

Javakurs 2010 – LE3

Methoden, Testen, Debuggen

Sebastian Dyroff, Mario Bodemann

23. März 2010



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Agenda 2010

- ① Methoden
- ② Testen
- ③ Debuggen
- ④ Java-API

Feedback of the Day

Feedback

Feedback: Vorlesung

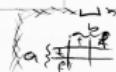
vormittags nachmittags

- Montag Dienstag
- Mittwoch Donnerstag
- Freitag

Positiv Lautstärke gut



Negativ Hellgrüne Schriftfarbe auf Folie = schlecht



0. Wiederholung

Wiederholung

Wiederholung

- Variablen und Zuweisungen

Wiederholung

- Variablen und Zuweisungen

```
1 int foo = 42;
2 String text = "Hallo Welt!";
3
4 int bar;
5 bar = 23;
```

Wiederholung

- Variablen und Zuweisungen
- Verzweigungen

Wiederholung

- Variablen und Zuweisungen
- Verzweigungen

```
1 if ( heuteIstRasenmaehertag == true ) {  
2     System.out.println("Geh Rasen maehen!");  
3 } else {  
4     System.out.println("Faulenzen!");  
5 }
```

Wiederholung

- Variablen und Zuweisungen
- Verzweigungen
- Schleifen

Wiederholung

- Variablen und Zuweisungen
- Verzweigungen
- Schleifen

```
1 System.out.println("Ich");
2 for(int count=0; count<10; count++) {
3     System.out.println("maehe");
4 }
```

Wiederholung

- Variablen und Zuweisungen
- Verzweigungen
- Schleifen

```
1 System.out.println("Ich");
2 for(int count=0; count<10; count++) {
3     System.out.println("maehe");
4 }
```

```
1 System.out.println("Ich");
2 int count = 0;
3 while(count<10) {
4     System.out.println("maehe");
5     count++;
6 }
```

Wiederholung

- Variablen und Zuweisungen
- Verzweigungen
- Schleifen
- Arrays

Wiederholung

- Variablen und Zuweisungen
- Verzweigungen
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- Arrays

```
1 int [] grashalme = new int[10];
2 grashalme[0] = 0;
3 grashalme[1] = 0;
4 grashalme[2] = 0;
5 ...
6 grashalme[9] = 0;
```

Wiederholung

- Variablen und Zuweisungen
- Verzweigungen
- Schleifen
- Arrays

```
1 int [] grashalme = new int[10];
2 grashalme[0] = 0;
3 grashalme[1] = 0;
4 grashalme[2] = 0;
5 ...
6 grashalme[9] = 0;
```

```
1 int [] grashalme = new int[10];
2 for(int halmNr=0; halmNr<grashalme.length; halmNr++) {
3     grashalme[halmNr] = 0;
4 }
```

```
System.out.println(...)
```

```
System.out.println(...)
```



1. Methoden

Beispiele

- `System.out.println(...)`
- `Math.random()`

Wie funktioniert so eine Methode?

Mathematische Funktion

Mathematische Funktion

- $4! = 1 \cdot 2 \cdot 3 \cdot 4$

Mathematische Funktion

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- $f(n) = \prod_{k=1}^n k$

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- Name: f

Mathematische Funktion

- $4! = 1 \cdot 2 \cdot 3 \cdot 4$
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- Name: f
- Eingabe: $n \in \mathbb{N}$

Mathematische Funktion

- $4! = 1 \cdot 2 \cdot 3 \cdot 4$
- $f(n) = \prod_{k=1}^n k$
- Name: f
- Eingabe: $n \in \mathbb{N}$
- Ausgabe: $f \rightarrow \mathbb{N}$

Mathematische Funktion

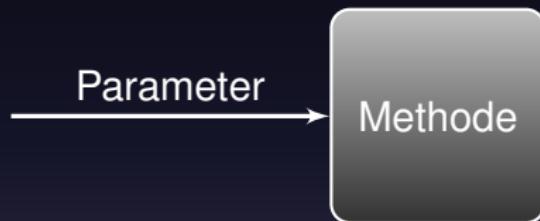
- $4! = 1 \cdot 2 \cdot 3 \cdot 4$
- $f(n) = \prod_{k=1}^n k$
- Name: f
- Eingabe: $n \in \mathbb{N}$
- Ausgabe: $f \rightarrow \mathbb{N}$
- Definition

Black-Box

Black-Box

Methode

Black-Box



Black-Box



Beispiel: factorial

- Methodename: factorial
- Parameter: int n
- Rückgabetyp: int

Wie rufe ich factorial auf?

Möglichkeiten des Methodenaufrufs

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- Einfach so:

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- Einfach so:

```
1 factorial(4);
```

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- Speichern des Rückgabewerts in einer Variablen:

Möglichkeiten des Methodenaufrufs

- Einfach so:

```
1 factorial(4);
```

- Speichern des Rückgabewerts in einer Variablen:

```
1 int facFour;  
2 facFour = factorial(4);
```

Möglichkeiten des Methodenaufrufs

- Einfach so:

```
1 factorial(4);
```

- Speichern des Rückgabewerts in einer Variablen:

```
1 int facFour;
2 facFour = factorial(4);
```

- Auswertung des Rückgabewerts in einem Ausdruck:

```
1 if ( factorial(4) == 24 ) {
2     ...
3 }
```

Syntax für den Aufruf

```
bezeichner(parameter, ...)
```

Wie schreibe ich eine neue Methode?

Syntax: Umgebung

Methoden gehören zu einer Klasse (`class`):

Syntax: Umgebung

Methoden gehören zu einer Klasse (class):

MathFunctions.java

```
1 public class MathFunctions {  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13 }
```

Syntax: Umgebung

Methoden gehören zu einer Klasse (class):

MathFunctions.java

```
1 public class MathFunctions {  
2     public static int factorial(int n) {  
3         ...  
4     }  
5  
6  
7  
8  
9  
10  
11  
12  
13 }
```

Syntax: Umgebung

Methoden gehören zu einer Klasse (class):

MathFunctions.java

```
1 public class MathFunctions {  
2     public static int factorial(int n) {  
3         ...  
4     }  
5  
6     public static int power(int base, int exp) {  
7         ...  
8     }  
9  
10  
11  
12  
13 }
```

Syntax: Umgebung

Methoden gehören zu einer Klasse (class):

MathFunctions.java

```
1 public class MathFunctions {  
2     public static int factorial(int n) {  
3         ...  
4     }  
5  
6     public static int power(int base, int exp) {  
7         ...  
8     }  
9  
10    public static void main(String args[]) {  
11        ...  
12    }  
13 }
```

