Java 8 Date Time API

What’s wrong with existing Date API?

Before we learn about new Date Time API let’s understand why existing Date API sucks. Look at the code shown below and try to answer what it will print.

```java
import java.util.Date;

public class DateSucks {

    public static void main(String[] args) {
        Date date = new Date(12, 12, 12);
        System.out.println(date);
    }
}
```

Can you answer what above code prints? Most Java developers will expect the program to print `0012-12-12` but the above code prints `Sun Jan 12 00:00:00 IST 1913`. My first reaction when I learnt that program prints `Sun Jan 12 00:00:00 IST 1913` was WTF???

The code shown above has following issues:

1. What each 12 means? Is it month, year, date or date, month, year or any other combination.
2. Date API month index starts at 0. So, December is actually 11.
3. Date API rolls over i.e. 12 will become January.
4. Year starts with 1900. And because month also roll over so year becomes `1900 + 12 + 1 == 1913`. Go figure!!
5. Who asked for time? I just asked for date but program prints time as well.
6. Why is there time zone? Who asked for it? The time zone is JVM’s default time zone, IST, Indian Standard Time in this example.

Date API is close to 20 years old introduced with JDK 1.0. One of the original authors of Date API is none other than James Gosling himself — Father of Java Programming Language.

There are many other design issues with Date API like mutability, separate class hierarchy for SQL, etc. In JDK1.1 effort was made to provide a better API i.e. `Calendar` but it was also plagued with similar issues of mutability and index starting at 0.

Java 8 Date Time API

Java 8 Date Time API was developed as part of JSR-310 and reside insides `java.time` package. The API applies **domain-driven design** principles with domain classes like LocalDate, LocalTime applicable to solve problems related to their specific domains of date and time. This makes API intent clear and easy to understand. The other design principle applied is the **immutability**. All the core classes in the `java.time` are immutable hence avoiding thread-safety issues.

Getting Started with Java 8 Date Time API

The three classes that you will encounter most in the new API are `LocalDate`, `LocalTime`, and `LocalDateTime`. Their description is like their name suggests:

- **LocalDate**: It represents a date with no time or timezone.
- **LocalTime**: It represents time with no date or timezone

- **LocalDateTime**: It is the combination of LocalDate and LocalTime i.e. date with time without time zone.

We will use JUnit to drive our examples. We will first write a JUnit case that will explain what we are trying to do and then we will write code to make the test pass. Examples will be based on great Indian president — A.P.J Abdul Kalam.

Kalam was born on 15th October 1931

```

import org.junit.Test;
import java.time.LocalDate;
import static org.hamcrest.CoreMatchers.equalTo;
import static org.junit.Assert.assertThat;

public class DateTimeExamplesTest {
    private AbdulKalam kalam = new AbdulKalam();
    @Test
    public void kalamWasBornOn15October1931() throws Exception {
        LocalDate dateOfBirth = kalam.dateOfBirth();
        assertThat(dateOfBirth.toString(), equalTo("1931-10-15"));
    }
}

```

`LocalDate` has a static factory method `of` that takes year, month, and date and gives you a `LocalDate`. To make this test pass, we will write `dateOfBirth` method in `AbdulKalam` class using `of` method as shown below.

```
import java.time.LocalDate;
import java.time.Month;

public class AbdulKalam {
    public LocalDate dateOfBirth() {
        return LocalDate.of(1931, Month.OCTOBER, 15);
    }
}
```

There is an overloaded `of` method that takes month as integer instead of `Month` enum. I recommend using `Month` enum as it is more readable and clear. There are two other static factory methods to create `LocalDate` instances — `ofYearDay` and `ofEpochDay`.

The `ofYearDay` creates LocalDate instance from the year and day of year for example March 31st 2015 is the 90th day in 2015 so we can create LocalDate using `LocalDate.ofYearDay(2015, 90)`.

```
LocalDate january_21st = LocalDate.ofYearDay(2015, 21);
System.out.println(january_21st); // 2015-01-21
LocalDate march_31st = LocalDate.ofYearDay(2015, 90);
System.out.println(march_31st); // 2015-03-31
```

The `ofEpochDay` creates LocalDate instance using the epoch day count. The starting value of is `1970-01-01`. So, `LocalDate.ofEpochDay(1)` will give `1970-01-02`.

