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Smalltalk Lecture 8

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<https://powcoder.com>

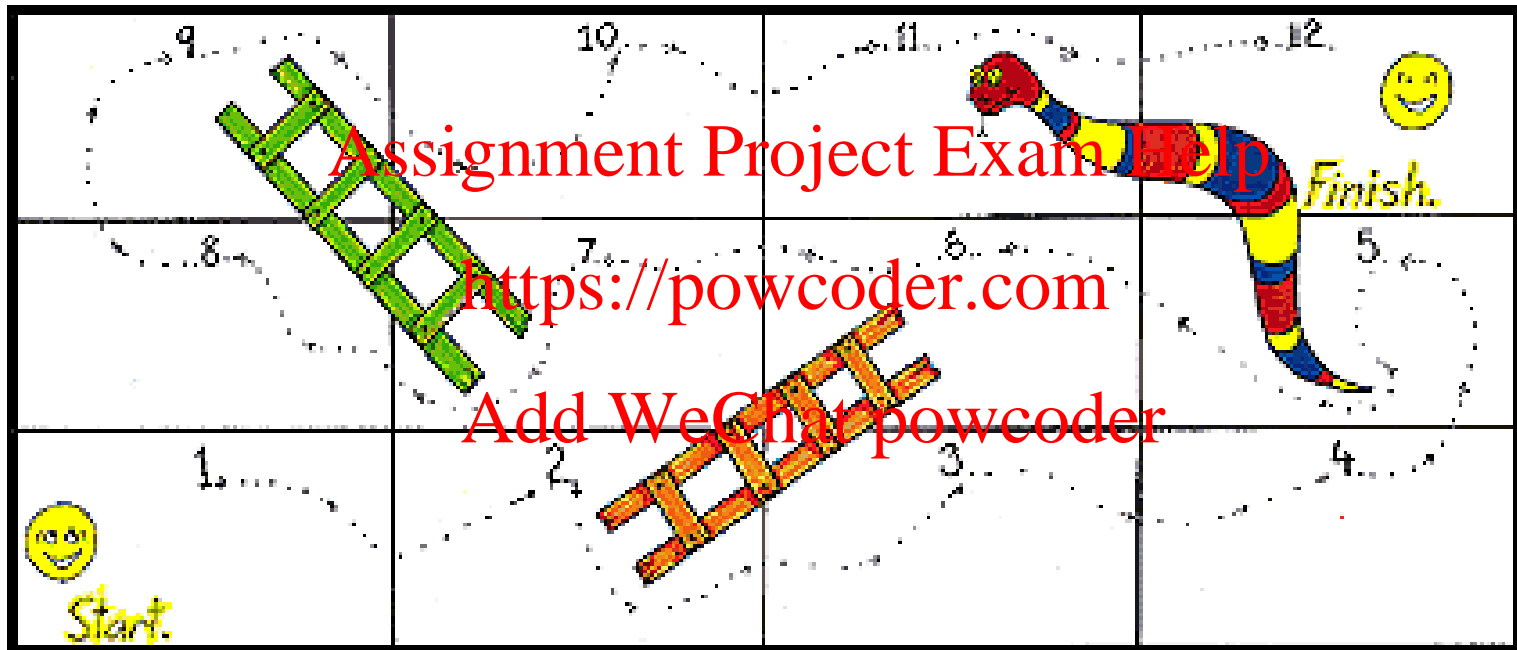
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Snakes and Ladders game

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http://en.wikipedia.org/wiki/Snakes_and_ladders

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Smalltalk example code

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We need a way to:

- Construct the board
- Add some players
- Play the game

The example script helps us to identify some classes and needed methods

```
SnakesAndLadders class>>example
  "self example playToEnd"
  ^ (self new)
    add: FirstSquare new;
    add: (LadderSquare forward: 4);
    add: BoardSquare new;
    add: BoardSquare new;
    add: BoardSquare new;
    add: BoardSquare new;
    add: (LadderSquare forward: 2);
    add: BoardSquare new;
    add: BoardSquare new;
    add: BoardSquare new;
    add: (SnakeSquare back: 6);
    add: BoardSquare new;
    join: (GamePlayer named: 'Jack');
    join: (GamePlayer named: 'Jill');
    yourself
```

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Cascade

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How do you format multiple messages to the same receiver?

