Programming in C

Chapter 4B
Looping Subtasks

Looping Subtasks

- We will examine some basic algorithms that use the while and if constructs. These subtasks include
  - Reading unknown quantity of data
  - Counting things
  - Accumulating (summing) totals
  - Searching for specific values
  - Finding extreme values

Looping Subtasks

- Examples will be based upon common models:

Priming Read

Initialize program state
Read the first value (priming read)
While (data exists)
    update program state as needed
    read next value(s)
Output final state

or

Input Count

Initialize program state
While (input count OK)
    update program state as needed
Output final state

- The type of state that must be maintained by the program depends on the nature of the problem and can include:
  - *indicator (true/false) variables*
  - *counter variables*
  - *sum variables*
  - *previous input value variables*

Counter-Controlled Repetition

- Number of items is known before loop

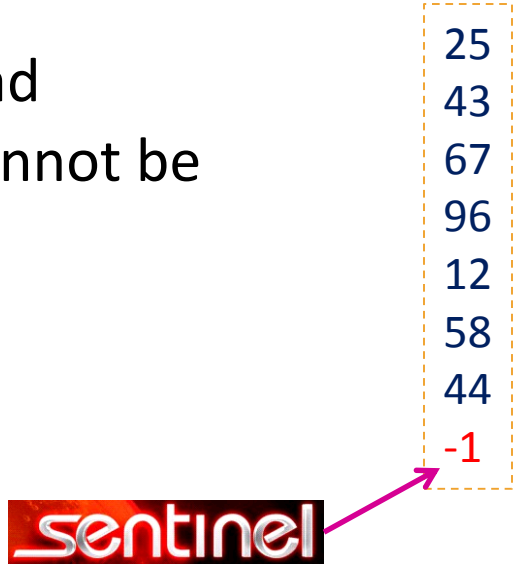
```
// Read and print 5 test scores
int count, score;
for (count = 1; count <= 5; count++) {
    scanf("%d", &score);
    printf("Score %d is %d\n", count, score);
}
```

- Suppose the problem becomes:

  Develop a class-averaging program that will process an arbitrary number of grade scores each time the program is run.

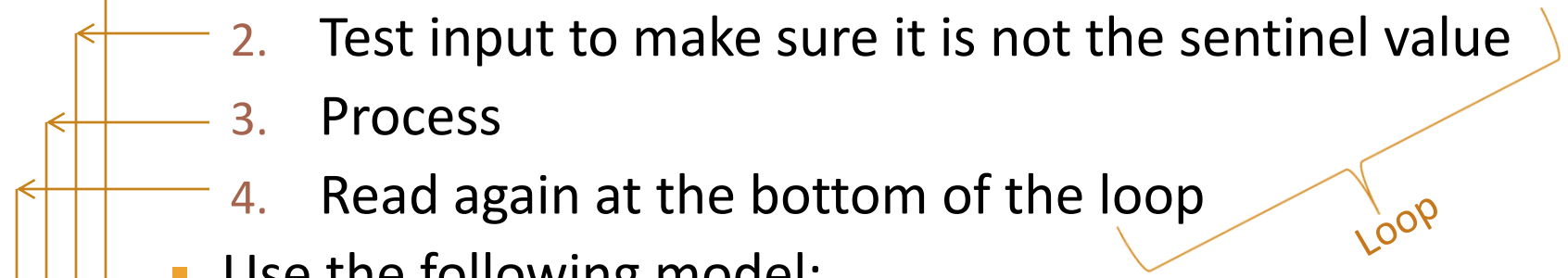
Sentinel-Controlled Repetition

- One way to handle an arbitrary number of input values is to have the user enter a special value to indicate the end of input.
- Such a value is a sentinel value.
  - Indicates end of valid input
  - Loop ends when sentinel value is read
  - Must choose a sentinel value that cannot be confused with a regular input value.



Sentinel-Controlled Priming Read

- For sentinel-controlled loops
  1. Read before the loop (**priming read**)
  2. Test input to make sure it is not the sentinel value
  3. Process
  4. Read again at the bottom of the loop
- Use the following model:




```
read before entering the loop
while (value_read != SENTINEL)
{
        // process
          …
        read at bottom of loop
                (before entering loop again)
}
```

Sentinel-Controlled Loop using Priming Read

25
43
67
96
12
58
44
-1


```
// Read and print numbers using priming read
int num;

scanf("%d", &num);              // Priming read
while (num != -1) {             // Sentinal is -1
    printf("%d\n", num);
    scanf("%d", &num);          // Read another number
}
```

