UNIVERSITY *of* TASMANIA

KIT101 Programming Fundamentals

Object-oriented Program Design

Week 8

- class and object ●
- method ●
- control structure
- statement

Creating Your Own Classes

11 Creating Your Own Data Types
12 More Object Orientation
13 Functional Decomposition
14 Object-oriented Program Design

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Tasks starting this week

8.1PP Programming Principles

- In about 2 pages of text, code snippets and images (if you want) explain some key programming and Java-related terms in your own words
- Do not be frightened. You need to write so we can understand you, not so you'll win prizes

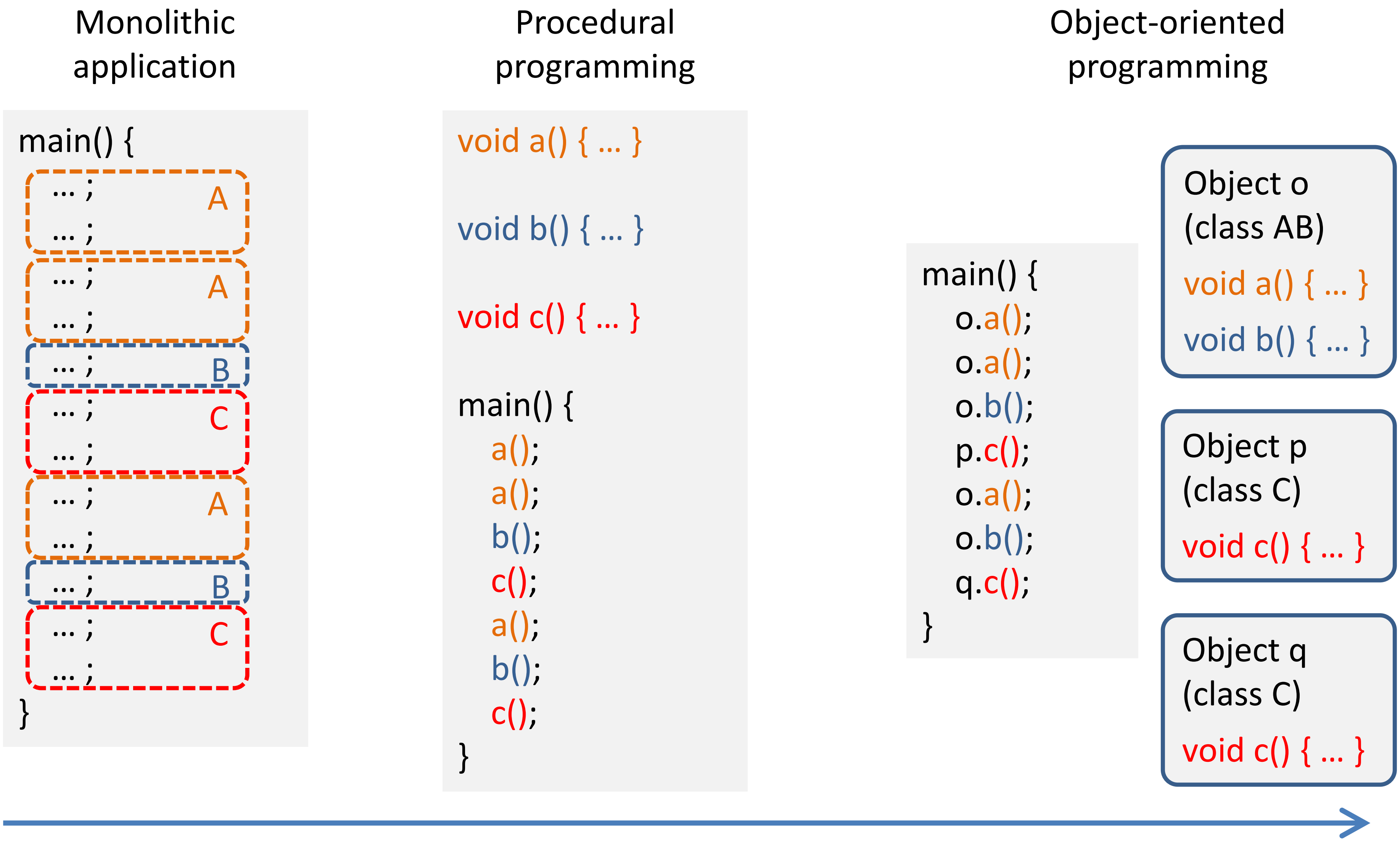
8.2CR Debug This

- Given some code containing errors and clues left by its mysterious author, identify and fix the errors, documenting what you did, what clues you followed, and what you changed

8.3DN Object-Oriented Collection Manager

- Transform your 7.1PP program (and 6.2CR class definition) to be more object-oriented (which is the topic of today's lecture)

From last lecture: Software is complex



Monolithic application

```
main() {
  … ;        A
  … ;
  … ;        A
  … ;
  … ;        B
  … ;        C
  … ;
  … ;        A
  … ;
  … ;        B
  … ;        C
  … ;
}
```

Procedural programming

```
void a() { … }

void b() { … }

void c() { … }

main() {
   a();
   a();
   b();
   c();
   a();
   b();
   c();
}
```

Object-oriented programming

```
main() {
   o.a();
   o.a();
   o.b();
   p.c();
   o.a();
   o.b();
   q.c();
}
```

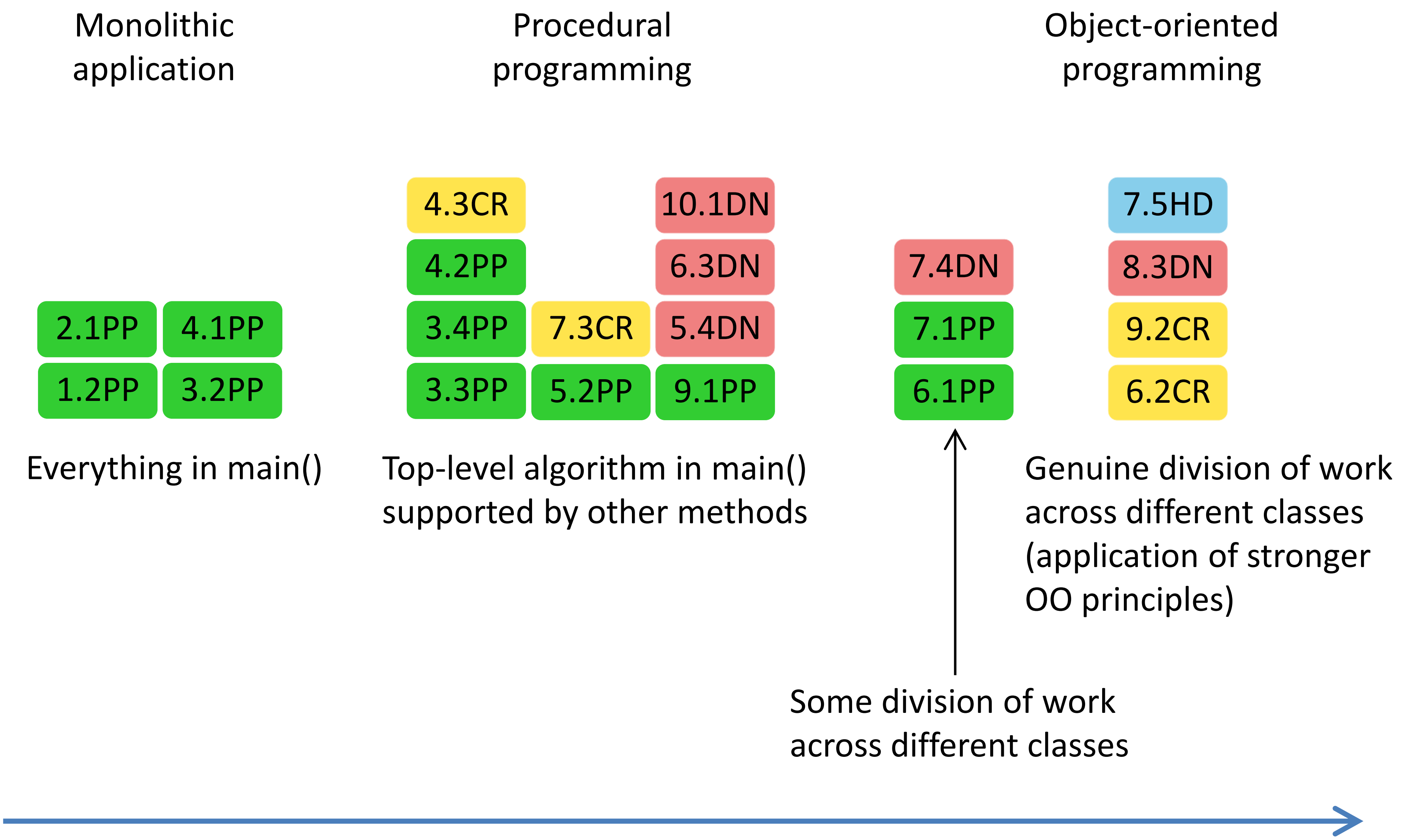
```
Object o
(class AB)
void a() { … }
void b() { … }
```

```
Object p
(class C)
void c() { … }
```

```
Object q
(class C)
void c() { … }
```

