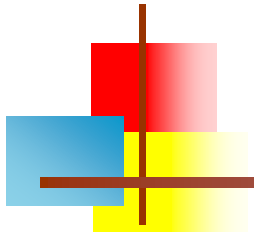
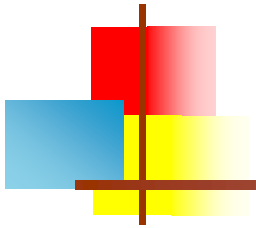


All the Operators

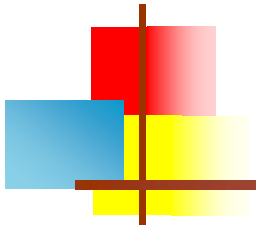


Precedence

- An operator with higher precedence is done earlier (precedes) one with lower precedence
  - A *higher* precedence is indicated with a *lower* number; zero is the highest precedence
- Most of the time, operators with equal precedence are done left to right
  - Examples:

    `3 + 4 * 5` gives `23`

    `10 - 5 - 2` gives `3`
- Exceptions: unary operators, casts, assignment operators, the ternary operator: all done right to left



Postfix operators

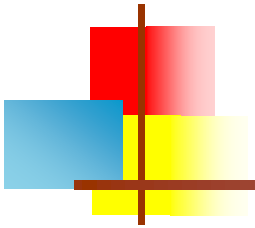
- Postfix operators have the highest precedence

(*parameters*) Parameter lists

[ ] Brackets indicate indexing into an array

- Accesses methods and variables

expr++, *expr*-- Postincrement, postdecrement



Unary prefix operators

- Unary prefix operators have the next highest precedence:

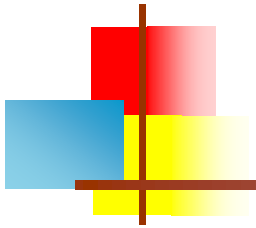
`++`*expr* Preincrement

`--`*expr* Predecrement

`+` `-` Unary plus and unary minus

`!` Logical negation (not)

`~` Bitwise complement (invert every bit)

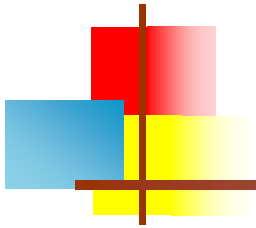


Object creation and casting

`new` Create a new instance of a class

`(`*type*`)` Cast (convert) to the given *type*

- Slides are in order of decreasing precedence
  - Higher precedence means "more tightly bound"
  - The lowest precedence operator is the "main" operator in an expression
  - Frequently the lowest precedence operator is *assignment*, for example `x = y + z;`



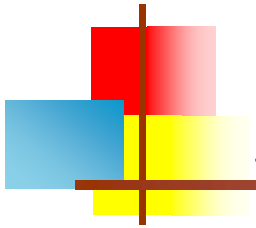
Multiplicative operators

* Multiply

/ Divide

% Modulus

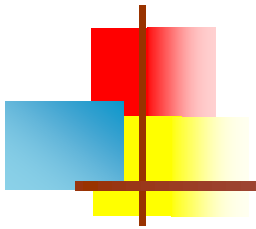
- These all have the same precedence



Additive operators

+ Add

- Subtract



Shift operators

<< Left shift, end off

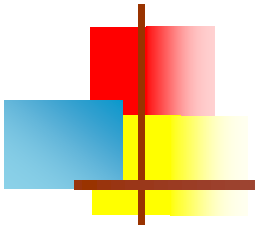
- For small integers, this is equivalent to multiplying by a power of two
- Example: `100 << 3` gives `800`

>> Right shift with sign extension

- For small integers, this is equivalent to an integer divide by a power of two
- Example: `100 >> 2` gives `25`

>>> Right shift with zero fill

- Does not make sense for numbers



Relational operators

`<` Less than

`<=` Less than or equal to

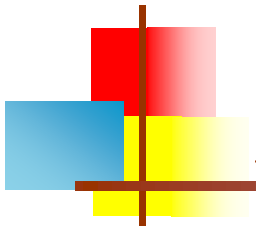
`>` Greater than

`>=` Greater than or equal to

`instanceof` Determines whether its left operand is an object whose type (class or interface) is the right operand

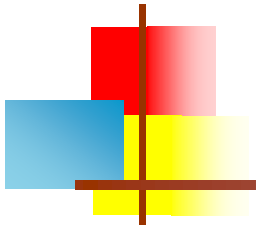
Example: `if (myPet instanceof Dog) {...}`

- These all have the same precedence, and it is *higher* than equality/inequality tests



A beginner's error

- `if (0 <= i < a.length) { ... }`
- Operations are done left to right
- `0 <= i` will be either `true` or `false`
- Neither `true < a.length` nor `false < a.length` is legal
- The correct expression should be
  `if (0 <= i && i < a.length) { ... }`



Equality and inequality

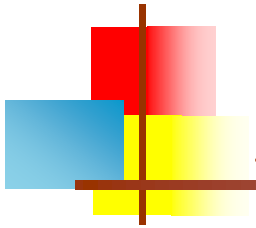
`==` Test if equal

- For primitive types, tests if the values are equal
- For objects, tests if both sides refer to the same object

`!=` Test if not equal

- For primitive types, tests if the values are unequal
- For objects, tests if the sides refer to different objects

- Reminder: these tests should not be used on floating-point numbers (`float` or `double`)

