Individual Reports

shotgunrobot

2D platformer game written in Java.
https://github.com/rustbyte/shotgunrobot

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A design pattern present in the Java based shooter game, shotgunrobot, is the Strategy pattern.

Why is it needed?

The Strategy pattern can be applied to classes that only differ in behaviour, but the concept of the classes are basically the same. Its purpose is to encapsulate each individual algorithm and make them interchangeable to the system [1].

In the case of shotgunrobot, this pattern is used with the **Mob** class. There are many different classes that inherit from the **Mob** class. Each of these classes that inherit from the **Mob** class are objects in game that can move and take damage, but each **Mob** type has a different behaviour while they exist in game, meaning that each class inheriting from **Mob** implements a different kind of algorithm.   The Strategy pattern here is used to determine how each of these Mob objects behaves as the game progresses, (specifically its tick function).

What role does it play?

As mentioned, **Mobs** are entities in the game which move and take damage. In this program, the way that any type of **Mob** object can get instantiated is through the classes **PlayerSpawnerTile**, **MobSpawnerTile** or **BossSpawnerTile**. Depending where you are in the level, the **Level** will initialize all **MobSpawnerTiles** with specific **Mob** type objects.

The different types of **Mob** objects that could be spawned are **Zombies**, **Humans**, **Players**, **Skeletons**, the **BatBoss**, and **Powerups**. The way the **Level** knows which type to spawn is based on the types of **Tiles** that are currently surrounding the player. When the **Level**, is generate this is when it knows where to place types of tiles where on the map, and therefore knowing which type of **Mob** object to spawn.

References

 [1] "Strategy Design Pattern," SourceMaking, [Online]. Available: http://sourcemaking.com/design_patterns/strategy. [Accessed 6 November 2014].

**Reverse Engineering Tools**

In order to generate a UML diagram and a sequence diagram for the Mob class, I have used the same plugin as we did for Milestone 3, ObjectAid UML Explorer.   Once the plugin was added in Eclipse, all it took was creating a new file of type Class Diagram or Sequence Diagram, and then drag and drop all classes/methods we wish to represent in the UML diagram/sequence diagram. ObjectAid UML Explorer is based on UML 2.0, and is able to depict Java classes, interfaces, enumerations and packages. It takes existing Java source code and transforms it into a UML class diagram. It also gets updated automatically if there are any other changes added to the code once the Class Diagram file is created.