LocalDate instance provide many accessor methods to access different fields like year, month, dayOfWeek, etc.

```
@Test
public void kalamWasBornOn15October1931() throws Exception {
    LocalDate dateOfBirth = kalam.dateOfBirth();
    assertThat(dateOfBirth.getMonth(), is(equalTo(Month.OCTOBER)));
    assertThat(dateOfBirth.getYear(), is(equalTo(1931)));
    assertThat(dateOfBirth.getDayOfMonth(), is(equalTo(15)));
    assertThat(dateOfBirth.getDayOfYear(), is(equalTo(288)));
}
```

You can create current date from the system clock using `now` static factory method.

```
LocalDate.now()
```

Kalam was born at 01:15am

```java
@Test
public void kalamWasBornAt0115() throws Exception {
    LocalTime timeOfBirth = kalam.timeOfBirth();
    assertThat(timeOfBirth.toString(), is(equalTo("01:15")));
}
```

`LocalTime` class is used to work with time. Just like `LocalDate`, it also provides static factory methods for creating its instances. We will use the `of` static factory method giving it hour and minute and it will return LocalTime as shown below.

```java
public LocalTime timeOfBirth() {
    return LocalTime.of(1, 15);
}
```

There are other overloaded variants of `of` method that can take second and nanosecond.

LocalTime is represented to nanosecond precision.

You can print the current time of the system clock using `now` method as shown below.

```java
LocalTime.now()
```

You can also create instances of `LocalTime` from seconds of day or nanosecond of day using `ofSecondOfDay` and `ofNanoOfDay` static factory methods.

Similar to `LocalDate` `LocalTime` also provide accessor for its field as shown below.

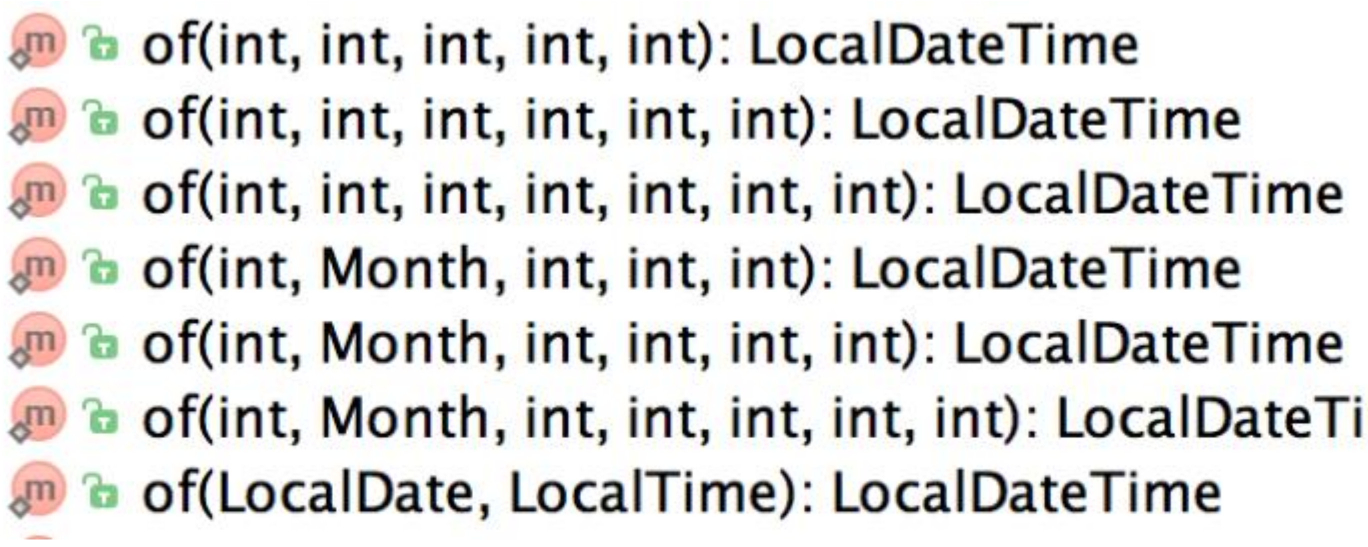
```java
@Test
public void kalamWasBornAt0115() throws Exception {
    LocalTime timeOfBirth = kalam.timeOfBirth();
    assertThat(timeOfBirth.getHour(), is(equalTo(1)));
    assertThat(timeOfBirth.getMinute(), is(equalTo(15)));
    assertThat(timeOfBirth.getSecond(), is(equalTo(0)));
}
```