Syntax: Aufbau

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Syntax: Aufbau

- Methoden-Kopf
 - enthält den Namen der Methode
 - enthält die Parameter
 - enthält den Rückgabetyp



Syntax: Aufbau

- Methoden-Kopf
 - enthält den Namen der Methode
 - enthält die Parameter
 - enthält den Rückgabetyp
- Methoden-Rumpf
 - ein Block ({ ... })
 - enthält die Funktion
 - gibt den Rückgabewert zurück



factorial, der Kopf

```
public static int factorial (int n) {  
}
```

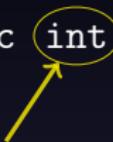
factorial, der Kopf

```
public static int factorial (int n) {
```

```
}
```

Rückgabetyp:

int



factorial, der Kopf

```
public static int factorial (int n) {  
}
```

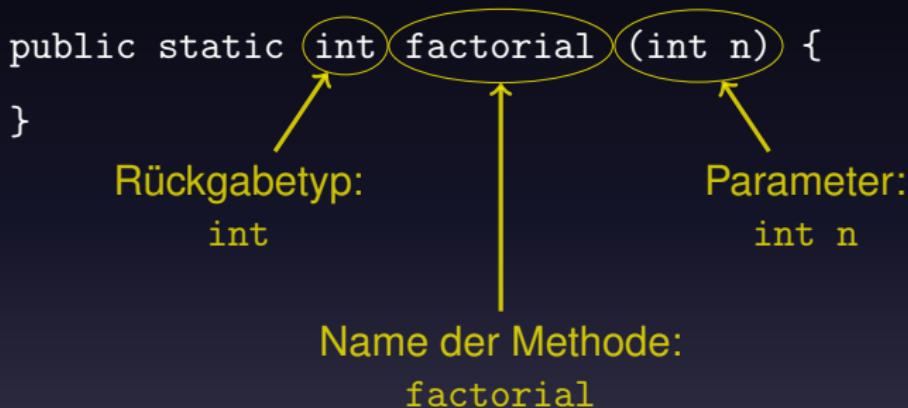
Rückgabetyp:

int

Name der Methode:

factorial

factorial, der Kopf



Syntax: Kopf

```
public static Typ methodenName (Typ name, ...) {  
}
```

Syntax: Kopf

```
public static Typ methodenName (Typ name, ...) {  
}
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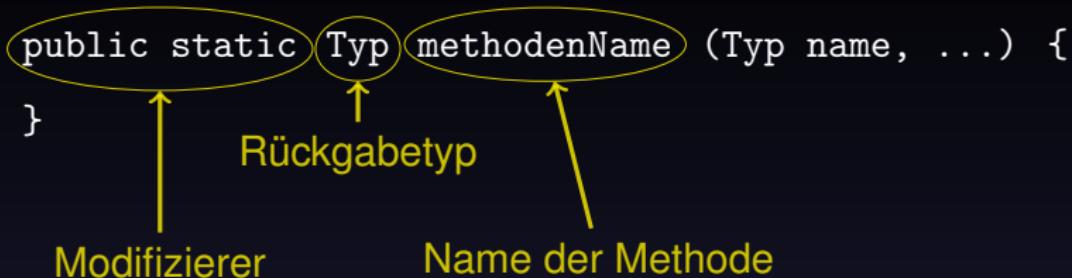
Modifizierer



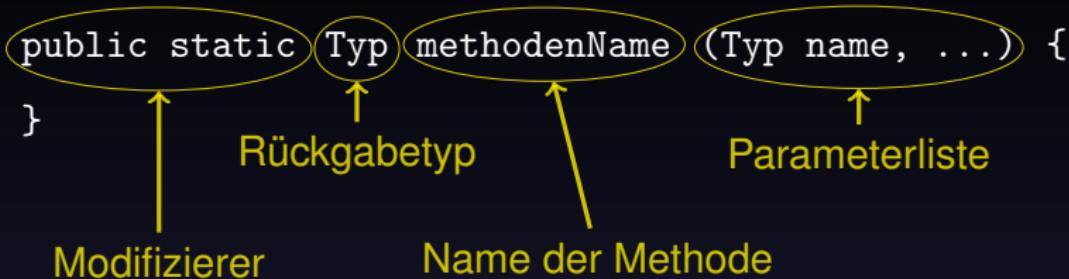
Syntax: Kopf

