03/09/2022 – 03/11/2022

**Concurrency vs. Parallel**

Concurrency: multiple tasks run simultaneously. You can’t tell which task comes first and which task comes after. You can’t tell the order in general.

Parallel: multiple tasks **physically** run simultaneously. This is an implementation level concept. In real time, there are at least two executors.

If there is concurrency, there does not have to have parallel.

If there is parallel, there must have concurrency.

ConcurrentModificationException example:

for (int i : myList) {

myList.remove(i);

}

**Multi-process vs. multi-thread**

Process: an independent execution of instructions with independent memory space, stack, heap, and OS resource. Each process sees a complete memory space (pretend to be the only task of a system). Different processes communicate through inter process communication (explicit IPC).

Thread: an independent execution of instructions with shared memory space. Each thread has its private stack, program counter, and register states. Thread in the same process has shared: heap, static memory segment, OS resource. Communication performed through shared memory read/writes.

Difference: **independent memory space**. If has, process; otherwise, thread.

Multi-process: higher communication overhead, better resource isolation (fault tolerance), higher creation/destroy overhead.

Multi-thread: lower communication overhead, worse resource isolation (fault tolerance), lower creation/destroy overhead.

Multi-thread example:

Public static void main () {

Thread t = new Thread () {

@Override

Public void run () {

System.out.println(“1”);

}

};

t.start();

System.out.println(“2”);

t.join();

System.out.println(“3”);

}

Main thread --- new thread --- print “2” --- join --- print “3” --- exit

| |

---------- print “1” -----

Another example:

Public static void main () {

Thread t = new Thread () {

@Override

Public void run () {

System.out.println(“1”);

}

};

t.start();

System.out.println(“2”);

}

Main thread --- new thread --- print “2” --- exit

| |

---------- print “1” -----

**When will JVM exit? When there are no alive non-daemon threads.**

To make t a daemon thread: t.setDaemon(true);

PS: for JVM, GC is a daemon thread.

**Ways of creating threads and making them run**

1. extends Thread
2. implements Runnable
3. implements Callable

**Methods of thread**

Static methods: sleep(1000), yield() // we can see yield() as sleep(0)

**Synchronization and Race**

Data race: If two “conflicting operations” are in different threads and are not properly synchronized (concurrent), they will introduce data races. In general, two operations conflict with each other if they operate on the same memory location, and at least one of them is a write. Races are mostly treated as bugs in Java programs.

Three factors of data race:

1. more than one operation work on the same memory location
2. at least one operation is a write
3. at least two of those operations are concurrent

**Locks**

**Deadlock**

Condition to form a deadlock:

1. mutual exclusion: at least one resource must be held in a non-shareable mode. Only one process can use the resource at any given instant of time.
2. hold and wait or resource holding: a process is currently holding at least one resource and requesting additional resources which are being held by other process.
3. no preemption: a resource can be released only voluntarily by the process holding.
4. circular wait

**Livelock**

**Condition Synchronization**

Producer consumer problem:

* Consumer: if the queue is empty, wait for it to be not empty, then poll one element from it.
* Producer: if the queue is full, wait for it to be not full, then offer one element to it.

03/14/2022

**Volatile keyword**

Ex:

Class SharedObj{

// changes made to sharedVar in one thread

// may not immediately reflect in other thread

static int sharedVar = 6;

}

Suppose two threads are working on the SharedObj and they are running on different processors. Each thread may have its own local copy of shared variables. If one thread modified its value, the changes may not reflect in the original one in the main memory instantly. Now the other thread is not aware of the modified value which leads to data inconsistency.

Class SharedObj{

// volatile keyword makes sure that the changes made in one thread are immediately

// reflect in other thread

static volatile int sharedVar = 6;

}

**volatile vs. synchronized**

1. Mutual exclusion: it means that only one thread or process can execute a block of code (critical section) at a time.
2. Visibility: it means that changes made by one thread to shared data are visible to other threads.

The keyword synchronized guarantees both mutual exclusion and visibility.

The keyword volatile guarantees only the visibility. The value of volatile variables will never be cached and all writes and reads will be done to and from the main memory.

!!! the use of volatile is limited to the cases as most of the times, atomicity is desired.

Ex: a++ is a compound read-modify-write sequence of operations that must execute atomically.

**Sequential consistency**

Writing of a normal variable without any synchronization actions might not be visible to any reading thread.