Kalam was born on 15 October at 01:15 am

When you want to represent both date and time together then you can use `LocalDateTime`. LocalDateTime also provides many static factory methods to create its instances. We can use `of` factory method that takes a `LocalDate` and `LocalTime` and gives `LocalDateTime` instance as shown below.

```java
public LocalDateTime dateOfBirthAndTime() {
    return LocalDateTime.of(dateOfBirth(), timeOfBirth());
}
```

There are many overloaded variants of `of` method which as arguments take year, month, day, hour, min, secondOfDay, nanosecondOfDay.



of(int, int, int, int, int): LocalDateTime
of(int, int, int, int, int, int): LocalDateTime
of(int, int, int, int, int, int, int): LocalDateTime
of(int, Month, int, int, int): LocalDateTime
of(int, Month, int, int, int, int): LocalDateTime
of(int, Month, int, int, int, int, int): LocalDateTi
of(LocalDate, LocalTime): LocalDateTime

To create current date and time using system clock you can use `now` factory method.

```
LocalDateTime.now()
```

Manipulating dates

Now that we know how to create instances of `LocalDate`, `LocalTime`, and `LocalDateTime` let's learn how we can manipulate them.

LocalDate, LocalTime, and LocalDateTime are immutable so each time you perform a manipulation operation you get a new instance.

Kalam 50th birthday was on Thursday

```
@Test
public void kalam50thBirthDayWasOnThursday() throws Exception {
    DayOfWeek dayOfWeek = kalam.dayOfBirthAtAge(50);
    assertThat(dayOfWeek, is(equalTo(DayOfWeek.THURSDAY)));
}
```

We can use `dateOfBirth` method that we wrote earlier with `plusYears` on `LocalDate` instance to achieve this as shown below.

```
public DayOfWeek dayOfBirthAtAge(final int age) {
    return dateOfBirth().plusYears(age).getDayOfWeek();
}
```

There are similar `plus*` variants for adding days, months, weeks to the value.

Similar to `plus` methods there are `minus` methods that allow you minus year, days, months from a `LocalDate` instance.

```
LocalDate today = LocalDate.now();
LocalDate yesterday = today.minusDays(1);
```

Just like LocalDate LocalTime and LocalDateTime also provide similar `plus*` and `minus*` methods.

List all Kalam's birthdate DayOfWeek

For this use-case, we will create an infinite stream of `LocalDate` starting from the Kalam's date of birth using the `Stream.iterate` method. `Stream.iterate` method takes a starting value and a function that allows you to work on the initial seed value and return another value. We just incremented the year by 1 and return next year birthdate. Then we transformed `LocalDate` to `DayOfWeek` to get the desired output value. Finally, we limited our result set to the provided limit and collected Stream result into a List.

```
public List<DayOfWeek> allBirthDateDayOfWeeks(int limit) {
    return Stream.iterate(dateOfBirth(), db -> db.plusYears(1))
            .map(LocalDate::getDayOfWeek)
            .limit(limit)
            .collect(toList());
}
```

Duration and Period

`Duration` and `Period` classes represents quantity or amount of time.