```
public static Typ methodenName (Typ name, ...) {  
}  
          ↑  
          Rückgabetyp  
↑  
Modifizierer
```

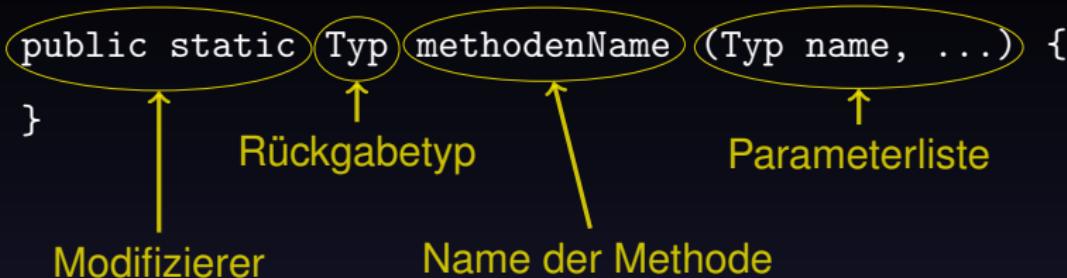
Syntax: Kopf



Syntax: Kopf

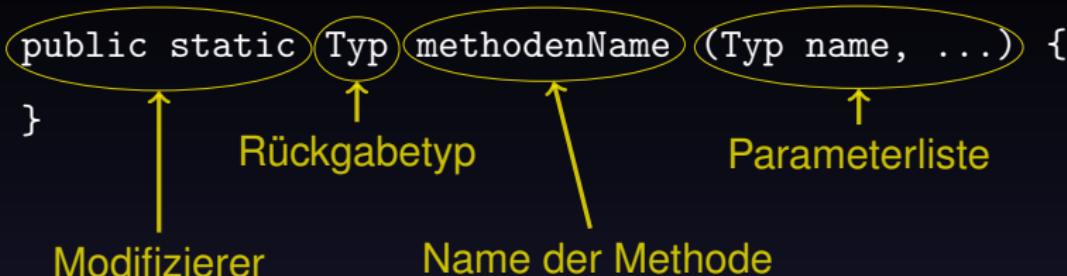


Syntax: Kopf



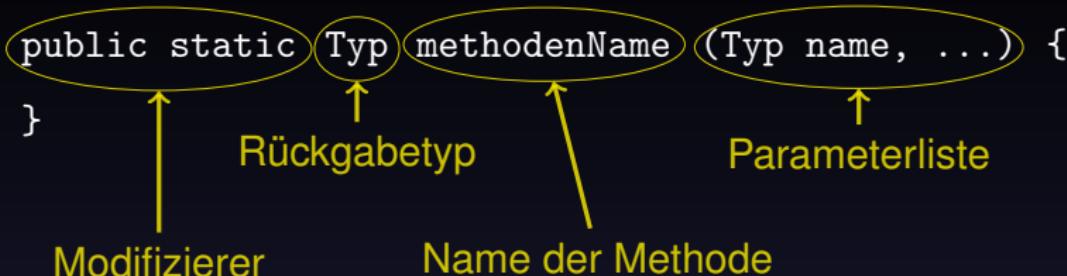
- mögliche Rückgabetypen:
 - einfache Datentypen (z.B. int, double, ...)
 - komplexe Datentypen (z.B. String, int [] (Arrays), ...)
 - void – keine Rückgabe

Syntax: Kopf



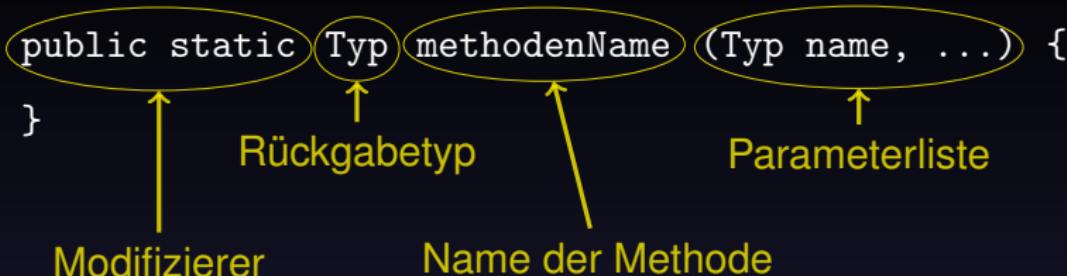
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 - `void` – keine Rückgabe
- Parameterliste kann $0 - \infty$ Parameter enthalten

Syntax: Kopf



- mögliche Rückgabetypen:
 - einfache Datentypen (z.B. `int, double, ...`)
 - komplexe Datentypen (z.B. `String, int []` (Arrays), ...)
 - `void` – keine Rückgabe
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- mögliche Parametertypen:

Syntax: Kopf



- mögliche Rückgabetypen:
 - einfache Datentypen (z.B. int, double, ...)
 - komplexe Datentypen (z.B. String, int [] (Arrays), ...)
 - void – keine Rückgabe
- Parameterliste kann $0 - \infty$ Parameter enthalten
- mögliche Parametertypen:
 - einfache Datentypen
 - komplexe Datentypen

Syntax: Kopf – Beispiele

Syntax: Kopf – Beispiele

```
1 public static void doSomething()
```

- keine Parameter
- keine Rückgabe (void)

Syntax: Kopf – Beispiele

```
1 public static void    doSomething()  
2 public static void    doSomething(int n)
```

- ein Parameter: int n
- keine Rückgabe (void)

Syntax: Kopf – Beispiele

```
1 public static void      doSomething()  
2 public static void      doSomething(int n)  
3 public static void      doSomething(int n, String s)
```

- zwei Parameter:
 - 1 int n
 - 2 String s
- keine Rückgabe (void)

Syntax: Kopf – Beispiele

```
1 public static void      doSomething()
2 public static void      doSomething(int n)
3 public static void      doSomething(int n, String s)
4 public static int       doSomething()
```

- keine Parameter
- Rückgabe: int

Syntax: Kopf – Beispiele

```
1 public static void      doSomething()
2 public static void      doSomething(int n)
3 public static void      doSomething(int n, String s)
4 public static int       doSomething()
5 public static String    doSomething()
```

- keine Parameter
- Rückgabe: String

Syntax: Kopf – Beispiele

```
1 public static void      doSomething()
2 public static void      doSomething(int n)
3 public static void      doSomething(int n, String s)
4 public static int       doSomething()
5 public static String    doSomething()
6 public static int[]     doSomething()
```

- keine Parameter
- Rückgabe: int [] (Array von int)

Syntax: Kopf – Beispiele

```
1 public static void      doSomething()
2 public static void      doSomething(int n)
3 public static void      doSomething(int n, String s)
4 public static int       doSomething()
5 public static String    doSomething()
6 public static int[]     doSomething()
```

Syntax: Rumpf

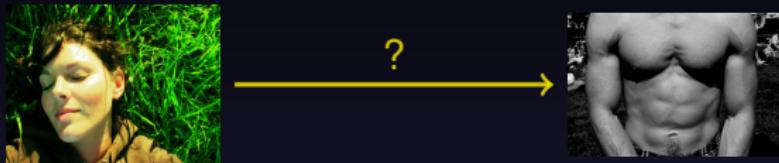
Syntax: Rumpf

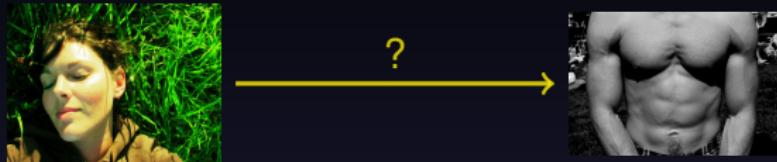
```
1 public static int factorial(int n) {  
2     int result = 1;  
3     ... //result (Fakultaet von n) wird berechnet  
4     return result;  
5 }
```

Syntax: Rumpf

```
1 public static int factorial(int n) {  
2     int result = 1;  
3     ... //result (Fakultaet von n) wird berechnet  
4     return result;  
5 }
```

- `return` «Rückgabewert»;
 - bricht Ausführung ab und gibt «Rückgabewert» zurück
 - bei Rückgabetyp `void`: `return;`





Wie kommen die Parameter
vom Kopf in den Rumpf?

einfache Antwort:

einfache Antwort:

Sie werden hinein kopiert.

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Sie werden hinein kopiert.



Parameterübergabe

Parameterübergabe

```
1 public static int factorial(int n) {  
2  
3  
4  
5  
6  
7  
8 }
```

Parameterübergabe

```
1 public static int factorial(int n) {  
2     int result = 1;  
3     while(n != 0) {  
4  
5         }  
6     return result;  
7 }  
8 }
```

Parameterübergabe

