

Java 8 Date and Time API

The Java 8 Date and Time API

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Module Outline

- Why do we need a new Date API in Java 8?

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- The new Date API from Java 8: 7 concepts

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- **Why do we need a new Date API in Java 8?**
- **The new Date API from Java 8: 7 concepts**
- **Instant and Duration**

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- Why do we need a new Date API in Java 8?
- The new Date API from Java 8: 7 concepts
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- LocalDate, Period

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- ZonedDateTime

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- The new Date API from Java 8: 7 concepts
- Instant and Duration
- LocalDate, Period
- TemporalAdjusters
- LocalTime
- ZonedDateTime
- Date formatters

The Date API in Java 7

- One class : `java.util.Date` (and `java.sql.Date`) [JDK 1.0]

The Date API in Java 7

- One class : `java.util.Date` (and `java.sql.Date`) [JDK 1.0]
- And one pattern

```
Date date = new Date(); // just now !
```

The Date API in Java 7

- How can I create a date for the 2014 / 2 / 10?
- I must use the Calendar class

```
Calendar cal = Calendar.getInstance(); // just now !  
cal.set(2014, 1, 10);                // january is 0  
  
Date feb10th = cal.getTime();
```

The Date API in Java 7

- How can I create a date for the 2014 / 2 / 10?
- I must use the Calendar class

```
Calendar cal = Calendar.getInstance(); // just now !  
cal.set(2014, 1, 10);                // january is 0  
  
Date feb10th = cal.getTime();
```

- How can I add 7 days to feb10th?

```
cal.add(Calendar.DAY_OF_MONTH, 7);  
  
Date oneWeekLater = cal.getTime(); // one week later
```

The Date API in Java 7

- The Date class is *mutable*: what does it mean?

The Date API in Java 7

- The Date class is *mutable*: what does it mean?
- Here is an example

```
public class Customer {  
  
    private Date creationDate;  
  
    public Date getCreationDate() {  
        return this.creationDate;  
    }  
}
```

The Date API in Java 7

- Some other code could do that

```
Customer customer = new Customer();  
  
Date d = customer.getCreationDate();  
d.setTime(0L);
```


The Date API in Java 7

- Some other code could do that

```
Customer customer = new Customer();  
  
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- Thus modifying the *value* of the date of creation of the customer object

The Date API in Java 7

- Some other code could do that

```
Customer customer = new Customer();  
  
Date d = customer.getCreationDate();  
d.setTime(0L);
```

- Thus modifying the *value* of the date of creation of the customer object
- How can I prevent that?

The Date API in Java 7

- Use a defensive copy!

```
public class Customer {  
  
    private Date creationDate ;  
  
    public Date getCreationDate() {  
        return new Date(this.creationDate.getTime()) ;  
    }  
}
```

The Date API in Java 7

- Use a defensive copy!

```
public class Customer {  
  
    private Date creationDate ;  
  
