CSC207 Cheat Sheet

Week 1 Java Basic

1.**The hybrid approach** (Java)**:** Before running, the human code is translated into bytecode (machine code) for the Java Virtual Machine. (Hardware independent)

2. **Pros of Static Typing**: More errors detected earlier in development, fewer errors at runtime and in shipped code.

3.**Pros of Dynamic Typing**: Deals naturally with certain types of self-describing data. Tends to reduce unnecessary clutter and duplication/repetition in code.

4.**Cons of Dynamic Typing**: More errors detected later in development and in maintenance. More errors at runtime and in shipped code.

5.**Primitive types**: byte (8-bit), short (16-bit), int (32-bit), long (64-bit), float (32-bit), double (64-bit), char (16-bit), boolean (1-bit)

Note：创建 primitive type 的值不需要用 new, primitive type 的值都是 immutable 的, variable 指向的都是 primitive type 的 value 本身

6. **Class type**: all other types, String, Integer, Balloon，创建 class variable 时一定要用 new 这个 keyword，variable 指向的是这个 object 的 address

7. **Auto-Conversion**: byte → short → int → long → float → double
char → int and above, boolean → no other types

8. 没有 follow <u>“can-auto-convert” directions</u> must be explicitly casted. e.g. long x = 207; short y = (short)x;

8.**operators:** !(NOT),&&(AND),||(OR),^(XOR)

9.HashMap<Integer, String> hm = **new** HashMap<Integer,String>()

10.**Scope of variables**

-class scope: variables declared in a class with “static” keyword，class 每个 instance 都 share 同一个

-class instance scope: variables declared in a class. 没有 static keyword，每个 object 都有一个自己的

-method scope: variables declared in a method, 出了这个 method 就用不了这个 variable 了

-block scope: variables declared in a method, and in a loop，在 loop 里的一个 variable，出了 loop 就用不了，就算还在 method，还是用不了

11.**Pass by value/reference**: 把一个 variable 放进 function 作为 parameter 时, primitive type 放进去的是 variable 的值(并没有对原本这个 variable 产生什么影响)，class type 放进去的是 variable 存的那个 address，对 parameter 做什么改变的话是会找到那个 address 对 address 里的那个 object 对改变的。

12. **Static**: when used on method, method becomes function,不需要借助这个 class 的 instance 来 call (static function 里能含有 non-static attribute/method)，当 static used on variables 时就像一个 global variable，这个 class 的所有 instance 都 share 这同一个 variable，并只会被 initialize 一次，,static method/attribute 可直接通过 class name 调用。

13. **Compare things**

```
 System.out.println(a == b);  // compares the reference
System.out.println(a.equals(b)); // compares the value
```

14. **private** Random rand = **new** Random();
int x = **this**.rand.nextInt(100);

Week 2 OOP

Overloading: 在一个 constructor 里 call 另一个 constructor using this(parameter)

Constructor in Child class: call parent’s constructor by super(args). if don’t call, parent’s default constructor with no args will be called, i.e., super().

Access modifiers	class	package	subclass	world
public	yes	yes	yes	yes
protected	yes	yes	yes	No
Default (pkg private)	yes	yes	No	No
private	yes	No	No	No

Week 3 Junit，inheritance, UML

Junit:一个 test suite 里会有一个 unit test (for each method), 每个 unit test 里还会有很多 test cases，*assertEquals*("a messege", expected value, actual value)，每个 test case 都是 follow @before @test @after 的顺序。

Inhetitance: Child can access Parent’s variable and method if and only if they are public or protected. CANNOT access those declared as private or default in the parent class.

Overriding: If you don’t want a method to be overridden by any child, declare it as final.

Shadowing: Child class re-declares a variable that exists in Parent.

Static binding happens at compile time, based on type information. （像 overloading 一样，调用哪个 function 是通过 parameter type，在 compile 的时候就知道了的）

Dynamic binding happens at runtime time (cannot be sure until running), based on the calling Object. 如果一个 subclass 的 object 被存到一个 parent class 的 variable 里，调用两个 class 都有的 method 会优先调用 subclass 的（如果 subclass 有这个 method 的话），但如果 parent class 没有这个 subclass 的 method，你就不能对 parent class call 这个 method，除非 cast，但如果存的不是一个 subclass 的 object 就不能 cast。random 也是一个 dynamic binding 的例子。

Abstract class：里面的 method 可以 implement 也可以只 declare，也可以有 variables，cannot be instantiated，subclass of an abstract class can still be abstract.

Liskov Substitution Principle: In other words, methods in the parent class must make total sense for the child class.

Array of subclass object is not a subclass from an array of parent class object

Generic Types：

drawShapes(ArrayList<Shape> lst)如果是 ArrayList<Cirvle>就进不去
drawShapesGeneric(ArrayList<? **extends** Shape> lst)就可以

UML：-private, +public, #protected, ~package, static <u>underline</u>

GIT：

```
git branch UserStoryN
git checkout UserStoryN
git add and git commit,  To push a new branch to remote: git push --set-upstream origin NEW_BRANCH
git checkout master （When you believe it’s done）
git pull
git merge UserStoryN
git push to the remote repo
```

Week4 OO Interface, GUI（不是重点，以往的 past test 从来没考过 GUI）

Interface: An interface is a group of **public** methods, declared but **not implemented**,也不能有 instance or static variables, except for public static final variables (constants). Implement 了一个 interface 的 class 可以被当做一个 interface 的 object 来看.