```
1 public static int factorial(int n) {  
2     int result = 1;  
3     while(n != 0) {  
4         result = result * n;  
5         n = n - 1;  
6     }  
7     return result;  
8 }
```

Call by Value

Call by Value

```
main(...)
```

Call by Value

```
main(...)
```



Call by Value

main(...)



methode(...)

Call by Value

main(...)

methode(...)

copy



Call by Value

main(...)



methode(...)



Call by Value

main(...)



methode(...)



Call by Value: Beispiel

Call by Value: Beispiel

```
1 public class Modify {  
2     public static void main(String args[]) {  
3         int value = 42;  
4  
5         modify(value);  
6  
7     }  
8     public static void modify(int value) {  
9         value = 23;  
10    }  
11 }  
12 }
```

Call by Value: Beispiel

```
1 public class Modify {  
2     public static void main(String args[]) {  
3         int value = 42;  
4         System.out.println("before: " + value);  
5         modify(value);  
6         System.out.println("after: " + value);  
7     }  
8     public static void modify(int value) {  
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```

Call by Value: Beispiel

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12}
```

```
1 ~ $ java Modify  
2 before: 42  
3 in modify: 23  
4 after: 42
```

Call by Value: Beispiel

```
1 public class Modify {  
2     public static void main(String args[]) {  
3         int value = 42;  
4         System.out.println("before: " + value),  
5         modify(value);  
6         System.out.println("after: " + value);  
7     }  
8     public static void modify(int value) {  
9         value = 23;  
10        System.out.println("in modify: " + value);  
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Call by Value: Beispiel

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1 ~ $ java Modify  
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Call by Value: Beispiel

```
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```

```
1 ~ $ java Modify  
2 before: 42  
3 in modify: 23  
4 after: 42
```

Wäre da nicht ein Problem. . .

Wäre da nicht ein Problem. . .

Bei großen Datenmengen in den Parametern
muss alles komplett **kopiert** werden!



Call by Reference

Call by Reference

```
main(...)
```



```
methode(...)
```

Call by Reference

```
main(...)
```



```
methode(...)
```

Call by Reference

```
main(...)
```



copy

```
methode(...)
```

Call by Reference

```
main(...)
```



```
methode(...)
```



Call by Reference

```
main(...)
```



```
methode(...)
```



Call by Reference

```
main(...)
```



```
methode(...)
```



Call by Reference: Beispiel

Call by Reference: Beispiel

```
1 public class HugeCopy {  
2     public static void main(String args[]) {  
3         int [] arr = new int[10000];  
4  
5         setOne(arr);  
6  
7     }  
8     public static void setOne(int q[]) {  
9         for(int i=0; i<q.length; i++) {  
10             q[i] = 1;  
11         }  
12     }  
13 }  
14 }
```

Call by Reference: Beispiel

```
1 public class HugeCopy {  
2     public static void main(String args[]) {  
3         int [] arr = new int[10000];  
4         System.out.println("before: " + arr[9999]);  
5         setOne(arr);  
6         System.out.println("after: " + arr[9999]);  
7     }  
8     public static void setOne(int q[]) {  
9         for(int i=0; i<q.length; i++) {  
10             q[i] = 1;  
11         }  
12         System.out.println("in setOne: " + arr[9999]);  
13     }  
14 }
```

Call by Reference: Beispiel

```
1 public class HugeCopy {  
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10             q[i] = 1;  
11         }  
12         System.out.println("in setOne: " + arr[9999]);  
13     }  
14 }
```

```
1 ~ $ java HugeCopy  
2 before: 0  
3 in setOne: 1  
4 after: 1
```

Call by Reference: Beispiel

```
1 public class HugeCopy {  
2     public static void main(String args[]) {  
3         int [] arr = new int[10000];  
4         System.out.println("before: " + arr[9999]),  
5         setOne(arr);  
6         System.out.println("after: " + arr[9999]);  
7     }  
8     public static void setOne(int q[]) {  
9         for(int i=0; i<q.length; i++) {  
10             q[i] = 1;  
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3 in setOne: 1  
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```

Call by Reference: Beispiel

```
1 public class HugeCopy {  
2     public static void main(String args[]) {  
3         int [] arr = new int[10000];  
4         System.out.println("before: " + arr[9999]);  
5         setOne(arr);  
6         System.out.println("after: " + arr[9999]);  
7     }  
8     public static void setOne(int q[]) {  
9         for(int i=0; i<q.length; i++) {  
10             q[i] = 1;  
11         }  
12         System.out.println("in setOne: " + arr[9999]);  
13     }  
14 }
```

```
1 ~ $ java HugeCopy  
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```

Call by Reference: Beispiel

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4         System.out.println("before: " + arr[9999]);  
5         setOne(arr);  
6         System.out.println("after: " + arr[9999]),  
7     }  
8     public static void setOne(int q[]) {  
9         for(int i=0; i<q.length; i++) {  
10             q[i] = 1;  
11         }  
12         System.out.println("in setOne: " + arr[9999]);  
13     }  
14 }
```

```
1 ~ $ java HugeCopy  
2 before: 0  
3 in setOne: 1  
4 after: 1
```

Call by Reference vs. Call by Value

- richtet sich nach Datentyp (automatisch)
- Call by Value
 - Kopieren der Parameter
 - für einfache Datentypen (int, double, float, char, ...)
- Call by Reference
 - Referenzieren der Parameter
 - für komplexe Datentypen
 - z.B. Arrays

2. Testen

Was heißt Testen?

Was kann man Testen?

Was kann man Testen?

Methoden

Wie Testen?

Der Idealfall:

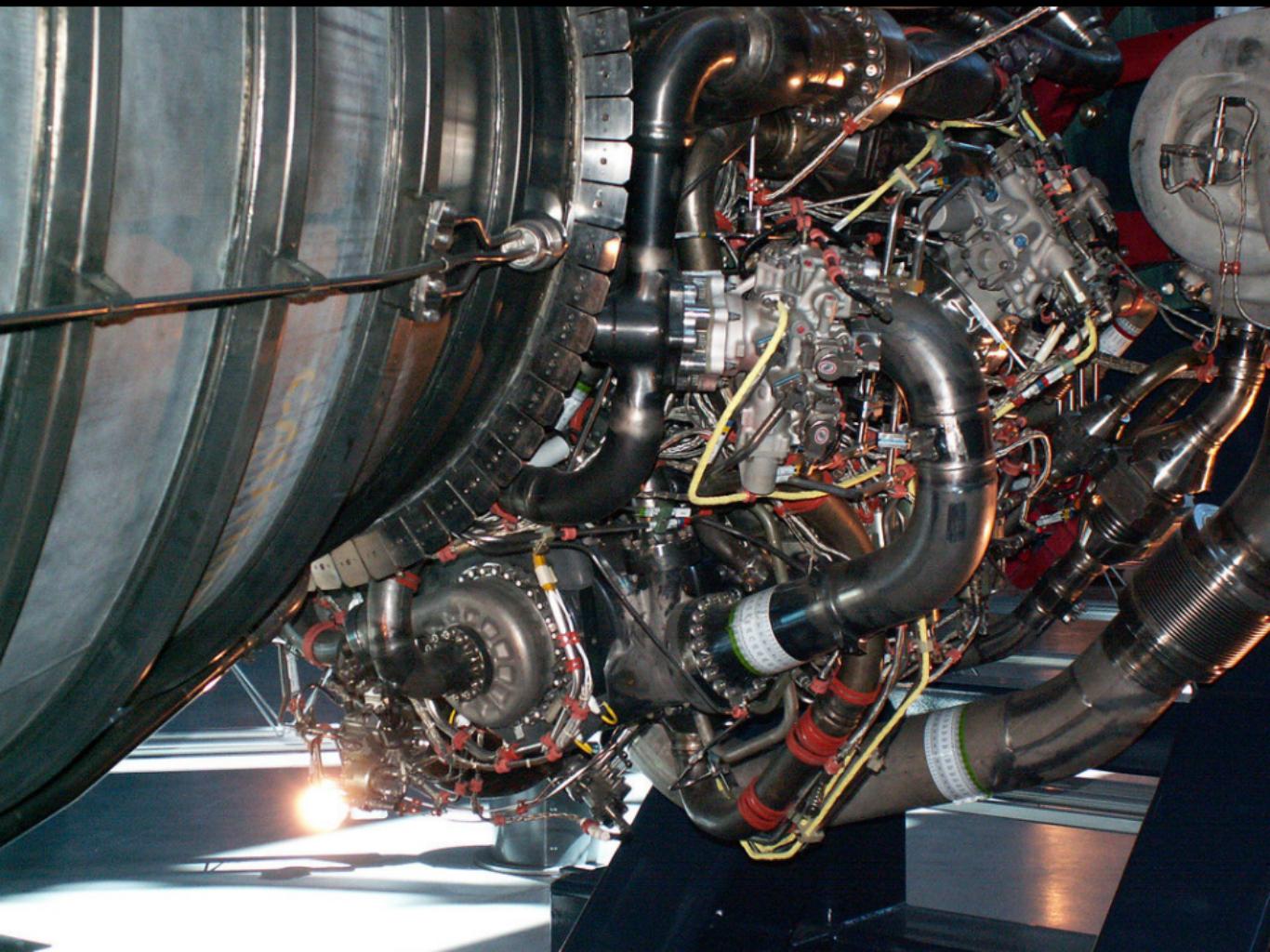
- ① Vorstellung davon was eine Method tun soll
- ② Methoden-Kopf erstellen
- ③ Testfälle schreiben
- ④ Methode implementieren
- ⑤ Testfälle aufrufen

Warum Testen?





ITLE LAUNCH
N FACILITY





Warum Testen?

Vorher Testen ist schneller
als hinterher Fehler zu suchen

denn:

Fehler sind meist schwer zu finden

Wie sollte ein Test aussehen?

Wie sollte ein Test aussehen?

Factorial.java

```
1 public static int factorial(int n) {return 0;}
```

```
2
```

```
3
```

```
4
```

```
5
```

```
6
```

```
7
```

```
8
```

```
9
```

```
10
```

```
11
```

Wie sollte ein Test aussehen?

Factorial.java

```
1 public static int factorial(int n) {return 0;}  
2  
3 public static void testFactorial() {  
4  
5  
6 }  
7  
8  
9 public static void main(String args[]) {  
10     testFactorial();  
11 }
```

Wie sollte ein Test aussehen?

Factorial.java

```
1 public static int factorial(int n) {return 0;}  
2  
3 public static void testFactorial() {  
4  
5  
6 }  
7  
8  
9 public static void main(String args[]) {  
10     testFactorial();  
11 }
```

```
1 ~ $ java Factorial  
2 factorial(4) expected: 24 result: 0  
3 factorial(1) expected: 1 result: 0  
4 factorial(0) expected: 1 result: 0
```

Wie sollte ein Test aussehen?

Factorial.java

```
1 public static int factorial(int n) {return 0;}  
2  
3 public static void testFactorial() {  
4     printTest("factorial", 4, factorial(4), 24);  
5     printTest("factorial", 1, factorial(1), 1);  
6     printTest("factorial", 0, factorial(0), 1);  
7 }  
8  
9 public static void main(String args[]) {  
10     testFactorial();  
11 }
```

```
1 ~ $ java Factorial  
2 factorial(4) expected: 24 result: 0  
3 factorial(1) expected: 1 result: 0  
4 factorial(0) expected: 1 result: 0
```

printTest

```
1 public static void printTest(
2     String methodName,
3     int param,
4     int result,
5     int expected) {
6
7     System.out.println(
8         methodName +
9         "(" + param + ")" + +
10        " expected: " + expected +
11        " result: " + result
12    );
13 }
```

```
1 ~ $ java Factorial
2 factorial(4) expected: 24 result: 0
3 factorial(1) expected: 1 result: 0
4 factorial(0) expected: 1 result: 0
```

Factorial implementiert, 1. Versuch

```
1 public static int factorial(int n) {  
2     int fac = 1;  
3     while(n != 0) {  
4         fac = fac * n;  
5         n = n - 1;  
6     }  
7     return fac;  
8 }
```

Factorial, 1. Versuch, Test

```
1 ~ $ java Factorial  
2 factorial(4) expected: 24 result: 24  
3 factorial(1) expected: 1 result: 1  
4 factorial(0) expected: 1 result: 1
```

Factorial: mehr Tests

```
1 public static void testFactorial() {  
2     printTest("factorial", 4, factorial(4), 24);  
3     printTest("factorial", 1, factorial(1), 1);  
4     printTest("factorial", 0, factorial(0), 1);  
5     printTest("factorial", -1, factorial(-1), 0);  
6 }
```

Was passiert?

Factorial, Test

```
1 ~ $ java Factorial
2 factorial(4) expected: 24 result: 24
3 factorial(1) expected: 1 result: 1
4 factorial(0) expected: 1 result: 1
5 -
```

Factorial, Test

```
1 ~ $ java Factorial  
2 factorial(4) expected: 24 result: 24  
3 factorial(1) expected: 1 result: 1  
4 factorial(0) expected: 1 result: 1  
5 -
```



... Stunden später ...