<https://powcoder.com>

- > Use a Cascade. Add WeChat powcoder
- > Separate the messages with a semicolon.
- > Put each message on its own line and indent one tab.
- > For readability, usually it's better to only use Cascades for messages with zero or one argument.

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Yourself

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How can you use the value of a Cascade if the last message doesn't return the receiver of the message?

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- > Append the message `yourself` to the Cascade.

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About yourself

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- > The effect of a cascade is to send all messages to the receiver of the first message in the cascade
 - `self new add: FirstSquare new; ...`
- > But the value of the cascade is the value returned by the last message sent

```
(OrderedCollection with: 1) add: 25; add: 35
```

35

- > To get the *receiver* as a result we must send the additional message `yourself`

```
(OrderedCollection with: 1) add: 25; add: 35; yourself
```

```
an OrderedCollection(1 25 35)
```

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Yourself implementation

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- > The implementation of `yourself` is trivial, and occurs just once in the system:

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```
Object>>yourself  
^ self
```

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Inheritance in Smalltalk

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- > Single inheritance

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- > Static for the instance variables

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- Instance variables are collected from the class and its direct and indirect superclasses.

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- > Dynamic for the methods

- Methods are looked up at run-time depending on the dynamic type of the receiver.

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Creating classes

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- > A class is created by sending a message to its superclass

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```
Object subclass: #SnakesAndLadders
    instanceVariableNames:
        players squares turn die over'
```

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Named Instance Variables

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- > Instance variables:
 - Begin with a *lowercase letter*
 - Must be explicitly declared: a list of instance variables
 - Name should be *unique* in the inheritance chain
 - Default value of instance variable is `nil`
 - *Private to the instance*, not the class (in contrast to Java)
 - Can be accessed by *all the methods of the class and its subclasses*
 - Instance variables *cannot be accessed by class methods*.
 - The clients must use *accessors* to access an instance variable.

Design Hint:

- Do not directly access instance variables of a superclass from subclass methods. This way classes are not strongly linked.

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Problem — how to initialize objects?

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Problem

- > To create a new instance of a class, the message `new` must be sent to the class
 - But the class (an object) cannot access the instance variables of the new object (!)
 - So how can the class establish the invariant of the new object?

Solution

- > Provide *instance-side initialization methods* in the protocol `initialize-release` that can be used to create a valid instance

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Explicit Initialization

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How do you initialize instance variables to their default values?

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> Implement a method `initialize` that sets all the values explicitly. <https://powcoder.com>

—Override the class message `new` to invoke it on new instances

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```
SnakesAndLadders>>initialize
  super initialize.
  die := Die new.
  squares := OrderedCollection new.
  players := OrderedCollection new.
  turn := 1.
  over := false.
```

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Who calls initialize?

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- > Override the class message `new` to invoke `initialize` on new instances.

<https://powcoder.com>
`SnakesAndLadders class>>new`
`^ self.basicNew initialize`

- > **NB:** You can override `new`, but you should *never* override `basicNew`!

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Ordered Collection

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How do you code Collections whose size can't be determined when they are created?

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- > Use an `OrderedCollection` as your default dynamically sized Collection.

How can you invoke superclass behaviour?

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- > Invoke code in a superclass explicitly by sending a message to `super` instead of `self`.

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- The method corresponding to the message will be found in the *superclass of the class implementing the sending method*.
- Always check code using `super` carefully. Change `super` to `self` if doing so does not change how the code executes!

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Extending Super

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How do you add to the implementation of a method inherited from a superclass?

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- > Override the method and send a message to super in the overriding method.

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A closer look at super

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- > Suppose SnakeSquare and LadderSquare are two subclasses of BoardSquare class
- > SnakeSquare and LadderSquare both extend the printOn: method of their superclass

<https://powcoder.com>

```
BoardSquare>>printOn: aStream
  aStream nextPutAll:
    '[' , position printString, self contents, ']'

LadderSquare>>printOn: aStream
  super printOn: aStream.
  aStream nextPutAll: forward asString, '+>'