GUI (Basic Workflow): populate a stage object passed to the start method, a stage has a scene, a scene contains a tree of stuff. Each node of the tree could be one of the following: Layout panes (organize how its subtrees appear), controls (labels, buttons, text fields, etc.), events (e.g. callback methods that defines what happens when key is pressed, mouse is clicked, etc.) class 先 extends Application（<u>javafx </u>的 class，包含了很多 implement 好的 function, 比如 start（Stage stage）

Grid Pane

```
public class LayoutGrid extends Application {
public static void main(String[] args)
{ launch(args);}
public void start(Stage stage) {
    initUI(stage);}
private void initUI(Stage stage) {
GridPane pane = new GridPane();
Scene scene = new Scene(pane);
pane.setHgap(10);
pane.setVgap(10);
pane.setPadding(new Insets(10));
grid pane 不用 getChildren,直接 add
pane.add(new Button("1"), 0, 0);
pane.add(new Button("2"), 1, 0);
pane.add(new Button("3"), 2, 0);
pane.add(new Button("4"), 0, 1);
stage.setTitle("Grid Layout");
stage.setScene(scene);
stage.show();}}
```

Flow

```
public class LayoutFlow extends
Application {
public static void main(String[] args)
{launch(args);}
public void start(Stage stage) {
initUI(stage);}
private void initUI(Stage stage) {
FlowPane pane = new FlowPane(5, 10);
Scene scene = new Scene(pane, 600,
480);
pane.getChildren().add(new
Button("North"));
pane.getChildren().add(new
Button("South"));
*same for west and east
pane.getChildren().add(new
TextField("Centre"));
stage.setTitle("Flow Layout");
stage.setScene(scene);
stage.show();}}
```

Border

```
public class LayoutBorder extends
Application {
public static void main(String[] args)
{launch(args);}
public void start(Stage stage) {
initUI(stage);}
private void initUI(Stage stage) {
BorderPane root = new BorderPane();
Scene scene = new Scene(root, 60, 48);
Label btop = new Label("top");
Label bleft = new Label("left");
Label bbottom = new Label("bottom");
Label bright = new Label("right");
root.setTop(btop);
root.setLeft(bleft);
root.setRight(bright);
root.setBottom(bbottom);
stage.setTitle("Border Layout");
stage.setScene(scene);
stage.show();}}
```

Complex

```
public class LayoutComplex extends Application
{
//BorderPane 里含有一个 GridPane
public static void main(String[] args)
{launch(args);}
public void start(Stage stage) {initUI(stage);}
private void initUI(Stage stage) {
BorderPane pane = new BorderPane();
pane.setTop(new Button("north"));
pane.setBottom(new Button("south"));
*same for west and east
GridPane cpane = new GridPane();
for (int i = 0; i < 9; i++) {
cpane.add(new Button("Centre " + i), i % 3, i / 3);
//(button #, row #, column #)}
pane.setCenter(cpane);
Scene scene = new Scene(pane);
stage.setTitle("Complex Layout");
stage.setScene(scene);
stage.show();}}
```

EventHandler: A handler is attached to certain events, when the event is detected, the handle method of the handler is invoked. Button.setOnAction(new eventHandler()), eventHandler class **implements** EventHandler<ActionEvent>, 当 click on the button，这个 class 里的 handle 才就会被调用. 用 String msg = ((Button) (event.getSource())).getText()就可以得到 button 上面的字

四种把 eventHanldler 和 button 连起来的方法

Alternative 1

```
buttonHi.addEventHandler(ActionEvent.ACTION ,
new HiByeEventHandler());
buttonBye.addEventHandler(ActionEvent.ACTION ,
new HiByeEventHandler());
```

Alternative 2（inner class）

不需要再有另一个 eventHandler class，直接创建个 EventHandler object 在里面写 handle function

```
EventHandler<ActionEvent> eventHandler = new
EventHandler<ActionEvent>() {
        public void handle(ActionEvent e) {
   *how you want the button to react when
pressed* } };
      bhi.setOnAction(eventHandler);
```

Alternative 3 (anonymous inner class)

```
bHi.setOnAction(new
EventHandler<ActionEvent>()
{public void handle(ActionEvent
event) { *how you want the button to
react when pressed*}});
```

Alternative 4 (Lambda)

```
bHi.setOnAction((event) -> {
*how you want the button to react
when pressed*});
```

Alternative 5

```
HiByeEventHandler hbh1 = new
HiByeEventHandler();
bHi.setOnAction(hbh1);
```

KeyMouse extends Application

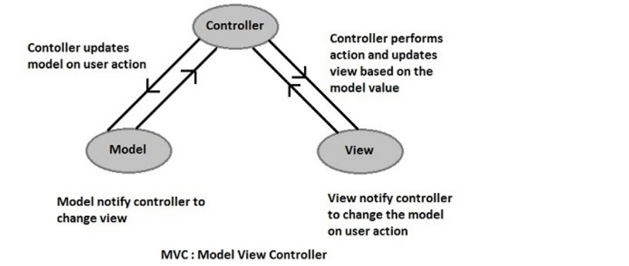
```
按按键：scene.setOnKeyTyped(
new EventHandler<KeyEvent>() {
public void handle(KeyEvent event) {
*how you want the button to react
when pressed*
System.out.println("key pressed: " +
event.getCharacter());
switch (event.getCharacter()) {}}
移动鼠标：scene.setOnMouseClicked
(new EventHandler<MouseEvent>() {
public void handle(MouseEvent e) {
 System.out.println("mouse clicked: "+
e.getSceneX()+" "+e.getSceneY());
```