03/15/2022

**String/StringBuilder/StringBuffer**

* String is immutable
* StringBuilder and StringBuffer are mutable
* StringBuffer is thread safe, StringBuilder is not

Constant pool

* == compares reference address
* Equals() depends on how you implement this method, usually compare the content. Default implementation is same as ==
* new -> in heap
* String a = “aaa”; String b = “aaa”; // in String pool, so a.equals(b) true

03/16/2022

Reviewed:

**Java Collection**

!!! Collection + Map, Map is not a part of Collection

* List – use ArrayList/LinkedList to implement
  + Remove() for both are O(n) not different reason
* Stack and Queue – use Deque to implement
  + For Deque, we use offerFirst(), pollFirst(), offerLast(), pollLast()
  + There are method like pop() but it can be confusing -> prefer not to use
* HashTable vs. HashMap vs. ConcurrentHashMap
* How HashMap works? Ex: find the value of a key
  + Key -> use hashCode() to get hash code
  + Hash code % length (16 buckets) -> get index of the bucket
  + Compare each nodes in that bucket, use equals()
  + If true, return value; if false until the end, does not exist
* Heap – use PriorityQueue
  + We **don’t know** which is larger: left and right

Tomorrow plan:

Comparable and comparator

JVM architecture

Today:

**Java reflection** – Reflection is a feature in the Java programming language. It allows an executing Java program to examine or "introspect" upon itself and manipulate internal properties of the program. For example, it's possible for a Java class to obtain the names of all its members and display them.

* jave.lang.reflect.\*;
* ex: Class c = Class.ForName("Student”);

Method m[] = c.getDeclaredMethods();

**Singleton design pattern**

* lazy initialization
  + object is created only if it is needed.
  + Implementation: use getInstance() method to return the instance.

public class SingletonExample1 {

private SingletonExample1() {}

private static SingletonExample1 instance = null;

public static SingletonExample1 getInstance() {

if (instance == null) {

instance = new SingletonExample1();

}

return instance;

}

}

* eager initialization
  + object of class is created when it’s loaded to the memory by JVM. It’s done by assigning the reference an instance directly.

public class SingletonExample2 {

private SingletonExample2() {}

private static SingletonExample2 instance = new SingletonExample2();

public static SingletonExample2 getInstance() {

return instance;

}

}

* thread safe
  + synchronized getInstance()

Factory design pattern

Builder design pattern

proxy design pattern

03/17/2022

Reviewed:

**Comparable vs. Comparator**

* Comparable

A comparable object can compare itself with another object.

The class implement Comparable interface to compare its instances.

Override the method compareTo().

class Movie implements Comparable<Movie> {  
 double rating;  
 String name;  
 int year;  
   
 public Movie(String name, double rating, int year) {  
 this.name = name;  
 this.rating = rating;  
 this.year = year;  
 }  
   
 @Override  
 public int compareTo(Movie m) {  
 return this.year - m.year;  
 }  
}

There is only one chance to implement the compareTo() method.

The object itself must know how it is to be ordered, and the sorting of objects needs to be based on natural order.

If a class implements Comparable interface, then collection of that object either List or Array can be sorted automatically by using Collections.sort() or Arrays.sort().

* Comparator

Comparator is external to the element type we are comparing. It’s a separate class.

We can create multiple separate classes to compare by different members.

class RatingCompare implements Comparator<Movie> {  
 @Override  
 public int compare(Movie m1, Movie m2) {  
 if (m1.getRating() < m2.getRating()) return -1;  
 if (m1.getRating() > m2.getRating()) return -1;  
 else return 0;  
 }  
}

We can write more than one custom comparator using different interpretations of what sorting means.

**JVM architecture**

* Class Loader – prepares the Java classes and loads them into main memory
  + Loading
    - Bootstrap Class Loader
    - Extension Class Loader
    - Application Class Loader
  + Linking
    - Verify
    - Prepare
    - Resolve
  + Initialization
    - Initialize
* Runtime Memory – holds the runtime variables and data
  + Method Area
  + Heap Area
  + Stack Area
    - Thread #1
    - Thread #2
    - Thread #N
  + PC Register
    - Thread #1
    - Thread #2
    - Thread #N
  + Native Method Stack
* Execution Engine – executes the Java program
  + Executions Engine
    - Interpreter
    - JIT Compiler
    - Garbage Collector
  + JNI (Native Method Interface)
  + Native Method Library

Tomorrow:

GC

Class Loader in details

Today:

Java Web

**OSI model (7 layers) and TCP/IP model (4 layers)**

|  |  |
| --- | --- |
| 7.Application layer | 1.Application layer |
| 6.Presentation layer |
| 5.Session layer |
| 4.Transport layer | 2.Transport layer |
| 3.Network layer | 3.Internet layer |
| 2.Data Link layer | 4.Network Access layer |
| 1.Physical layer |