-1!

Factorial implementiert, 2. Versuch

```
1 public static int factorial(int n) {  
2     if(n<0){return 0;}  
3     int fac = 1;  
4     while(n != 0) {  
5         fac = fac * n;  
6         n = n - 1;  
7     }  
8     return fac;  
9 }
```

Factorial implementiert, 2. Versuch

```
1 public static int factorial(int n) {  
2     if(n<0){return 0;}  
3     int fac = 1;  
4     while(n != 0) {  
5         fac = fac * n;  
6         n = n - 1;  
7     }  
8     return fac;  
9 }
```

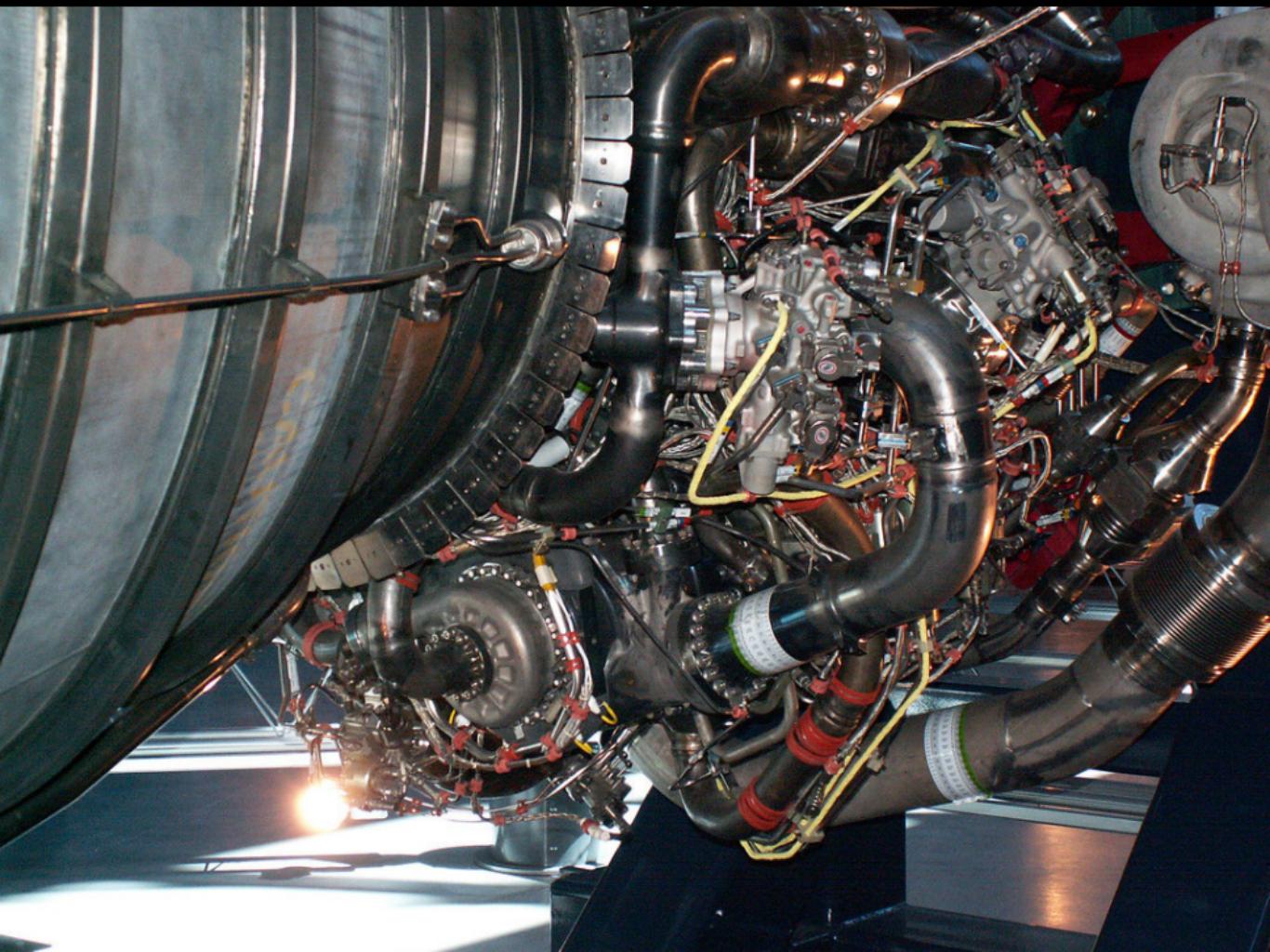
```
1 ~ $ java Factorial  
2 factorial(4) expected: 24 result: 24  
3 factorial(1) expected: 1 result: 1  
4 factorial(0) expected: 1 result: 1  
5 factorial(-1) expected: 0 result: 0
```

Grundsätze zum Testen

- Erst den Test, dann die Implementierung
- typische Fälle testen
- Randbereiche testen
- Sonderfälle testen
- Viel hilft Viel!

5. Debugging





(Debugging == Wie finde ich die lose Schraube?)

Systematik

- Fehlerstelle eingrenzen
- Programmablauf überprüfen

Systematik

- Fehlerstelle eingrenzen
- Programmablauf überprüfen
- durch: Kontrollausgaben

Beispiel - Modulo

```
1 public static int modulo(int zahl, int divisor) {  
2     int modulo = zahl;  
3  
4     while(modulo > divisor) {  
5  
6         modulo = modulo - divisor;  
7     }  
8  
9     return modulo;  
10 }  
11 }
```

Beispiel - Modulo

Code wurde nicht getestet

Beispiel - Modulo

Code wurde nicht getestet

Falsches Ergebnis

ohne Kontrollausgaben

```
1 public static int modulo(int zahl, int divisor) {  
2     int modulo = zahl;  
3  
4     while(modulo > divisor) {  
5  
6         modulo = modulo - divisor;  
7     }  
8  
9     return modulo;  
10 }  
11 }
```

mit Kontrollausgaben

```
1 public static int modulo(int zahl, int divisor) {  
2     int modulo = zahl;  
3     System.out.println(zahl + " % " + divisor);  
4     while(modulo > divisor) {  
5         System.out.print("modulo - divisor: " + modulo +  
6             " - " + divisor + " = " + (modulo - divisor));  
7         modulo = modulo - divisor;  
8     }  
9     System.out.println(zahl+" % "+divisor+" = " + modulo);  
10    return modulo;  
11 }
```

