Foodchain

An interactive ecosystem

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Objective:

Explore and ***simulate*** environmental scenarios

How do different variables affect a Foodchain?

What is the cause of Foodchain imbalance?

Which organism has the highest survival rate?

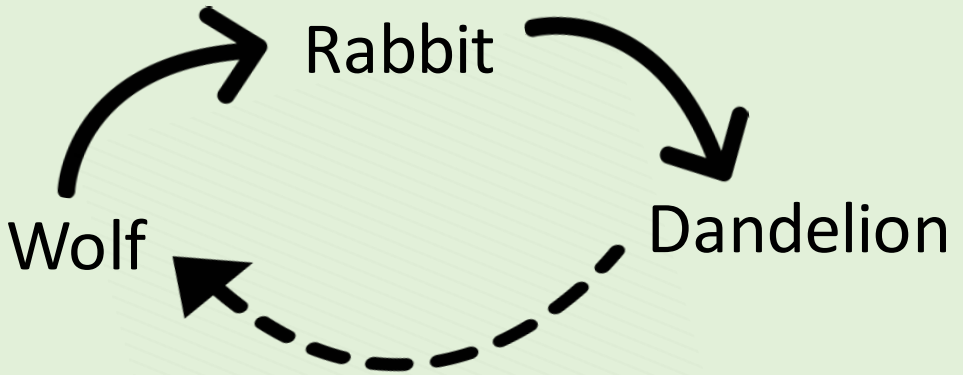
What and is there an optimal Foodchain?

What is in the Foodchain environment (initially)?

• Animals - Wolf - Rabbit	• Plants - Dandelion

Foodchain hierarchy

(**Predator -> Prey**)



What are the *variables* in the ecosystem?

Weather condition (Rainfall): factor multiplied to plant variables in order to affect growth, birth, etc.

- Intensity (Range: 1-10)

Birth periods: periods of time between reproduction counted by **ticks***

- Wolf born period (Range: 1-400)
- Rabbit born period (Range: 1-400)

Birth rate: the percentage rate of successful reproduction every birth period

- Wolf born rate (Range: 1-100%)
- Rabbit born rate (Range: 1-100%)
- Dandelion born rate (Range: 1-100%)

Exploration:

Scenarios with differing **Independent Variables**

Scenario #1: Light Rainfall (weather condition)

Variables

- Weather condition= Lowest (1)
- Birth periods= Initial (200)
- Birth rates= Initial (50%)

Description:

A situation in which a habitat experiences abnormally low levels of rainfall.

Results (Data):

- Video Data

Timestamps:

1. At 00:01:10, Dandelions die out

2. At 00:01:58, Rabbits die out

3. Lastly, at 00:02:10, Wolves die out

Conclusion:

- The dandelion died out first due to the lack of rain (born period impacted)
- This then caused the rabbits to die out from lack of food source, dandelion
- Lastly, the wolves die due to lack of rabbits
- Shortage of rainfall causes **imbalance** of the Foodchain and is not optimal

Real World Application

- An example of this could be the deserts or droughts
- Lack of rainfall or bodies of water
- **This is a problem because they:**
    - Plant growth depends on rainfall
    - Land becomes infertile
    - Does not support life (lack of water)

Scenario #2: Shortened Wolf born period

Variables:

- Weather condition= Initial (5)
- Wolf born period= Lowest (1)
- Rabbit born period= Initial (200)
- Birth rates= Initial (50%)

Description:

A situation in which the habitat's wolves reproduce at an abnormally high rate; period of time between each birth shortened

Results (Data):

- Video Data

Timestamps:

1. At 00:01:06, Rabbits die out

2. At 00:01:36, Wolves die out

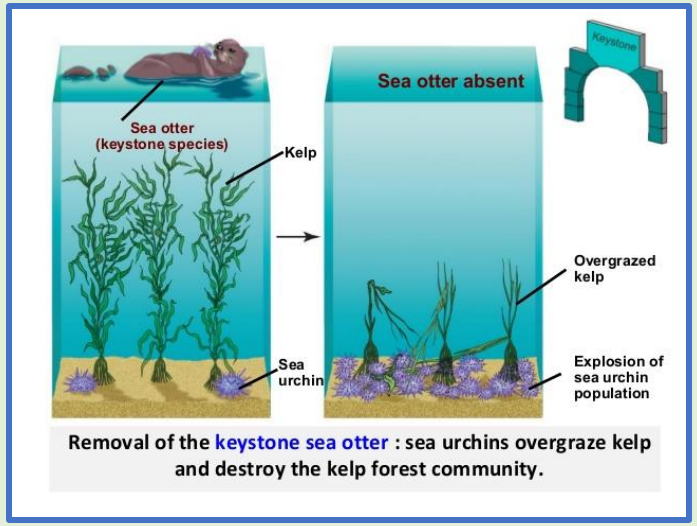
3. Dandelions keep growing (may eventually die out)

Conclusion:

- The rabbits died out first due to the amount of wolves (produced by the low born period)
- This then caused the wolves to die out from lack of food source, rabbits
- The dandelion aren't fatally affected by this since their predator rabbit died first
- A large production of wolves causes **imbalance** of the Foodchain and is not optimal

Real World Application

- An example of this could be **keystone predators**
- **This means:**
  - Predators introduced to moderate prey population and competition



- **This is could be a problem because they**:
  - Could hunt prey population to extinction

Scenario #3: Shortened Rabbit born period

Variables:

- Weather condition= Initial (5)
- Wolf born period= Initial (200)
- Rabbit born period= Lowest (1)
- Birth rates= Initial (50%)

Description:

A situation in which the habitat's rabbits reproduce at an abnormally high rate; period of time between each birth shortened

Results (Data):

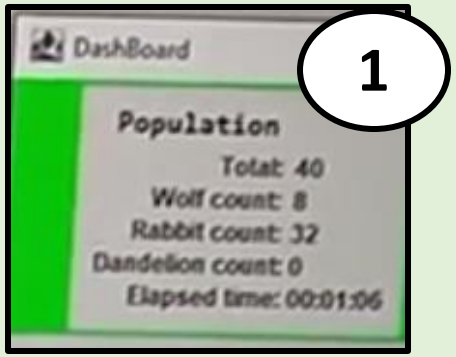
- Video Data

Timestamps:

1. At 00:01:06, Dandelions die out

2. At 00:01:36, Rabbits die out

3. Lastly, at 00:02:06, Wolves die out



Conclusion:

- The dandelion died out first due to the amount of rabbits (produced by the high born rate)
- This then caused the rabbits to die out from lack of food source, dandelion
- Lastly, the wolves die due to lack of rabbits
- A large production of rabbits causes **imbalance** of the Foodchain and is not optimal

Real World Application

- An example of this could be the European rabbits in Australia
- **European rabbits:**
  - Have a lack of natural predators
  - Can give birth to more than **four litters** a year with as many as **five kits** (baby rabbits) each (**high birth rate**).
- **This is a problem because they:**
  - Drive out native species from their homes
  - Compete for food and other resources
  - Loss of plant biodiversity

Exploration Takeaways

- Foodchain imbalance could be caused by:
  - Due to drastic changes in the variables, some part of the Foodchain is eliminated, the entire chain of predators before it that relied on it for food would be affected
  - **Example from our Foodchain:**
    1. Wolf->Rabbit (high birth rate)->~~Dandelion~~ (all eaten by Rabbit; extinct)
    2. Wolf->~~Rabbit~~ (high birth rate but now; no food source; all eaten by Wolf; extinct)
    3. ~~Wolf~~ (no food source, extinct)