*Increasing **separation of concern**. Different parts of the software take greater responsibility for solving smaller parts of the overall problem.*

Programming tasks in this unit



Monolithic application

2.1PP 4.1PP

1.2PP 3.2PP

Everything in main()

Procedural programming

4.3CR 10.1DN

4.2PP 6.3DN

3.4PP 7.3CR 5.4DN

3.3PP 5.2PP 9.1PP

Top-level algorithm in main() supported by other methods

Object-oriented programming

7.5HD

7.4DN 8.3DN

7.1PP 9.2CR

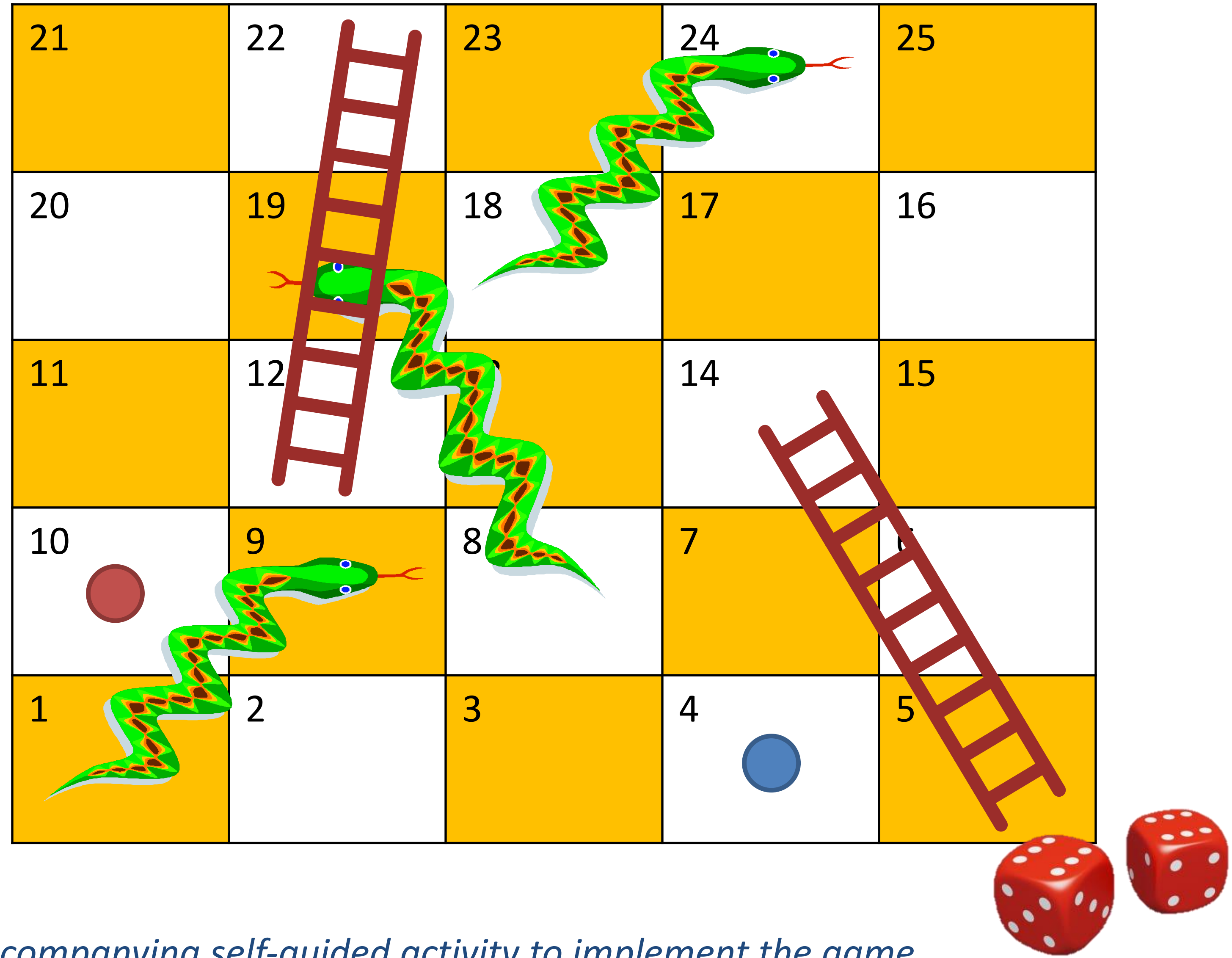
6.1PP 6.2CR

Some division of work across different classes

Genuine division of work across different classes (application of stronger OO principles)

*Increasing **separation of concern**. Different parts of the software take greater responsibility for solving smaller parts of the overall problem.*