Timer

```
public TimerDemo() {
Timer tickTimer = new Timer();
tickTimer.schedule(new TickTask(), 1000, 800);
private class TickTask extends TimerTask {
 @Override
public void run() {
System.out.println("Tick!!");}}
```

```
Timeline timer1 = new Timeline(new
KeyFrame(Duration.millis(1500),
new TimerHandler("Tick", lbl_tick)));
timer1.setCycleCount(Animation.INDEFINITE);
timer1.play();
```

Week5 MVC, Observer/Observable, Scrum (重点)


Controller
Contoller updates model on user action
Controller performs action and updates view based on the model value
Model
View
Model notify controller to change view
View notify controller to change the model on user action
MVC : Model View Controller

Model(Observable): the internal object, data, application state
View(Observer): the user interface, reflecting the changes in model.
Controller:
1. receive an event triggered from the view.
2.can manipulate the model and change the application state.
3. connects the model and the view, so that when change to the model happens, the model and notify the view to make the corresponding change.

Observer/Observable (java 自带的)
extends Observable:
addObserver(): add an observer
setChanged(): set the "changed" flag to be true
notifyObservers(): tell all observers about the change
后两个 method 一般一起用，当 model 里的 method 让 object 的状态产生变化时就 notifyObservers，但如果没有变化就不要 call 这两个 method. Model 里的 notifyObserver 对应的就是 observer 里的 update。
implements Observer: update(Observable o, Object arg) which is called when the observer is notified about a change by the observable. Model 里的 change 你想要怎么样在 view 里展现出来都写在 Update 里.

Summary of MVC:
Better extensibility and reusability
Supports better collaboration

Scrum
Waterfall V.S. Agile (preferred, Iterative approach)
Scrum is an agile methodology

Week6 Design Patterns: singleton, iterator (重点)

Observer/Observable (User Defined)

When certain objects need to be informed about the changes occurred in other objects. example: MVC GUI

Advantage: It supports the principle of loose coupling between objects that interact with each other. It allows sending data to other objects effectively without any change in the Subject or **Observer** classes. **Observers** can be added/removed at any point in time.

Implementation:

```
public interface Observer {public void update ();}
public class Observable {
private ArrayList<Observer> observers = new ArrayList<Observer>();
public void attach(Observer o) {this.observers.add(o);}
public void detach(Observer o) {this.observers.remove(o);}
public void notifyObservers() {for (Observer o : this.observers) {o.update();}}}
```

note:如果没有变化就不要 call 这两个 notifyObservers()

Advanced Issues: Push and Pull communication methods

push model: observable 一次性把所有一大堆信息全部 push 给所有 observer，有用的没用的全都有，这些信息 observer 可以自己决定用不用。有点浪费的是他涵盖了很多没用的信息，有可能很占空间。

pull model:每次有新的 change 时 observable 只 call notify 这个 method，告诉 observer something has changed，但不告诉 observer 什么东西 change 了，observer 要是想知道发生了什么需要自己去 observable 那里 pull 新的信息，缺点就是会有很多 threads 同时访问 observable，需要排队解决什么的，所以运行时间可能会变慢。（concurrency issue, b/c multiple access on Observable.）

对于这两种方法而言没有说哪个更好哪个不好，都有自己的 pros and cons，用哪个取决于你的 application，你的 program，你的需求是什么

Iterator

Advantage: have a unified mechanism to traverse any collection, hide the internal implementation of the collection, i.e., how the elements are really stored

Implementation:

The Collection class（其实还是用 ArrayList 在存东西） implements the Iterable< collection class > interface, and the iterator() method, which returns an iterator that points to the beginning of the collection.(相当于加上了 index)

例如：
```
public class SongCollection implements Iterable<Song>
public Iterator<Song> iterator() {return new SongCollectionIterator(songs);}
```

The Collection's iterator class implements the Iterator<collection class> interface, includes:
1.constructor: create a new iterator pointing at the beginning of the collection
2.hasNext(): return False iff the iterator is at the end of the collection
3.next(): return the current item, move iterator one step forward.

```
public class SongCollectionIterator implements Iterator<Song> {
private ArrayList<Song> songs;
private int indexKey;
public SongCollectionIterator(ArrayList<Song> s) {this.songs = s; indexKey = 0; }
public boolean hasNext() {return this.indexKey < this.songs.size();}
public Song next() {Song r =  this.songs.get(indexKey);  indexKey++; return r;}
```

```
Collection c;
Iterator it = c.iterator();
while (it.hasNext()) { print(it.next()); }
```

另一种 java 自带的接口:
```
for (Object o: Collection c) { print(o); }
```

Week7 Design Patterns: Strategy, Command, Composite (重点)

Strategy

Use when you have a family of algorithms, and you want to use them interchangeably. You want to be able to change the algorithm being used dynamically at runtime. You want to encapsulate the algorithms.

Advantage: Separate algorithms into classes that can be plugged in at runtime, Strategy enables the clients to choose the required algorithm, without using a "switch" statement or a series of "if-else" statements.