SnakeSquare>>printOn: aStream
  aStream nextPutAll: '<-', back asString.
  super printOn: aStream.
```

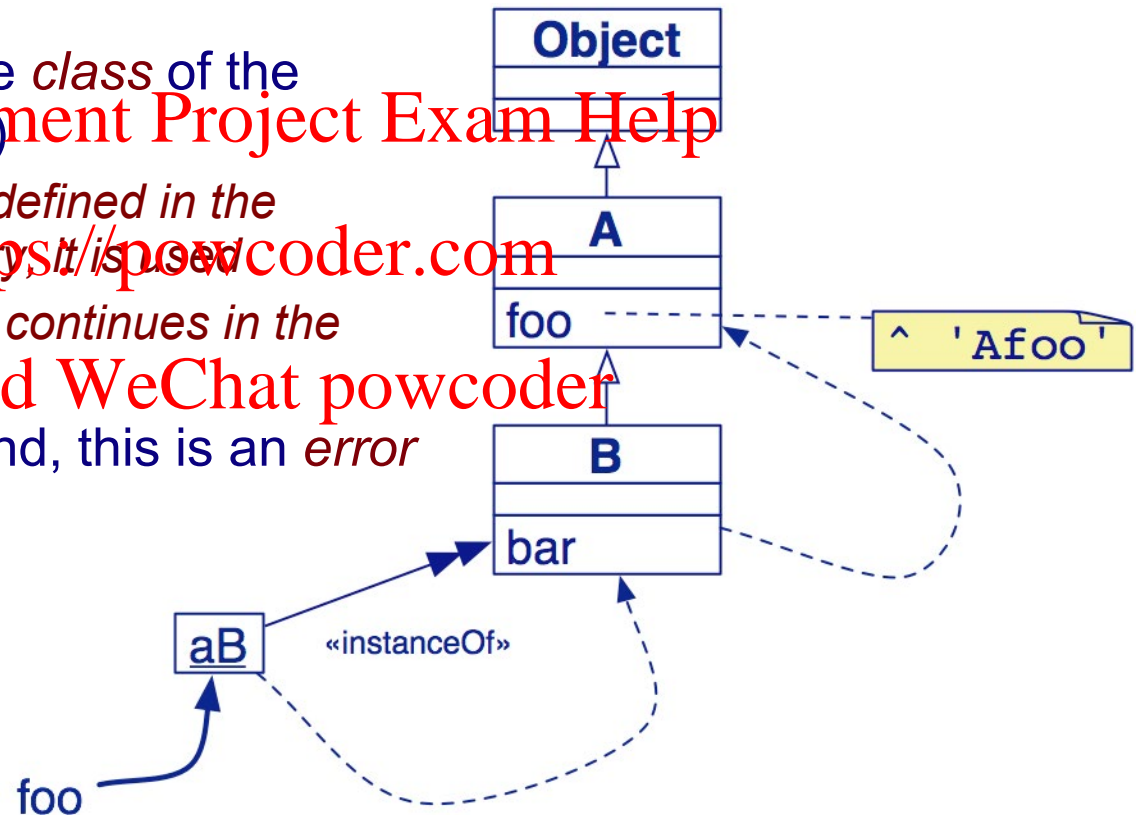
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Normal method lookup

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Two step process:

- Lookup starts in the *class* of the receiver (an object)
 1. If the method is defined in the method dictionary, it is used
 2. Else, the search continues in the superclass
- If no method is found, this is an *error*
- ...



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Message not understood

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When method lookup fails, an error message is sent to the object and lookup starts again with this new message.

