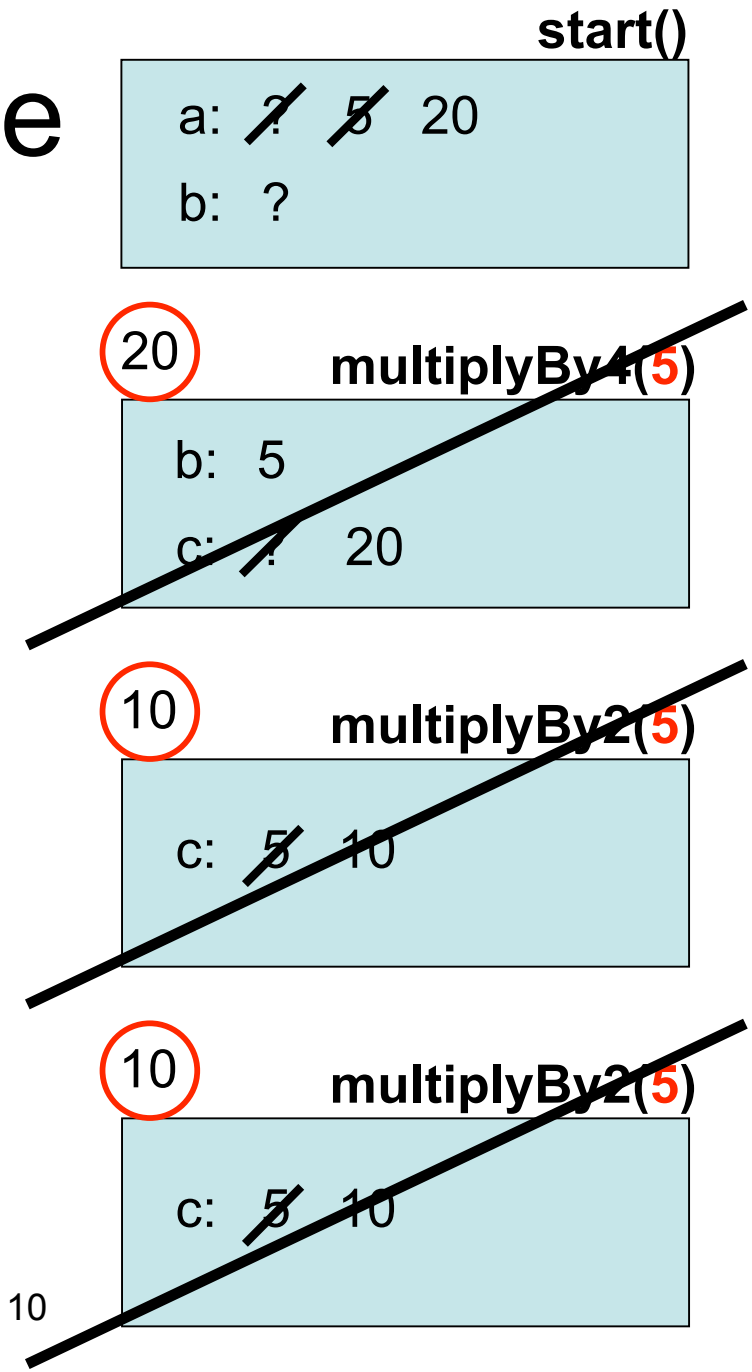


Tracing code

```
public class Multiply {

    public void start() {
        int a, b;
        a = 5;
        a = multiplyBy4(a);
        System.out.println(a);
    }

    private int multiplyBy4(int b) {
        int c;
        c = multiplyBy2(b) + multiplyBy2(b);
        return c;
    }

    private int multiplyBy2(int c) {
        c = c + c;
        return c;
    }
}
```

output

20



Boolean expressions

A boolean expression is a statement (fact) about the world

- The statement can be assessed for truth

Examples:

- "Apples are red"
- "John went to the store last Saturday"
- "I prefer red wine to white wine"
- "The square of the hypotenuse of a right angle triangle is equal to the sum of the squares of the other two sides"
- "CompSci 101 is the best course I have ever done"

Truth values

Every boolean expression must be either true or false

Example:

- That apple weighs 110 grams (true)
- 1 + 1 = 3 (false)

We might use letters to stand for our sentences, to make them easier to discuss:

- Let P stand for: "The coffee contains milk"
- We can then say "P is false" or "P is true"

Combining expressions

We can combine expressions using "and", "or" and "not"