Sequence Diagram
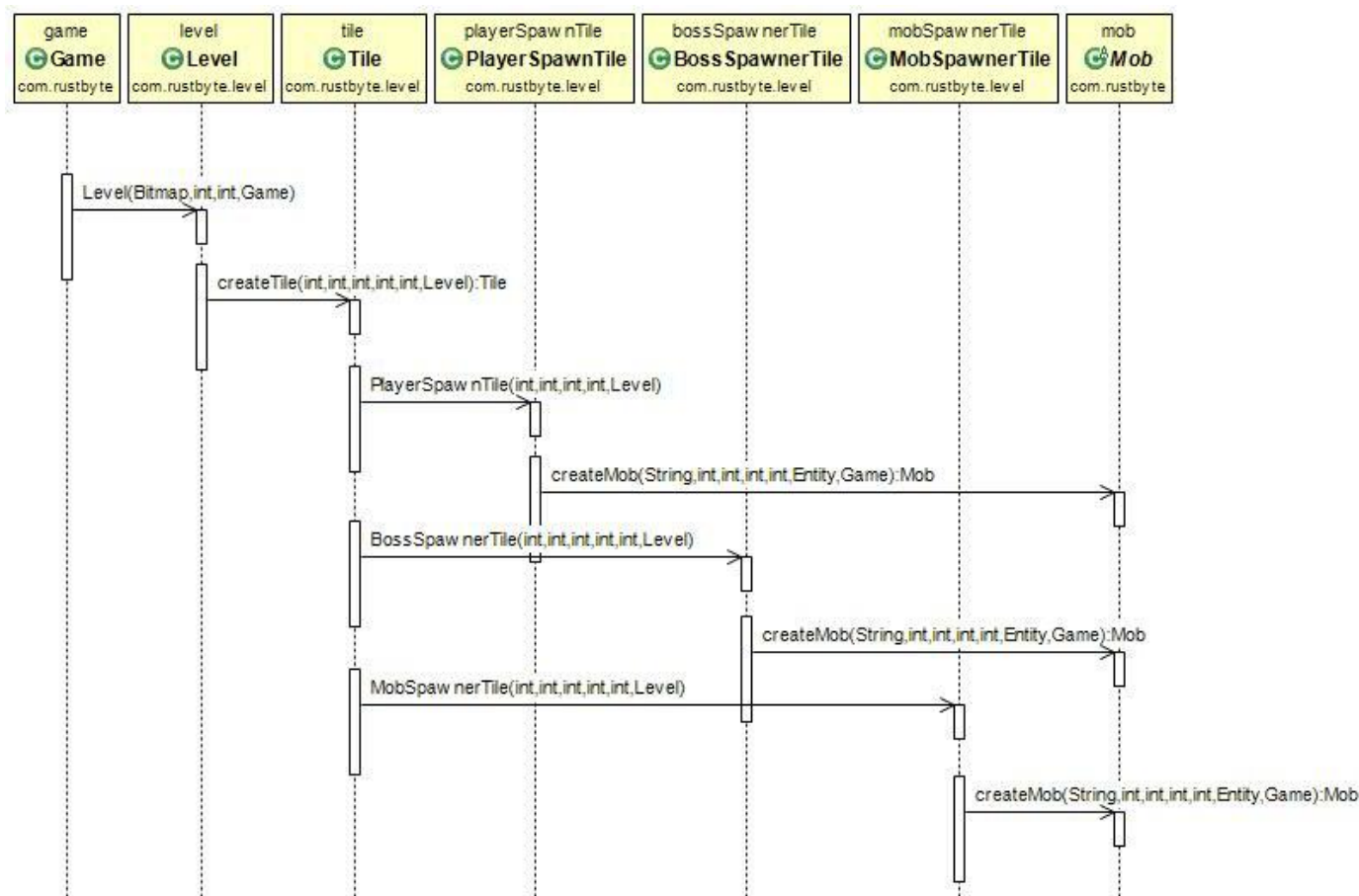
UML Diagram
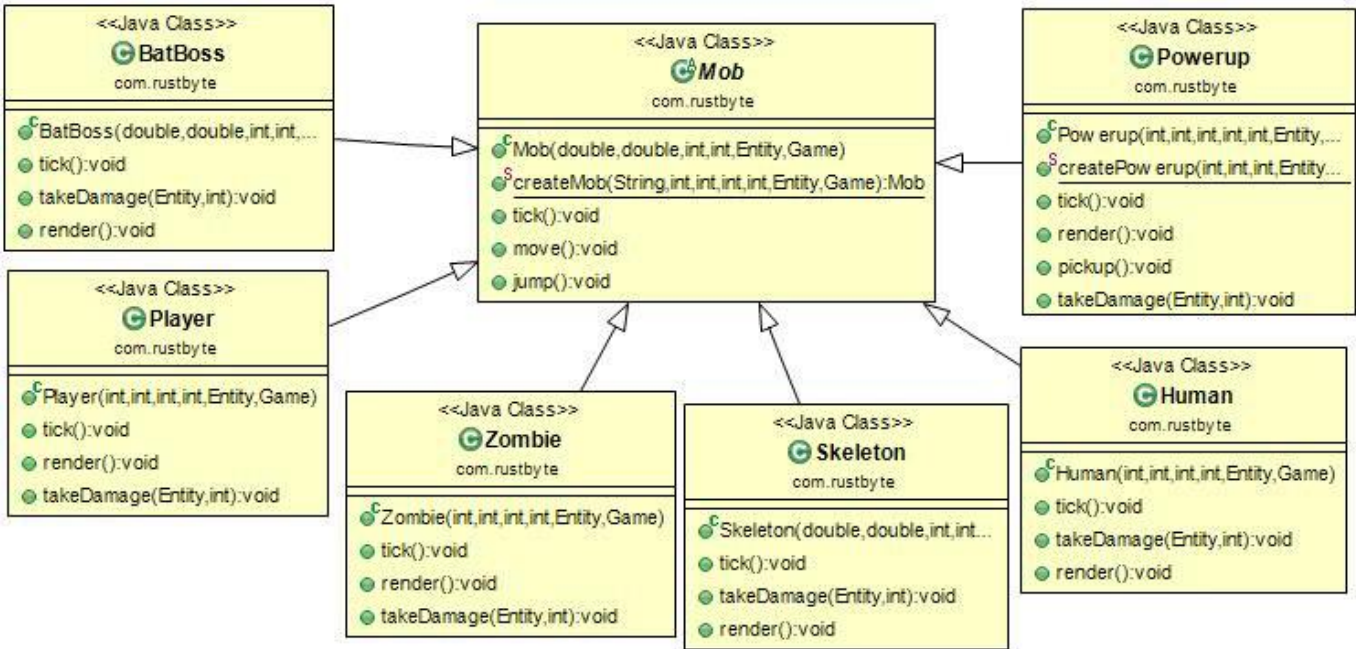
Code

```
public abstract class Mob extends Entity {
      public static Mob createMob(String mobType, int x, int y, int w,
      int h, Entity ent, Game game) {...}
      @Override
      public void tick() {...}
    }

    public class Player extends Mob {
      @Override
      public void tick() {...}
    }

    public class Human extends Mob {
      @Override
      public void tick() {...}
    }

    public class Zombie extends Mob {
      @Override
      public void tick() {...}
    }

    public class Skeleton extends Mob {
      @Override
      public void tick() {...}
    }

    public class BatBoss extends Mob {
      @Override
      public void tick() {...}
    }

    public class PowerUp extends Mob {
      @Override
      public void tick() {...}
    }
}
```