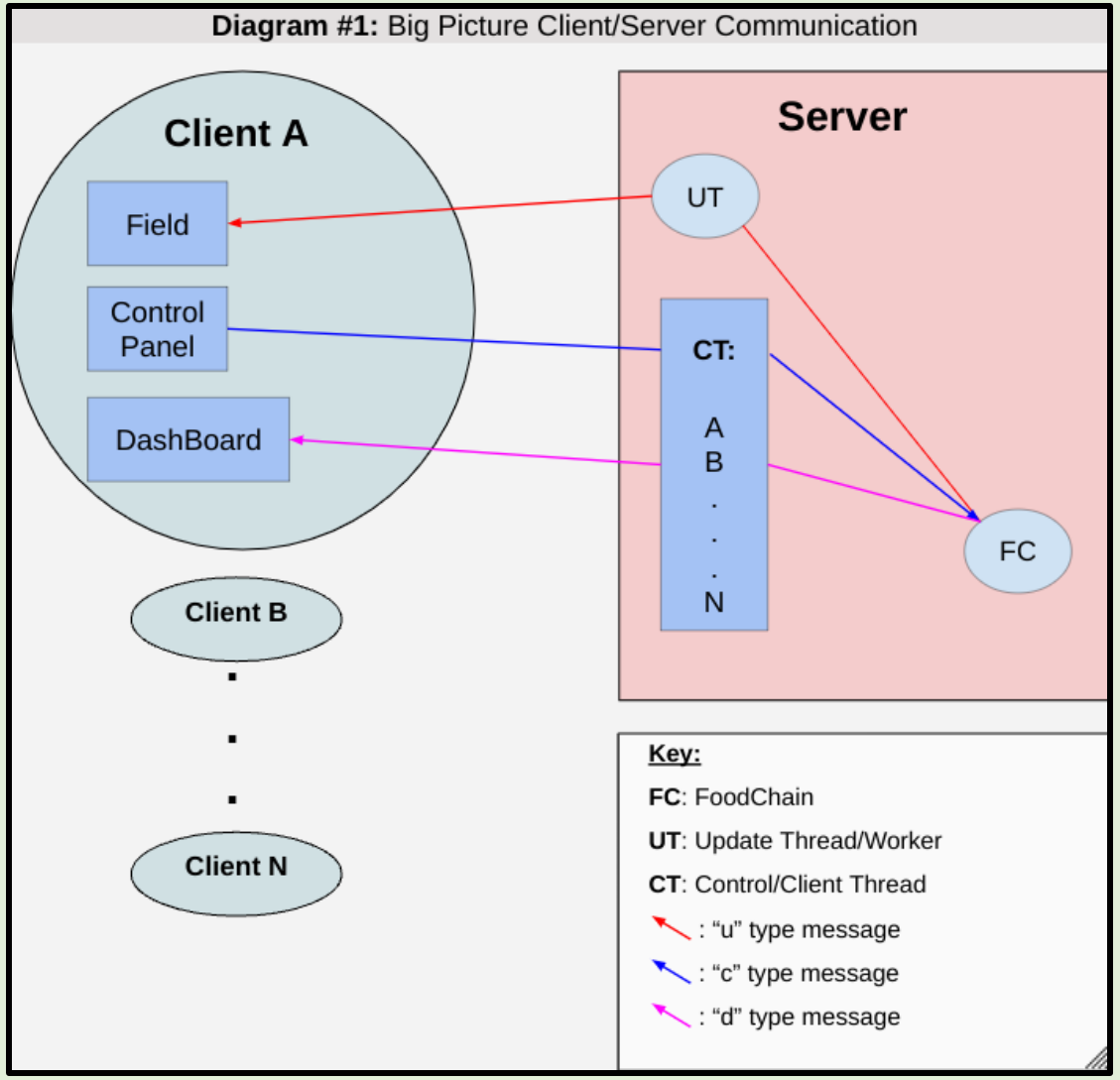
  - Introduction of **non-native species** with extremely high birth rates, such as the rabbit, could end up causing plant species, like the dandelion, **to go extinct**, which causes the rabbits to go extinct as well, if dandelions were a crucial part of their diet; this also impacts the wolves who hunt the rabbits for food (the WHOLE Foodchain affected)

Simulation:

Creating the Foodchain

The Broader Picture

- Create a **Server** with a running environment
- Multiple **Clients** from different platforms that can connect to Server to view environment

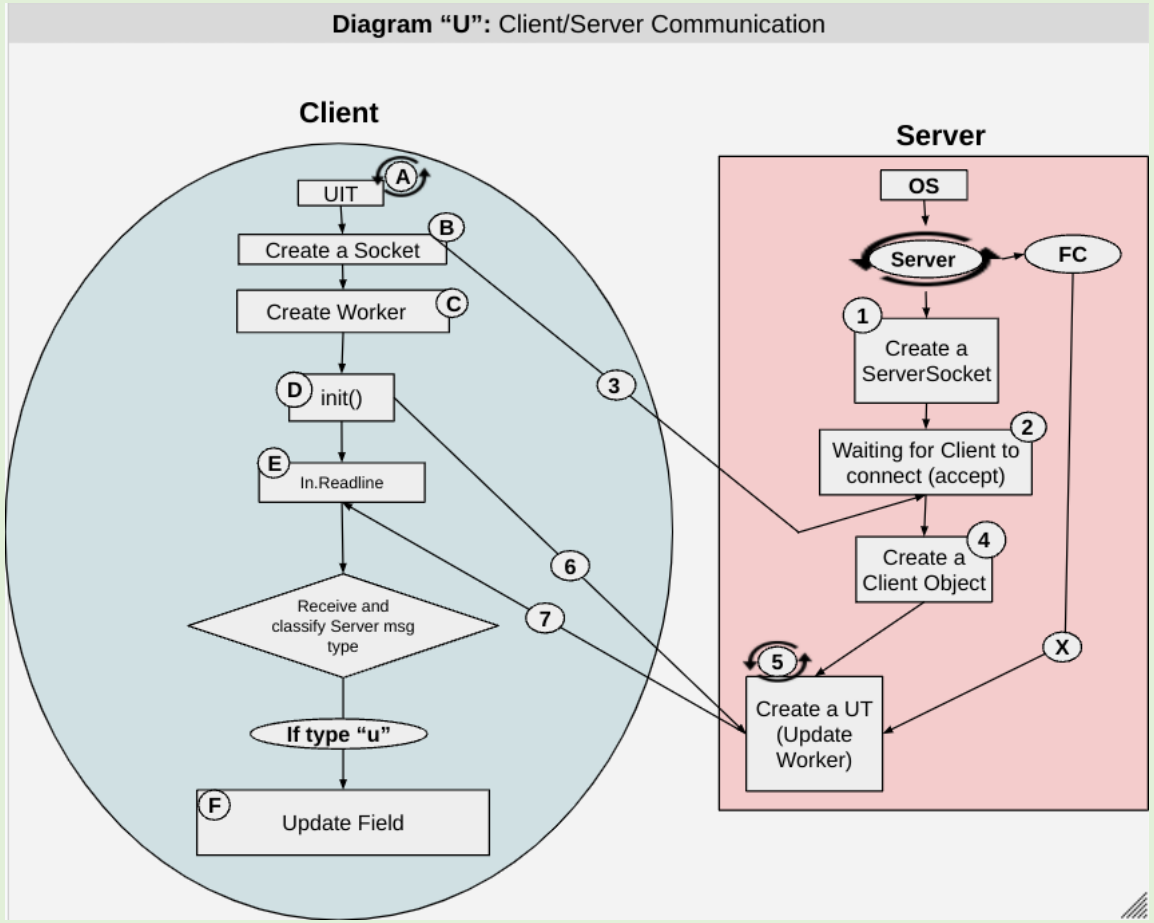


Messages: "U", "C", "D"