- Let P = "The coffee has milk"
- Let Q = "The coffee has sugar"

P and Q

- The coffee has milk and the coffee has sugar
- True when both p and q are true

P or Q

- The coffee has milk or the coffee has sugar
- True when either p is true or q is true

not P

- It is not the case that the coffee has milk
- True when p is false

Truth tables: AND, OR

A truth table describes the different truth values for a logical operator

Truth table for logical AND operator

p	q	p and q
true	true	true
true	false	false
false	true	false
false	false	false

Truth table for logical OR operator

p	q	p or q
true	true	true
true	false	true
false	true	true
false	false	false

Example: Let p = "The coffee has milk", Let q = "The coffee has sugar"

Assume that the coffee has milk (p is true), but no sugar (q is false)

- Can use the truth table for AND to establish that "p and q" is false
- Can use the truth table for OR to establish that "p or q" is true

Truth tables: NOT

A truth table describes the different truth values for a logical operator

Truth table for logical NOT operator

p	NOT p
true	false
false	true

Example:

- p = "The coffee has milk"
- q = "The coffee has sugar"

- Assume that the coffee has milk (p is true), but no sugar (q is false)
- Using truth table
  - "not p" is false
  - "not q" is true

Java: boolean type

Java has a primitive type called boolean

- Holds only two possible values:
  - **`true`**
  - **`false`**

`boolean` variables

- Declare a variable of **`boolean`** type
- **`boolean`** variables can hold either the value **`true`** or the value **`false`**

```
boolean isStudent;
boolean hasBlueHair;

isStudent = true;
hasBlueHair = false;
```

Naming conventions

Boolean variables hold values which are true or false

- Variables names should remind you of their contents
- Names of boolean variables express a fact that should be true or false

Bad boolean variable names

```
boolean susan;
boolean age;
boolean whenIsThisLectureOver;
```

Good boolean variable names

```
boolean enrolledIn101;
boolean hasPassed;
boolean gameIsOver;
```

Java: Logical Operators

Logical "AND"

- `&&`
- Example: `p && q`

total less than or equal to 21
and
total greater than dealer

Logical "OR"

- `||`
- Example: `p || q`

today is Saturday
or
today is overcast

Logical "NOT"

- `!`
- Example: `!p`

it is not the case that the lecture is over

Truth tables: NOT

A truth table describes the different truth values for a logical operator

Truth table for logical NOT operator

p	! p
true	false
false	true

Truth tables: AND, OR

A truth table describes the different truth values for a logical operator

Truth table for logical AND operator

p	q	p && q
true	true	true
true	false	false
false	true	false
false	false	false

Truth table for logical OR operator

p	q	p || q
true	true	true
true	false	true
false	true	true
false	false	false

Exercise: boolean expressions

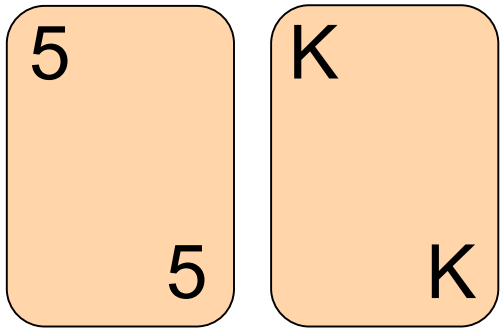
What is the output of the following:

```
boolean a = true;
boolean b = true;
boolean c = false;

boolean d = (a && b) || (a && c);
boolean e = a || (!c);
boolean f = (c || b) && (c || a);

System.out.println( d && e );
System.out.println( f || a );
```

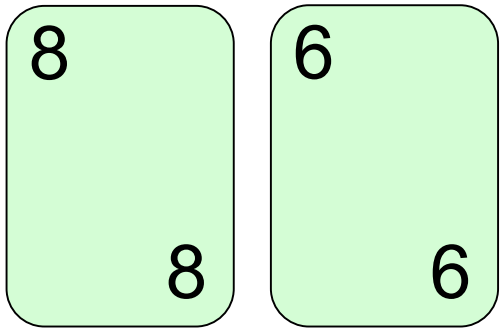
```
true
true
```

Example: boolean expressions

Using logical operators to form compound boolean expressions



Your hand



Dealer's hand

```
boolean totalGreaterThan21 = false;
boolean totalGreaterThanDealer = true;

boolean youWin = (!totalGreaterThan21 &&      true
                                  totalGreaterThanDealer );
```