    public Date getCreationDate() {  
        return new Date(this.creationDate.getTime()) ;  
    }  
}
```

- Overheads: new object to create on each call, overhead for the garbage collector
- Having a mutable Date class has a cost!

The Date API in Java 8

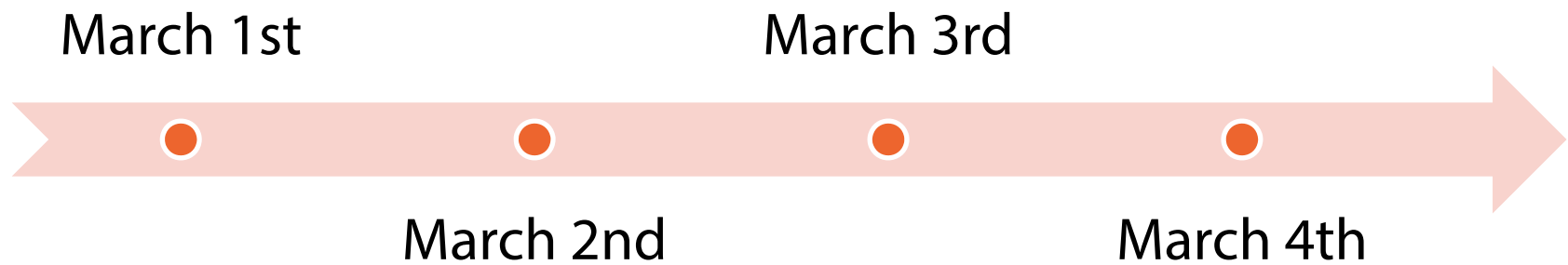
- New API, package is `java.time`
- New key concepts
- Interoperation with the legacy API

1st Concept: Instant

- **And Instant is a point on the time line**

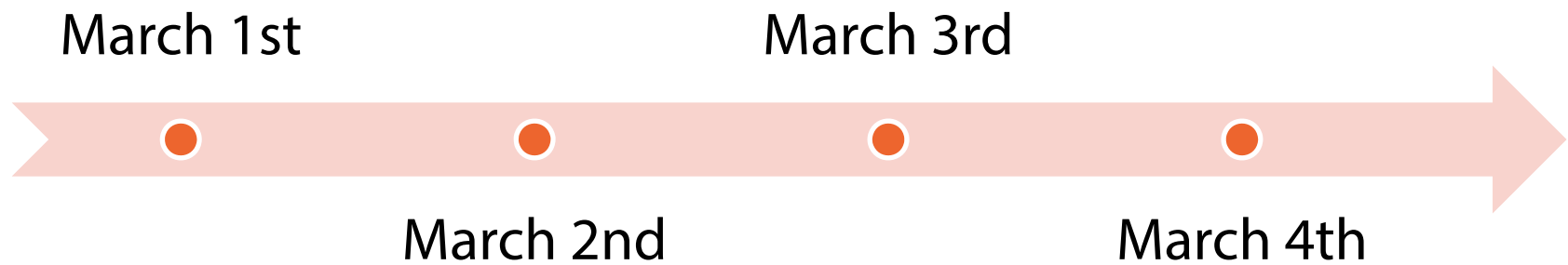
1st Concept: Instant

- And Instant is a point on the time line



1st Concept: Instant

- And Instant is a point on the time line



- The precision is the nanosecond!

1st Concept: Instant

- And Instant is a point on the time line
- Instant 0 is the January the 1st, 1970 at midnight GMT
- Instant.*MIN* is 1 billion years ago
- Instant.*MAX* is Dec. 31 of the year 1,000,000,000
- Instant.*now*() is the current instant

1st Concept: Instant

- And Instant is a point on the time line



- Precision is the nanosecond

1st Concept: Instant

- **An Instant is immutable**

1st Concept: Instant

- An Instant is immutable
- How can I use Instant?

```
Instant start = Instant.now();
```

```
// some long computations
```

```
Instant end = Instant.now();
```

1st Concept: Instant

- An Instant is immutable
- How can I use Instant?

```
Instant start = Instant.now();  
  
// some long computations  
  
Instant end = Instant.now();
```

- New concept: Duration

```
Duration elapsed = Duration.between(start, end);  
long millis = elapsed.toMillis();
```

2nd Concept: Duration

- A Duration is the amount of time between two Instant

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- A Duration is the amount of time between two Instant
- Methods :
- `toNanos()`, `toMillis()`, `toSeconds()`, `toMinutes()`, `toHours()`, `toDays()`
- `minusNanos()`, ...
- `plusNanos()`, ...

2nd Concept: Duration

- A Duration is the amount of time between two Instant
- Methods :
- toNanos(), toMillis(), toSeconds(), toMinutes(), toHours(), toDays()
- minusNanos(), ...
- plusNanos(), ...
- And also :
- multipliedBy(), dividedBy(), negated()
- isZero(), isNegative()

Many Cases Are Not Covered

- There are many cases where a date is not an « instant »

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- Ex: « Shakespeare was born Apr. 23rd, 1564 »

Many Cases Are Not Covered

- There are many cases where a date is not an « instant »
- Ex: « Shakespeare was born Apr. 23rd, 1564 »
- Ex: « Let us meet a 1pm and have lunch together! »

3rd Concept: LocalDate

- We need another concept for those « dates »
- New concept: LocalDate

3rd Concept: LocalDate

- We need another concept for those « dates »
- New concept: LocalDate
- How to create a LocalDate?