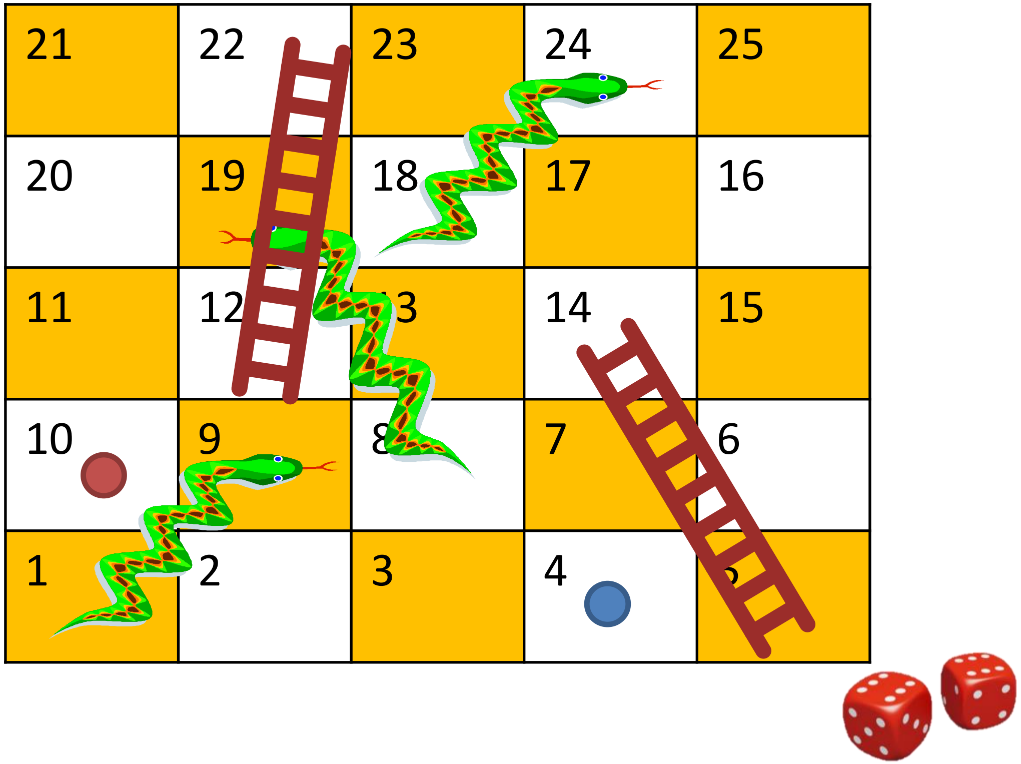
Motivating example: Snakes & Ladders



There is an accompanying self-guided activity to implement the game

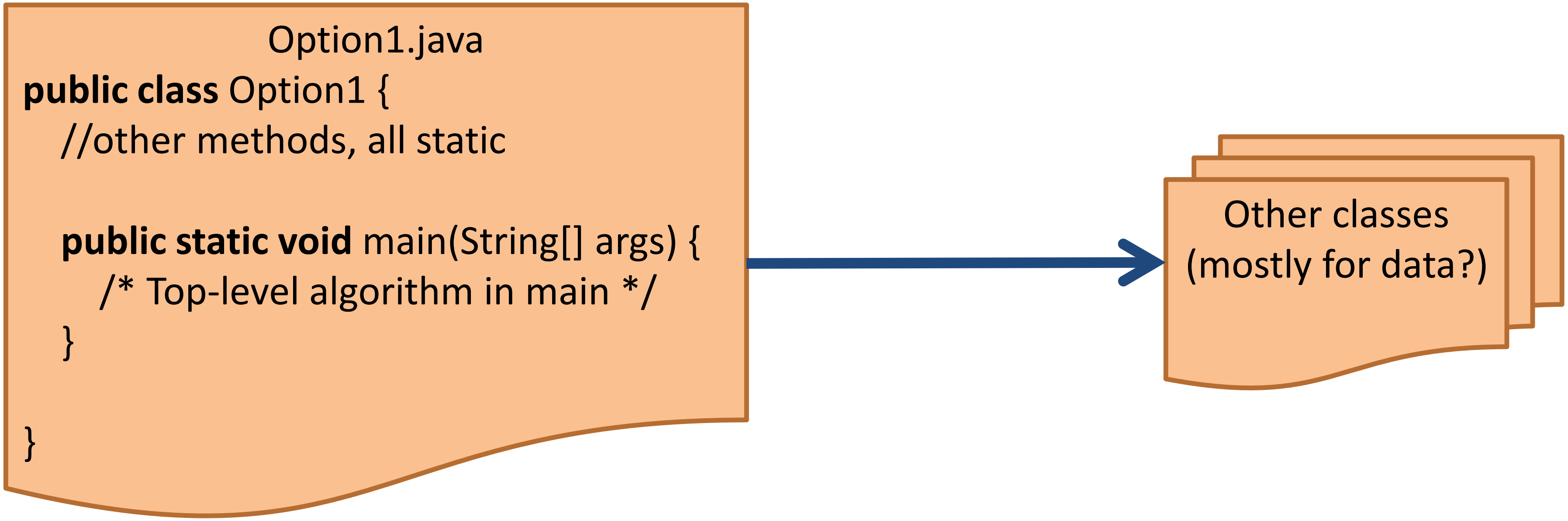
What kind of objects in the game?

Task: What kinds of objects could we model in this game? What kind of attributes and abilities might they have?



Single source → interacting objects

Use other objects, but keep the top-level algorithm in main()
and other static methods of that class



Option1.java

```
public class Option1 {
    //other methods, all static

    public static void main(String[] args) {
        /* Top-level algorithm in main */
    }

}
```

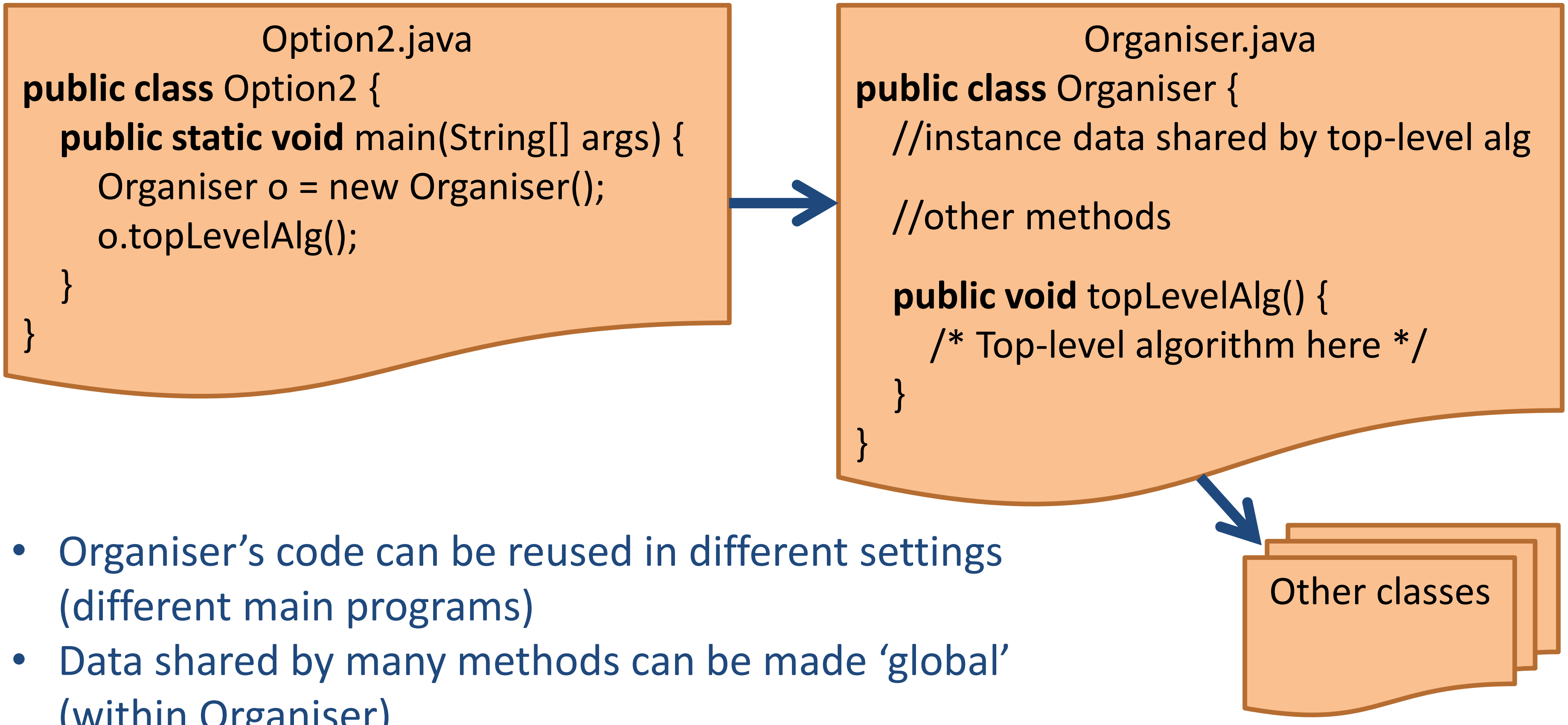
Other classes
(mostly for data?)