Ausgaben

Ausgaben

```
1 6 % 2
2 modulo - divisor: 6 - 2 = 4
3 modulo - divisor: 4 - 2 = 2
4 6 % 2 = 2
```

Ausgaben

```
1 6 % 2
2 modulo - divisor: 6 - 2 = 4
3 modulo - divisor: 4 - 2 = 2
4 6 % 2 = 2
```

- modulo(6, 2) sollte 0 sein
- Wo ist der Fehler?
 - Es wurde 1x zu wenig modulo abgezogen
 - Vergleich ist falsch
 - 4. Zeile: > Sollte >=

Debugging - Lösung

```
1 public static int modulo(int zahl, int divisor) {  
2     int modulo = zahl;  
3     //System.out.println(zahl + "%" + divisor);  
4     while(modulo >= divisor) {  
5         //System.out.print("modulo - divisor: " + modulo +  
6         //    "- " divisor + " = " + (modulo -divisor));  
7         modulo = modulo - divisor;  
8     }  
9     //System.out.println(zahl+"%" +divisor+"=" + modulo);  
10    return modulo;  
11 }
```


3. Java-API

Java-API



Java-API

- Standard-Funktionen:
 - Konsolenausgaben
 - Mathematische Berechnungen
 - Datenstrukturen (Listen, Bäume)
 - ...



Java-API

Wie finde ich diese Standard-Funktionen?

Java-API



Java-API



[Java Platform SE 6](#) [[Diese Seite übersetzen](#)]

Frame Alert. This document is designed to be viewed using the frames feature. If you see this message, you are using a non-frame-capable web client.

java.sun.com/javase/6/docs/api/ - 2k - [Im Cache](#) - [Ähnliche Seiten](#)

Java-API - Übersicht

The screenshot shows the Java API documentation interface. On the left is a sidebar with a tree view of packages and a list of all classes. The main content area has a header with tabs for Overview, Package, Class, Use, Tree, Deprecated, Index, and Help, with 'Tree' selected. Below the tabs are links for PREV and NEXT, and buttons for FRAMES and NO FRAMES. The title 'Java™ Platform, Standard Edition 6 API Specification' is centered above a paragraph stating it's the API specification for version 6 of the Java™ Platform, Standard Edition. A 'See:' section points to a 'Description' link. The main content is a table titled 'Packages' with rows for various Java packages and their descriptions.

Packages	
java.applet	Provides the classes necessary to create an applet and the classes an applet uses to communicate with its applet context.
java.awt	Contains all of the classes for creating user interfaces and for painting graphics and images.
java.awt.color	Provides classes for color spaces.
java.awt.datatransfer	Provides interfaces and classes for transferring data between and within applications.
java.awt.dnd	Drag and Drop is a direct manipulation gesture found in many Graphical User Interface systems that provides a mechanism to transfer information between two entities logically associated with presentation elements in the GUI.
java.awt.event	Provides interfaces and classes for dealing with different types of events fired by AWT components.

Exkurs: Package

Exkurs: Package



Exkurs: Package



Exkurs: Package



- Ähnlich einer Verzeichnisstruktur

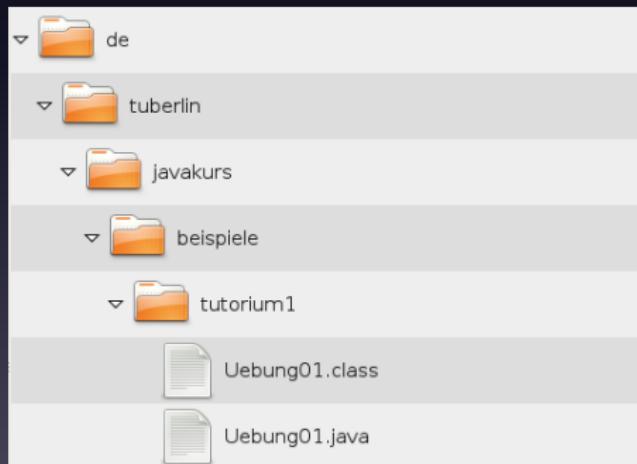
Exkurs: Package



- Ähnlich einer Verzeichnisstruktur
- Strukturierung nach unterschiedlichen Gesichtspunkten,

Exkurs: Package

```
1 package de.tuberlin.javakurs.beispiele.tutorium1;  
2  
3 public class Uebung01 {  
4 ...  
5 }
```



Java-API - Übersicht

The screenshot shows a web browser displaying the Java™ Platform, Standard Edition 6 API Specification. The left sidebar contains a navigation tree with categories like Java™ Platform Standard Ed. 6, Packages, and All Classes. The main content area has a header with links for Overview, Package, Class, Use, Tree, Deprecated, Index, Help, and buttons for PREV, NEXT, FRAMES, and NO FRAMES. Below the header is the title "Java™ Platform, Standard Edition 6 API Specification". A descriptive text states, "This document is the API specification for version 6 of the Java™ Platform, Standard Edition." Under the heading "See:", there is a link to "Description". The main content is a table titled "Packages" with rows for various Java packages and their descriptions.

Packages	
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java.awt.dnd	Drag and Drop is a direct manipulation gesture found in many Graphical User Interface systems that provides a mechanism to transfer information between two entities logically associated with presentation elements in the GUI.
java.awt.event	Provides interfaces and classes for dealing with different types of events fired by AWT components.

Java-API - Math.random()

The screenshot shows a Java API documentation page for the `Math.random()` method. The left sidebar lists various Java packages and classes, with the `java.lang` package highlighted by a yellow box and a red cursor arrow pointing to it. The main content area displays the **Java™ Platform, Standard Edition 6 API Specification**. It includes an overview of the API, links to Tree, Deprecated, Index, and Help, and options for FRAMES or NO FRAMES. The page also states that it is the API specification for version 6 of the Java™ Platform, Standard Edition. Below this, there is a "See:" section with a "Description" link, and a "Packages" section listing several Java packages with their descriptions.

Java™ Platform Standard Ed. 6

[All Classes](#)

Packages

[java.applet](#)
[java.awt](#)
[java.awt.color](#)
[java.awt.datatransfer](#)
[java.awt.dnd](#)

[ManagementPermission](#)
[ManageReferralControl](#)
[ManagerFactoryParameters](#)
[Manifest](#)
[Manifest](#)
[Map](#)
[Map.Entry](#)
[MappedByteBuffer](#)
[MARSHAL](#)
[MarshalException](#)
[MarshalException](#)
[MarshalException](#)
[MarshalledObject](#)
[Marshaller](#)
[Marshaller Listener](#)
[MaskFormatter](#)
[Matcher](#)

[MatchResult](#)

[Math](#)

[MathContext](#)

[Math class in java.lang](#)

[MBean](#)
[MBeanNotificationInfo](#)

Overview [Package](#) [Class](#) [Use](#) [Tree](#) [Deprecated](#) [Index](#) [Help](#)

[PREV](#) [NEXT](#)

[FRAMES](#) [NO FRAMES](#)

Java™ Platform Standard Edition 6

API Specification

This document is the API specification for version 6 of the Java™ Platform, Standard Edition.

