

Revision

- Most programs need to do repetitive jobs.
- To do repetitive things without writing repetitive statements, we need a looping construct.
- In Java, we write loops by using while statements.
- An iteration of a loop is a time when the loop body is executed.
- Different iterations of the same while statement can do different things, because the values of variables may be changed during the previous iteration.
- Writing loops that behave really differently at different iterations can be rather difficult.

0911B L10-1

Writing loops

- Loops are written with top-down design, just like other parts of the program.
- We must have a high-level idea about what each iteration of the while-loop should do.
- We also want to have an idea about what is the state of the program when an iteration begins. We say that at the beginning, some loop invariants holds.
- For the loop to make sense, at the end of an iteration we must prepare the state for the next iteration. We say that at the end, we restore the loop invariants.
- Loop invariants are promises. You promise that no matter how the program reaches the beginning of a loop, the invariants hold.

0911B L10-2

Our last example

Consider our last “more complicated” example

- In each iteration, we want to read the value of stock of a day. We also optionally print out the 5-days running average of a day.
- The exact design of a loop is based on the loop invariant.
- The loop invariant: at the beginning of a loop,
 - Last 5 days values are in *day5*, *day4*, ..., *day1*.
 - Current day is already setup.
 - Last day average is not printed out yet.
- Therefore, in the loop we print out the running average if available, and then restore the invariant by shifting the values and reading a new last-day value.

0911B L10-3

The pseudo-code of the loop

Due to the invariant, we can write the high-level description of the loop easily. With this high level description we get the program we examined last time.

```
// Setup the loop invariant
Set Current day to 1
Read the last day value to day5
While the last day value is not 0
Do
  // Loop invariants: last 5 days value in day5 to day1;
  // Current day is correct, and running average is not printed.
  If Current day is 5 or later
  Then
    Print out running average
  // Restore invariants
  Add 1 to Current day
  Shift values of stock
  Read the last day value
```

0911B L10-4

Nested loops

- A while statement is one single Java statement, just like an if/else statement or a simple statement. So it can appear within an if/else statement, a compound statement, etc.
- If a while statement appears within another while statement, we say we have a nested while statement.

```
// Print a multiplication table
int i = 1;
while (i <= 10) { // Print row i.
  int j = 1;
  while (j <= 10) { // Print column j. Space is already printed if needed.
    System.out.print(i * j);
    if (j++ != 10)
      System.out.print(" ");
    else
      System.out.println("");
  }
  ++i;
}
```

0911B L10-5