Duration represents quantity or amount of time in seconds, nano-seconds, or days like 10 seconds.

Period represents amount or quantity of time in years, months, and days.

Calculate number of days kalam lived

```
@Test
public void kalamLived30601Days() throws Exception {
    long daysLived = kalam.numberOfDaysLived();
    assertThat(daysLived, is(equalTo(30601L)));
}
```

To calculate number of days kalam lived we can use `Duration` class. `Duration` has a factory method that takes two `LocalTime`, or `LocalDateTime` or `Instant` and gives a duration. The duration can then be converted to days, hours, seconds, etc.

```
public Duration kalamLifeDuration() {
    LocalDateTime deathDateAndTime = LocalDateTime.of(LocalDate.of(2015, Month.JULY
    return Duration.between(dateOfBirthAndTime(), deathDateAndTime);
```

```java
}

public long numberOfDaysLived() {
    return kalamLifeDuration().toDays();
}
```

Kalam lived 83 years 9 months and 12 days

```java
@Test
public void kalamLifePeriod() throws Exception {
    Period kalamLifePeriod = kalam.kalamLifePeriod();
    assertThat(kalamLifePeriod.getYears(), is(equalTo(83)));
    assertThat(kalamLifePeriod.getMonths(), is(equalTo(9)));
    assertThat(kalamLifePeriod.getDays(), is(equalTo(12)));
}
```

We can use `Period` class to calculate number of years, months, and days kalam lived as shown below. Period's `between` method works with `LocalDate` only.

```java
public Period kalamLifePeriod() {
    LocalDate deathDate = LocalDate.of(2015, Month.JULY, 27);
    return Period.between(dateOfBirth(), deathDate);
}
```

Printing and Parsing dates

In our day-to-day applications a lot of times we have to parse a text format to a date or time or we have to print a date or time in a specific format. Printing and parsing are very common use cases when working with date or time. Java 8 provides a class `DateTimeFormatter` which is the main class for formatting and printing. All the classes and interfaces relevant to them resides inside the `java.time.format` package.

Print Kalam birthdate in Indian date format

In India, `dd-MM-YYYY` is the predominant date format that is used in all the government documents like passport application form. You can read more about Date and time notation in India on the wikipedia.

```java
@Test
public void kalamDateOfBirthFormattedInIndianDateFormat() throws Exception {
    final String indianDateFormat = "dd-MM-YYYY";
    String dateOfBirth = kalam.formatDateOfBirth(indianDateFormat);
    assertThat(dateOfBirth, is(equalTo("15-10-1931")));
}
```

The `formatDateofBirth` method uses `DateTimeFormatter` `ofPattern` method to create a new formatter using the specified pattern. All the main main date-time classes provide two methods – one for formatting, `format(DateTimeFormatter formatter)`, and one for parsing, `parse(CharSequence text, DateTimeFormatter formatter)`.

```
public String formatDateOfBirth(final String pattern) {
    DateTimeFormatter formatter = DateTimeFormatter.ofPattern(pattern);
    return dateOfBirth().format(formatter);
}
```

For the common use cases, `DateTimeFormatter` class provides formatters as static constants. There are predefined constants for `BASIC_ISO_DATE` i.e **20111203** or `ISO_DATE` i.e. **2011-12-03**, etc that developers can easily use in their code. In the code shown below, you can see how to use these predefined formats.

```
@Test
public void kalamDateOfBirthInDifferentDateFormats() throws Exception {
    LocalDate kalamDateOfBirth = LocalDate.of(1931, Month.OCTOBER, 15);
    assertThat(kalamDateOfBirth.format(DateTimeFormatter.BASIC_ISO_DATE), is(equalT
    assertThat(kalamDateOfBirth.format(DateTimeFormatter.ISO_LOCAL_DATE), is(equalT
    assertThat(kalamDateOfBirth.format(DateTimeFormatter.ISO_ORDINAL_DATE), is(equa
}
```