Implementation:
1.Create a common Interface for all the algorithms/strategies in the family.
2.Implement the interface for each concrete strategy.
3.The class using the strategies has the strategy Interface object 去存我们的 concrete strategy, which can be set using a setter method.
4.Clients use the setter method to change strategies dynamically

```
public interface RobotStrategy {public String nextCommand();}
public class RobotStrategyDefensive implements RobotStrategy {
public String nextCommand() {return "defense";}}
public class Robot { private String name; private RobotStrategy
strategy;
public Robot(String name) { this.name = name; this.strategy = new
RobotStrategyNormal();}
void move() { System.out.print(name + " makes a move: ");
String command = this.strategy.nextCommand();
System.out.println(command);} robot.setStrategy(new
RobotStrategyAggressive()); for (int i = 0; i < 10; ++i) {robot.move();
// these moves are aggressive
public interface CompareStrategy {
public static final int LESS = -1; EQUAL = 0; GREATER = 1;
public int compare(String s1, String s2);}
public class CompareStrategyNormal implements CompareStrategy {
public int compare(String s1, String s2) {
if (s1.compareTo(s2) < 0) {return CompareStrategy.LESS;}
else if (s1.compareTo(s2) > 0) {return CompareStrategy.GREATER;}
return CompareStrategy.EQUAL;}}
public class OrderedStringList {
private ArrayList<String> list = new ArrayList<String>();
private CompareStrategy strategy;public
OrderedStringList(CompareStrategy strategy) {this.strategy =
strategy;}
public void add(String s) {for (int i = 0; i < this.list.size(); i++) {
if (strategy.compare(s, this.list.get(i)) == CompareStrategy.LESS)
{ this.list.add(i, s);return;}}this.list.add(s);}
```

Command

You want to send requests/commands to a receiver object, to make the receiver object perform various actions. a hard drive could queue up a sequence of write command, **reorder them** to **optimize performance,** then **execute the commands in batch.**

Advantage: It decouples the classes that invoke the operation from the object that knows how to execute the operation. It allows you to create a sequence of **commands** by providing a queue system. Extensions to add a new command is easy and can be done without changing the existing code.

Implementation:
1.Create a common interface for all commands for a given receiver object which include an execute() method. And keeps a reference of the receiver object.

```
public interface BalloonCommand {public abstract void execute();}
```

2.Implement the interface for each concrete command (implement the execute() method). Uses the action methods of the receiver class.

```
public class InflateCommand implements BalloonCommand {
private Balloon balloon; private int amount = 0;
public InflateCommand(Balloon balloon, int amount) {
this.balloon = balloon; this.amount = amount;}
public void execute() {this.balloon.inflate(amount);}}
```

3.Client: instantiate a receiver object, instantiate concrete commands. Issue the command by: command.execute()

```
Balloon b1 = new Balloon("RED", 100);
BalloonOperator operator = new BalloonOperator();//the invoker
operator.acceptCommand(new InflateCommand(b1, 20));
operator.operateAll();
```

4.Invoker: stores the commands, and issue them by calling execute() on them.

```
public class BalloonOperator {
ArrayList<BalloonCommand> commandQueue;
public BalloonOperator() {
commandQueue = new ArrayList<BalloonCommand>();}
public void acceptCommand(BalloonCommand command) {
this.commandQueue.add(command);}
void operateAll() {
for (BalloonCommand command: this.commandQueue) {
command.execute();}commandQueue.clear(); }
```

Composite

When working with an object with recursive structure. a component of class A is composed of one or more components of class A. (composed graphics and arithmetic expressions)

Advantage: easy to use for the client, **no if statement is needed** in order to handle Composite and Simple differently.

Implementation:
1.Define a common interface for the simple component and the composite component.

```
public interface GraphicComponent {public void paint();}
```

2. Implementations these interface, one for simple component, one for the composite implementations.

```
public class GraphicSimple implements GraphicComponent {
private String name = "";
public GraphicSimple(String name) {this.name = name;}
public void paint() {System.out.println(name + ": simple component");
```

3.The composite component has an addElement() method which adds a component (simple or composite) to the composite.

```
public class GraphicComposite implements GraphicComponent {
private ArrayList<GraphicComponent> children = new
ArrayList<GraphicComponent>(); private String name = "";
public GraphicComposite(String name) {this.name = name;}public
void paint() {System.out.println(this.name + ": composite
component");for (GraphicComponent c: this.children) {c.paint();}}
public void add(GraphicComponent c) {this.children.add(c);}}
```

4.The client uses the methods defined in the interface.

```
GraphicSimple carBody = new GraphicSimple("rectangle");
GraphicSimple wheel1 = new GraphicSimple("circle");
GraphicSimple treeTop = new GraphicSimple("triangle");
GraphicSimple treeBotm = new GraphicSimple("rectangle");
GraphicComposite car = new GraphicComposite("group 1");
GraphicComposite tree = new GraphicComposite("group 2");
car.add(carBody); car.add(wheel1);  car.add(wheel2);
tree.add(treeTop); tree.add(treeBottom);
GraphicComposite wholePic = new GraphicComposite("main
group");   wholePicture.add(car);
wholePicture.add(tree);wholePicture.paint();
```

Week8 Design Patterns: Factory, Builder(重点)

Factory（simple creation process）

Advantage：Creates objects without exposing the instantiation logic to the client.

The product of a factory could also be a strategy, a command 等

Implementation: factory 是不能有 parameters 的

1.Create a base class or interface for the product (Food)
2.Implement concrete product classes by extending the base class (Burger, Pizza, Salad, etc.)
3.Create the Factory class with a createProduct(String productID) method, returns objects of different types according to productID

```
public class Food {}
public class Pizza extends Food {}
public class Salad extends Food {}
public class FoodFactory {
public Food createProduct(String product) {
if (product.equals("Burger")) return new Burger();
if (product.equals("Fries")) return new Fries();
return null;}
```

Singleton

Application needs **only one** instance of an object, e.g., logger object. Also, provides a global point of access to that instance.

Advantage: Instance control: Singleton prevents other objects from instantiating their own copies of the Singleton object, ensuring that all objects access the single instance.