Sentinel-Controlled Loop using Input Count

```
25
43
67
96
12
58
44
-1
```


```c
// Read and print numbers using input count
int inputCount;                         // Items read
int num;

while (scanf("%d", &num) == 1 && num != -1) {
                                        // Sentinal is -1
   printf("%d\n", num);
}
```

Example of sentinel-controlled loop

```
25 43
67 96
12 58
44 99
-1
```


```
// Read pairs and print sums
int num1, num2, sum;

scanf("%d", &num1);          // Priming read
while (num1 != -1) {         // Sentinal is -1
    scanf("%d", &num2);      // Read second number
    sum = num1 + num2;
    printf("%d + %d = %d\n", num1, num2, sum);
    scanf("%d", &num1);      // Read another first number
}
```

Processing an arbitrary number of pairs

- Sometimes it is not possible to find a sentinel value

- We can use
  - End-of-input controlled loops
    - Uses return from scanf
    - Can be fooled by invalid data
  - End-of-file controlled loops
    - Uses function feof

End of Data

- Hardware & Software End-Of-File
  - Keyboard
    - Ctrl-d (Does not work on Mac!)

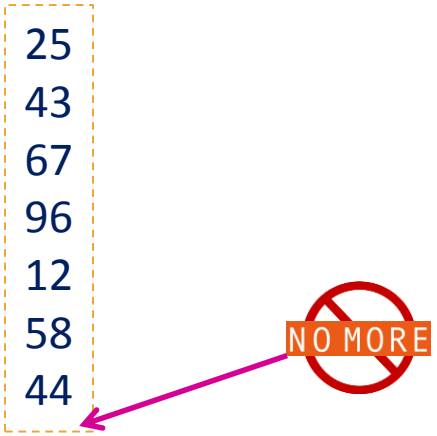
```
25 43
67 96
12 58
44 99
Ctrl-d
```

The End Is Here!

Redirection

- Redirection: Read / Write to actual file
  - stdin: **`cmd < input-file`**
    - Ex: **`./a.out < nums.txt`**
  - stdout: **`cmd > output-file`**
    - Ex: **`./a.out > report.txt`**
  - stdout (append): **`cmd >> output-file`**
    - Ex: **`./a.out >> report.txt`**
  - Both: **`cmd < input-file > output-file`**
    - Ex: **`./a.out < nums.txt > report.txt`**
  - Leave out prompts when designing for redirection

Example: End-of-input controlled loop using items read & priming read




```
// Read and print using items read & priming read
int inputCount;                         // Items read
int num;

intputCount = scanf("%d", &num);   // Priming read
while (intputCount == 1) {         // Check count
   printf("%d\n", num);
   inputCount = scanf("%d", &num); // Read another number
}
```

Example: End-of-input controlled loop using just items read

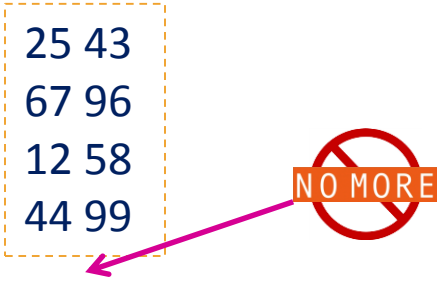
```
// Read and print using just items read
int num;

while (scanf("%d", &num) == 1) {   // Check count
    printf("%d\n", num);
}
```

```
//or
while (scanf("%d", &num) != EOF) {    // Check for EOF
    printf("%d\n", num);
}
```

25
43
67
96
12
58
44

Example: End-of-input controlled loop using number of items read




```
// Read pairs and print sums using items read
int num1, num2, sum;

while (scanf("%d %d", &num1, &num2) == 2) {      // Check items read
    sum = num1 + num2;
    printf("%d + %d = %d\n", num1, num2, sum);
}
```

Detecting End-of-File

- Function: feof
  - Syntax: **`feof(file-pointer)`**
    - Returns true or false
    - Standard input: `feof(stdin)`
  - Use in a while loop -

```
while (!feof(stdin))
```

Example: End-of-file controlled loop

25
43
67
96
12
58
44


```
// Read and print numbers using EOF
int num;

scanf("%d", &num);          // Priming read
while (!feof(stdin)) {      // Check for EOF
   printf("%d\n", num);
   scanf("%d", &num);       // Read another number
}
```

Example: end-of-file controlled loop

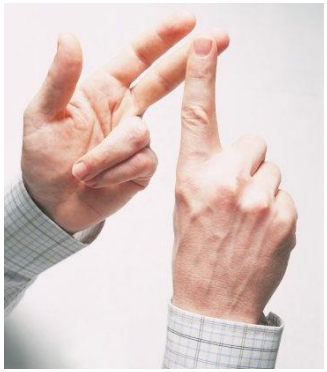
```
25 43
67 96
12 58
44 99
```


```
// Read pairs and print sums using end-of-file
int num1, num2, sum;

scanf("%d", &num1);          // Priming read
while (!feof(stdin)) {       // Check for EOF
    scanf("%d", &num2);      // Read second number
    sum = num1 + num2;
    printf("%d + %d = %d\n", num1, num2, sum);
    scanf("%d", &num1);      // Read another first number
}
```

