Onward! with Math Vectors

Prof. Y C Cheng
2009/10/9

國立台北科技大學 資訊工程系
National Taipei University of Technology
Dept of Comp Sci and Info Engr
Math Vector

- Compute the dot product of two vectors of the same dimension. For example,
  \[(1, 0) \ast (1, 1) = 1\]
  \[(1, 1, 0) \ast (0, 1, 1) = 1\]
  \[(1,0)\ast(1,1,0)\text{ is illegal}\]
  Length of a vector: \[\|(1,1,0)\| = \sqrt{2}\]
  Unit vector of \((1,1,0) = (1,1,0)/\sqrt{2}\]
\( \mathbf{a} = (a_1, a_2, a_3) \)

\[ \| \mathbf{a} \| = \sqrt{a_1^2 + a_2^2 + a_3^2} \]

\[ \| \mathbf{a} \| = \sqrt{\mathbf{a} \cdot \mathbf{a}}. \]

Unit vector of \( \mathbf{a} \) = \( 1/\| \mathbf{a} \| \) (\( a_1, a_2, a_3 \))
Devise a plan – list the tasks

1. As a programmer, I can write the main program
3. v As a programmer, I can define a n-dimensional vector with given values for its components
4. v As a programmer, I can print a vector.
5. v As a programmer, I can compute the dot product of two vectors of the same dimension
7. v As a programmer, I can detect if two vectors can have a dot product
8(3). v As a programmer, I can define a n-dimensional vector with given values for its components with class.
9(4). v As a programmer, I can print a class-version vector.
10. As a programmer, I can compute the length of a vector
11. As a programmer, I can multiply a vector by a scalar.
12. As a programmer, I can compute the unit vector of a given vector.
10. As a programmer, I can compute the length of a vector

- a C function?
  - length = findLength(v);
  - double findLength(MathVector v);
- Or a member function of MathVector?)
  - length = v.length();
  - double MathVector::length();
- Since length seems to be a part of a MathVector, let’s try the member function version!
11. As a programmer, I can multiply a vector by a scalar.

• Again, a C function?
  – MathVector *pv = scalarMultiply(s, v);
  – MathVector * scalarMultiply(double s, MathVector v);

• Or a C++ member function of MathVector?
  – MathVector *pv = v.scalarMultiply(s)
  – MathVector * MathVector::scalarMultiply(double s);

• Let’s try the class version again!
12. As a programmer, I can compute the unit vector of a given vector.

- Class version again.
  - MathVector *puv = v.unitVector();
  - MathVector * v.unitVector();
So far...

• Class with data members, constructors and ordinary member functions
  – MathVector v(2, 1, 0);
  – MathVector u(3,0,0,0);
  – double length();
  – MathheVector * unitVector();

• MathVector not yet complete
• Looked at call by value and call by reference
• Explained how dynamic memory allocation from heap is used.
Looking back – can we improve the program?

• So far, MathVector (with data members and member functions) and some C functions have been written.

• What we want to do seems to have been achieved.

• But are we happy with the current program?
  – e.g., make printVector() a member?
  – We have written 180 lines of code in one file, it is getting difficult to move around.
So next...

• Change the program structure while making sure that the program still works!
  – Ensure that it works by writing unit tests. (this is called unit tests)
  – Make the change in small steps; no big changes in one step (This is called refactoring)

• Also, we have not return memory used in MathVector (borrowed by using new operator)