Keeps top-level algorithm in one place, but can become complex to manage, especially as the complexity of the data model grows

Overall is less object-oriented

Single source → interacting objects

Using an 'organiser' class



Option2.java

```
public class Option2 {
   public static void main(String[] args) {
      Organiser o = new Organiser();
      o.topLevelAlg();
   }
}
```

Organiser.java

```
public class Organiser {
   //instance data shared by top-level alg

   //other methods

   public void topLevelAlg() {
      /* Top-level algorithm here */
   }
}
```

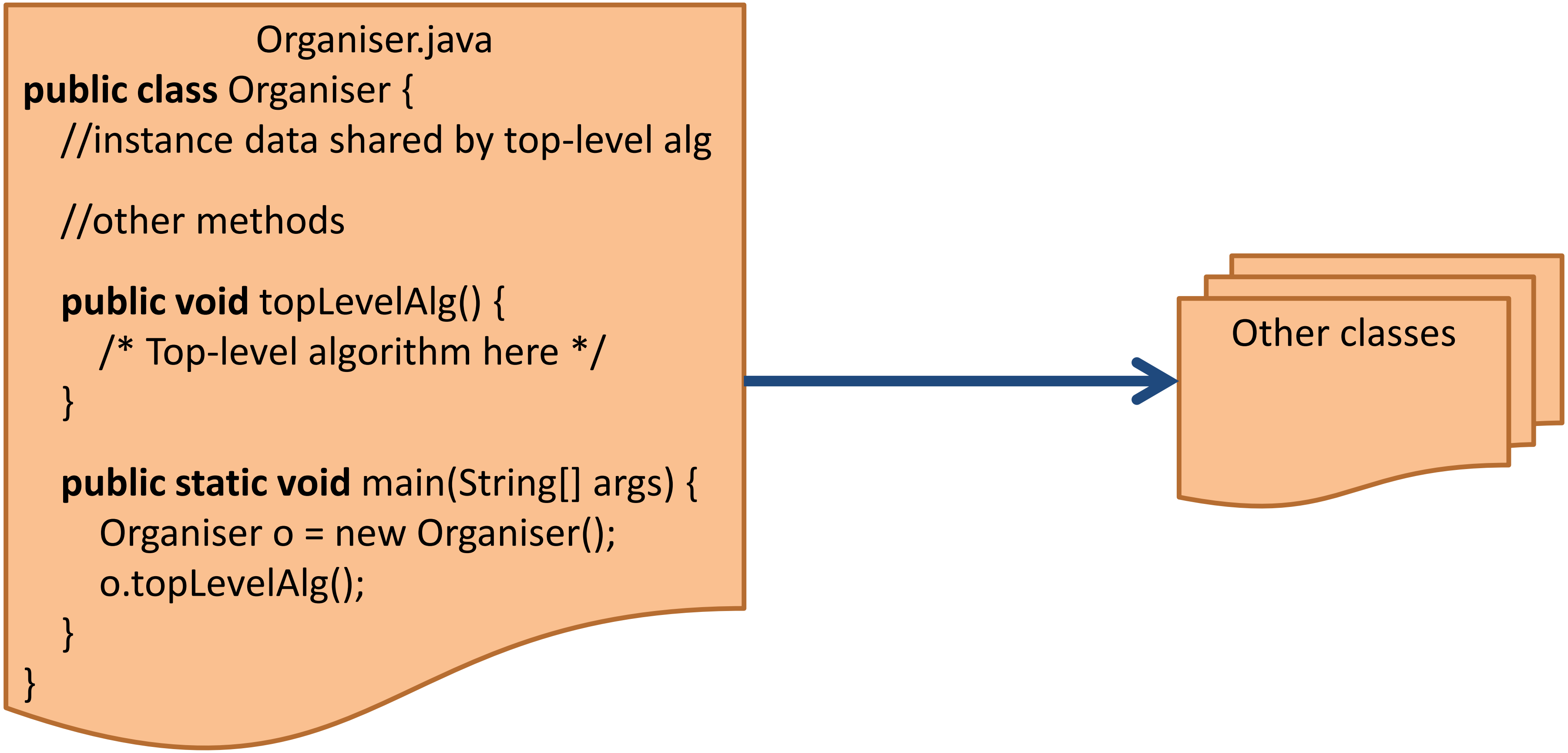
Other classes

- Organiser's code can be reused in different settings (different main programs)
- Data shared by many methods can be made 'global' (within Organiser)
- Facilitates change from console to graphical application
- But one more file and may seem like overkill for simple programs

See Task 8.3DN Object-oriented Collection Manager

Single source → interacting objects

Using an ‘organiser’ class with in-built main()



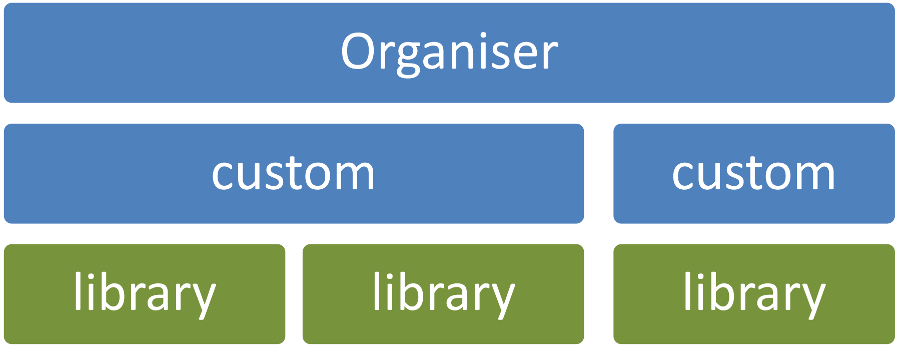
Organiser.java

```
public class Organiser {
    //instance data shared by top-level alg

    //other methods

    public void topLevelAlg() {
        /* Top-level algorithm here */
    }

    public static void main(String[] args) {
        Organiser o = new Organiser();
        o.topLevelAlg();
    }
}
```

Other classes

Option 3 is if you really hate additional files; done if you’ve decided exactly how your program is going to be used, since a little less flexible