Looping Subtask: Counting

- Example: Find the number of scores in a file
  - Here the program state that must be maintained is a *counter* that maintains the number of scores that have been read so far.
- Steps
  - Declare an int variable for the count
  - Initialize the count to zero
  - Increment the count in the body of the loop



Looping Subtask: Counting

```
// Print score count w/priming read
int scoreCount;              // counter
int score;

scoreCount = 0;              // initialize counter

printf("Enter first score or ctrl-d to end: ");
scanf("%d", &score);
while (!feof(stdin)) {
    scoreCount++;                // increment counter
    scanf("%d", &score);
    printf("Enter next score or ctrl-d to end: ");
}

printf("Score count is %d\n", scoreCount);
```

Looping Subtask: Counting

```
// Print score count w/scanf in while
int scoreCount;              // counter
int score;

scoreCount = 0;              // initialize counter

printf("Enter first score or ctrl-d to end: ");
while (scanf("%d", &score) == 1) {
    scoreCount++;                // increment counter
    printf("Enter next score or ctrl-d to end: ");
}

printf("Score count is %d\n", scoreCount);
```

Looping Subtask: Counting

```
// Print score count w/for
int scoreCount;              // counter
int score;

scoreCount = 0;              // initialize counter

printf("Enter first score or ctrl-d to end: ");
for (scoreCount = 0; scanf("%d", &score) == 1, scoreCount++)
    printf("Enter next score or ctrl-d to end: ");

printf("Score count is %d\n", scoreCount);
```

Looping Subtask: Counting

```
// Print score count w/for & no prompts
int scoreCount;              // counter
int score;

scoreCount = 0;              // initialize counter

for (scoreCount = 0; scanf("%d", &score) == 1, scoreCount++)
    /*null*/ ;

printf("Score count is %d\n", scoreCount);
```

Counting Example

- What if we want to print the number of passing scores (scores >= 70)?
  - We need a mechanism that allows us to count only if the score is greater than or equal to 70
  - Use *if* stmt

Looping Subtask: Counting

```
// Print passing score count
int passCount;                  // passing counter
int score;

passCount = 0;                  // initialize counter

scanf("%d", &score);
while (!feof(stdin)) {
   if (score >= 70)
      passCount++;              // increment pass counter
   scanf("%d", &score);
}

printf("Passing score count is %d\n", passCount);
```

Counting Example

- What if we want to print the number of passing scores (scores >= 70) and the number of failing scores?
  - Use *if -else*

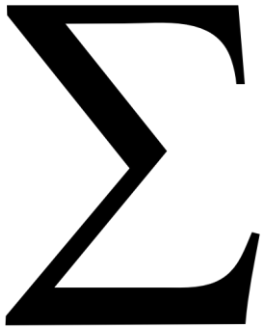
Looping Subtask: Counting

```
// Print passing and failing score count
int passCount;                  // passing counter
int failCount:                  // failing counter
int score;

passCount = 0;                  // initialize counters
failCount = 0;

scanf("%d", &score);
while (!feof(stdin)) {
   if (score >= 70)
      passCount++;              // increment pass counter
   else
      failCount++;              // increment fail counter
   scanf("%d", &score);
}

printf("Passing score count is %d\n", passCount);
printf("Failing score count is %d\n", failCount);
```



Looping Subtask: Accumulation (Summing)

- The state that must be maintained is the sum of all values that have been seen so far.
  - Declare a variable to hold the sum (accumulator)
  - Initialize the sum to zero
  - In the body of the loop, add the new value to the sum

Accumulating Example

```
// Print score sum
int scoreSum;                   // total accumulator
int score;

scoreSum = 0;                   // initialize total

scanf("%d", &score);
while (!feof(stdin)) {
   scoreSum += score;           // add score to total
   scanf("%d", &score);
}

printf("Score total is %d\n", scoreSum);
```

Counting & Accumulating Example

- Problem
  - *A class of ten students took a quiz.*
  - *The grades (integers in the range 0 to 100) for this quiz are available to you.*
  - *Determine the class average on the quiz.*

- Hint: Requirements for an average
  - Count of number of items
  - Sum of the items

Counting & Accumulating Example

- Pseudocode:

Set total to zero

Set grade counter to one

While grade counter is less than or equal to ten

Input the next grade
Add the grade into the total
Add one to the grade counter

Set the class average to the total divided by ten

Print the class average

Looping Subtasks: Searching

- Need a variable to indicate whether or not the program has encountered the target value, call it *found*
- Initialize *found* to 0 (false)
- Each time through the loop, check to see if the current value equals the target value
  - If so, assign 1 to *found*

Searching Exercise

Write a C program that

1. Reads a target score at the beginning of the file
2. Reads a set of scores and determines if the target score is in the set of scores
3. If found prints

   `Target ## was found`

   otherwise prints

   `Target ## was not found`

Looping Subtasks: Searching

```
// Determine if target score is found
int score, target;
int found = 0;                          // found = false

scanf("%d", &target);

scanf("%d", &score);
while (!feof(stdin)) {
    if (score == target)
        found = 1;                      // found = true
    scanf("%d", &score);
}

if (found)
    printf("Target %d was found\n", target);
else
    printf("Target %d was not found\n", target);
```

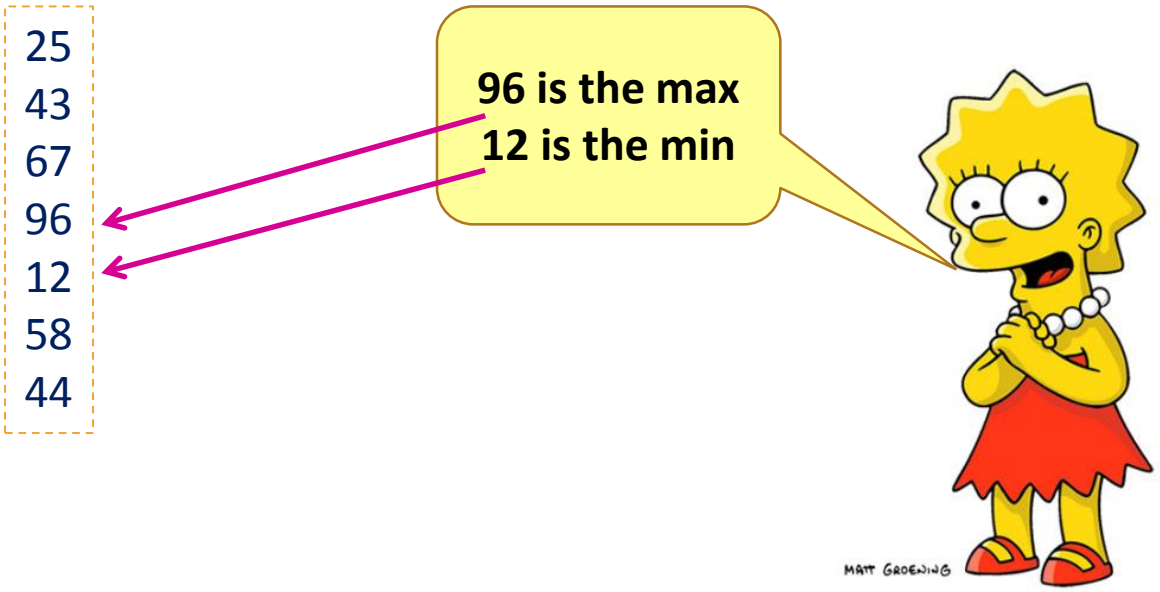
Searching Improvement

- Stop searching if target has been found

```
scanf("%d", &score);
while (!feof(stdin) && !found) {
        // stop if EOF or target found
    if (score == target)
        found = 1;                  // found = true
    scanf("%d", &score);
}
```

Looping Subtasks: Finding Extremes

- Finding Extreme Values (e.g. maximum, minimum)
  - Need a variable (such as maxValue) to remember the most extreme value encountered so far



Looping Subtasks: Finding Extremes

- Finding Extreme Values (e.g. maximum, minimum)
  - Initialize the maxValue (minValue) to some value
    - maxValue: Lower value than any data
    - minValue: Higher value than any data
    - Or for both: The first data value
  - For each data item
    - Compare the current value to maxValue (or minValue)
    - If the current value is > maxValue (< minValue), replace maxValue (minValue) with the current value.

Extremes Exercise

Write a C program that

1. Reads a set of scores from a file
2. Determines and prints the maximum score

Looping Subtasks: Finding Extremes

```
// Determine maximum score
int score, maxScore;

scanf("%d", &score);
maxScore = score;              // initialize max

while (!feof(stdin)) {
   if (score > maxScore)
      maxScore = score;        // reset max
   scanf("%d", &score);
}

printf("Maximum score is %d\n", maxScore);
```

Programming in C

Chapter 4B
Looping Subtasks

THE END