Parsing text to LocalDateTime

Let’s suppose we have to parse `15 Oct 1931 01:15 AM` to a LocalDateTime instance as shown in code below.

```
@Test
public void shouldParseKalamDateOfBirthAndTimeToLocalDateTime() throws Exception {
    final String input = "15 Oct 1931 01:15 AM";
    LocalDateTime dateOfBirthAndTime = kalam.parseDateOfBirthAndTime(input);
    assertThat(dateOfBirthAndTime.toString(), is(equalTo("1931-10-15T01:15")));
}
```

We will again use `DateTimeFormatter` `ofPattern` method to create a new `DateTimeFormatter` and then use the `parse` method of `LocalDateTime` to create a new instance of `LocalDateTime` as shown below.

```
public LocalDateTime parseDateOfBirthAndTime(String input) {
    return LocalDateTime.parse(input, DateTimeFormatter.ofPattern("dd MMM yyyy hh:m
}
```

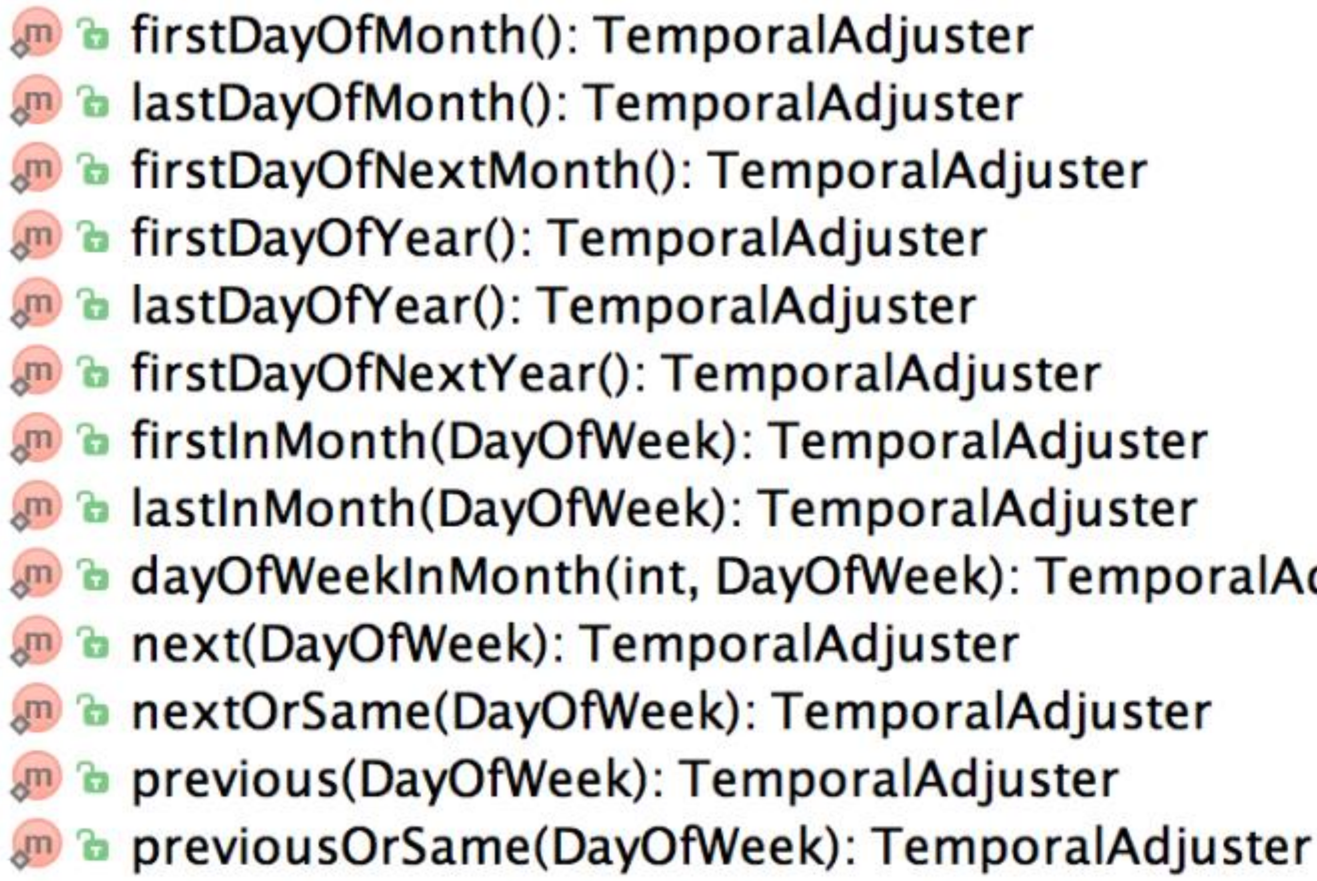
Advance date time manipulation with TemporalAdjusters