Retrieving values from Server side to update Client's UI elements

"U" messages: Update Field UI

Server's Update Worker constantly pushes values to update FoodChainField (state of animals, position, environment)



"U" messages (Update Field UI): Server side

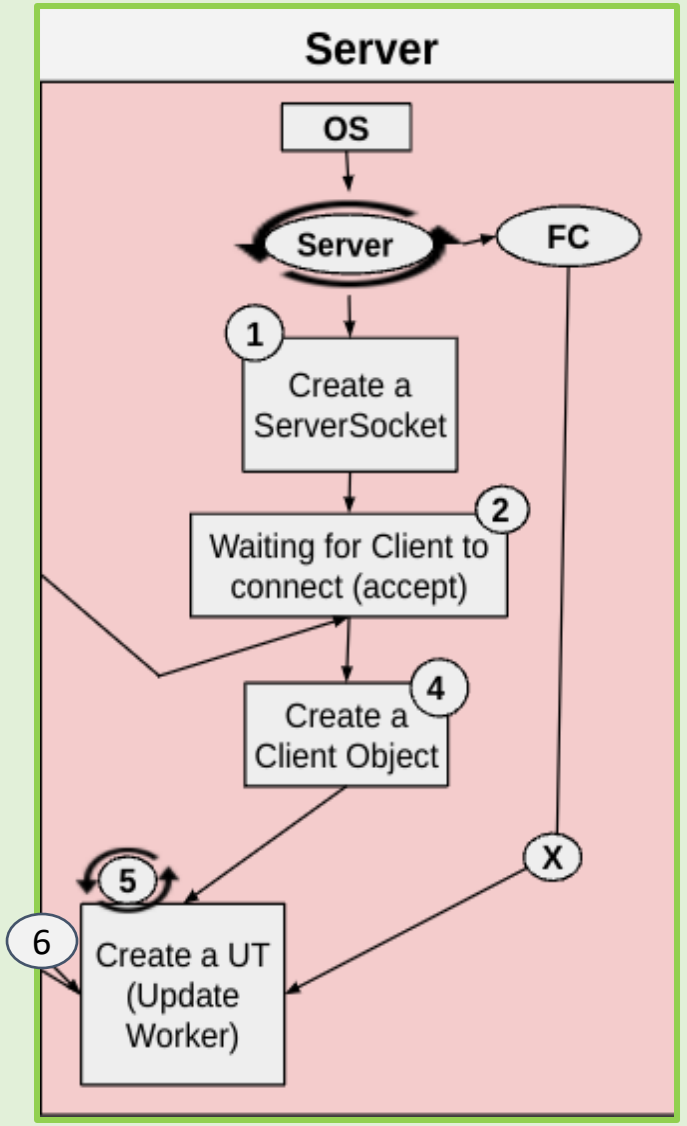
Tool Tips:

2. Call accept of ServerSocket (block Server control)

7. Constantly broadcast to all CT in Client List

X. Update Worker constantly updates using

FoodChain class's Life List (thread list)



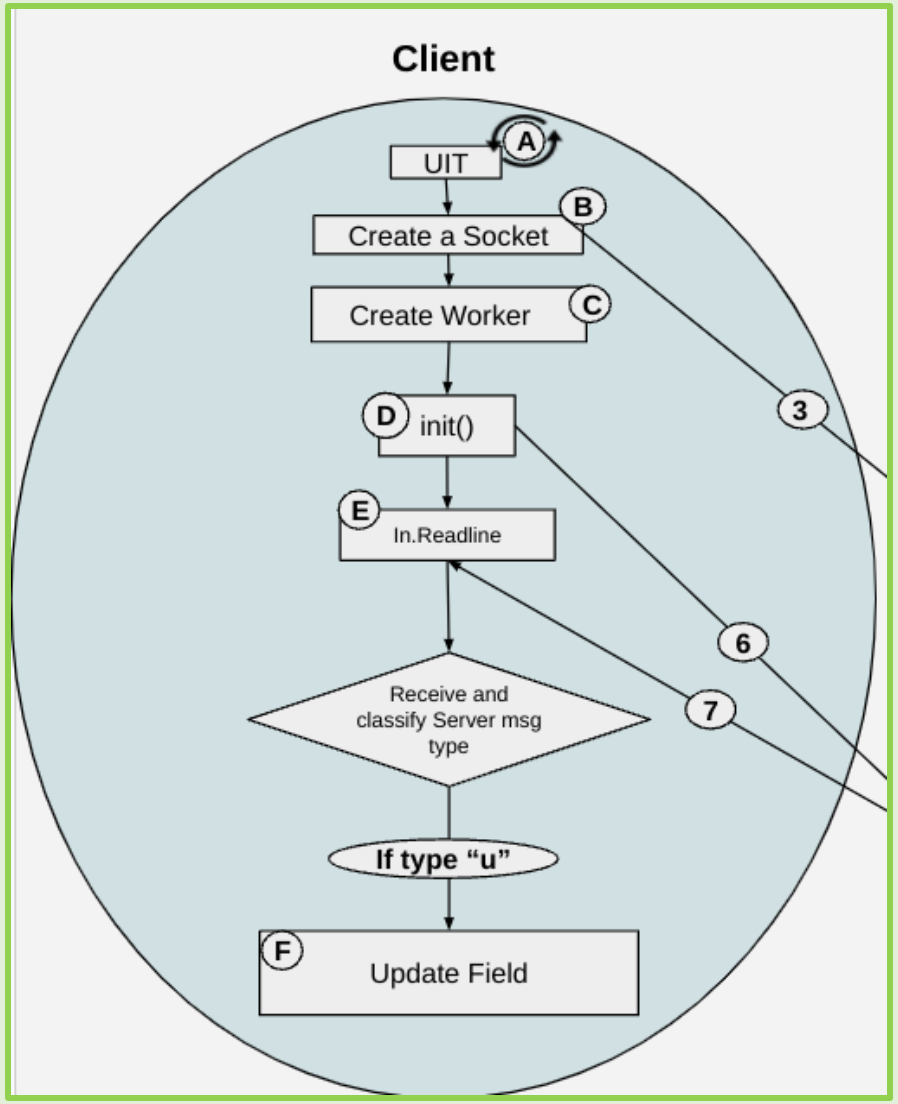
"U" messages (Update Field UI): Client side

Tool Tips:

A: create a UI Thread

B: create a Socket (unblocks Server that was waiting for Client response)