self doesNotUnderstand: #foobar

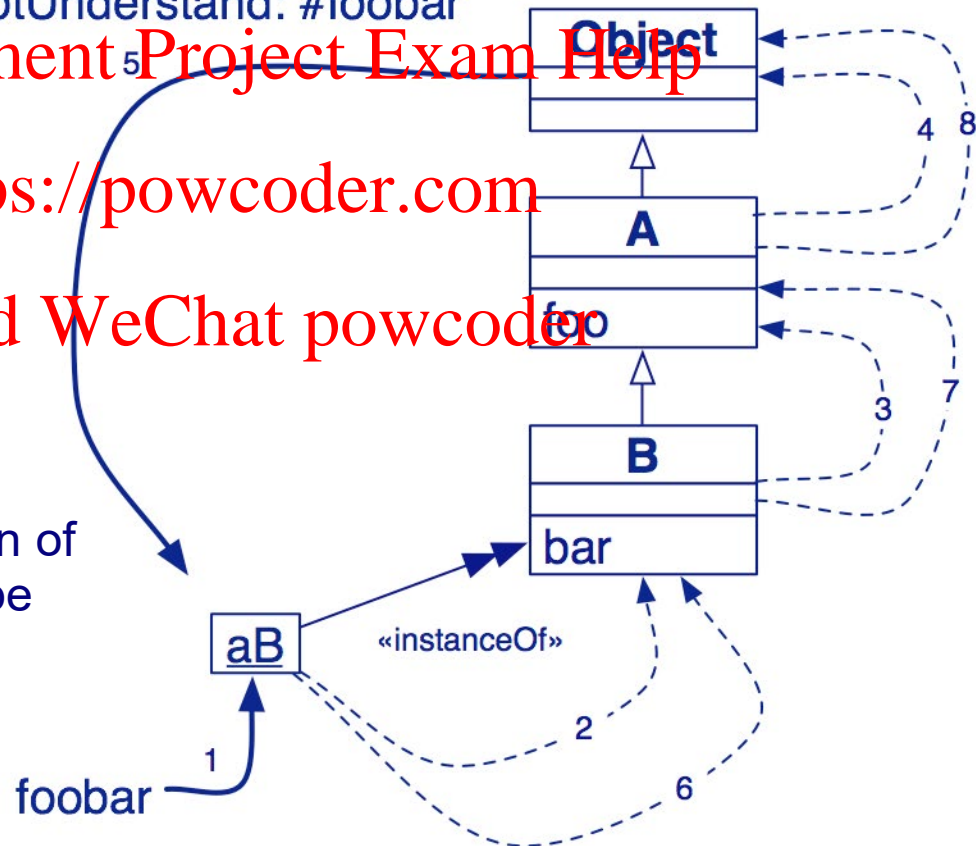
open debugger

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<https://powcoder.com>

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NB: The default implementation of `doesNotUnderstand:` may be overridden by any class.



Super

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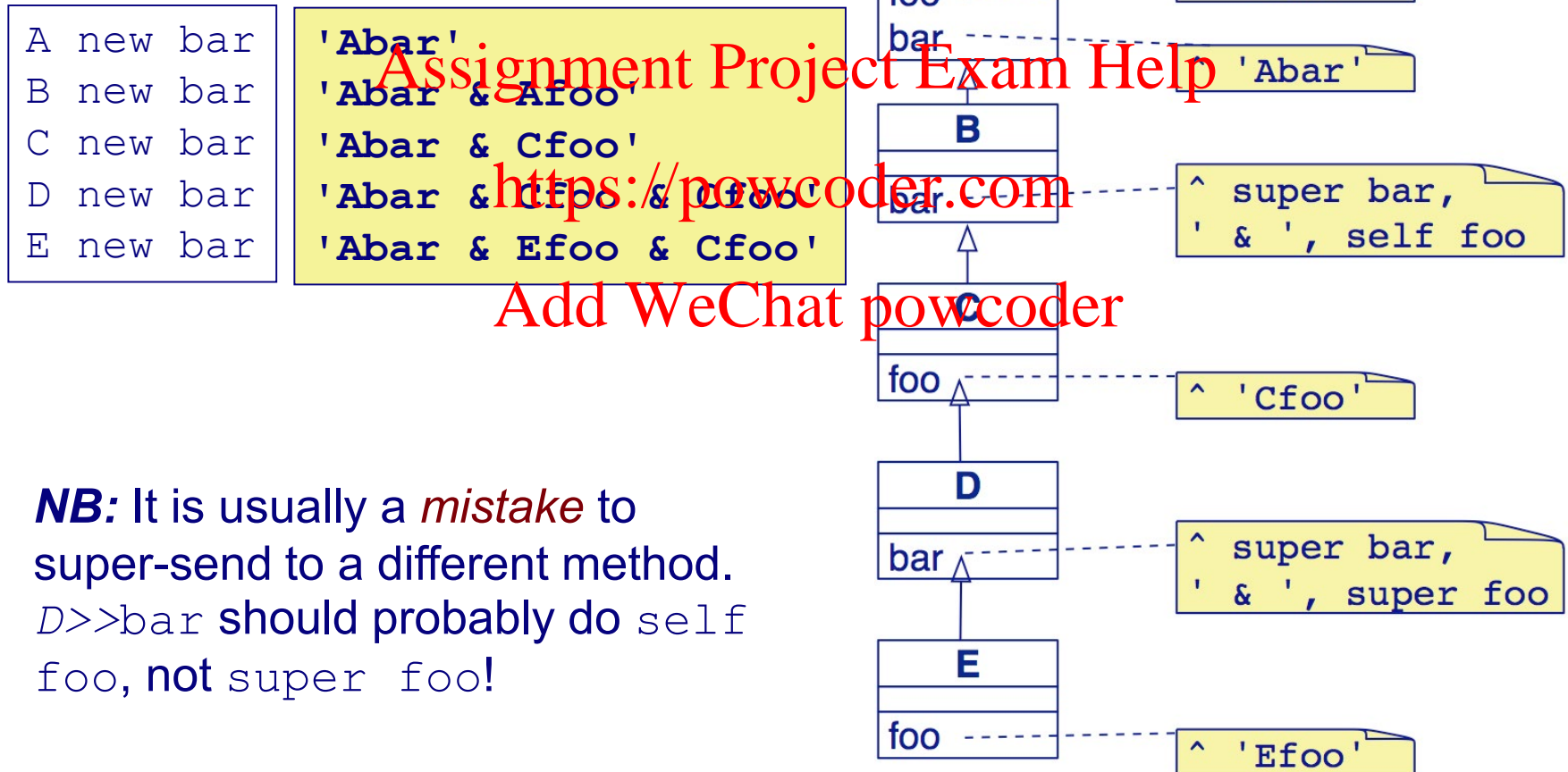
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- > Super modifies the usual method lookup to *start in the superclass of the class whose method sends to super*
<https://powcoder.com>
- **NB:** lookup does *not* start in the superclass of the receiver!
 - *Cf. C new bar on next slide*
- Super is not the superclass!