‘Library’ versus ‘Organiser’ classes



Library class

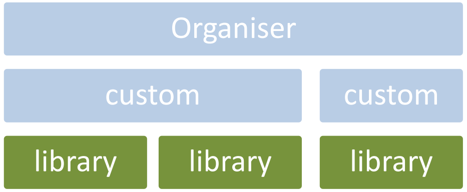
- the low-level ‘components’ of your software
- general purpose (or common enough to allow reuse)

Organiser class

- defines the top-level algorithm
- problem-specific
- may use other problem-specific (custom) classes and library classes

(This is a *useful* distinction; these are not labels you will need to memorise)

Suitable modules for ‘library’ classes



Organiser

custom custom

library library library

Constructor

One method for **each 'action'** the object can perform

- plus any necessary methods to do the separate parts of the action

Setters for instance variables

- if needed/appropriate

Getters for instance variables

- if needed

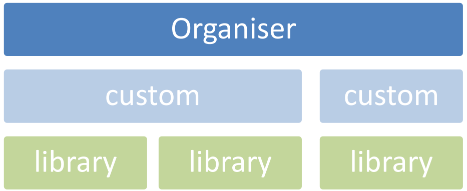
A **trace()** method

```
private void trace(String message) {
    System.out.println(message);
}
```

Not *required* by Java, but useful to have

- for use during development

Suitable modules for ‘organiser’ classes



Constructor

- if necessary to do any set up

One method for **each sub-problem**

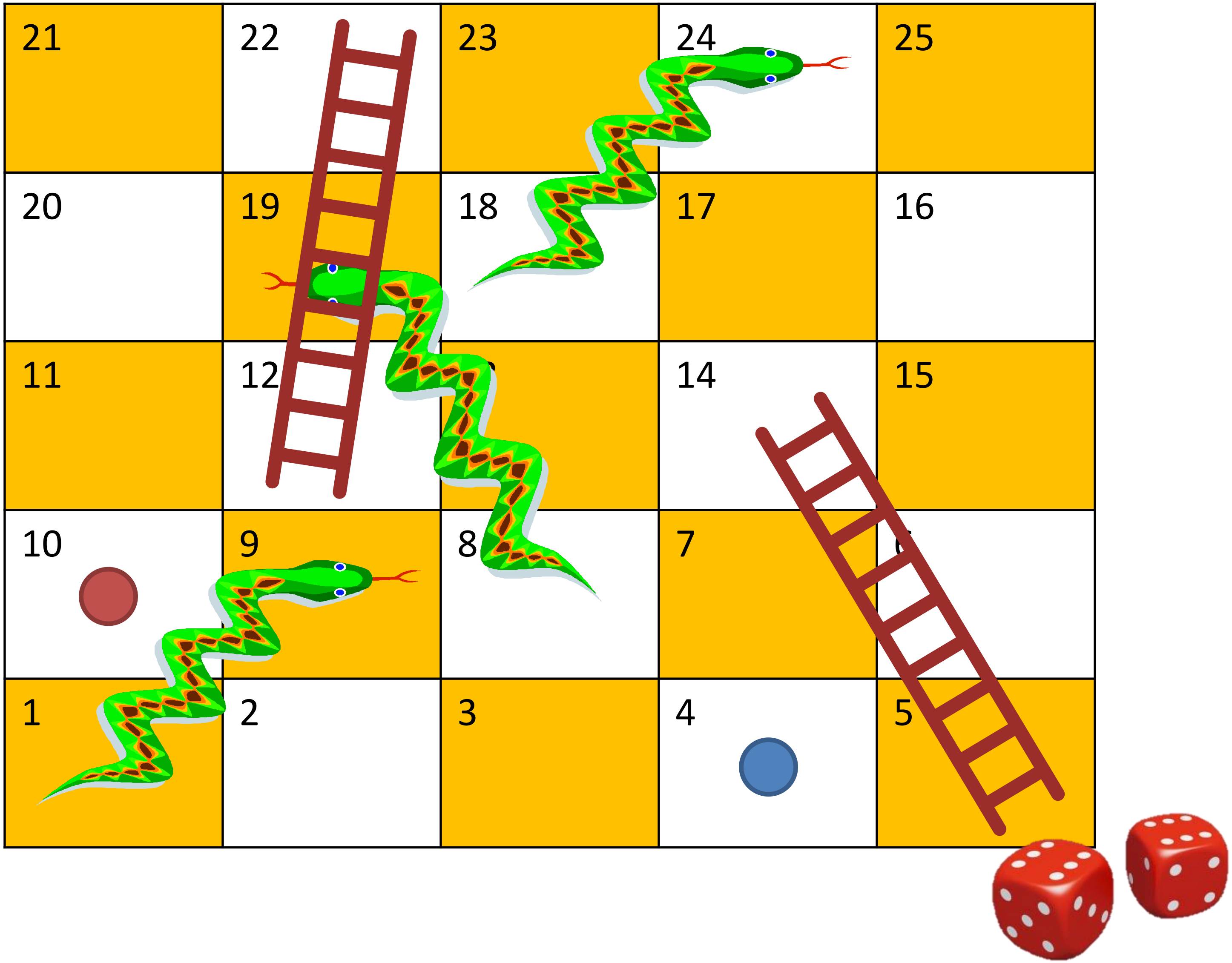
- Often these relate to:
  - Input
  - Processing
  - Output

Any methods needed for **separate parts** of each sub-problem

A **trace()** method

- for use during development

Returning to Snakes & Ladders



What subtasks in Snakes & Ladders?

Partial top-level algorithm

- create any other components (objects)
- ask if user wants to play
- while user wants to play
    - play one game
        - set player positions to 0
        - set current player
        - while the game is not over
            - current player moves
            - if game not yet over
                - swap players
        - announce winner
    - see if user wants to play again

Task: Assume we’ve drafted the top-level algorithm as above

Sketch a structure chart of a possible breakdown into different tasks

Note: You can largely ignore parameters and return types; think in terms of responsibilities

An example task breakdown

Top-level algorithm

```
Create **Die** and **Board** objects
Ask if user wants to play
While user wants to play
    Play one game
        Set player positions to 0
        Set current player
        While the game is not over
            Current player moves
            If game not yet over
            Swap players
        Announce winner
See if user wants to play again
```