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Patterns Observed: Strategy and Template Method Patterns

Why are they needed?

To define the skeleton of an algorithm in an operation, deferring some steps to client subclasses. Template Method lets subclasses redefine certain steps of an algorithm without changing the algorithm's structure. [1]
In shotgun robot, the basic flow of method calls for each subclass (super.tick()--> ishurt()--> takedamage()-->tick()) is the same, however once they reach the tick() function, each subclass needs to handle it in its own way. This "build order" is where the template method pattern shines, allowing the modification of other process that affect a swath of classes without shotgun surgery becoming necessary.

The Strategy pattern can be applied to classes that only differ in behaviour, but the concept of the classes are basically the same. Its purpose is to encapsulate each individual algorithm and make them interchangeable to the system. [2]
The destructible interface is applied to the abstract Mob class, which is the base for Human, Player, Batboss, Zombie, Skeleton and Powerup. Each of those then have to implement the takeDamage() method that was passed down to them. Depending on what class gets instantiated, our algorithm/behavior changes.

Roles

The Template Method pattern allows for some fine-tuned granularity in a mostly homogeneous recipe, all the while providing a means of easy modification. In this case the tick function is just one step of many toward bringing each mob class to life, but one that is unique across the derived siblings. You will spend far more time maintaining code than writing it, so this is a powerful asset. The Strategy pattern allows the unique handling of our single common function across varying classes.The takeDamage function will occur in each class but will be handled differently according to its runtime instantiation. Given both the Inheritance of **Mob** and the ***destructible*** interface, unique behavior is forced into derived classes. Shared attributes from **Mob** ensure that state and general expected behavior is kept, whilst the interface gives each derived class unique behavior.
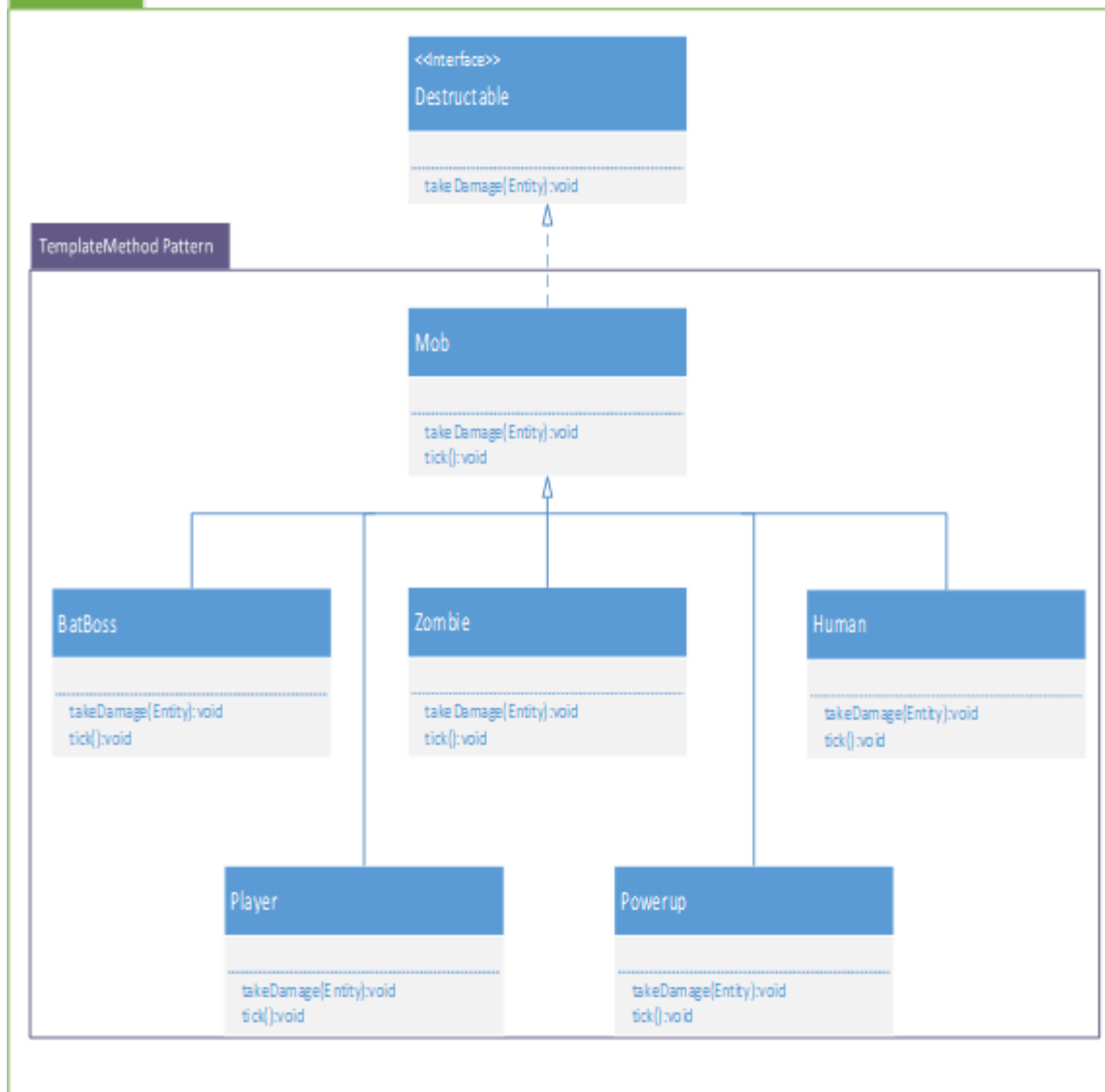
Sources

[1] SourceMaking, "TemplateMethod," SourceMaking, [Online]. Available: http://sourcemaking.com/design_patterns/template_method.