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Super sends

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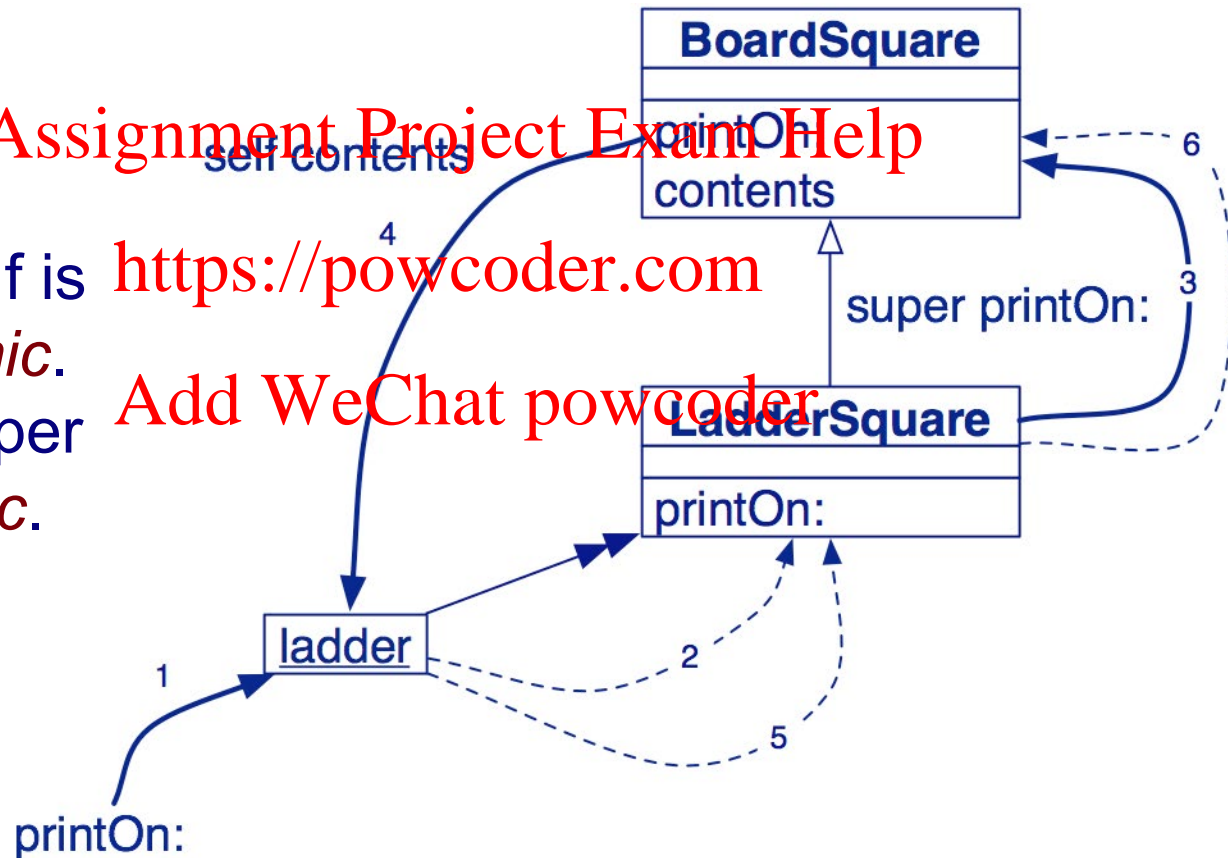
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Self and super

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Sending to self is always *dynamic*.
Sending to super is always *static*.



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Getting Method

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How do you provide access to an instance variable?

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- > Provide a method that returns the value of the variable.
 - Give it the same name as the variable.
 - NB: doesn't need to be called "get."