```
LocalDate now = LocalDate.now();  
LocalDate dateOfBirth =  
    LocalDate.of(1564, Month.APRIL, 23);
```

4th Concept: Period

- A Period is the amount of time between two `LocalDate`
- Same concept as `Duration`, same kind of methods

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- A Period is the amount of time between two LocalDate
- Same concept as Duration, same kind of methods
- When was Shakespeare born?

```
Period p = dateOfBirth.until(now);  
System.out.println("# years = " + p.getYears());
```

4th Concept: Period

- A Period is the amount of time between two LocalDate
- Same concept as Duration, same kind of methods
- When was Shakespeare born?

```
Period p = dateOfBirth.until(now);  
System.out.println("# years = " + p.getYears());
```

```
long days = dateOfBirth.until(now, ChronoUnit.DAYS);  
System.out.println("# days = " + days);
```


5th Concept: DateAdjuster

- Useful to add (or subtract) an amount of time to an Instant or a LocalDate

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- Useful to add (or subtract) an amount of time to an Instant or a LocalDate
- Use the method with()

```
LocalDate now = LocalDate.now();  
LocalDate nextSunday =  
    now.with(TemporalAdjusters.next(DayOfWeek.SUNDAY));
```

TemporalAdjusters

- 14 static methods to adjust an Instant or a LocalDate
- `firstDayOfMonth()`, `lastDayOfMonth()`
- `firstDayOfYear()`, `lastDayOfYear()`
- `firstDayOfNextMonth()`, `firstDayOfNextYear()`

TemporalAdjusters

- 14 static methods to adjust an Instant or a LocalDate
- `firstInMonth(DayOfWeek.MONDAY)`
- `lastInMonth(DayOfWeek.TUESDAY)`
- `dayOfWeekInMonth(2, DayOfWeek.THURSDAY)`

TemporalAdjusters

- 14 static methods to adjust an Instant or a LocalDate
- `next(DayOfWeek.SUNDAY)`
- `nextOrSame(DayOfWeek.SUNDAY)`
- `previous(DayOfWeek.SUNDAY)`
- `previousOrSame(DayOfWeek.SUNDAY)`

6th Concept: LocalTime

- A LocalTime is a time of day
- Ex: 10:20
- Pattern

```
LocalTime now = LocalTime.now();  
LocalTime time = LocalTime.of(10, 20) ; // 10:20
```

6th Concept: LocalTime

- A LocalTime is a time of day
- Ex: 10:20
- Pattern

```
LocalTime now = LocalTime.now();  
LocalTime time = LocalTime.of(10, 20) ; // 10:20
```

- Plus a set of methods to manipulate the time

```
LocalTime bedTime = LocalTime.of(23, 0);  
LocalTime wakeUpTime = bedTime.plusHours(8); // 7:00
```

7th Concept: Zoned Time

- There are Time Zones all over the earth
- Java uses the IANA database (<https://www.iana.org/time-zones>)
- The zones are available from

```
Set<String> allZonesIds = ZoneId.getAvailableZoneIds();  
  
String ukTZ = ZoneId.of("Europe/London");
```


7th Concept: Zoned Time

- How to create a zoned time

```
System.out.println(  
    ZonedDateTime.of(  
        1564, Month.APRIL.getValue(), 23, // year / month / day  
        10, 0, 0, 0, // h / mn / s / nanos  
        ZoneId.of("Europe/London"))  
); // prints 1564-04-23T10:00-00:01:15[Europe/London]
```

7th Concept: Zoned Time

- ZonedDateTime exposes a set of methods to compute other zoned times : plus, minus, with, etc...