**HTTP**

HTTP Request

* HTTP version type
* A URL
* HTTP method
  + GET, PUT, POST…
* HTTP request headers
* HTTP body (optional)

HTTP Response

* HTTP status code
  + 1XX information
  + 2XX success
    - 200 OK, get/put/post
    - 201 successfully created, post
    - 202 successfully received the request, but still processing
    - 204 no content, usually update the resources without changing the current display page, put
  + 3XX redirection
    - 307 temporary redirect
    - 308 permanent redirect
  + 4XX client error
    - 400 bad requests, the server could not understand the request due to invalid syntax
    - 401 unauthorized, the client is not authenticated
    - 403 forbidden, the client has not permission
    - 404 not found, the server cannot find the requested resources
  + 5XX server error
    - 500 internal server error
    - 501 not implemented, method not supported by the server
    - 502 bad gateways
* HTTP response header
* HTTP response body (optional)

03/18/2022 – 03/19/2022

Reviewed:

**Garbage Collection**

Serial GC – single thread

Parallel GC – multi thread

G1 GC – separate all the memory space into different chunks

CMS GC – concurrent mark and sweep GC

PS: Deprecated since java 9, and completely removed in java 14

Young generation / old generation / permanent generation

| | | | |

Eden S0 S1 tenured permanent

**Class Loader in details**

* Loading
* Bootstrap Class Loader
  + Extension Class Loader
  + Application Class Loader
* Linking
  + Verify
  + Prepare
  + Resolve
* Initialization
  + Initialize

Tomorrow:

keywords

03/21/2022

Reviewed:

**Keywords**

* data types
  + byte, short, int, long, float, double, char, boolean (all have a wrapper class)
* flow control
  + if, else, switch, case, default (2 kinds), for, do, while, break, continue, return
  + default
    - new feature in java 8 allows an interface to provide an implementation. We can add default methods in an interface to support lambda expressions.
    - Access modifier when there is no assigned access modifier to a class to its variables. Difference from private, it allows same package access.
* modifier
  + public, private, protected, static, final, //(rest for tomorrow)abstract, synchronized, native, strictfp, transient, volatile
  + final vs. finally vs. finalized

Tomorrow:

Rest of the keywords

Today:

Java application - **Three layers architecture (Controller-Service-Repository)**

Client

|

Web(controller) layer – present the application’s features and data to users.

|

Service(business) layer – business logic implementation, like calculation and evaluation. Also processing the data passing between the other two layers.

|

Data (DAO) layer – interacting with database to save and restore application data.

|

Database

**Inversion of Control** – lifecycle of all objects is controlled by a framework but not developer

**Dependency Injection** – an implantation of IoC, where the control being inverted is setting an object’s dependencies.

* Types: Constructor, Setter, field

Spring 4 main components: @Controller, @Service, @Component, @Repository

Two annotation we gonna use to choose which implementation we want to use

@Primary -> declaration of beans

@Qualifier -> @Autowired

03/22/2022

Reviewed:

**Keywords**

* modifier
  + public, private, protected, static, final, //abstract, synchronized, native, strictfp, transient, volatile
    - synchronized – only one thread can execute at a time.
    - native – non-access modifier that is used to access methods implemented in a language other than Java.
    - strictfp – used for restricting floating-point calculations and ensure the same result on every platform while performing operations in the floating-point variables. Used with classes, interfaces, and methods.
    - Transient – make the variable nor serialized. Serialization is the process of converting an object into a byte stream.
    - Volatile
* exception handling (6)
  + try, catch, finally, throw, throws, assert
    - assert – used for testing. Two ways to use:
      * assert expression;
      * assert expression1 : expression2;
* class related (6)
  + class, package, import, extends, implements, interface
* object related (4)
  + new, instanceof, super, this

Tomorrow:

OOP

Maybe some exceptions

Today:

**Waterfall style** – everything in scheduled, less communication between business and IT

* break a big project into several phases, each phase takes several months
* problem: demand may change over time, chunky

**Agile style**

* Break a project into very small sprints, each sprint takes 1-2 weeks
* Information board – put tickets of this sprint and assign people to work on the tickets. Each ticket has a point (based on difficulty).
* Scrum meeting – usually PM meet with businessperson, decide tickets
* Initial planning meeting – at the beginning of each sprint, to decide value of ticket
* Stand-up meeting – everyday, talk about today & tomorrow work, and any blocks or difficulties

**CI/CD** – continuous integration, continuous delivery/deployment. A method to frequently deliver applications to customers by introducing automation into the stages of app development.