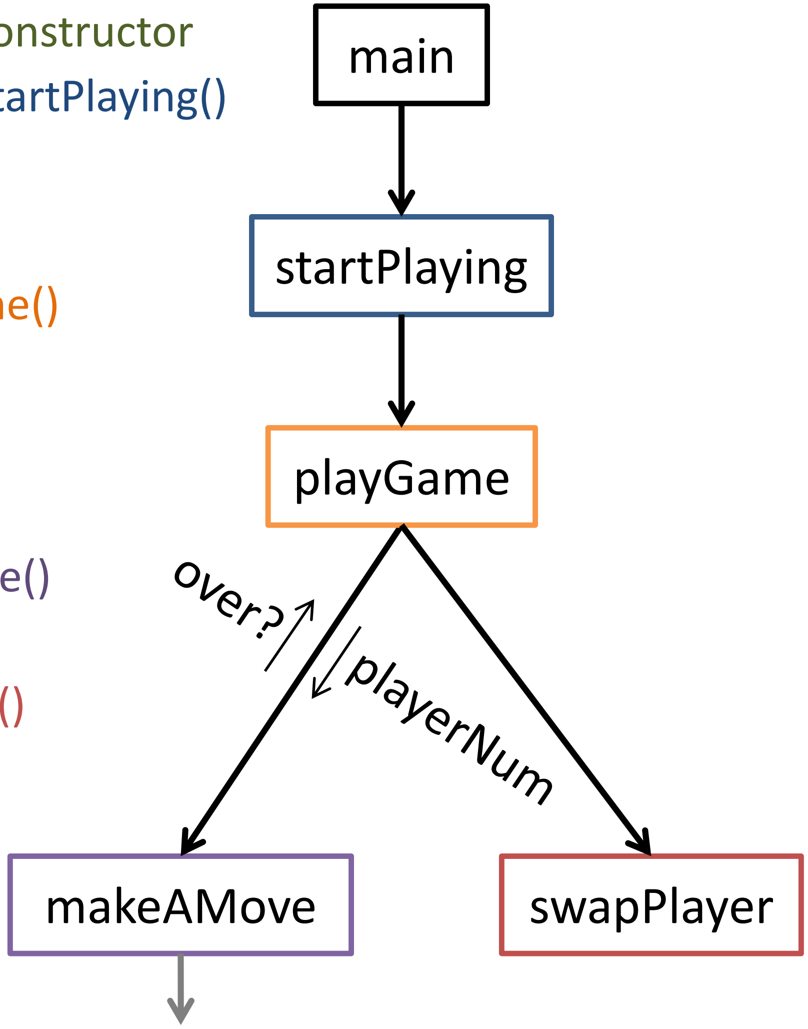
SALGame() constructor

startPlaying()

playGame()

makeAMove()

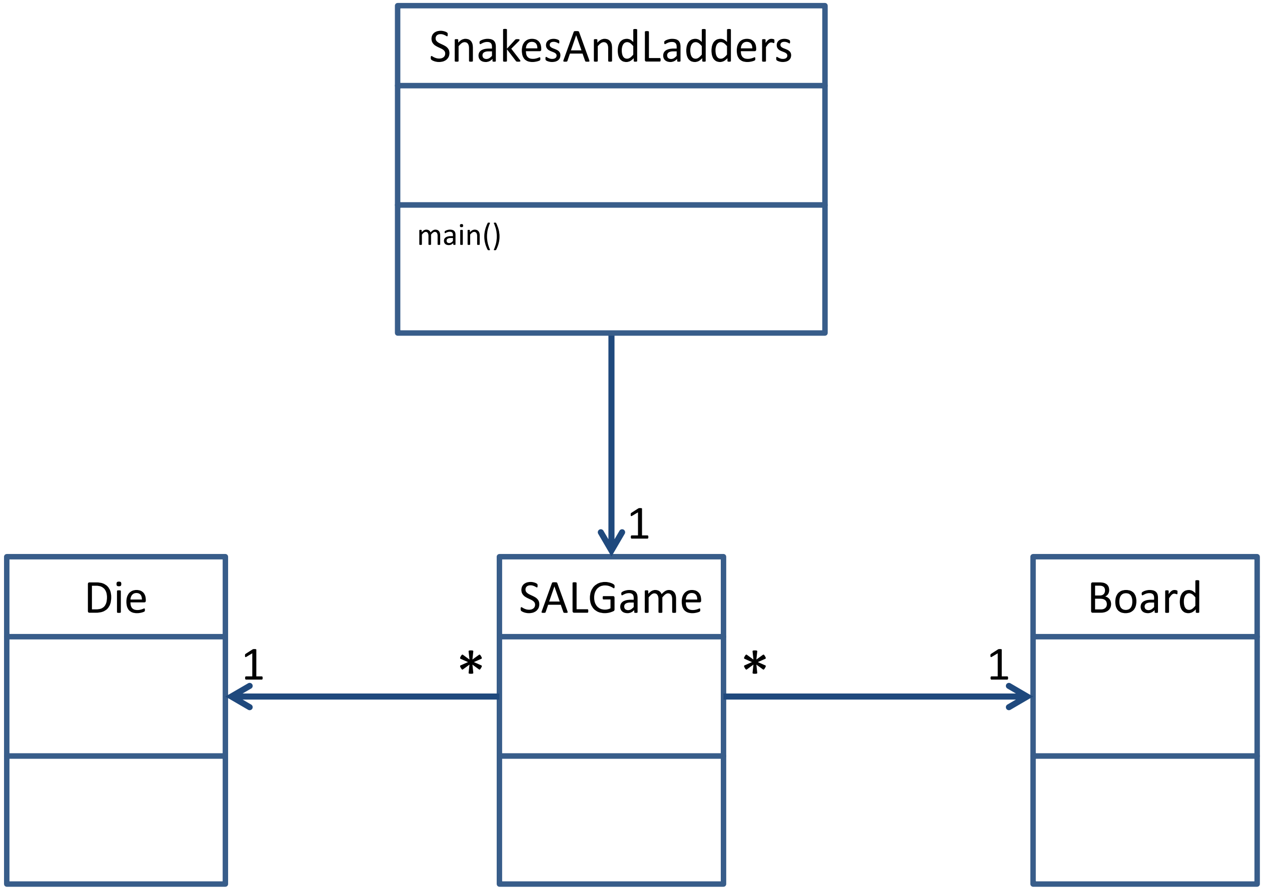
swapPlayer()