C: create a Worker Thread for Client



"U" messages (Update Field UI): Client side

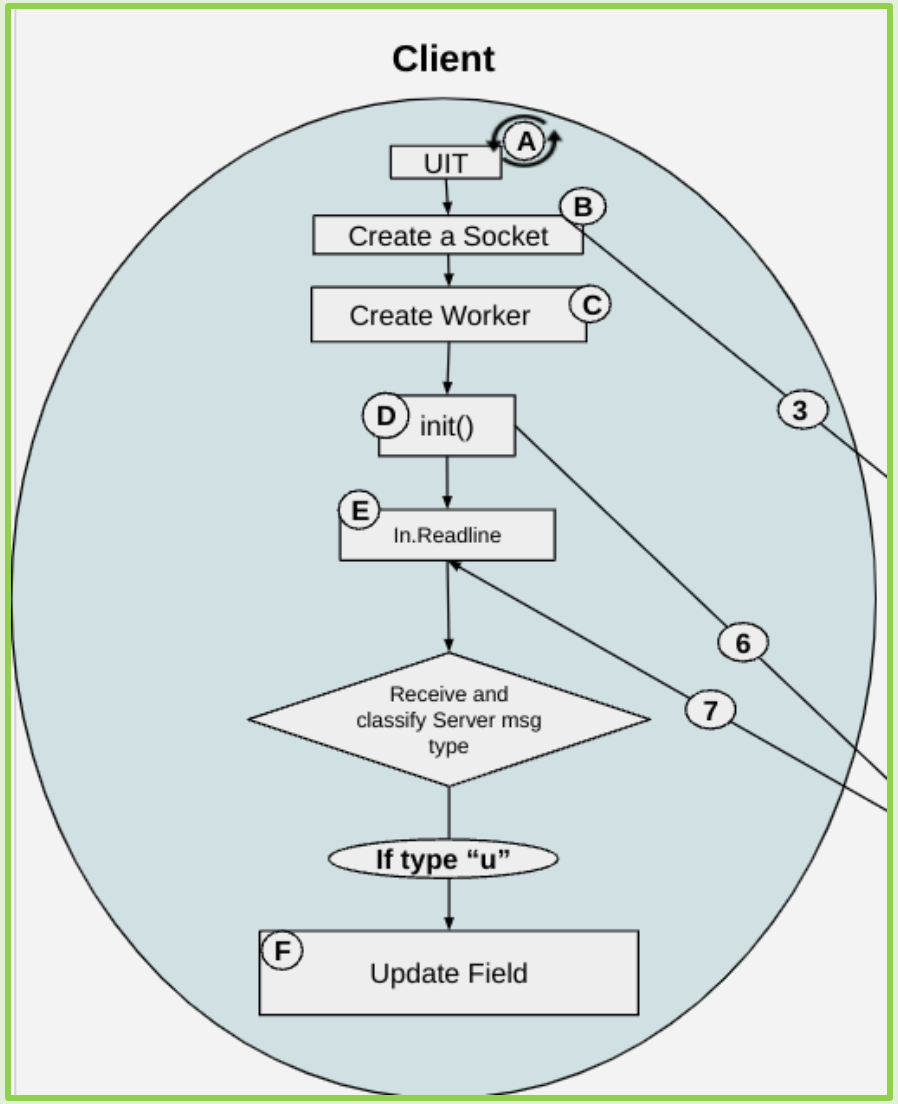
Tool Tips:

D(6): call init() method to send (out) key

from Client that need initial slider values

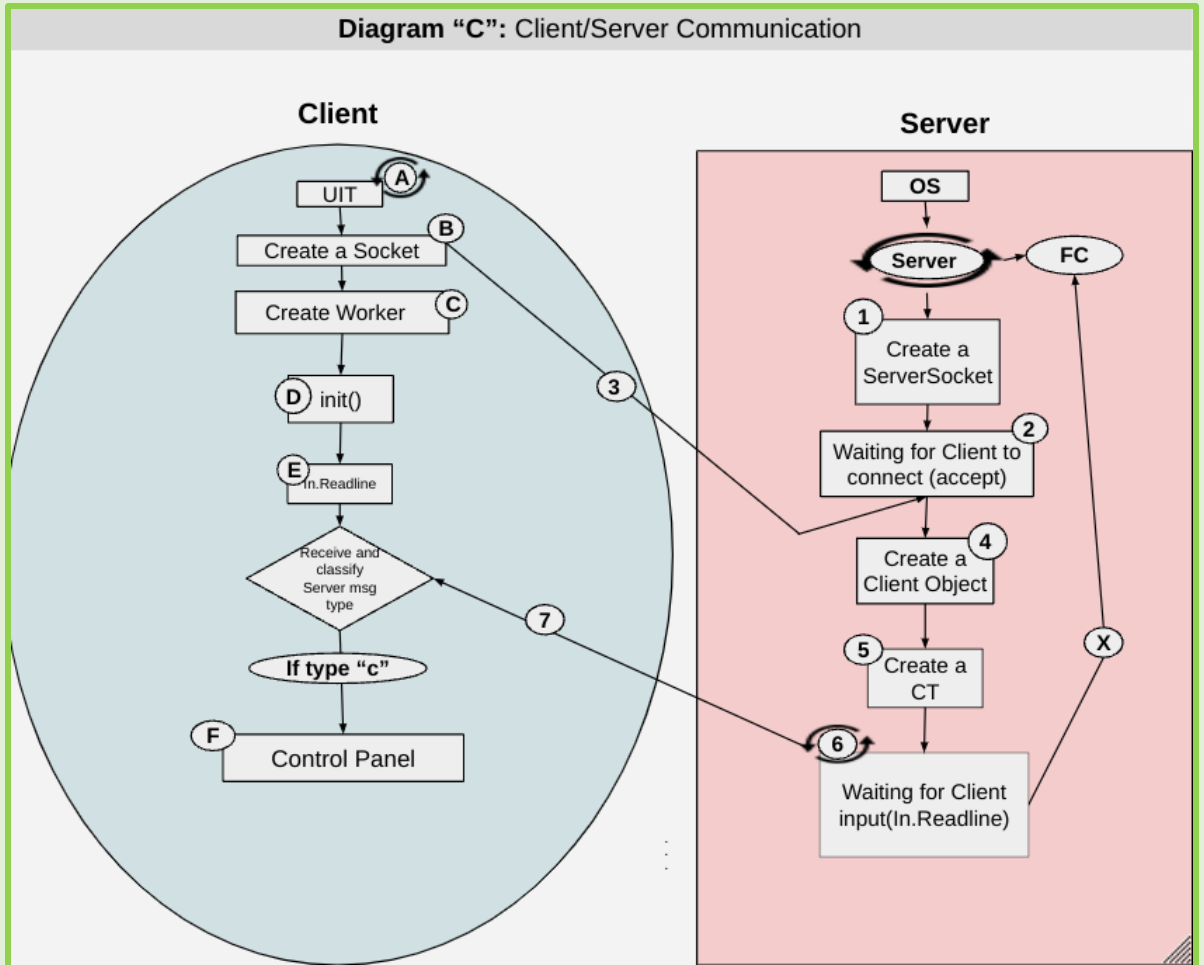
E: waiting for msg from Server (in)

F: Update FoodChainField UI



"C" messages: Update Control Panel

Client's Control Panel sends update request to Server's Client Worker (updates change of values on sliders)



"C" messages (Update Field UI): Server side

Tool Tips:

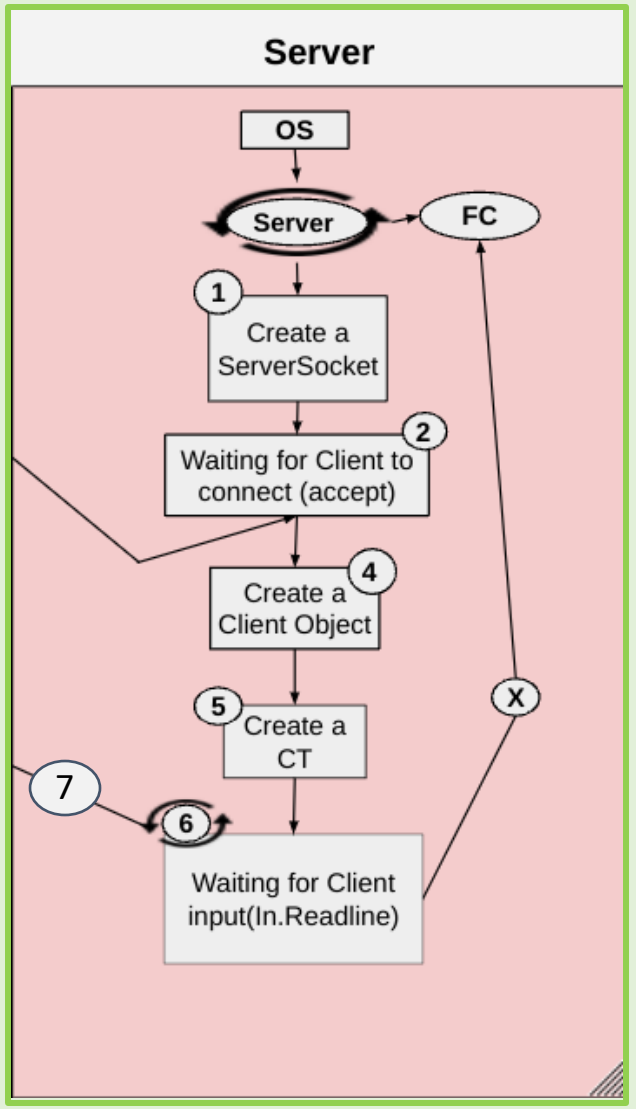
2. Call accept of ServerSocket (block Server control)