CI – new code changes to an app are regularly built, tested, and merged to a shared repository.

CD (continuous deployment) – automatically release a developer’s changes from the repository to production.

CI/CD tools – Jenkins, GitHub Action

Stages of a CI/CD pipeline

* Source
* Build
* Test
* Deploy

How to build a CI/CD pipeline with GitHub actions? https://github.blog/2022-02-02-build-ci-cd-pipeline-github-actions-four-steps/

* Create or choose a repository, and pick a project
* Open GitHub Actions in your repository to start building your CI/CD workflow
* Make changes to your code to trigger your CI/CD pipeline
* Take a look at the workflow visualizer and live logs to get a full look into how your pipeline is running

03/23/2022

Today:

Spring

1. IOC
   1. DI types: Constructor, Setter, field
   2. Bean scope: 5(?)
2. AOP
   1. Definition: aspect-oriented programming

// log - old way  
class Server1 {  
 public void method1(){  
 // log before  
 // business logic  
 // log after  
 }  
  
 public void method2(){  
 // log before  
 // business logic  
 // log after  
 }  
}

Redundant code, hard to change (remove logs)

So, we have AOP:

In AOP, aspects enable the modularization of concerns such as transaction management, logging or security that cut across multiple types and objects (cross cutting concerns).

* 1. Key terminology
     1. Aspect
        1. a class that implements enterprise application concerns that cut across multiple classes, such as transaction management, logging, security.
        2. Aspects are implemented regular classes using Spring XML configuration.
        3. Regular classes annotated with @Aspect annotation (@AspectJ style).
     2. Join Point – a point during the execution of a program, such as the execution of a method or the handling of an exception.
     3. PointCut
        1. A predicate that matches join points.
        2. Advice is associated with a pointcut and runs at any join point matches by the pointcut.
        3. Spring framework uses the AspectJ Pointcut expression language.
     4. Advice
        1. Before: advice that executes before a join point
        2. After: advice to be executed regardless of the means by which a join point exits (normal or exception return)
        3. After return: advice to be executed after a join point completes
        4. After throwing: advice to be executed if a method exits by throwing an exception
        5. Around: advice that surrounds a join point such as a method invocation

In three tier layers

Controller -> service -> DAO (repository) -> connect with DB

The proxy class poses as the target bean, intercepting advised method calls and forward the calls to target bean.

* 1. Transaction
     1. How to achieve transaction handling?
        1. Original method to handle transaction:

Connection con = dataSource.getConnection();

Try (connection) {

con.setAutoCommit(false);

// execute sql statement

connection.commit();

} catch (SQLException e) {

connection.rollback();

}

* + - 1. Spring’s Programmatic Transaction Management:

@Service

Public class Userservice {

@Autowired

private TransactionTemplate template;

public Long registerUser(User user) {

Long id = template.execute(status -> {

// execute sql

// insert the user to db and return id

Return id;

})

}

}

* + - 1. Spring’s XML declarative transaction management:

// config in the xml file

<tx: advice id = ‘’, transaction-manager=…>

…

</tx: advice>

<aop>

</aop>

* + - 1. Spring’s @Transactional annotation: (easiest way in three)

Public class UserService {

@Transactional

Public Long registerUser(User user) {

// execute sql

// insert user

Return id;

}

}

* + 1. Propagation level and isolation level

@Service

Public class UserService {

@Autowired

Private InvoiceService service;

@Transactional

Public void invoice() {

service.createpdf();

}

}

@Service

Public class InvoiceService {

@Transactional(propagation = Propagation.REQUIRED)

Public void createPdf() {}

}

-------------------physical only one transaction, but logically there are two-----------------

Get connection,

Start transaction,

Call invoice, create pdf,

Close transaction

------- propagation = Propagation.REQUIRED // if there is already a transaction, use the existed one, otherwise, create a new one--------------

-------default, there is propagation = Propagation.REQUIRED, so you don’t have to explicitly write this--------------

* + - 1. Propagation level
         1. **required**
         2. **required\_new**
         3. support
         4. mandatory
         5. not\_supported
         6. never
         7. nested
      2. Isolation level (in Spring annotation transaction)
         1. default: will use the default isolation level for the RDBMS
         2. read\_uncommitted
         3. read\_committed
         4. repeatable\_read
         5. serializable

Reviewed:

Change plan to Spring setup

Three tier layers

Spring components

@Controller, @Service, @Component, @Repository

Implementation of @Autowired and examples

Tomorrow:

OOP

Maybe some exceptions

03/24/2022

1. Spring MVC
   1. MVC

图

* + 1. Model: contains the data of the application
    2. Controller: business logic of application. @Controller
    3. View: web pages, JSP (old tech)
    4. Front controller: in spring MVC, dispatcher servlet

图

* 1. Flow of Spring MVC
     1. 图
     2. All incoming request is intercepted by the dispatcherServlet that work as the front controller
     3. The dispatcherServlet gets an entry of handler mapping from the xml file and forwards the request to the controller
     4. The controller returns an object of ModelAndView
     5. The dispatcherServlet checks the entry of the view resolver in xml file and invokes the specified view component

1. Spring Boot
   1. Advantage
      1. Provide a flexible way to config the java beans, xml configuration and database transactions
      2. Batch processing and manage rest endpoints
      3. Everything is auto configed
      4. Annotation based spring application
      5. Ease dependency management
      6. Include embedded servlet container -> Tomcat
   2. Spring Boot starters
      1. 图
   3. Auto Config
      1. @EnableAutoConfiguration

public class Application {

public static void main(String[] args) {

SpringApplication.run(DemoApplication.class, args);

}

}

* 1. SpringBootApplication

@SpringBootApplication annotation includes @EnbaleAutoConfiguration, @ComponentScan, @SpringBootConfiguration

图

1. Rest API Design
   1. HTTP method
      1. Get: retrieve

Put: update (whole)

Post: create

Delete: remove

Patch: update (partial)

* + 1. Safe: get
    2. Idempotent: get, put, delete
    3. Cacheable: get, post (in some cases)
    4. Cache-control: (查一下)
  1. HTTP status code
     1. 1XX information
     2. 2XX success

200 OK

201 Ok and created as a result, use with post, and put

202 accepted, but is still processing

204 no content, use with put

* + 1. 3XX redirect

307 temporary redirect

308 permanent redirect

* + 1. 4XX client error

400 bad requests

401 unauthorized

403 forbidden

404 not found

405 method not allowed

* + 1. 5XX server error

500 internal server error

501 request method not implemented

* 1. HTTP URL Design

Handle CRUD (create, read, update, delete) actions using HTTP method:

* + 1. get /api/employees

Retrieves a list. Of employees

get /api/employees/10

retrieve a specific employee

put /api/employees/10

update employee #10

post /api/employees

create a new employee

delete /api/employees/10

delete employee #10

parch /api/employees/10

partial update employee #10

* + 1. each employee has different emails

get /api/employees/10/emails

retrieve a list of emails for employee #10

get /api/employees/10/emails/5

post /api/employees/10/emails

put /api/employees/10/emails/5

patch /api/employees/10/emails/5

delete /api/employees/10/emails/5

* + 1. filtering, sorting, and searching
       1. filtering

get /api/employees?state=open

* + - 1. sorting

get /api/employees?sort=created\_at,salary

// default ascending order, if want descending, use -salary

* + - 1. searching

get /api/employees?q=java

* + - 1. combine all:

get /api/employees?q=java&state=open&sort=salar

* + 1. limit fields

get /api/employees?field=id,department&…

* + 1. auto loading (manager is not a field of employee)

get /api/employees/10?embed=manager.name

get /api/employees/10?expand=manager.name

* 1. Spring RESTful API

@RestController, @Controller, @Service, @Repository,

@GetMapping, @PostMapping, @PutMapping, @DeleteMapping, @RequestMapping

@PathVariable, @RequestParam,

@RequestBody, @ResponseBody

1. Exception Handling
   1. Exception handling flow

图

@ExceptionHandler

图

@ControllerAdvice

图

@ResponseStatus

@ResponseStatus(value = HttpStatus.NOT\_FOUND)

public class NoSuchElementFoundException extends RuntimeException {

// …

}

1. Validation

图

Common validation annotations

@NotNull, @NotEmpty, @NotBlank, @Min, @Max, @Pattern, @Email …

图

@Valid, @Validated

1. RestDemo

Reviewed:

**OOP**

Abstraction – hide all the internal implementation

* Abstract class – contains abstract methods
* Interface – only abstract methods and default methods

Encapsulation – hide the data in a single entity or unit along with a method to protect information from outside

* Declare all the variables be private
* Provide getter and setter

Inheritance

* Extends – for class, can only extends one class
* Implements – for interface, can implement multiple interfaces

Polymorphism – the ability of an object to take many forms

* Override – implement inherited methods in subclasses (both abstract and non-abstract methods can be overridden, must implement abstract methods in subclasses)
* Overloading – methods have same name but different signatures (number of parameters or type of parameters)

Tomorrow:

Exception and its examples

Weekend – notes for spring, and spring demos