Also calls methods of the Board

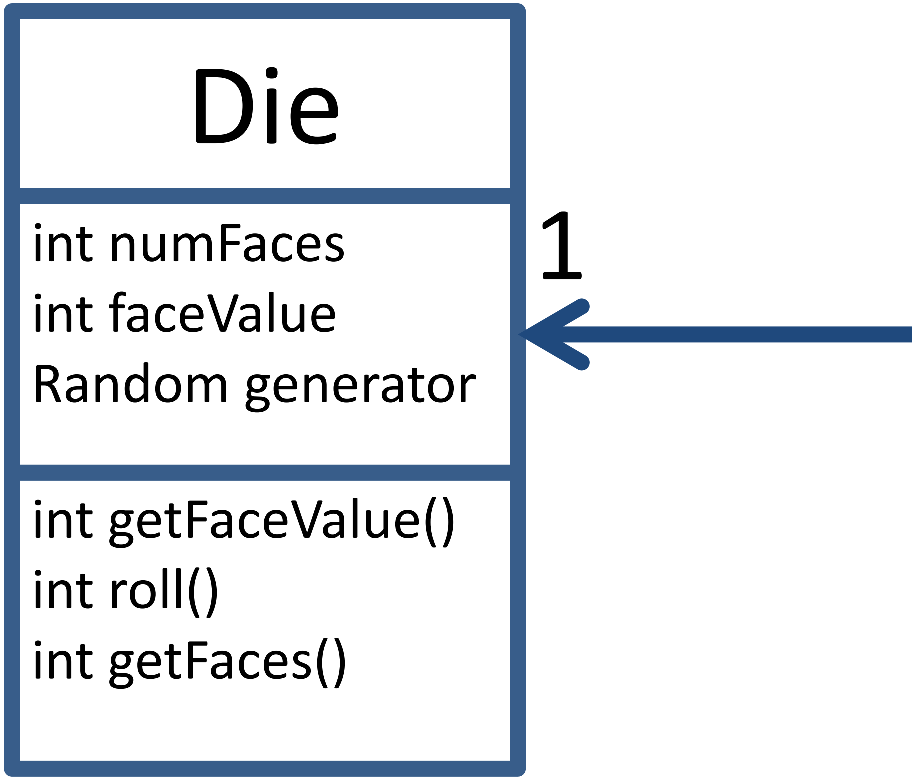
Snakes & Ladders classes

One, relatively simple approach



If you've ever studied databases then this should look familiar

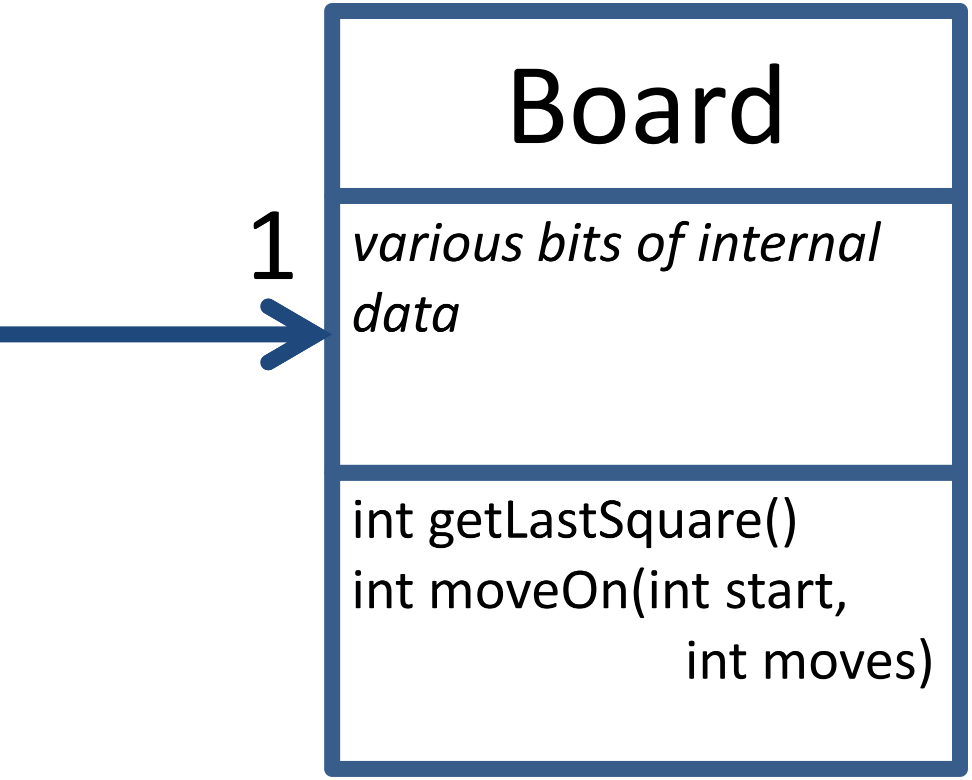
Die is responsible for creating a virtual six-sided game die, holding its state and randomising the upward facing side



Die

int numFaces
int faceValue
Random generator

int getFaceValue()
int roll()
int getFaces()



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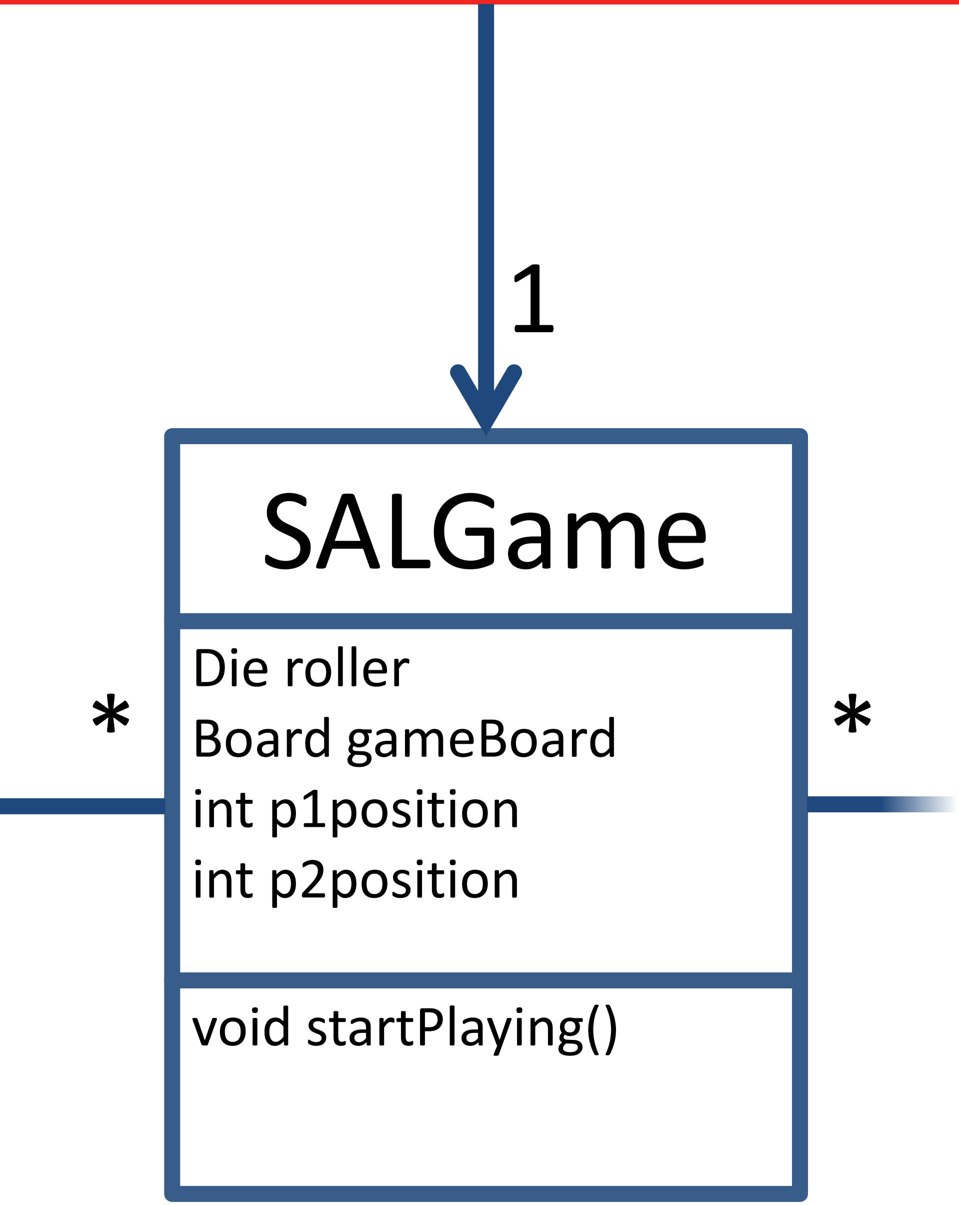
Board

various bits of internal data

int getLastSquare()
int moveOn(int start,
                 int moves)

Board knows how many squares there are, where the snakes and ladders begin and end and can tell you where you’ll end up after a given number of moves starting from a particular square