```
ZonedDateTime currentMeeting =  
    ZonedDateTime.of(  
        LocalDate.of(2014, Month.MARCH, 12), // LocalDate  
        LocalTime.of(9, 30),                // LocalTime  
        ZoneId.of("Europe/London")  
    );  
  
ZonedDateTime nextMeeting =  
    currentMeeting.plus(Period.ofMonth(1));
```

7th Concept: Zoned Time

- ZonedDateTime exposes a set of methods to compute other zoned times : plus, minus, with, etc...

```
ZonedDateTime currentMeeting =  
    ZonedDateTime.of(  
        LocalDate.of(2014, Month.MARCH, 12), // LocalDate  
        LocalTime.of(9, 30),                // LocalTime  
        ZoneId.of("Europe/London")  
    );  
  
ZonedDateTime nextMeeting =  
    currentMeeting.plus(Period.ofMonth(1));
```

- And to change the time zone:

```
ZonedDateTime nextMeetingUS =  
    nextMeeting.withZoneSameInstant(ZoneId.of("US/Central"));
```

How to Format a Date

- The new date API proposes a new formatter: `DateTimeFormatter`
- The `DateTimeFormatter` proposes a set of predefined formatters, available as constants

```
ZonedDateTime nextMeetingUS =  
    nextMeeting.withZoneSameInstant(ZoneId.of("US/Central"));  
  
System.out.println(  
    DateTimeFormatter.ISO_DATE_TIME.format(nextMeetingUS)  
);  
// prints 2014-04-12T03:30:00-05:00[US/Central]  
  
System.out.println(  
    DateTimeFormatter.RFC_1123_DATE_TIME.format(nextMeetingUS)  
);  
// prints Sat, 12 Apr 2014 03:30:00 -0500
```

Bridges Between the APIs

- **How to interoperate with the legacy Date API?**

Bridges Between the APIs

- How to interoperate with the legacy Date API?
- Instant & Date:

```
Date date = Date.from(instant);    // legacy -> new API  
Instant instant = date.toInstant(); // API -> legacy
```

Bridges Between the APIs

- How to interoperate with the legacy Date API?

- Instant & Date:

```
Date date = Date.from(instant);    // legacy -> new API  
Instant instant = date.toInstant(); // API -> legacy
```

- Instant & TimeStamp:

```
TimeStamp time = TimeStamp.from(instant); // legacy -> new API  
Instant instant = time.toInstant();       // API -> legacy
```

Bridges Between the APIs

- How to interoperate with the legacy Date API?

- Instant & Date:

```
Date date = Date.from(instant);      // legacy -> new API
Instant instant = date.toInstant();  // API -> legacy
```

- Instant & TimeStamp:

```
TimeStamp time = TimeStamp.from(instant); // legacy -> new API
Instant instant = time.toInstant();       // API -> legacy
```

- LocalDate & Date :

```
Date date = Date.from(localDate);      // legacy -> new API
LocalDate localDate = date.toLocalDate(); // API -> legacy
```


Bridges Between the APIs

- How to interoperate with the legacy Date API?

- Instant & Date:

```
Date date = Date.from(instant);      // legacy -> new API
Instant instant = date.toInstant();  // API -> legacy
```

- Instant & TimeStamp:

```
TimeStamp time = TimeStamp.from(instant); // legacy -> new API
Instant instant = time.toInstant();       // API -> legacy
```

- LocalDate & Date :

```
Date date = Date.from(localDate);      // legacy -> new API
LocalDate localDate = date.toLocalDate(); // API -> legacy
```

- LocalTime & Time

```
Time time = Time.from(localTime);      // legacy -> new API
LocalTime localTime = time.toLocalTime(); // API -> legacy
```

Summary

- The new Date API from Java 8 fixes the issues of Java 7
- The new concepts of « date » in Java
- The new concepts of « duration » in Java
- How to compute a new date from a given date
- How to deal with time zones
- How to format date following the established standards