[2] SourceMaking, "Strategy Pattern," SourceMaking, [Online]. Available: http://sourcemaking.com/design_patterns/strategy.

[3] W. Contributors, "Template Method Design Pattern," Wikipedia, [Online]. Available: http://en.wikipedia.org/wiki/Template_method_pattern.

Code

```java
public interface Destructable{
      public void takeDamage(Entity source);
}


public abstract class Mob extends Entity implements Destructable {
        public static Mob createMob(String mobType, int x, int y, int w,
         int h, Entity ent, Game game) {...}
      @Override
      public void tick() {...}
      }
}


      public class Player extends Mob {
      @Override
      public void tick() {...}
      public void takeDamage(Entity source) {...}      }
      public class Human extends Mob {
      @Override
      public void tick() {...}
      public void takeDamage(Entity source) {...}
      }
      public class Zombie extends Mob {
      @Override
      public void tick() {...}
      public void takeDamage(Entity source) {...}
      }
      public class Skeleton extends Mob {
      @Override
      public void tick() {...}
      public void takeDamage(Entity source) {...}
      }
      public class BatBoss extends Mob {
      @Override
      public void tick() {...}
      public void takeDamage(Entity source) {...}
      }
      public class PowerUp extends Mob {
      @Override
      public void tick() {...}
       public void takeDamage(Entity source) {...}
      }
```

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Observed pattern: Strategy Pattern

WHY IS IT NEEDED
The strategy pattern allows you to eliminate duplicate code and it also provides flexibility to change behavior by changing the composed strategy object dynamically, without causing much coupling. It separates behaviour from super and subclasses.[1]

WHAT ROLE DOES IT PLAY
The shotgunrobot project implements the strategy pattern on the Mob class. Many classes inherit from the Mob class, such as Zombie, Human, Skeleton Player and BatBoss. Each of the these classes implement a takeDamage method but each method varies to some degree depending on what kind of character it is for example, a regular enemy, such as a zombie or skeleton, takes damage different than a boss. This is where the strategy pattern comes into play.