5. Create a Client Thread

6. Client Thread waits for Client to send Control request

7. Client Thread sends values from FoodChain to Client

X. Retrieves values requested by Client from FoodChain



"C" messages (Update Field UI): Client side

Tool Tips:

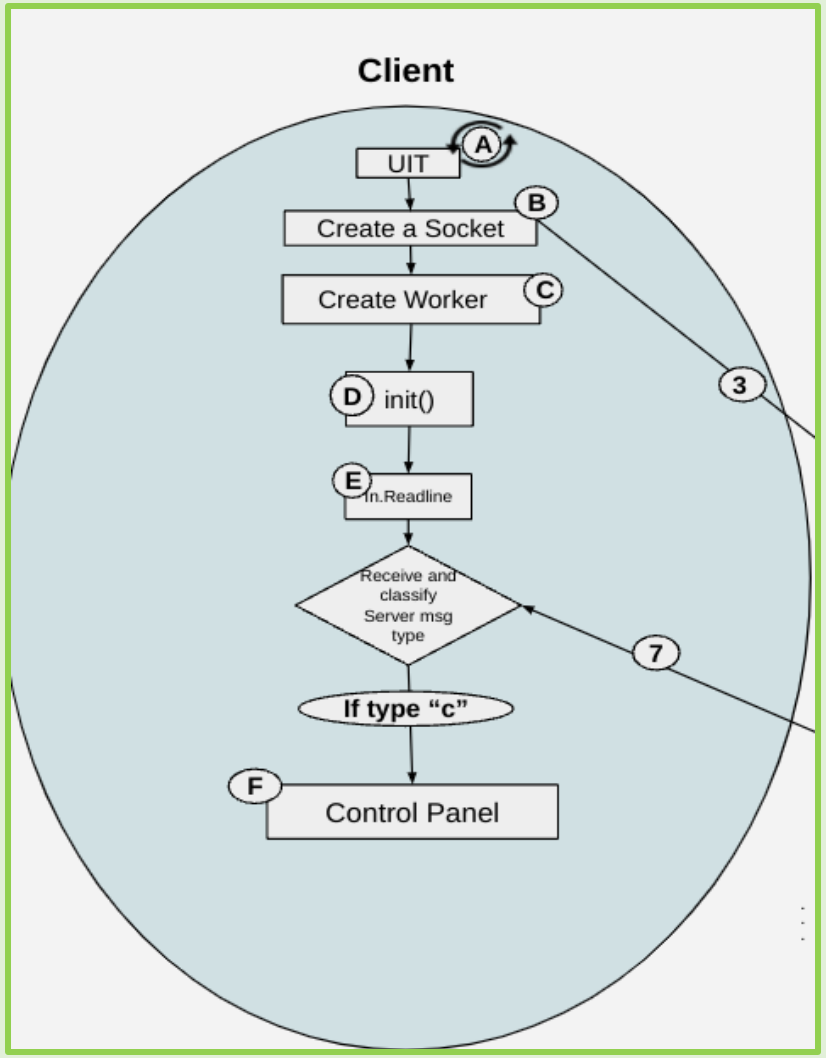
A: create a UI Thread

B: create a Socket (unblocks Server that was waiting for Client response)

C: create a Worker Thread for Client

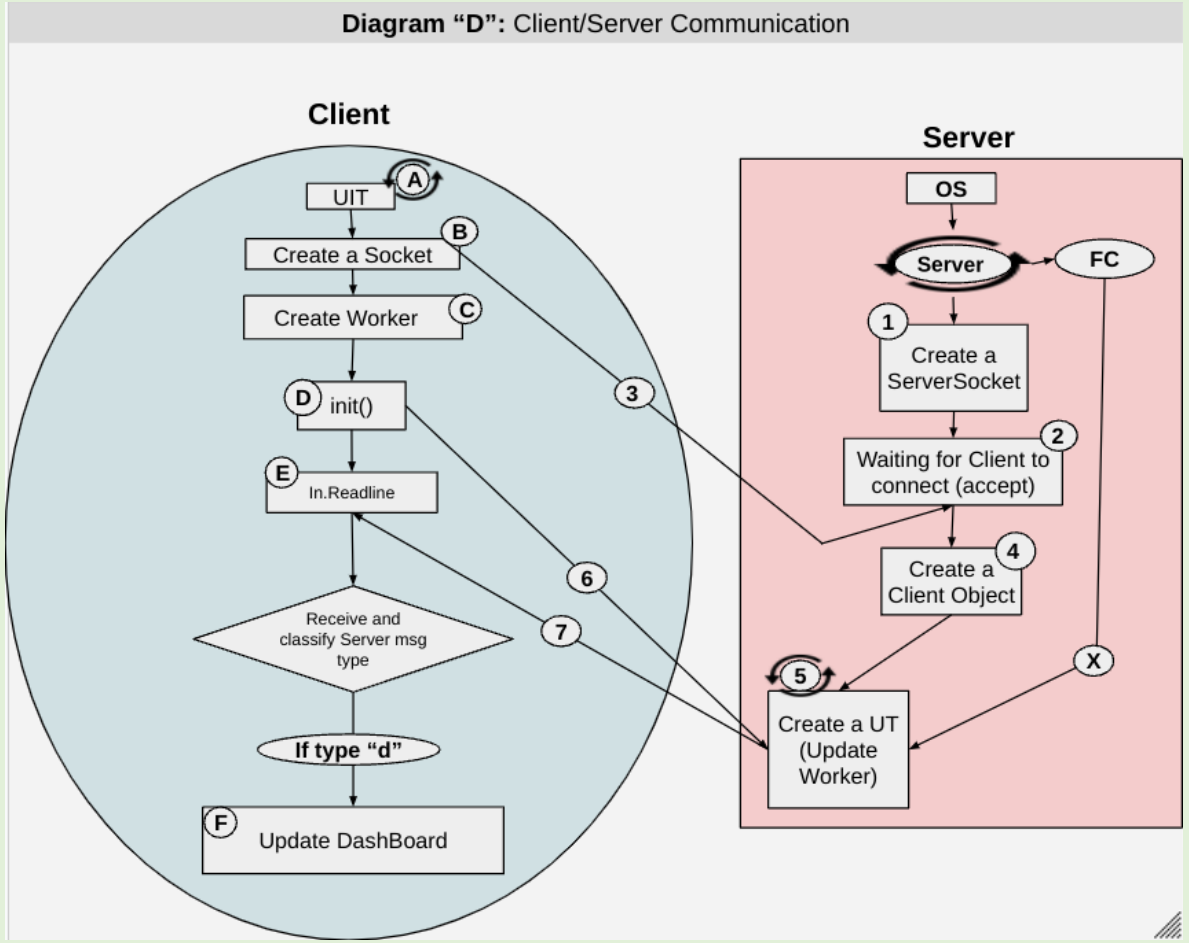
E: waiting for msg from Server (in)

F: Update Control Panel (values in sliders)



"D" messages: Update Control Panel

Client's DashBoard sends update request to Server's Client Worker
(constantly pushing values displayed on DashBoard, population, weather, etc.)



