ETH zürich

Assignment 6

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TA lecture, Informatics II D-BAUG

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“Präsenzstunden” Today

In the same room as last week *(standard)*

- **HIL E 15.2**
- **15:00 - 18:00**
- **Timon Gehr** *(arriving 15:45)*

We proudly present . . .

TA lectures in **Italian**

- **Thursdays**
- **12:45-13:30**
- **HIT F 31.1**
- **Raffaele Lauro**

. . . *Buon divertimento!*

Outline

Java Generics

“Type Parameters”

- Generics allow a type or method to operate on objects of various types.

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“Type Parameters”

- Generics allow a type or method to operate on objects of various types.
- You can see **generics** as a **parameter** to hand a **type** to a class when instantiating objects of this class.
- In the class there’s just place holder where in the object the type **must** be known (i. e. the place holder has been replaced by a type).

Java Generics

Building Houses

In the example of classes being a **construction plan** for a house while the houses are the objects built after the plan. The “generic” could e. g. be the color of the walls in the bathroom.

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Building Houses

In the example of classes being a **construction plan** for a house while the houses are the objects built after the plan. The “generic” could e. g. be the color of the walls in the bathroom.
You can use the **same construction plan** and just “**replace**” the bathroom color from e. g. white to light-green.

Java Generics

“Type Parameters”

- Thanks to **generics** there are many helpful data structures *(implemented as classes)* which you can aggreagte **and while doing so**, set the according data type.

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“Type Parameters”

- Thanks to **generics** there are many helpful data structures *(implemented as classes)* which you can aggreagte **and while doing so**, set the according data type.
- **Examples** are `ArrayList`, `Vector` and `LinkedList`.

Outline

Place Holder “★”

```
1  public class Example
2  {    private String bla;
3
4       public Example(String def)
5       {    bla = def;
6       }
7
8       public String get()
9       {    return bla;
10      }
11      public void set(String str)
12      {    bla = str;
13      }
14 }
```

Place Holder Wanted

The aim of generics, is to replace e. g. the type “String” by a placeholder “★”.

Place Holder “★”

Basically . . .

- **From:** `private String bla;`

Place Holder “★”

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- **From:** `private String bla;`
- **To:** `private ★ bla;`

Place Holder “★”

Basically ...

- **From:** `private String bla;`
- **To:** `private ★ bla;`
- **From:** `public String get()`

Place Holder “★”

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- **From:** `private String bla;`
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Place Holder "★"

Basically ...

- **From:** `private String bla;`
- **To:** `private ★ bla;`
- **From:** `public String get()`
- **To:** `public ★ get()`
- **From:** `public void set(String str)`

Place Holder "★"

Basically ...

- **From:** `private String bla;`
- **To:** `private ★ bla;`
- **From:** `public String get()`
- **To:** `public ★ get()`
- **From:** `public void set(String str)`
- **To:** `public void set(★ str)`

Side by Side

```java
public class Example
{   private String bla;

    public Example(String def)
    {   bla = def;
    }

    public String get()
    {   return bla;
    }

    public void set(String str)
    {   bla = str;
    }
}
```

```java
public class Example<T>
{   private T bla;

    public Example(T def)
    {   bla = def;
    }

    public T get()
    {   return bla;
    }

    public void set(T str)
    {   bla = str;
    }
}
```

Question

Who can see the five differences?

Example as a Generic

```
1  public class Example<T>
2  {    private T bla;
3
4       public Example(T def)
5       {    bla = def;
6       }
7
8       public T get()
9       {    return bla;
10      }
11      public void set(T str)
12      {    bla = str;
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14 }
```

With Generics

"T" is the **place holder**.

Example as a Generic

```
1  public class Example<T>
2  {    private T bla;
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4       public Example(T def)
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9       {    return bla;
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11      public void set(T str)
12      {    bla = str;
13      }
14 }
```

With Generics

"T" is the **place holder**. When an object is built according to class `Example`, also the class place holder "T" has to be replaced by an object of an actual class.

Using a Generic Class

```
1 public class Test1 // Without Generics
2 {   public static void main(String[] args)
3     {   Example e = new Example("Hallo");
4         System.out.println(e.get());
5         e.set("Test");
6         System.out.println(e.get());
7     }
8 }
```

```
1 public class Test2 // Using a generic class
2 {   public static void main(String[] args)
3     {   Example<String> e = new Example<String>("Hallo");
4         System.out.println(e.get());
5         e.set("Test");
6         System.out.println(e.get());
7     }
8 }
```

Instantiation

Test2, Line 3: "`String`" is inserted as the actual type for "`T`".

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Let's have an easy Assignment

1. Simplify your Highscore using a `LinkedList`.
   Shorter code is better code!

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   - Make your `LinkedList` a **generic**.

Let's have an easy Assignment

1. Simplify your Highscore using a `LinkedList`.
   Shorter code is better code!
2. Calculate the complexity of two different ways to insert a new score. No programming needed for this question.
3. For those who like and enjoy:
   - Make your `LinkedList` a **generic**.
   - Make your `GrowingArray` a **generic** *(tricky, non-standard)*.