Implementation:

1. object created when the program starts

```
Public final class Singleton{
Private static final Singleton INSTANCE = new Singleton();
Private Singleton(){}
Public static Singleton getInstance(){return Instance}}
```

2. object created when the first time you use the Singleton class

```
Public class Singleton{
Private static Singleton instance = new null;
Public static synchronized Singleton getInstance(){
If (instance ==null)instance = new Singleton(); return instance;}
```

要创建 singleton object 只能通过 Singleton s1 = Singleton.*getInstance*(); 因为 singleton 的 constructor 是 private 的

Builder（complex creation process）

Advantage：able to customize many attributes of the object, and separates object construction from its representation. The client doesn’t need to see the constructor of the product class

Implementation (Basic)

1.Define the Product class with different attributes (to be customized) and their setter methods.
2.Define a Builder class that keeps the options for setting the Product's attributes, and has methods (buildParts()) for building different parts of the product.
3. Builder has a getProduct() method that create a Product object, configures its attributes, and returns the Product object.

```
public class Pizza {private String name; private boolean extraCheese, extraSauce;
public Pizza(String name) {this.name = name; this.extraCheese = false; this.extraSauce = false;}
public void setExtraCheese(boolean extraCheese) { this.extraCheese = extraCheese;}
public void setExtraSauce(boolean extraSauce) {this.extraSauce = extraSauce;}
public class PizzaBuilder {
private String name; private boolean extraSauce = false,  extraCheese = false;
;public PizzaBuilder(String name) {this.name = name;}
public void addExtraSauce() {this.extraSauce = true;}
public void addExtraCheese() {this.extraCheese = true;}
public Pizza getPizza() {Pizza p = new Pizza(this.name);
p.setExtraCheese(extraCheese); p.setExtraSauce(extraSauce);  return p;}
```

Builder (Concrete Builder)

Extends from the Builder and make a concrete builder with a specific configuration.

```
public class HawaiianPizzaBuilder extends PizzaBuilder {
public HawaiianPizzaBuilder() {
super("Hawaiian");
this.addPineapple();
this.addPepperoni();}}
PizzaBuilder hawaiianBuilder = new HawaiianPizzaBuilder();
Pizza h0 = hawaiianBuilder.getPizza();
System.out.println(h0);
```

Builder(Director-like cashier)

```
public class PizzaDirector { private PizzaBuilder builder;
private ArrayList<Pizza> pizzas = new ArrayList<Pizza>();
public PizzaDirector() {}
public void construct() { builder = new HawaiianPizzaBuilder();
builder.addExtraCheese(); pizzas.add(builder.getPizza());
pizzas.add(builder.getPizza()); builder = new DeluxePizzaBuilder();
pizzas.add(builder.getPizza()); pizzas.add(builder.getPizza());
pizzas.add(builder.getPizza());}
public ArrayList<Pizza> getPizzas() {return this.pizzas;}}
// use the director to construct a bunch of pizza
PizzaDirector director = new PizzaDirector();
director.construct();
ArrayList<Pizza> pizzas = director.getPizzas();
for (Pizza p : pizzas) {System.out.println(p);}
```

Builder (Chain Builder-like restaurant crew)

```
public class PizzaChainBuilder {
private String name; private boolean extraSauce = false;
private boolean extraCheese = false;
public PizzaChainBuilder(String name) {this.name = name;}
//就可以一直点一直点一直加那些 method，之前这些 method return void 的时候就不可以把这些 method 全写一行,其他都和普通 builder 是一样的
// return the builder itself rather than void
public PizzaChainBuilder addExtraSauce() {
this.extraSauce = true; return this;}
public PizzaChainBuilder addExtraCheese() {this.extraCheese = true;
return this;}
Pizza p1 = new PizzaChainBuilder("TheLarry")
.addExtraCheese().addExtraSauce().addPepperoni().getPizza();
System.out.println(p1);
```

Week9 JavaIO, Regular expressions (重点)

Byte Streams (unbuffered): handle I/O of raw binary data, Reads and writes one byte at a time.

```
EX. FileInputStream in = new FileInputStream(“input.txt”)
FileOutputStream in = new FileOutputStream(“output.txt”)
Int c;
While ((c = in.read())!=-1){out.write(c);}
```

Character Streams(unbuffered **)**: handle I/O of character data, automatically handling translation to and from the local character set. Reads and writes one char (two bytes) at a time.

```
EX. FileReader in = new FileReader(“input.txt”)
FileWriter in = new FileWriter(“output.txt”)
Int c;
While ((c = in.read())!=-1){out.write(c);}
```

```
//这个 function 允许你 input 进去 string，你在 console 写“nishisheiya”会把每个 char 放进 array 里, 这是直接在 console 里 read characters
char[] c = new char[10];
try { for (int i = 0; i < c.length; i++) {
c[i] = (char) System.in.read();}}// System.in is an InputStream
 catch (IOException e) {System.out.println(e);}
```

Scanner: allows a program to read and write formatted text.

```
Scanner scan = new Scanner(System.in);//先创建一个 scanner 我们才可以得到 user input
System.out.println("How many balloons?");
int numBalloons = Integer.parseInt(scan.nextLine());
System.out.println("What colour?");
String colour = scan.nextLine();
```

这是从 file 读取

```
try {BufferedReader in = new BufferedReader(new FileReader("words.txt"));
Scanner s = new Scanner(in);
while (s.hasNextLine()) { String line = s.nextLine();
if (line.startsWith("ab")) {System.out.println(line);}
s.close();//这里是 scanner close
} catch (FileNotFoundException e) {
System.out.println(e);}
```