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SALGame

Die roller

Board gameBoard

int p1position

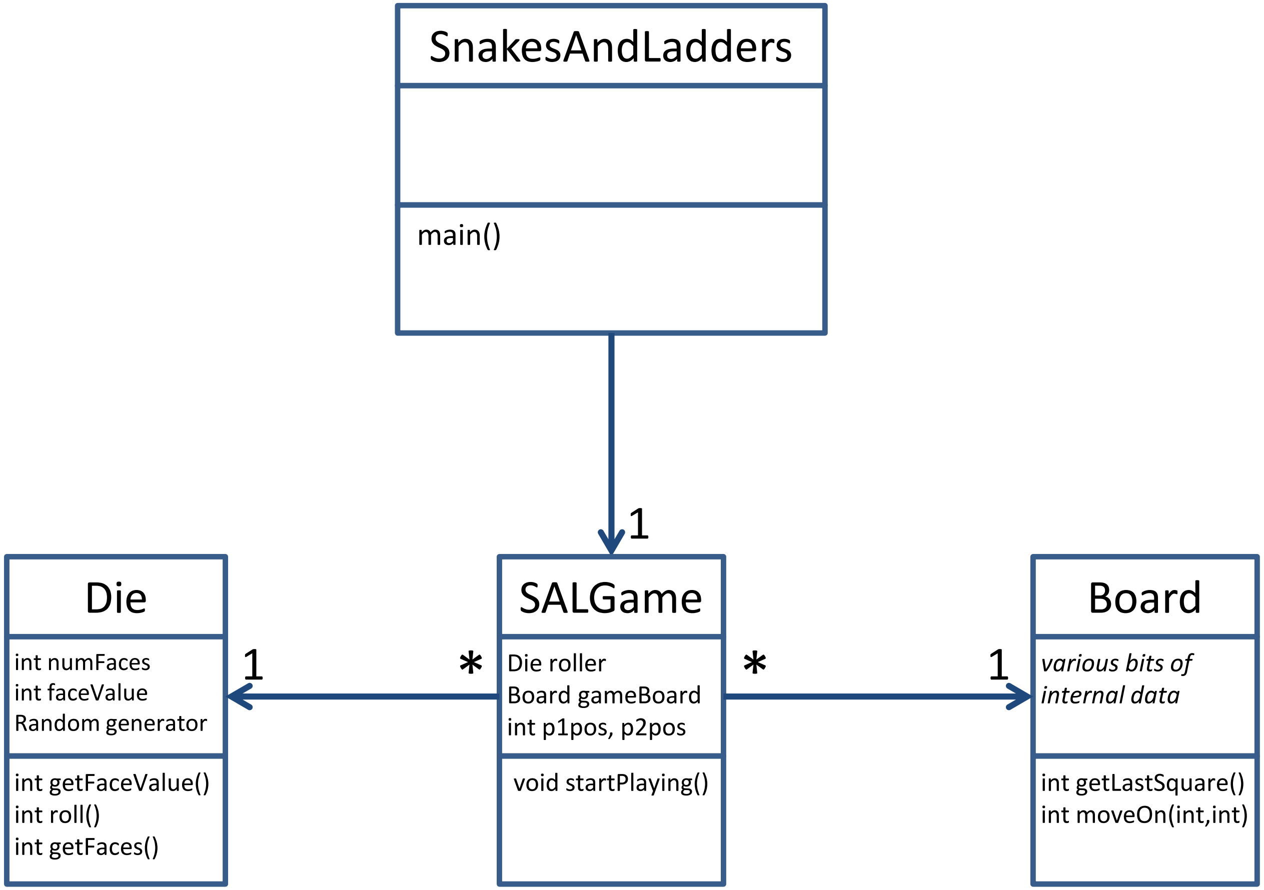
int p2position

void startPlaying()

Top-level algorithm

- create **Die** object
- create **Board** object
- declare **int** variables for player positions
- see if user wants to play
- while user wants to play
  - play one game
  - see if user wants to play again

Snakes & Ladders classes



SnakesAndLadders

main()

SALGame

Die roller
Board gameBoard
int p1pos, p2pos

void startPlaying()

Die

int numFaces
int faceValue
Random generator

int getFaceValue()
int roll()
int getFaces()

Board

various bits of internal data

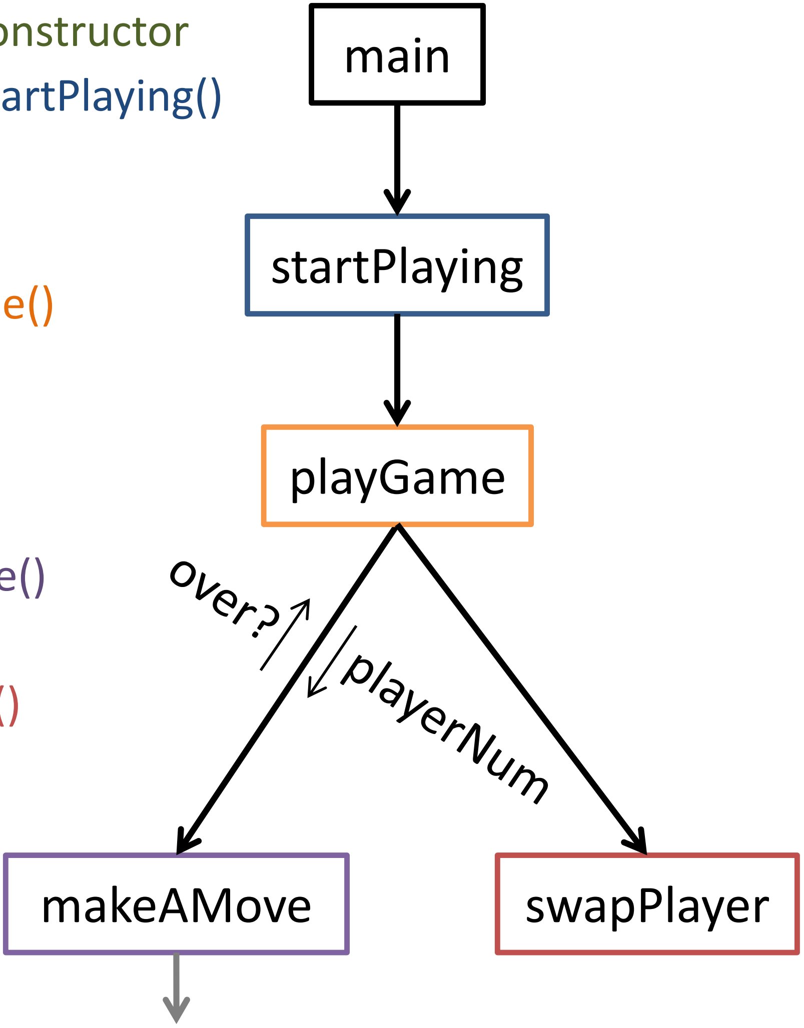
int getLastSquare()
int moveOn(int,int)

Later: download and work through the self-guided development of the Snakes and Ladders game yourself

Let’s implement it

Top-level algorithm

```
Create **Die** and **Board** objects                SALGame() constructor
Ask if user wants to play                           startPlaying()
While user wants to play
    Play one game                                   playGame()
        Set player positions to 0
        Set current player
        While the game is not over
            Current player moves                    makeAMove()
            If game not yet over
                Swap players                        swapPlayer()
        Announce winner
See if user wants to play again
```



Also calls methods of the Board