Announcements

MP3 available, due 10/2, 11:59p. EC due 9/25.

Abstract Base Classes:

```
class flower {
public:
    flower();
    virtual void drawBlossom() = 0;
    virtual void drawStem() = 0;
    virtual void drawFoliage() = 0;
    …
};
```

```
void daisy::drawBlossom()  {
// whatever
}
void daisy::drawStem()  {
// whatever
}
void daisy::drawFoliage()  {
// whatever
}
```

```
class daisy:public flower {
public:
    virtual void drawBlossom();
    virtual void drawStem();
    virtual void drawFoliage();
    …
private:
    int blossom; // number of petals
    int stem; // length of stem
    int foliage // leaves per inch
};
```

```
flower f;
daisy d;
flower * fptr;
```

Concluding remarks on inheritance:

Polymorphism: objects of different types can employ methods of the same name and parameterization.

```
animal ** farm;

farm = new animal*[5];
farm[0] = new dog;
farm[1] = new pig;
farm[2] = new horse;
farm[3] = new cow;
farm[4] = new duck;

for (int i=0; i<5;i++)
    farm[i]->speak();
```

Inheritance provides DYNAMIC polymorphism—type dependent functions can be selected at run-time. Wikipedia: Polymorphism in OOP

Next topic: “templates” are C++ implementation of static polymorphism, where type dependent functions are chosen at compile-time.

What do you notice about this code?

```
void swapInt(int x, int y){
   int temp;
   temp = x;
   x = y;
   y = temp;
}
```

```
void swapChar(char x, char y){
   char temp;
   temp = x;
   x = y;
   y = temp;
}
```

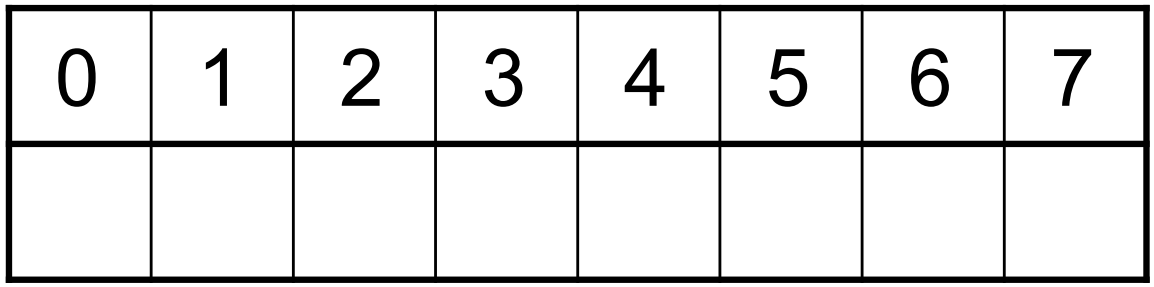
```
int main(){
   int a = 1; int b = 2;
   char c = 'n'; char d = 'm';
   swapInt(a,b);
   swapChar(c,d);
   cout << a << " " << b << endl;
   cout << c << " " << d << endl;
}
```

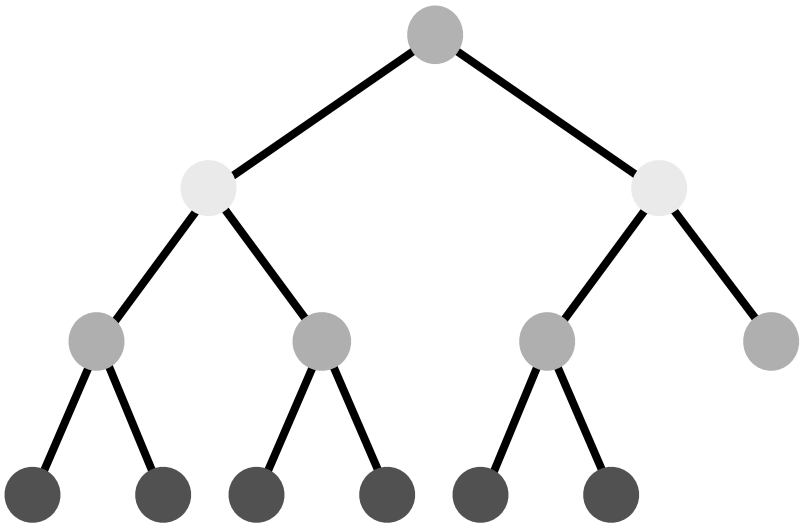
Function templates:

```
template <class T>
void swapUs(T & x, T & y){
   T temp;
   temp = x;
   x = y;
   y = temp;
}
```

```
int main(){
   int a = 1; int b = 2;
   char c = 'n'; char d = 'm';
   swapUs      (a,b);
   swapUs      (c,d);
   cout << a << " " << b << endl;
   cout << c << " " << d << endl;
}
```

Classes can be given templates too:





Class templates:

```
template <class T>
class ezpair {
private:
   T a, b;
public:
   ezpair (T first, T second);
   T getmax ();
};
```

```
template <class T>
T ezpair<T>::getmax()  {
   T retmax;
   retmax = (a>b ? a : b);
   return retmax;
}

template <class T>
ezpair<T>::ezpair(T first,T second){
   a = first;
   b = second;
}
```

```
int main () {
   ezpair<int> twoNums(100, 75);
   cout << twoNums.getmax();
   return 0;
}
```

Class templates:

```
template <class T>
class ezpair {
private:
   T a, b;
public:
   ezpair (T first, T second);
   T getmax ();
};
```

```
template <class T>
T ezpair<T>::getmax()  {
   T retmax;
   retmax = (a>b ? a : b);
   return retmax;
}

template <class T>
ezpair<T>::ezpair(T first,T second){
   a = first;
   b = second;
}
```

Challenge1: write the function signature for the copy constructor (if we needed one) for this class.

_____ _____ :: _____ (_____)

Challenge2: How do you declare a dynamic array of `mypair`s of integers?

Challenge3: How do you allocate memory if you want that array to have 8 elements?

A note on templates:

```
template <class T, class U>
T addEm(T a, U b) {
   return a + b;
}

int main() {
   addEm<int,int>(3,4);
   addEm<double,int>(3.2,4);
   addEm<int,double>(4,3.2);
   addEm<string,int>("hi",4);
   addEm<int,string>(4,"hi");
}
```