File 同时 read 和 write 的例子

```
public static void fileReadWrite() throws IOException {//这里 thro 一个 exception 之后就不会报错
这个 function 就是把 words.txt 里的文件写用 out.write(c)写到"words-copy.txt"去了，同时把 o 字母替换成***
FileReader in = null;  FileWriter out = null;
try {in = new FileReader("words.txt");
out = new FileWriter("words-copy.txt");//在这里就创建了个新的 file
int c; System.out.println("Copying...");
while ((c = in.read()) != -1) {//read（）如果没有更多东西了就会 return-1
if (c == 'o') {//把原文件里所有 o 用***替换掉
out.write("***");}else {out.write(c);}} System.out.println("Done!");
} finally {//和我们之前学的 try catch 一样，finally 是无论如何都会 run 的
if (in != null) {in.close();}if (out != null) {out.close();}}
```

Buffered Streams: optimize input and output by reducing the number of calls to the native API.

Advantage: for read: one disk access reads/writes (batch write) a batch of data from/to the disk to a memory area (call buffer), then Java read() gets data from the buffer. Much smaller number of disk access, much more efficient. **The System.in and System.out are essentially files.**

EX. BufferedReader in = new BufferedReader (FileReader(“input.txt”))

这也是从 console 直接读取，read a line at a time

```
BufferedReader lineInput = new BufferedReader(newInputStreamReader(System.in));
String line;
try {while ((line = lineInput.readLine()) != null) {
System.out.println("line = " + line + ", size=" + line.length());}}
catch (IOException e) {
System.out.println(e);}
// Alternatively, use a scanner
Scanner sc = new Scanner(System.in);
```

Read from files, read words and count the number of lines in the file, 把 words.txt 里的 q 开头的所有单词都 print 出来了，和 q 开头单词的总数

```
try {FileReader fr = new FileReader("words.txt");
BufferedReader lineInput = new BufferedReader(fr);
String line; int count = 0;
while ((line = lineInput.readLine()) != null) {
if (line.startsWith("q")) {System.out.println(line);count++;}}
fr.close();//这里就就把那个 file 关上了
System.out.println(count);} catch (FileNotFoundException e)
{System.out.println(e);} catch (IOException e1)
{System.out.println(e1);}
```

Regular Expression (string matching)

Pattern	Matches	Explanation	Pattern	Explanation
a*	“” “a” “aa”	Zero or more times	\t	A tab
b+	“b” “bb”	One or more times	\n	A new line
ab?c	“ac” “abc”	Zero or one time	.	Any character
[abc]	“a” “b” “c”	One from a set	\d	A digit [0-9]
[a-c]	“a” “b” “c”	One from a range	\D	A non-digit [^0-9]
[abc]*	“” “acbccb”	combination	\s	A whitespace[\t\n\x0B\f\r]
^	anchors	Matches beginning of the line 如果没有会自动加	\S	A non-whitespace [^\s]
$	anchors	Matches the end of the line 如果没有会自动加	\w	A word char [a-zA-Z_0-9]
\	\^, \$, *	Escape, matches the actual symbol	\W	A non-word char [^\w]
[^abc]	negation	Any char except a,b or c	[a-z&&[def]]	Intersection, d, e, or f
[a-zA-Z]	range	a thru z or A thru Z inclusive	[a-z&&[^bc]]	Subtraction, a thru z except for b and c
[a-d[m-p]]	union	A thru d or m thru p	[a-z&&[^m-p]]	Subtraction ,a thru z but not m thru p
X{n}	Exactly n times	X{n,} at least n times	X{n,m}	At least n but no more than m times
(a|z)	“OR”, matches a or z			

EX. to match the student number (\d{9}\d?) or (\d{9,10}), to match the grade, ((100)| ([1-9]?\d))一百，两位数，一位数的情况分别考虑, 并且不能出现 09 这样的分数，所以第一位只能[1-9]

Note: 在 java 里要写"(\\d\\d\\d)ABC\\1" 才行，两个 slash

Capturing Groups

Capturing groups allow you **to treat multiple characters** as a single unit. Use 括号 to group. For example, (BC)* means zero or more instances of BC, e.g., BC, BCBC, BCBCBC, etc.

1.groups are numbered by counting their opening parentheses from left to right. Group0 永远是最大的那个整体

2.**Backreference**

The section of the input string matching the capturing group(s) is saved in memory for later recall via backreference.

A backreference is specified in the regular expression as a backslash (\) followed by a digit indicating the number of the group to be recalled.

pattern	Example matching string
(\d\d)\1	1212
(\w*)\s\1	asdf asdf

*用 matcher.groupCount()可以得到 group 总数，用 m.group(i)可以得到第 1 个 group

Regex in Java

A proper regex for this set matches all strings in this set and does NOT match any string NOT in this set.

```
Pattern pNaturalNum =Pattern.compile("(0|[1-9]+\\d*)");（a DFA if built here by the compile）
Matcher m= pNaturalNum.matcher(string);
System.out.println(m.matches()); (match() will return true or false)
Pattern pCircle=Pattern.compile("^Circle$");(也可以 match 一模一样的 string)
```

简易版本： System.out.println (Pattern.matches(“a*b”, “aaaaab”));

match() V.S. find()

match()一定要是一模一样的 match 了才会 return true

find（）只要有一个 sub-string match 了就会 return true

```
p = Pattern.compile("(\\d\\d\\d)ABC\\1");//ABC 后面一定要跟 group1 里的内容，which is 三个 digits
m = p.matcher("123ABC123");  System.out.println(m.matches());//true
m = p.matcher("123ABC456"); System.out.println(m.matches());//false
```