```
LoadedDie>>roll
  self assert: roll notNil.
  ^ roll
```

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Setting Method

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How do you change the value of an instance variable?

- > Provide a method with the same name as the variable.
 - Have it take a single parameter, the value to be set.
 - *NB: doesn't need to be called set...*

```
LoadedDie>>roll: aNumber  
  self assert: ((1 to: 6) includes: aNumber).  
  roll := aNumber.
```


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Decomposing into Methods

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How do you divide a program into methods?

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- > Divide your program into methods that perform one identifiable task.

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- Keep all of the operations in a method at the *same level of abstraction*.
- This will naturally result in programs with *many small methods, each a few lines long*.

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Method size

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> Most methods will be small and self-documenting

— Few exceptions:

- *Complex algorithms*
- *Scripts (configurations)*
- *Tests*

<https://powcoder.com>

```
SnakesAndLadders>>playOneMove
| result |
self assert: self invariant.
^ self isOver
  ifTrue: ['The game is over']
  ifFalse: [
    result :=
      (self currentPlayer moveWith: die),
      self checkResult.
    self updateTurn.
    result ]
```

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Intention Revealing Message

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How do you communicate your intent when the implementation is simple?

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- > Name the message so it communicates what is to be done rather than how it is to be done.
 - > Code a simple method for the message.
 - > Send a message to self.
- <https://powcoder.com>
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```
SnakesAndLadders>>currentPlayer  
^ players at: turn
```

```
SnakesAndLadders>>move  
...  
self currentPlayer printNl.  
...
```

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Intention Revealing Selector

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What do you name a method?