"D" messages (Update Field UI): Server side

Tool Tips:

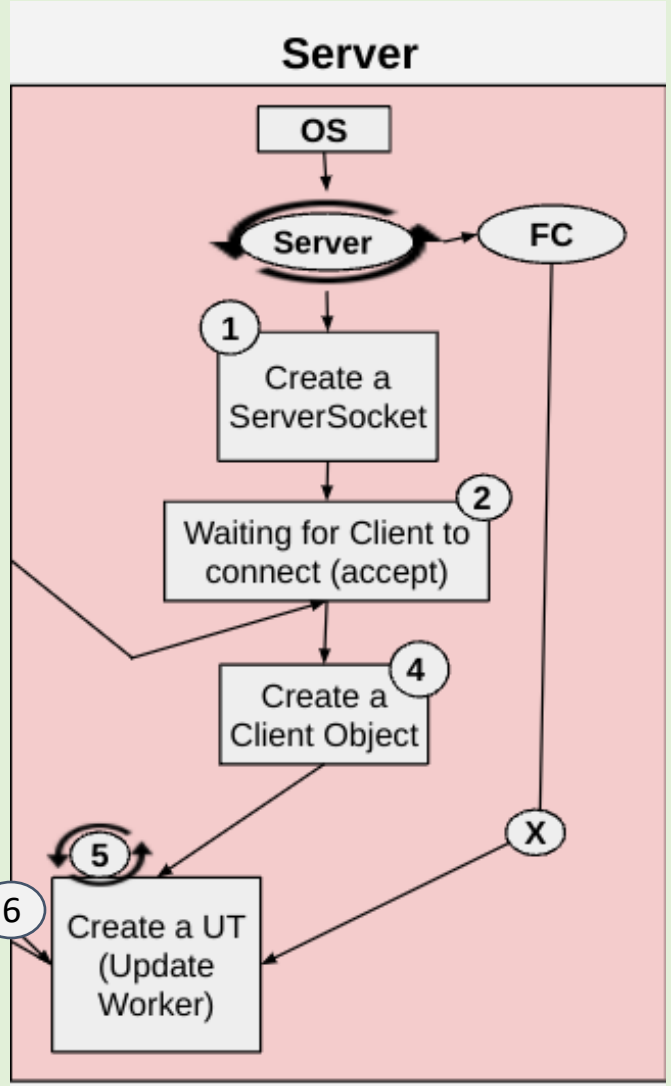
2. Call accept of ServerSocket (block Server control)

4. Create a Client Thread

5. Client Thread waits for Client to send Dashboard request

6. Client Thread sends Dashboard values from FoodChain to Client

X. Retrieves values requested by Client from FoodChain



"D" messages (Update Field UI): Client side

Tool Tips:

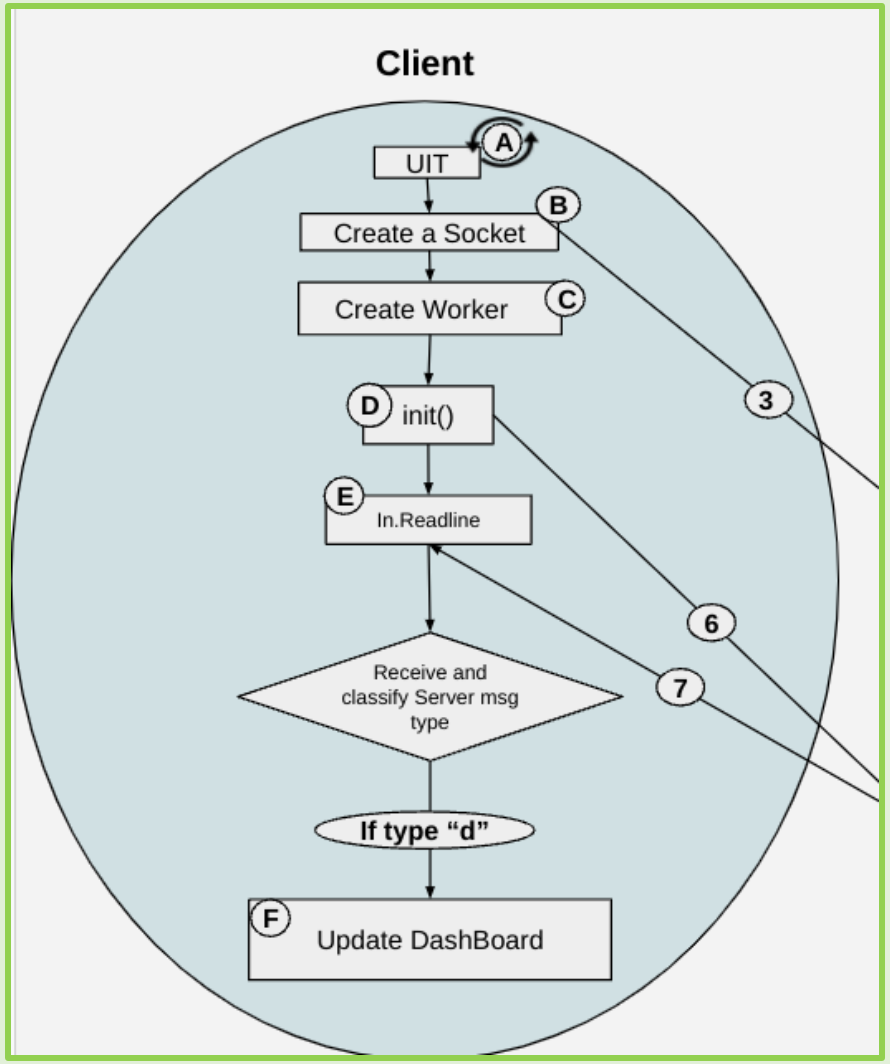
A: create a UI Thread

B: create a Socket (unblocks Server that was waiting for Client response)

C: create a Worker Thread for Client

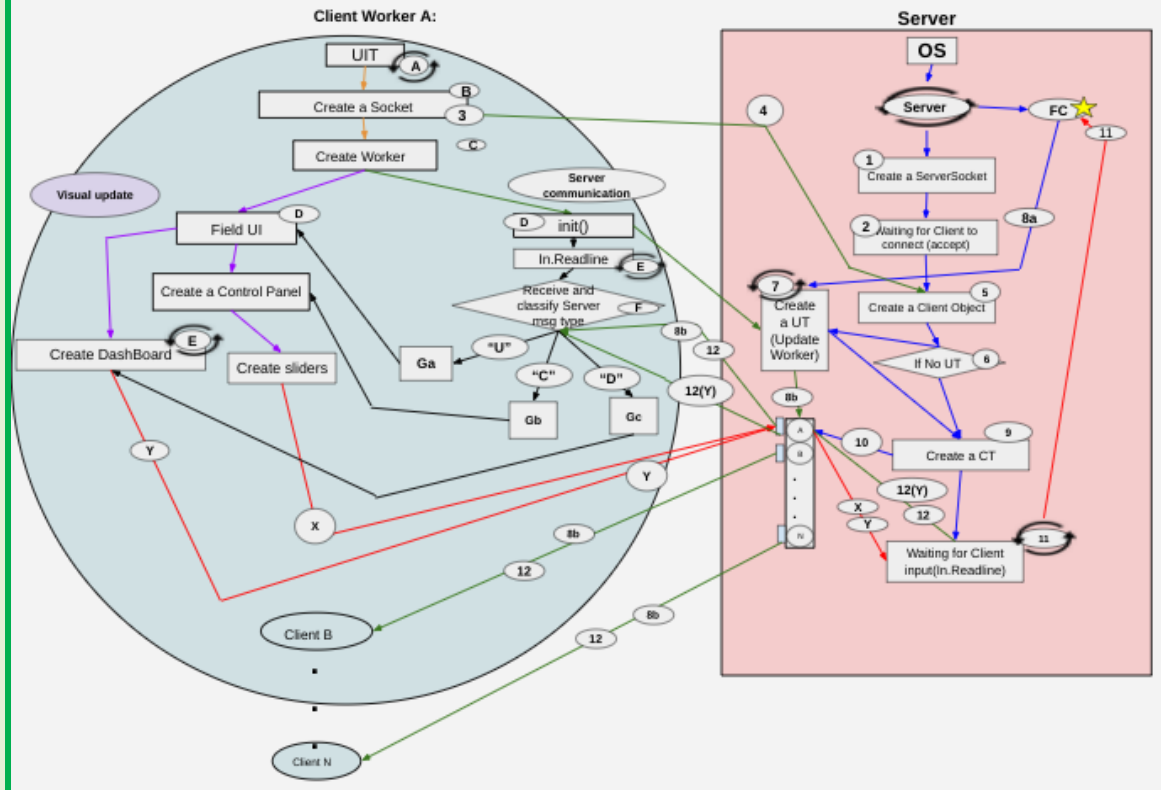
E: waiting for msg from Server (in)