See:

[Description](#)

Packages

java.applet	Provides the classes necessary to create an applet and the classes an applet uses to communicate with its applet context.
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Java-API - Math.random()

The screenshot shows the Java API documentation for the `Math.random()` method. The left sidebar lists various Java packages and classes, with `Math` being the active link, highlighted by a red arrow and a yellow box containing the text "class in java.lang". The main content area displays the `Class Math` page, showing the class hierarchy from `java.lang.Object` to `java.lang.Math`. It includes a brief description of the class's purpose, a note about its implementation, and detailed information about its methods and accuracy.

Java™ Platform Standard Ed. 6

[All Classes](#)

Packages

- [java.applet](#)
- [java.awt](#)
- [java.awt.color](#)
- [java.awt.datatransfer](#)
- [java.awt.dnd](#)

[ManagementPermission](#)

[ManageReferralControl](#)

[ManagerFactoryParameters](#)

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[Map](#)

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[MappedByteBuffer](#)

[MARSHAL](#)

[MarshalException](#)

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[MarshalledObject](#)

[Marshaller](#)

[Marshaller Listener](#)

[MaskFormatter](#)

[Matcher](#)

[MatchResult](#)

Math

[MathContext](#)

[Math](#) class in `java.lang`

[MBean](#)

[MBeanNotificationInfo](#)

[PREV CLASS](#) [NEXT CLASS](#)

[FRAMES](#) [NO FRAMES](#)

SUMMARY: NESTED | [FIELD](#) | CONSTR | [METHOD](#)

[DETAIL](#): [FIELD](#) | CONSTR | [METHOD](#)

Java™ Platform Standard Ed. 6

java.lang

Class Math

`java.lang.Object`

`java.lang.Math`

public final class `Math`
extends `Object`

The class `Math` contains methods for performing basic numeric operations such as the elementary exponential, logarithm, square root, and trigonometric functions.

Unlike some of the numeric methods of class `strictMath`, all implementations of the equivalent functions of class `Math` are not defined to return the bit-for-bit same results. This relaxation permits better-performing implementations where strict reproducibility is not required.

By default many of the `Math` methods simply call the equivalent method in `strictMath` for their implementation. Code generators are encouraged to use platform-specific native libraries or microprocessor instructions, where available, to provide higher-performance implementations of `Math` methods. Such higher-performance implementations still must conform to the specification for `Math`.

The quality of implementation specifications concern two properties, accuracy of the returned result and monotonicity of the method. Accuracy of the floating-point `Math` methods is measured in terms of *ulp*s, units in the last place. For a given floating-point format, an ulp is the distance between the two floating-point values representing a numerical value. When discussing the accuracy of a method as a whole, an at a specific argument, the number of ulps cited is for the worst-case error at that argument. If a method always has an error less than 0.5 ulps, the method always returns the floating-point number nearest the exact result; such a method is *correctly rounded*. A correctly rounded method is generally the best a floating-point approximation. However, it is impractical for many floating-point methods to be correctly rounded. Informally, with a 1 ulp error bound, when the exact result is a representable number, the

Java-API - Math.random()

Java™ Platform Standard Ed. 6	direction of the second argument.
static float nextAfter (float start, double direction)	Returns the floating-point number adjacent to the first argument in the direction of the second argument.
static double nextUp (double d)	Returns the floating-point value adjacent to <i>d</i> in the direction of positive infinity.
static float nextUp (float f)	Returns the floating-point value adjacent to <i>f</i> in the direction of positive infinity.
static double pow (double a, double b)	Returns the value of the first argument raised to the power of the second argument.
static double random ()	Returns a double value with a positive sign, greater than or equal to 0.0 and less than 1.0.
static double rint (double a)	Returns the double value that is closest in value to the argument and is equal to a mathematical integer.
static long round (double a)	Returns the closest long to the argument.
static int round (float a)	Returns the closest int to the argument.
static double scalb (double d, int scaleFactor)	Return <i>d</i> $\times 2^{\text{scaleFactor}}$ rounded as if performed by a single correctly rounded floating-point multiply to a member of the double value set.
static float scalb (float f, int scaleFactor)	Return <i>f</i> $\times 2^{\text{scaleFactor}}$ rounded as if performed by a single correctly rounded floating-point multiply to a member of the float value set.
signum (double d)	Returns the signum function of the argument; zero if the argument is zero, 1.0 if the argument is greater than zero, -1.0 if the argument is less than zero.
signum (float f)	Returns the signum function of the argument; zero if the argument is zero, 1.0 if the argument is greater than zero, -1.0 if the argument is less than zero.
static double sin (double a)	Determines the sine of an angle.

[MatchResult](#)

[Math](#)

[MathContext](#)

[Math class in java.lang](#)

[MBeanNotificationInfo](#)

Java-API - Math.random()

```
static double
```

```
random()
```

Returns a `double` value with a positive sign, greater than or equal to 0.0 and less than 1.0.

Java-API - Math.random()

```
static double random()
```

Returns a double value with a positive sign, greater than or equal to 0.0 and less than 1.0.

- Bezeichnung

Java-API - Math.random()

```
static double random()
```

Returns a double value with a positive sign, greater than or equal to 0.0 and less than 1.0.

- Bezeichnung
- Beschreibung

Java-API - Math.random()

```
static double random()  
    Returns a double value with a positive sign, greater than or equal to 0.0 and  
    less than 1.0.
```

- Bezeichnung
- Beschreibung
- Rückgabewert und Typ

Java-API - Math.pow()

```
static double pow(double a, double b)
```

Returns the value of the first argument raised to the power of the second argument.

Java-API - Math.pow()

```
static double pow(double a, double b)
```

Returns the value of the first argument raised to the power of the second argument.

- Parameter (Anzahl und Typen)
 - double a, double b

Fragen?

Viel Spaß bei den
Übungen!

Bildquellen

Dank an / Thanks to:

Name: Steve Berry URL: www.flickr.com/photos/unloveable/2387650243/
Name: Marc Worrel URL: www.flickr.com/photos/mworrell/266913194/
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