Week10 Finite State Machine / DFA (重点，应该会有一道大题，还是画 DFA 的图，有 trapping state（到这个 state 后直接就 break ）

分别用 DFA 和 regex 来判断一个 string 是否是 5 个倍数

```
public static boolean recognise5Regex(String s) {
Pattern p = Pattern.compile("^\\d*(0|5)$");
Matcher m = p.matcher(s);
return m.matches();}

public static boolean recognise5FSM(String s) {
char[] c = s.toCharArray(); // so you can get a char by c[i]
int len = s.length(); int i = 0;  int state = 0; // Start out in the initial state
while (i < len) {
switch (state) {
case 0://注意他这个每个 state，也就是 0，1 都有 3 条通向外面的 path！！
if (c[i] == '0' || c[i] == '5') state = 1;//accepting state
else if ('0' <= c[i] && c[i] <= '9') state = 0;
else state = 2;//trapping state break;
case 1:
if (c[i] == '0' || c[i] == '5') state = 1;
else if ('0' <= c[i] && c[i] <= '9') state = 0;
else state = 2; break;
case 2://trapping state break;} i = i + 1;}
return state == 1;//看当前 state 是否是 accepting state 来决定 accept 与否}
```

```
public void parseMarks2() throws IOException {
BufferedReader inputStream = null;//读取一行
try {
Pattern pColons = Pattern.compile("^:{14}$");//::::::::::::::这一串符号
Pattern pStartMarksLine = Pattern.compile("MARKS For Assignment 1, Part 2");
Pattern pGUIMarks = Pattern.compile("^GUI:\\s*(\\d(\\.\\d)?)/5\\s*$");//这里的\\s*是空格,分数是\d/5，几点几不一定要存在
Pattern pCodeMarks = Pattern.compile("^CODE:\\s*(\\d(\\.\\d)?)/5\\s*$");//一模一样的对照这个 string
Pattern pEndMarksLine = Pattern.compile("^END MARKS$");//(.*)是 utorid
Pattern pUtorid = Pattern.compile("^(.*)/JugPuzzleGame/src/JugPuzzleGUIController\\.java$");
inputStream = new BufferedReader(new FileReader(basePath + "all.txt"));//在所有 directory 里找到 all.txt 这个 file
int state = 0;// State 0 is before "::::::::::::::::"，一共 7 个 state，每行一个 state，等遇到新的“::::::::::”就回到 state0
Matcher m; String l, utorid = "";  float guiMark = 0, codeMark = 0; lineNumber = 0;
while ((l = inputStream.readLine()) != null) { lineNumber++;
switch (state) {
case 0: // state before :::::::
m = pColons.matcher(l);
if (m.matches()) {//如果是:::::::了，initialize 所有新的信息，因为已近读到了一个新的 student
utorid = ""; guiMark = 0; codeMark = 0;  state = 1;} break;
case 1: // after reading the opening ::::::: m = pUtorid.matcher(l);
if (m.matches()) {//如果读到 utorid 那一行了
utorid = m.group(1);//用 group1 把这个学生的 utorid 记下
state = 2;//继续往下读} else {//如果出错了，出一个提示语，但不真的报错，结束程序  error("Expecting utorid line");return;}break;
case 2: // after reading the utorid m = pColons.matcher(l);
if (m.matches()) state = 3; else { error("Expecting colons"); return;}break;
case 3: // after reading the :::: below the utorid line
m = pStartMarksLine.matcher(l); if (m.matches()) {state = 4; break;}//如果不 match“MARKS For Assignment 1, Part 2”
m = pColons.matcher(l);//但 match“:::::::”的话 if (m.matches()) { error("Expecting start marks line");return;}break;
case 6: // after reading the CODE mark
m = pEndMarksLine.matcher(l);//读到“END MARKS”
if (m.matches()) {//因为我们再 main 里 call 的 method，我们 parse 时 utoridToStudent 里应该已经是有所有 student 的 object 了，我们就可以通过当前读到的学生的 utorid 的到 treeMap 里的 student 本人，在把它们的 marks 赋值给它们各自
this.utoridToStudent.get(utorid).setGuiMark(guiMark); this.utoridToStudent.get(utorid).setCodeMark(codeMark);
state = 0;//当前学生的信息就收集齐了，回到 state0 准备读取新的学生的数据！}}}
// Checks at the end of reading，因为如果我们读到了'END MARKS'，state 一定是等于 0 的
if (state != 0) {error("Expected end of file");} else {for (String s : this.utoridToStudent.keySet()) {
System.out.println(utoridToStudent.get(s));}}} finally {if (inputStream != null) {inputStream.close();}}}
```

Week11 Floating Point (重点) *不能用小数做 loop counter，会变成 infinite loop

Decimal: $\sum_{i=1}^{n} d_i \ \ 10^{-i}$

Binary: $\sum_{i=1}^{n} d_i \ 2^{-i}$

IEEE-754 Floating Point Format

sign s (1 bit) | exponent e (8 bits) | mantissa M(23 bits)