The strategy pattern separates the different ways in which a Mob can take damage depending on what kind of Mob it is. The Destructable interface contains a takeDamage method therefore all the classes that implement the interface must define the method. From there, the Mob class should have an instance of the Destructable interface and a method referencing back to the strategies.
The diagram below shows how the strategy pattern would be implement with the classes in the in the give code for shotgunrobot

REFERENCE
[1] Java.dzone.com, (2014). *Design Patterns Uncovered: The Strategy Pattern | Javalobby*. [online] Available at: http://java.dzone.com/articles/design-patterns-strategy [Accessed 10 Nov. 2014]

CODE

```java
public interface Destructable {
        public void takeDamage(Entity source, int amount);
}

public abstract class Mob extends Entity implements Destructable {...}
public class Human extends Mob {
        public void takeDamage(Entity source, int amount) {...}
...
}
public class BatBoss extends Mob {
        public void takeDamage(Entity source, int amount) {...}
...
}
public class Skeleton extends Mob {
        public void takeDamage(Entity source, int amount) {...}
...
}
public Zombie(int x, int y, int w, int h, Entity p, Game g) {
        public void takeDamage(Entity source, int amount) {...}
...
}
public Player(int x, int y, int w, int h, Entity p, Game g)   {
        public void takeDamage(Entity source, int amount) {...}
...
}
```

The *factory* design pattern is implemented as a static method belonging to the **Mob** class (*See Mob#createMob()*). This factory method wraps the constructors of all the possible subclasses of **Mob**, returning the desired constructor based on a received argument. Within the **MobSpawnerTile** class, the result of Mob#createMob() is passed to the Game#addEntity() method.

This can be considered an implementation of the *Chain of Responsibility* pattern. Each time a mob is created, the object is passed as an entity to the **entities** arrayList on the Game object. Game#addEntity() wraps the arrayList#add method, as well as performing some auxiliary processing such as declaring the entity as "alive", and incrementing the count of humans or Zombies.

References:

Factory: http://www.drdobbs.com/jvm/creating-and-destroying-java-objects-par/208403883

Chain of Responsibility: http://sourcemaking.com/design_patterns/chain_of_responsibility

Code

```java
public abstract class Mob extends Entity implements Destructable {
    // preceding code
    public static Mob createMob(String mobType,
    int x, int y, int w, int h, Entity ent, Game game) {
        switch(mobType) {
            case "HUMAN": result = new Human(x,y,w,h,ent,game); break;
            case "ZOMBIE": result = new Zombie(x,y,w,h,ent,game); break;
            case "SKELETON": result = new Skeleton(x,y,w,h,ent,game); break;
            case "BATBOSS": result = new BatBoss(x,y,62,41,ent,game); break;
            }
        return result;
    }
    // remaining code
}
```

```java
public class MobSpawnerTile extends Tile {
//. . .
    private void spawnMob() {
        if(. . .) {
                level.game.addEntity( Mob.createMob(. . .);
                nextMobTimer = 60;
                numMobsSpawned++;
        }
        // . . .
    }
//. . .
}
```

```java
public class Game {
    public void addEntity(Entity ent) {
        ent.alive = true;
        entities.add(ent);
        if( ent instanceof Human ) numHumans++;
```