F: Update Dashboard (values in labels)



The Whole Picture: Client/Server System

Diagram #1: Client/Server System



Key:

- : socket
- : thread (runnable)
- : see Diagram #2
- : communication between Client/Server
- : User action procedure
- : Client procedure
- : Client (Visual update) procedure
- : Client (Visual update) procedure

Tool Tips:

2. Call accept of ServerSocket
4. Send a connection request to unblock waiting server caused by accept()
6. Add the ClientThread or CT (socket/address) to list
7. Client's Worker receives changed fields and updates
 *Update thread continuously broadcast LifeList to Client's Worker
8a. Update Worker updates using FoodChain class's Life List (thread list) using getLifeList
8b. Constantly broadcast to all CT in Client List
11. CT waits for input from Client
11. Server uses apply() to change fields to match Client fields
12. Call broadcast() method to all Client Workers
*Y. CT only out.println to its own client/socket

A: create a UI Thread
C: create a Worker Thread for Client

Visual update

E: create DashBoard as Runnable, then a thread that sends update requests to Server when opened

Server communication

D: call init() method to send (out) key from Client that need initial slider values
E: waiting for msg from Server (in)
Ga, Gb,Gc: call update()/setFields() to set Server values to Client values for Field UI/Control Panel sliders/Dashboard

Ha: update field values to Field
Hb: repaint Control Panel
X: User action adjusting slider value detected by slider's ChangeListener, sent as msg with toJson() to Server's CT through socket

Java Application

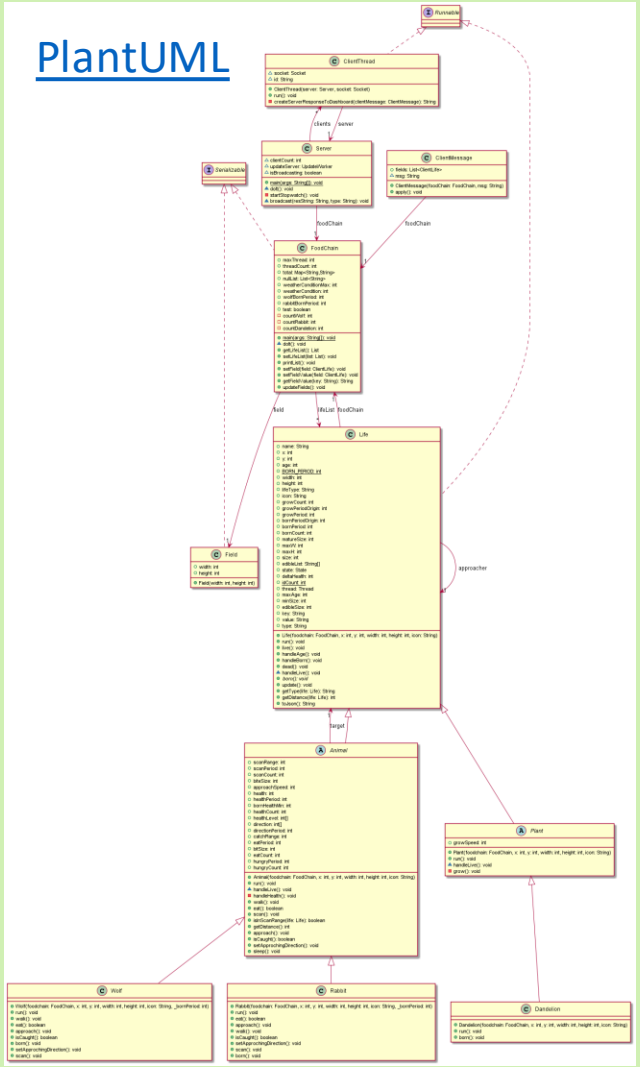
OOP Programming

- Inheritance
- Encapsulation
- Polymorphism

Inheritance

The system of superclasses and subclasses in which subclasses can inherit superclasses' accessible fields and methods

PlantUML



WHY?

- less code needed; parent class code can be reused

in child class

- reduce redundancy

*cleaner code

- Overriding: methods with identical "signatures"

in superclass and its subclass, but

polymorphism narrows it down to lowest subclass

Inheritance examples

```
public abstract class Life implements  Runnable{
                                ...
    public void dead() {
        List <Life> lifeList = foodChain.getLifeList();

        for (int i=0; i<lifeList.size(); i++) {
            Life life = lifeList.get(i);
            if (life==null) {
                continue;
            }
            if (life.state==State.DEAD) {
                lifeList.set(i, null);
                break;
            }
        }

        if (foodChain.test) {
            System.err.println(this.name+" dead.
        }
    }
```

```
public abstract class Animal extends Life {
                                ...
  void handleLive() {

      switch (state) {
          case NORMAL:
              walk();


              break;
          case SLEEP:
              sleep();
              break;
          case SCANNING:
              scan();
              break;
          case APPROACHING:
              approach();
              break;
          case EATING:
              eat();
              break;
          case DEAD:
              dead();
              break;
          case BORN:
              born();
              break;
          default:
              break;

      }
      handleHealth();
  }
```

Life superclass of Animal class

Animal class can reuse Life class's method dead()

Encapsulation

the process of wrapping or hiding data from other classes

WHY?

- maintenance of the code becomes easier and cleaner

*easy to change

- Setting fields and methods private is also important in efficiency.

*prevents other classes to access

Foodchain's List lifeList is encapsulated with the private access modifier

```
public class FoodChain implements Serializable{
    private List <Life> lifeList = new ArrayList <Life>();
                                    ...
  public void setField(ClientLife field) {
      if (field.value==null) {
          return;
      }

      if (field.key.equals("weatherCondition")) {
          weatherCondition = Integer.parseInt(field.value);
          //System.err.println("weatherCondition="+weatherCondition);

      } else if (field.key.equals("wolfBornPeriod")) {
          int newPeriod = Integer.parseInt(field.value);
          for (int i=0; i<lifeList.size();i++) {
              Life life = lifeList.get(i);
              if (life==null || !(life instanceof Wolf)) {
                  continue;
              }
              //int oldPeriod = life.bornPeriod;
              life.bornPeriod = newPeriod;
              //if (newPeriod<oldPeriod) {
                  life.bornCount = 0;//Math.min(life.bornCount, life.bornPeriod);
              //} else {
              //  life.bornCount = Math.max(life.bornCount, life.bornPeriod);
              //}
          }
          wolfBornPeriod = newPeriod;

      } else if (field.key.equals("rabbitBornPeriod")) {
```

Going through different (keys): able to use lifeList's values

```
public class ClientMessage {
                                    ...

    public void apply() {

        for (int i=0; i<fields.size(); i++) {
            ClientLife field = fields.get(i);
            foodChain.setField(field);

        }
    }
```

ClientThread class's apply() method does not know what happens in setField() or lifeList as they are encapsulated

Polymorphism

: an action with multiple forms

WHY?

