Mathematics & Computer Science Department

C++ Programming

Introduction to the "Array" Data Structure

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```
// computing average with seperate variables
#include<iostream>
using namespace std;
int main()
{
    int exam1, exam2, exam3, exam4 ;

    cout << "\nGrade on exam1 ? " ;
    cin >> exam1;
    cout << "\nGrade on exam2 ? ";
    cin >> exam2;
    cout << "\nGrade on exam3 ? " ;
    cin >> exam3;
    cout << "\nGrade on exam3 ? ";
    cin >> exam4;

    cout << "\n\nAverage is: "
         << (exam1+exam2+exam3+exam4)/4 ;

    cout << "\n\n";
    system("pause");
    return 0;
}
```

```
Grade on exam1 ? 90
Grade on exam2 ? 100
Grade on exam3 ? 85
Grade on exam3 ? 76

Average is: 87
Press any key to continue . . .
```

computer memory storage
(abstract representation)

exam1	exam2	exam3	exam4
90	100	85	76

method 1:

use an integer variable to hold each grade.

PRO: all the grades are saved (in case we want to get at them again)

CON: redundant code – highly inefficient, and works only for a fixed number of grades

```
// computing average with a single over-written variable in a loop
#include<iostream>
using namespace std;
int main()
{
     int exam ;
     int numExams ;
     int runTotal = 0;

     cout << "\nHow many exams ? ";
     cin >> numExams ;

     for (int i = 1 ; i <= numExams ; i++)
          {
          cout << "\nGrade on exam " << i << " ? " ;
          cin >> exam;
          runTotal = runTotal + exam ;
          }

     cout << "\n\nAverage is: "
          << (runTotal)/numExams ;

     cout << "\n\n";
     system("pause");
     return 0;
}
```

```
How many exams ? 6
Grade on exam 1 ? 98
Grade on exam 2 ? 87
Grade on exam 3 ? 90
Grade on exam 4 ? 86
Grade on exam 5 ? 90
Grade on exam 6 ? 79

Average is: 88
```

computer memory storage
(abstract representation)

Method 2:

use a loop and an integer variable to hold all grades, keep track of running total.

PRO: **efficient code**, can work for **any number of grades**

CON: **each grade is lost** after the next grade over-writes it in the same variable

```
// computing average with a loop and an array
#include<iostream>
using namespace std;
int main()
{
     int exam[100] ;
     int numExams ;
     int runTotal = 0;

     cout << "\nHow many exams ? ";
     cin >> numExams ;

     for (int i = 1 ; i <= numExams ; i++)
          {
          cout << "\nGrade on exam " << i << " ? " ;
          cin >> exam[i];
          runTotal = runTotal + exam[i] ;
          }

     cout << "\n\nAverage is: "
          << (runTotal)/numExams ;

     cout << "\n\n";
     system("pause");
     return 0;
}
```

```
How many exams ? 5
Grade on exam 1 ? 90
Grade on exam 2 ? 88
Grade on exam 3 ? 93
Grade on exam 4 ? 100
Grade on exam 5 ? 72

Average is: 88
Press any key to continue .
```

computer memory storage
(abstract representation)

exam	0	1	2	...	n
		90	88		

Method 3:

use an integer Array.

PRO: all the grades are saved (in case we want to get at them again).
And code is efficient – will work for any number of grades.

CON: none.

```
// computing average, and finding minimum & maximum
#include<iostream>
using namespace std;
int main()
{
    int exam[100] ;
    int numExams , minimum = 9999 , maximum = 0 ;
    int runTotal = 0;

    cout << "\nHow many exams ? ";
    cin >> numExams ;

    for (int i = 1 ; i <= numExams ; i++)
        {
        cout << "\nGrade on exam " << i << " ? " ;
        cin >> exam[i];
        if (exam[i] > maximum) maximum = exam[i];
        if (exam[i] < minimum) minimum = exam[i];
        runTotal = runTotal + exam[i] ;
        }

    cout << "\n\nAverage is: "
         << (runTotal)/numExams << "\nLowest was: "
         << minimum << "\nHighest was: " << maximum;

    cout << "\n\n";
    system("pause");
    return 0;
}
```

```
How many exams ? 4

Grade on exam 1 ? 90

Grade on exam 2 ? 100

Grade on exam 3 ? 85

Grade on exam 4 ? 88


Average is: 90
Lowest was: 85
Highest was: 100

Press any key to continue . . .
```

finding the minimum and maximum in an array

```
    int exam[100] ;
    int numExams , minimum = 9999 , maximum = 0 ;
    int runTotal = 0 , maxindex , minindex ;