$(-1)^s * (1+M)*2^{e-127}$

*range of exponent is from

(0-127) to (255-127) = -127 to 128

*mantissa 第一位永远是 1，就不存他了

*sign：1 for negative and 0 for positive

Convert binary to decimal

Integer: 1100 1111

$1(2^7)+1(2^6)+0(2^5)+0(2^4)+1(2^3)+1(2^2)+1(2^1)+1(2^0)=207$

Faction:0.0111

$0(2^{-1})+1(2^{-2})+1(2^{-3})+1(2^{-4})=0.25+0.125+0.0626=0.4375$

*在 binary 里 mantissa 一定是小数了，因为他的整数位一定是 1 并且被省略了，要用小数的方法求出后加 1

*exponent 就用整数的方法求（**exponent 要减 127**）

*最后写成$(-1)^s * (1+M)*2^{e-127}$的形式

Convert decimal to binary

*若是整数位不是 0，就一直除 2，一直除到整数位是 1，然后 exponent 就是你除的 2 的次数。若整数位是 0，就一直乘 2，一直乘到整数位是 1，然后乘上 2^{-int}（int 就是你乘的 2 的次数，记住是负的），再分别把 sign，mantissa，exponent 变成 binary 的形式（**exponent 要加 127** 后再变）

*mantissa（除去 1 的小数位）乘 2，用得出的结果的小数位再乘 2，再用上一位的小数位乘 2，保证每次乘 2 的数的整数位是 0，记住每次乘 2 后的结果的整数位（会是 0 或 1），一直乘到有 23 位 bit 就行，按顺序读（可能还需要再往后乘几位 for rounding purpose）

*convert int to binary:一直用小学方法除 2，每次的 remainder 就是 bit，下一次用 quotient 继续除 2，一直除到 quotient 为 0 为止（**然后从下往上读**）

*若是要 convert negative int to binary，可以找出他的 positive binary，然后用 1s complement 的方法，把 0，1 互换。或者前面加一个 sign bit

special values

Zero: 0[00000000]00000000000000000000000（“^0{32}$”）

Positive Infinity: 0[11111111]00000000000000000000000（"^01{8}0{23}$”）

Negative Infinity：1[11111111]00000000000000000000000（"^11{8}0{23}$”）

Not a Number: *[11111111]-anything-but-all-zero-（"^[01]1{8}[01]{23}$")

Zero To 255: "([0-9]|[1-9][0-9]|1[0-9][0-9]|2[0-4][0-9]|25[0-5])"

Natural Number: "(0|[1-9]+\\d*)"

Overflow：overflow is the largest representable number

0[11111110]11111111111111111111111 = +1.11111111111111111111111(binary) x 2^(127) *exponent 不能全是 1 不然就会变成 not a number

Underflow：Underflow is the smallest positive representable number

(not really)0[00000001]00000000000000000000000 =1.00000000000000000000000(binary) x 2^(-126)) *exponent 不能全是 0 不然就会变成 0

(real underflow)0[00000000]00000000000000000000001=0.00000000000000000000001(binary) x 2^(-126) = 2^(-23) x 2^(-126) = 1 x 2^(-149)

Denormalized Numbers:

我们上面是只允许在整数位是 1,用负的 exponent 来达到最小数，但现在可以在 exponent 变小的同时也把 mantissa 变小，不在是一点几，而是 0.00…1

0[00000001]00000000000000000000000=+1.00000000000000000000000x2^(-126)=1.17549435E-38

0[00000000]10000000000000000000000=+0.10000000000000000000000x2^(-126)=5.877472E-39

0[00000000]01000000000000000000000=+0.01000000000000000000000x2^(-126)=2.938736E-39

2^{0}	2^{1}	2^{2}	2^{3}	2^{4}	2^{5}	2^{6}	2^{7}	2^{8}	2^{9}	2^{10}	2^{11}	2^{12}	2^{13}	2^{14}	2^{15}
1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768
0000 0001	0000 0010	0000 0100	0000 1000	0001 0000	0010 0000	0100 0000	1000 1000								

Rounding:

1.round to the nearest even number (17.5 to 18, 16.5 to 16)

2.at the 23rd bit, we must round to the nearest even, 看第 23 后 3 位来决定

a. If the next (24th) bit is a 0, then you round down directly (do nothing)

b. If the next bit is a 1, followed by either a 10, 01, or 11, you round up (add 1 to the mantissa's 0 least significant digit.)

c. If the next three digits are "100" this is a tie (we are midway (.5) between two representable numbers). In this case:

i. If the last number in the mantissa (23rd bit) is a 1, then round up

ii. If the last number in the mantissa (23rd bit) is a 0, then round down (do nothing)

(i.e. if the mantissa is odd, we're adding 1, if it's even, do nothing. Hence, this is considered rounding to even.)

ex. 001 100→010, 110 011→110

Machine Epsilon: eps is such that 1 + eps is the smallest possible mantissa you can get that is > 1. Machine Epsilon is the best precision you can have in the mantissa.再小了 machine 就比不了了

For single precision, eps = 1 x 2^{-23} ≈ 1.19e-7 (i.e., if you add 1.0 by 1e-7, nothing’s gonna change.)

For double precision, eps = 1 x 2^{-52} ≈ 2.22e-16

*非常大的数和非常小的数相加一定要先把小的数全部加起来，**可以先 sort**，从小的开始加。And adding a very small quantity to a very large quantity can mean the smaller quantity falls off the end of the mantissa. But if we add small quantities to each other, this doesn’t happen. And if they accumulate into a larger quantity, they may not be lost when we finally add the big quantity in.

*Avoid checking equality between two numbers using “==”

don’t check this condition: x == 0.207 ○ check this: (x >= 0.207-0.0001) && (x <= 0.207+0.0001) ○ or check this: abs(x - 0.207) <= 0.0001

*当 fraction 转换成 binary（with infinite digit）会被 rounded，convert back to decimal 的时候就会不准确，但只有小数点后 7 位是 significant 的，我们只保留这 7 位就够了