- One variable name can be used to store variables of many data types
- Overloading: methods with different "signatures" (name, parameters, return type) in terms of parameters (different number, type, or both)

Ex. : void A(int i) vs void A() vs void A(int i, int ii)

-Overriding

Life.java

```java
public abstract class Life implements  Runnable{
    public Life(FoodChain foodchain, int x, int y, int width, int height, String icon) {

                                                    ...

    public void live() {
        while (state!=State.DEAD) {
            try{Thread.sleep(100);}catch(InterruptedException e){System.out.println(e);}
            handleAge();
            handleLive();
            handleBorn();
        }
```

Plant.java

```java
public abstract class Plant extends Life {


    public Plant(FoodChain foodchain, int x, int y, int width, int height, String icon) {

                                                    ...

    void handleLive() {
        switch (state) {
        case GROW:
            grow();
            break;
        case DEAD:
            dead();
            break;
        case BORN:
            born();
            break;
        default:
            break;

    }
    }
```

Animal.java

```java
public abstract class Animal extends Life {

    public Animal(FoodChain foodchain, int x, int y, int width, int height, String icon) {

                                                    ...

    void handleLive() {

        switch (state) {
            case NORMAL:
                walk();


                break;
            case SLEEP:
                sleep();
                break;
            case SCANNING:
                scan();
                break;
            case APPROACHING:
                approach();
                break;
            case EATING:
                eat();
                break;
            case DEAD:
                dead();
                break;
            case BORN:
                born();
                break;
            default:
                break;

        }
        handleHealth();
    }
```

Abstraction

: reducing an object to its fundamentals in order to hide its attributes, methods, or communication

WHY?

- - To avoid implementation of methods for classes that we don’t want an instance of
- Useful when wanting to force concrete classes to do individual implementation instead of using parent implementation
- Classes that are set abstract do not have to override/implement abstract methods from its parent class

Life (Animal, Plant as well) set to abstract to never be instantiated, so born() is set abstract

```
public abstract class Life implements  Runnable{
                                        ...
public abstract void born();
```

Does not need to implement born() from parent class because of abstraction

```
public abstract class Animal extends Life {
```

Animal extends Life

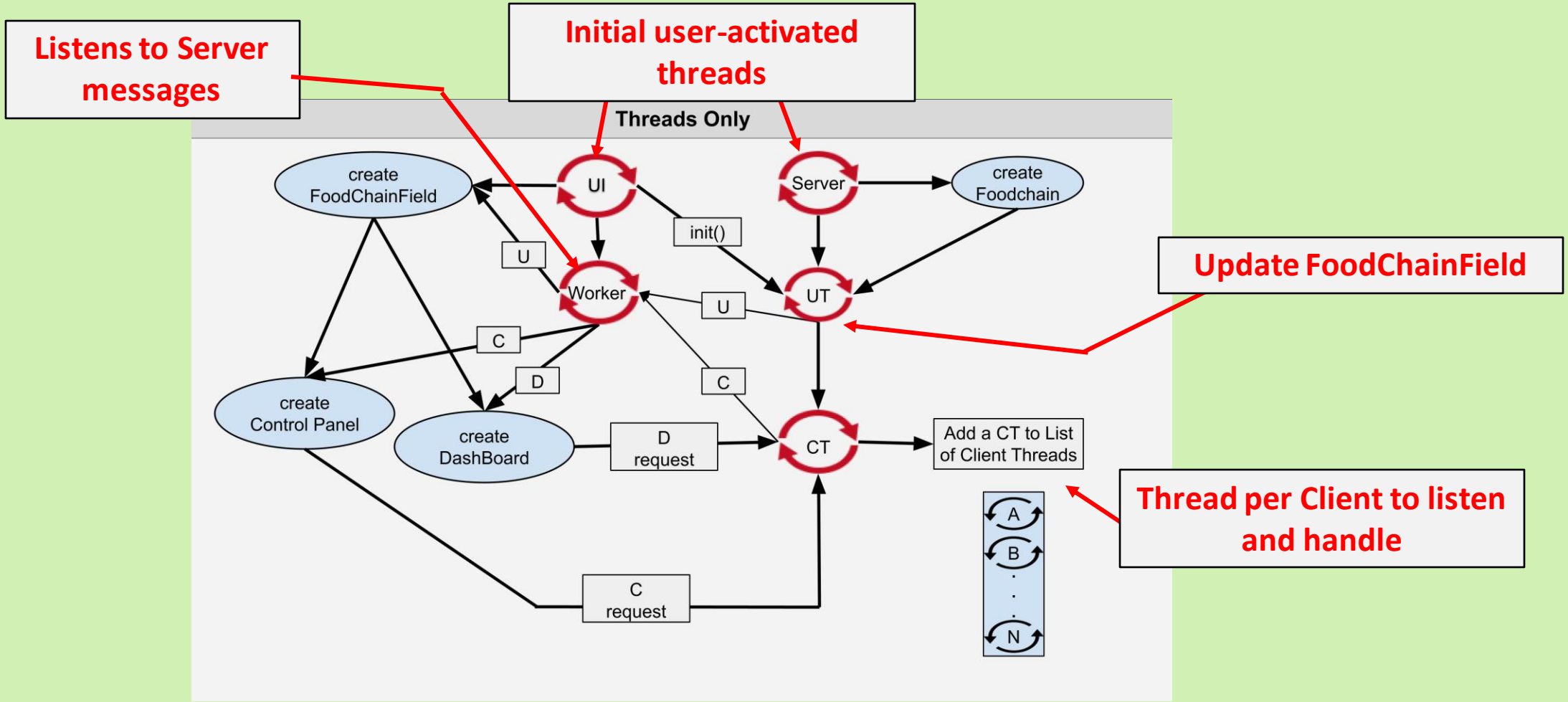
Since Wolf class is concrete, the class must implement abstract born() from its parent class

```
public class Wolf extends Animal{
                                        ...
    public void born(){
        Life life = new Wolf(this.foodChain, this.x+1, this.y+1, maxW/2, maxH/2, icon, bornPeriod);
        foodChain.addLife(life);
        life.thread = new Thread(life);
        life.thread.start();
        foodChain.threadCount++;
        state = State.NORMAL;
        if (foodChain.test) {
            System.err.println("born "+life.name+" from "+this.name);
        }
    }
```

Wolf extends Animal

Multi-Thread

: concurrent actions (threads) executed by CPU; required for management in multi-socket Client systems (5 in this example)



Problem: Race Condition

: more than 1 thread race to perform the same action and end up overlapping/error

ex: CT and UT use same socket (PrintWriter out method) to communicate with client

Synchronized: Only one thread can use method at a time, so broadcasting wouldn't overlap

Solution: Mutual exclusive, or not allowing two events happen at once

```
synchronized void broadcast(String resString, String type) {
    try {
        for (int i=0; i<clients.size(); i++) {
            ClientThread client = clients.get(i);

            PrintWriter out = new PrintWriter(client.socket.getOutputStream(), true);
            out.println(resString);
            //if (type=="c") {
            //  System.err.println("Broadcasting to "+client.id+": "+resString);
            //}

        }

    } catch (Exception e) {
        System.out.println("Initializing error. Try changing port number!" + e);
    }
}
```

Appendix

- Ticks (Slide 4): an iteration through the class, Life's live() method