    cout << "\nHow many exams ? ";
    cin >> numExams ;

    for (int i = 1 ; i <= numExams ; i++)
        {
        cout << "\nGrade on exam " << i << " ? " ;
        cin >> exam[i];
        if (exam[i] > maximum) {maximum = exam[i];
                                maxindex = i ; }
        if (exam[i] < minimum) {minimum = exam[i];
                                minindex = i; }
        runTotal = runTotal + exam[i] ;
        }

    cout << "\n\nAverage is: "
         << (runTotal)/numExams << "\nLowest was: "
         << minimum << " on exam "  << minindex
         << "\nHighest was: " << maximum
         << " on exam " << maxindex;

    cout << "\n\n";
    system("pause");
    return 0;
}
```

```
How many exams ? 4

Grade on exam 1 ? 90

Grade on exam 2 ? 100

Grade on exam 3 ? 87

Grade on exam 4 ? 70


Average is: 86
Lowest was: 70 on exam 4
Highest was: 100 on exam 2

Press any key to continue .
```

providing more detail on the data

```cpp
#include<iostream>
using namespace std;
int main()
{    int exam[100] ;
    int numExams , minimum = 9999 , maximum = 0 ;
    int runTotal = 0 , maxindex , minindex ;
    cout << "\nHow many exams ? ";
    cin >> numExams ;
    for (int i = 1 ; i <= numExams ; i++)
       {cout << "\nGrade on exam " << i << " ? " ;
        cin >> exam[i];
        if (exam[i] > maximum) {maximum = exam[i];
                                maxindex = i ; }
        if (exam[i] < minimum) {minimum = exam[i];
                                minindex = i; }
        runTotal = runTotal + exam[i] ;  }

    cout << "\n\nThe grades are: \n\n";
    for (int j =1 ; j <=numExams ; j++ )
        cout << "\nExam " << j << " : " << exam[j];
    cout << "\n\nAverage is: "
         << (runTotal)/numExams << "\nLowest was: "
         << minimum << " on exam "  << minindex
         << "\nHighest was: " << maximum
         << " on exam " << maxindex;

    cout << "\n\n";
    system("pause");
    return 0;
}
```

```
How many exams ? 4

Grade on exam 1 ? 90

Grade on exam 2 ? 100

Grade on exam 3 ? 67

Grade on exam 4 ? 88


The grades are:


Exam 1 : 90
Exam 2 : 100
Exam 3 : 67
Exam 4 : 88

Average is: 86
Lowest was: 67 on exam 3
Highest was: 100 on exam 2

Press any key to continue . .
```

```cpp
#include<iostream>
using namespace std;
int main()
{    int exam[100] , numExams , minimum = 9999 , maximum = 0 ;
     int runTotal = 0 , maxindex , minindex , cgIndex , newGrade ;
     cout << "\nHow many exams ? ";
     cin >> numExams ;
     for (int i = 1 ; i <= numExams ; i++)
        {cout << "\nGrade on exam " << i << " ? " ;
         cin >> exam[i];
         if (exam[i] > maximum) {maximum = exam[i]; maxindex = i ; }
         if (exam[i] < minimum) {minimum = exam[i]; minindex = i; }
         runTotal = runTotal + exam[i] ;  }
     cout << "\n\nThe grades are: \n\n";
     for (int j=1;j<=numExams;j++)cout <<"\nExam "<<j<<" : "<<exam[j];
     cout << "\n\nAverage is: " << (runTotal)/numExams << "\nLowest was:
          << minimum << " on exam "  << minindex << "\nHighest was: "
          << maximum << " on exam " << maxindex;
     cout << "\n\nWhat grade would you like to change? ";
     cin >> cgIndex;
     cout << "\nAnd what would you like to change it to? ";
     cin >> newGrade;
     exam[cgIndex] = newGrade;
     runTotal = 0;
     cout <<"\n\nYour grades are now:";
     for(int x=1;x<=numExams;x++) {cout << exam[x] << " ";
                                   runTotal = runTotal + exam[x];}
     cout<<"\nAverage is now: " << runTotal/numExams << " !  (-: ";
     cout << "\n\n";
     system("pause");
     return 0; }
```

```
How many exams ? 3

Grade on exam 1 ? 90

Grade on exam 2 ? 67

Grade on exam 3 ? 94


The grades are:


Exam 1 : 90
Exam 2 : 67
Exam 3 : 94

Average is: 83
Lowest was: 67 on exam 2
Highest was: 94 on exam 3

What grade would you like to change? 2

And what would you like to change it to? 96


Your grades are now:90 96 94
Average is now: 93 !  (-:

Press any key to continue . . .
```