Description of Design Pattern Usage
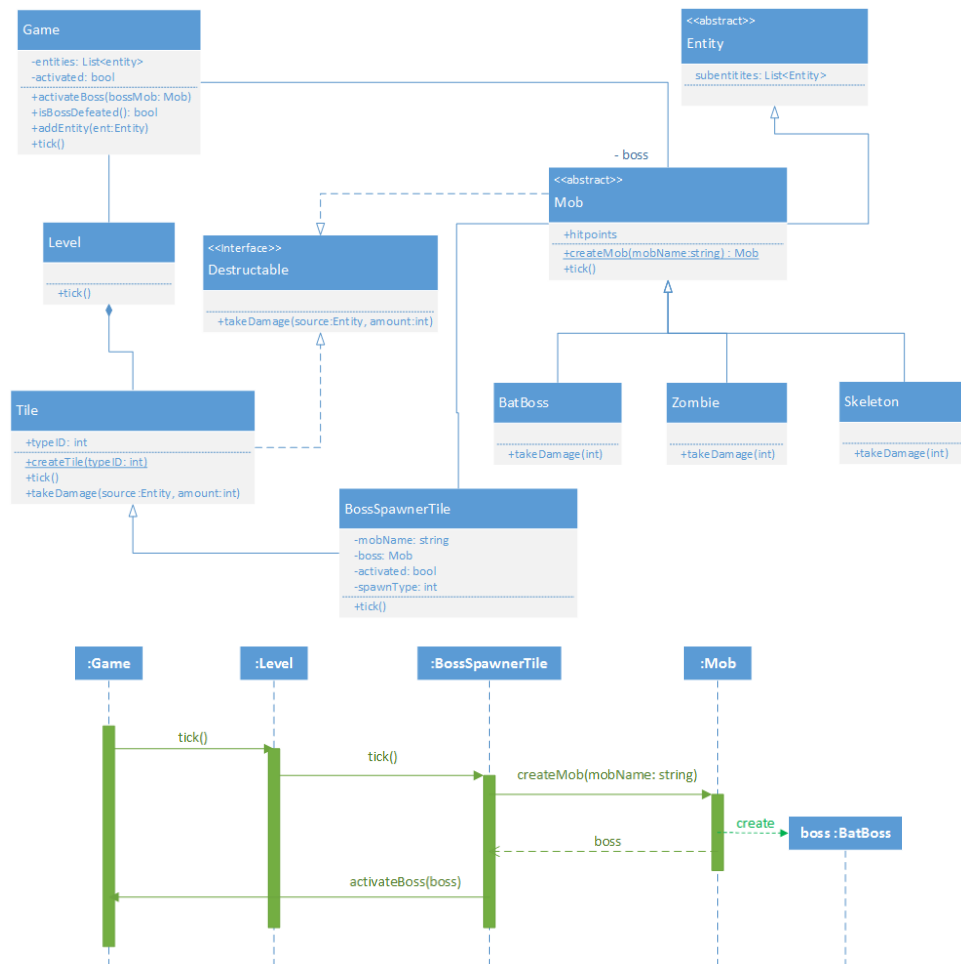
In Shotgun Robot, the Game class has a reference to the boss of the level. The Game class is responsible to checking whether or not the boss has been defeated. To facilitate extending the system to include new kinds of bosses, the Game class should not be responsible for the creation of the boss objects nor should it be coupled to specific implementations of the boss object. Instead of being coupled to the class of the boss, the Game class is coupled to the abstract class Mob which, through its static method for mob creation, returns the bridge that can be used as a boss.

The game includes a level that holds an object of type BossSpawnerTile. The boss spawner tile is responsible for initializing the boss and adding to the game for activation. In this way, the Game class does not need to know the specific implementation of the boss. It only knows the interface specified in the Mob class that the boss inherits from.

The BossSpawnerTile itself is created using the factory pattern, with the Tile class as the factory. BossSpawnerTile is a subclass of the Tile class and overrides the tick method. There are other subclasses of Tile, and the Level class is responsible for calling the static method for tile creation in the Tile class to retrieve the needed instantiations of tile subclasses.

Relevant Code:

```java
public class Game {
        private List<Entity> entities;
        private boolean bossActivated;
        private Mob boss;
        private Label bossStatusLabel;
        …
        public Game(int wid, int hgt);
        public void activateBoss(Mob bossMob);
        public boolean isBossDefeated();
        public void tick();
        …
}

public class BossSpawnerTile extends Tile {
        private boolean activated;
        private int spawnType;
        private String mobName;
        private Mob boss;
        …
        public BossSpawnerTile(int type, int x, int y, int wid, int hgt, Level lev);
        public void tick();
        private void spawnMob();
        …
}

public abstract class Mob extends Entity implements Destructable {
        public int hitpoints;
        …
        public Mob(double x, double y, int w, int h, Entity p, Game g);
        public void tick();
        public static Mob createMob(String mobType, int x, int y, int w, int h,
                                Entity ent, Game game);
        …
}

public class Tile implements Destructable {
        public int typeID;
        …
        public Tile(int x, int y, int wid, int hgt, Level lev);
        public void tick();
        public static Tile createTile(int typeID, int tx, int ty, int tw, int th,
                                        Level l);
        public void takeDamage(Entity source, int amount);
        …
}
```