> Name methods after what they accomplish

- Well-named methods can eliminate the need for most comments

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```
SnakesAndLadders>>updateTurn  
  turn := 1 + (turn\players size).
```

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Some Naming Conventions

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- > Use imperative verbs for methods performing an action
 - `moveTo`, `leaveCurrentSquare`, `playOneMove`
- > Prefix testing methods (i.e., that return a boolean) with “is” or “has”
 - `isNil`, `isNotOver`, `isOccupied`
- > Prefix converting methods with “as”
 - `asString`

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Message Comment

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How do you comment methods?

- > Communicate important information that is not obvious from the code in a comment at the beginning of the method.
<https://powcoder.com>
 - Method dependencies
 - To-do items
 - Sample code to execute

```
SnakesAndLadders>>playToEnd  
    "SnakesAndLadders example playToEnd"  
...
```

Hint: too many comments may indicate problems in the source code!
— Try to refactor code and rename methods to get rid of comments!

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Slow Fibonacci

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```
Object subclass: #Fibs.
```

```
Fibs extend [  
  at: anIndex [  
    anIndex = 1 ifTrue: [ ^ 1 ].  
    anIndex = 2 ifTrue: [ ^ 1 ].  
    ^ (self at: anIndex - 1) + (self at: anIndex - 2)  
  ]  
].
```

```
Fibs new at: 40
```

```
102334155
```

Takes about 10 seconds.

Forget about much larger values!

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Cacheing Fibonacci

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```
Object subclass: #Fibs.
```

```
Fibs instanceVariableNames: 'cache'.
```

```
Fibs extend [  
    initialize [ cache := Dictionary new ]  
]
```

Introduce the cache ...

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Cacheing Fibonacci

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Now we introduce the lookup method, and redirect all accesses to use the cache lookup

```
Fibs extend [
  at: anIndex [
    anIndex = 1 ifTrue: [ ^ 1 ]
    anIndex = 2 ifTrue: [ ^ 1 ]
    ^ (self lookup: anIndex - 1) + (self lookup: anIndex - 2)
  ]
  lookup: anIndex [
    ^ cache at: anIndex ifAbsentPut: [ self at: anIndex ]
  ]
].
```

```
Fibs new initialize ; at: 100
```

```
354224848179261915075
```

... is virtually instantaneous!

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Comparing Method

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How do you order objects with respect to each other?

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- > Implement `<=` to return true if the receiver should be ordered before the argument
 - `<, <=, >, >=` are defined for `Magnitude` and its subclasses.

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Sorted Collection

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How do you sort a collection?

> Use a Sorted Collection.

— Set its sort block if you want to sort by some criterion other than <=

<https://powcoder.com>

```
# ( 'Snakes' 'Ladders' ) asSortedCollection
```

```
a SortedCollection('Ladders' 'Snakes')
```

```
# ( 'Snakes' 'Ladders' ) asSortedCollection: [:a :b | b<=a ]
```

```
a SortedCollection('Snakes' 'Ladders')
```

```
# ( 'Snakes' 'Ladders' ) asSortedCollection  
  sortBlock: [:a :b | b<=a ]
```

```
a SortedCollection('Snakes' 'Ladders')
```

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Interval

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How do you code a collection of numbers in a sequence?

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> Use an `Interval` with start, stop and optional step value.

<https://powcoder.com>

— Use the Shortcut Constructor methods `Number>>to:` and `Number>>to:by:` to build intervals

```
1 to: 5  
(1 to: 5) asSet  
(10 to: 100 by: 20) asOrderedCollection
```

```
(1 to: 5)  
a Set(1 2 3 4 5)  
an OrderedCollection(10 30 50 70 90)
```

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Duplicate Removing Set

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How do you remove the duplicates from a Collection?

> Send asSet to the collection

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```
'hello world' asSet
```

```
a Set(Character space $r $d $e $w $h $l $o)
```

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Searching Literal

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How do you test if an object is equal to one of several literal values?

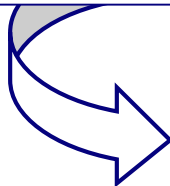
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- > Ask a literal Collection if it includes the element you seek

<https://powcoder.com>

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```
char = $a | char = $e | char = $i | char = $o | char = $u |  
char = $A | char = $E | char = $I | char = $O | char = $U
```



```
'aeiou' includes: char asLowercase
```

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Concatenation

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How do you put two collections together?

> Send “,” to the first with the second as argument

```
(1 to: 3), (4 to: 6)
```

<https://powcoder.com>

```
#(1 2 3 4 5 6)
```

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```
(Dictionary newFrom: { #a -> 1}), (Dictionary newFrom: { #b -> 2})
```

```
a Dictionary(#a->1 #b->2 )
```