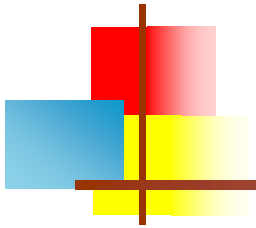


AND

& AND

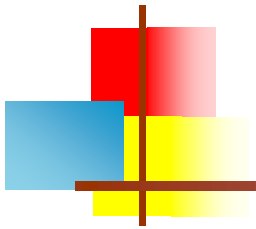
- For integral types, ANDs each corresponding pair of bits
  - 0 & 0 == 0
    0 & 1 == 0
    1 & 0 == 0
    1 & 1 == 1
- For booleans, performs the logical AND operation

- Boolean & is like &&, but both operands are evaluated, even if it is possible to decide the result from the left operand alone



Exclusive OR

- ^ XOR
  - For integral types, XORs each corresponding pair of bits
    - 0 ^ 0 == 0
      0 ^ 1 == 1
      1 ^ 0 == 1
      1 ^ 1 == 0
  - For booleans, performs the logical XOR operation
    - a ^ b is true if either a is true or b is true, but not both
- There is no ^^ operation

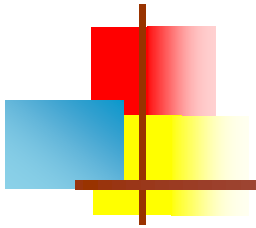


OR

OR

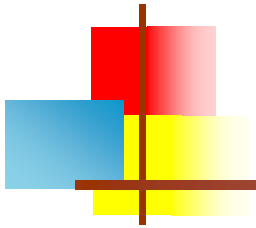
- For integral types, ORs each corresponding pair of bits
  - 0 | 0 == 0
    0 | 1 == 1
    1 | 0 == 1
    1 | 1 == 1
- For booleans, performs the logical OR operation

- Boolean | is like | |, but both operands are evaluated, even if it is possible to decide the result from the left operand alone



The ternary operator

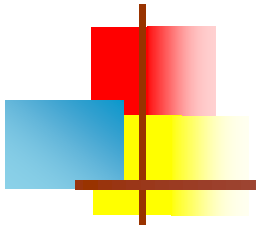
- ***boolean-expr*** `?` ***expression-1*** `:` ***expression-2***
- This is like `if-then-else` for values rather than for statements
- If the ***boolean-expr*** evaluates to `true`, the result is ***expression-1***, else it is ***expression-2***
- Example: `max = a > b ? a : b ;` sets the variable `max` to the larger of `a` and `b`
- ***expression-1*** and ***expression-2*** need not be the same type, but either result must be useable
- *The ternary operator is right associative!*
  - To avoid confusion, use parentheses if your expression has more than one ternary operator



The assignment operators I

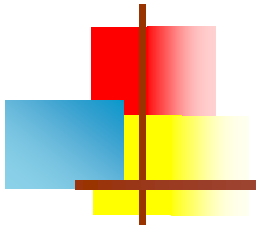
- The assignment operators have the lowest precedence
  - Assignment *is* an operation
  - Assignment is right associative

    `a = b = c = 7.5 * w;`
    - assigns `7.5*w` to `c`, then assigns `c` to `b`, then assigns `b` to `a` – *if* all these assignments are legal
- Example:
  - `if ((line = reader.newLine()) == null) { ... }`



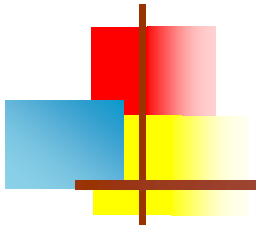
The assignment operators II

- There are a *lot* of assignment operations besides =
- ***variable* += *expression*** means the same as
  variable* = *variable* + *expression
- ***variable* -= *expression*** means the same as
  variable* = *variable* - *expression
- ***variable* *= *expression*** means the same as
  variable* = *variable* * *expression
- ***variable* /= *expression*** means the same as
  variable* = *variable* / *expression



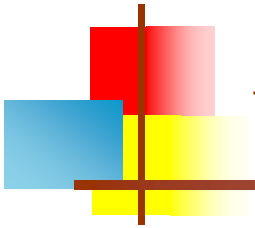
The assignment operators III

- ***variable* %= *expression*** means the same as
  variable* = *variable* % *expression
- ***variable* <<= *expression*** means the same as
  variable* = *variable* << *expression
- ***variable* >>= *expression*** means the same as
  variable* = *variable* >> *expression
- ***variable* >>>= *expression*** means the same as
  variable* = *variable* >>> *expression



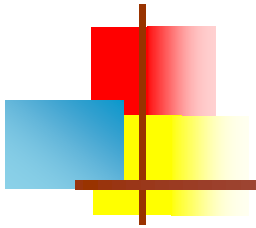
The assignment operators IV

- ***variable*** **&=** ***expression*** means the same as
  variable **=** ***variable*** **&** ***expression***
- ***variable*** **|=** ***expression*** means the same as
  variable **=** ***variable*** **|** ***expression***
- ***variable*** **^=** ***expression*** means the same as
  variable **=** ***variable*** **^** ***expression***



What you need to know

- You should understand what each operator does
- Parameter lists, array indexing, casting, postfix `++` and `--`, and the dot operator are done first
  - In particular, a cast refers to the *one* following entity, so to cast the result of an expression you need extra parentheses
  - Example 1: ***variable*** `=` `(`***type***`)(`***expression***`);`
  - Example 2: ***variable*** `=` `((`***type***`)`***variable***`).`***method***`();`
- In arithmetic, the unary operators `+` and `-` are done first, then multiplication and division, then addition and subtraction
- All assignment operators are done last
- For anything else, it's a good idea to use parentheses anyway (even if you remember the order of precedence, other people won't)



The End