Outline

Fibonacci in Java

Implementation

The aim is to put the following formula into code such that f_3 and the following 24 Fibonacci numbers are printed.

$$f_1 = f_2 = 1 \tag{1}$$

$$f_n = f_{n-1} + f_{n-2} \tag{2}$$

Fibonacci Code

```
1  public class PrintFibonacci
2  {    public static void main(String[] args)
3       {    int x, y, z;
4            x = 1; // start condition
5            y = 1; // start condition
6            for (int i=0; i<25; ++i)
7            {    z = x+y; // calculation
8                 System.out.println(z);
9                 x = y; // move the numbers
10                y = z;
11           }
12      }
13 }
```

Who understands this Code?

```
1  public class PrintFibonacci
2  {    public static int addPrint(int a, int b, int n)
3       {    int c = a + b;
4            System.out.println(c);
5            if (n > 1)
6            {    addPrint(b, c, n-1);
7            }
8            return c;
9       }
10
11      public static void main(String[] args)
12      {    addPrint(1, 1, 25);
13      }
14 }
```

Recursive Implementation

```
1  public class PrintFibonacci
2  {   public static int addPrint(int a, int b, int n)
3      {   int c = a + b;
4          System.out.println(c);
5          if (n > 1)
6          {   addPrint(b, c, n-1);
7          }
8          return c;
9      }
10     public static void main(String[] args)
11     {   addPrint(1, 1, 25);
12     }
13 }
```

Recursive Fibonacci Implementation

You can achieve the same goals using **recursive** and **iterative** programming. Often recursive code is smaller but a “bit more difficult to understand”.

Biggest Integer-Fibonacci-Number

Highest Fibonacci Number below MAX_VALUE

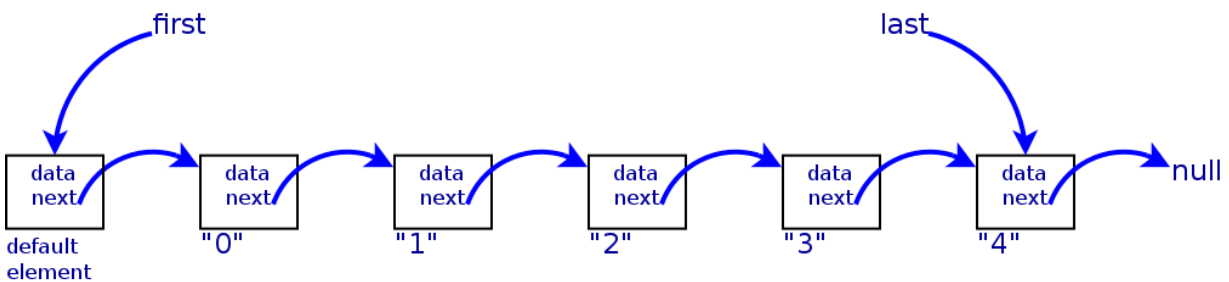
It's 2147483647, but this can't be calculated using the recursive solution (stack-overflow). Recursive solutions make the stack **exceed its limits** because of the repeated method invocations.

```
1  public class PrintFibonacci
2  {   public static void main(String[] args)
3      {   int x=1, y=1;
4          long z=1;
5          while (z < Integer.MAX_VALUE)
6          {   z = x+y;
7              x = y; // move the numbers
8              y = z;
9          }
10         System.out.println(z);
11     }
12 }
```

Outline

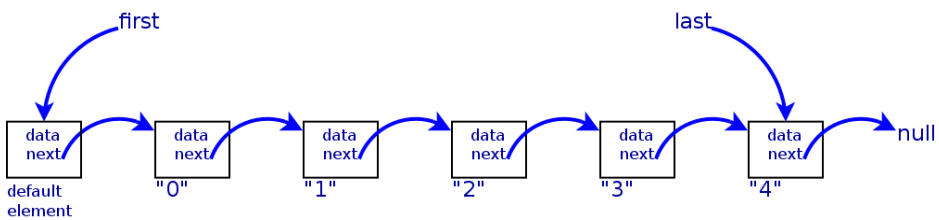
Example Solution: `insert`

```
1  public void insert(int pos, int dat)
2  {    ListElement le = new ListElement(dat);
3       ListElement bef = locate(pos-1);
4       ListElement aft = bef.next;
5       bef.next = le;
6       le.next  = aft;
7       if (aft == null)
8       {    last = le;
9       }
10 }
```



Example Solution: `delete`

```
1  public void delete(int pos)
2  {    if (pos < length())
3       {    ListElement bef = locate(pos - 1);
4            ListElement del = bef.next;
5            ListElement aft = del.next;
6            bef.next = aft;
7            if(last == del)
8            {    last = bef;
9            }
10      }
11 }
```



Example Solution: `sort`

```
1  private void sort()
2  {    boolean done = false;
3       while (!done)
4       {    done = true;
5            ListElement le = first.next;
6            while (le.next != null)
7            {    if (le.data < le.next.data)
8                 {    int tmp = le.data; // swap values
9                      le.data = le.next.data;
10                     le.next.data = tmp;
11                     done = false;
12                }
13                le = le.next;
14 }    }    } // saving space on the slide :-)
```

Questions from your side?

Please

- Feedback?
- Additions?
- Remarks?
- Wishes?
- ...

All the Best!