In `Manipulating dates` section, we learnt how we can use `plus*` and `minus*` methods to manipulate dates. Those methods are suitable for simple manipulation operations like adding or subtracting days, months, or years. Sometimes, we need to perform advance date time manipulation such as adjusting date to first day of next month or adjusting date to next working day or adjusting date to next public holiday then we can use `TemporalAdjusters` to meet our needs. Java 8 comes bundled with many predefined temporal adjusters for common scenarios. These temporal adjusters are available as static factory methods inside the `TemporalAdjusters` class.

```
LocalDate date = LocalDate.of(2015, Month.OCTOBER, 25);
System.out.println(date);// This will print 2015-10-25

LocalDate firstDayOfMonth = date.with(TemporalAdjusters.firstDayOfMonth());
System.out.println(firstDayOfMonth); // This will print 2015-10-01

LocalDate firstDayOfNextMonth = date.with(TemporalAdjusters.firstDayOfNextMonth())
System.out.println(firstDayOfNextMonth);// This will print 2015-11-01

LocalDate lastFridayOfMonth = date.with(TemporalAdjusters.lastInMonth(DayOfWeek.FR
System.out.println(lastFridayOfMonth); // This will print 2015-10-30
```

- **firstDayOfMonth** creates a new date set to first day of the current month.
- **firstDayOfNextMonth** creates a new date set to first day of next month.
- **lastInMonth** creates a new date in the same month with the last matching day-of-week. For example, last Friday in October.

I have not covered all the temporal-adjusters please refer to the documentation for the same.



firstDayOfMonth(): TemporalAdjuster
lastDayOfMonth(): TemporalAdjuster
firstDayOfNextMonth(): TemporalAdjuster
firstDayOfYear(): TemporalAdjuster
lastDayOfYear(): TemporalAdjuster
firstDayOfNextYear(): TemporalAdjuster
firstInMonth(DayOfWeek): TemporalAdjuster
lastInMonth(DayOfWeek): TemporalAdjuster
dayOfWeekInMonth(int, DayOfWeek): TemporalAdju
next(DayOfWeek): TemporalAdjuster
nextOrSame(DayOfWeek): TemporalAdjuster
previous(DayOfWeek): TemporalAdjuster
previousOrSame(DayOfWeek): TemporalAdjuster

Writing custom TemporalAdjuster

You can write your own adjuster by implementing `TemporalAdjuster` functional interface. Let's suppose we have to write a TemporalAdjuster that adjusts today's date to next working date then we can use the `TemporalAdjusters` `ofDateAdjuster` method to adjust the current date to next working date as show below.

```
LocalDate today = LocalDate.now();
TemporalAdjuster nextWorkingDayAdjuster = TemporalAdjusters.ofDateAdjuster(localDa
    DayOfWeek dayOfWeek = localDate.getDayOfWeek();
    if (dayOfWeek == DayOfWeek.FRIDAY) {
        return localDate.plusDays(3);
    } else if (dayOfWeek == DayOfWeek.SATURDAY) {
        return localDate.plusDays(2);
    }
    return localDate.plusDays(1);
});
System.out.println(today.with(nextWorkingDayAdjuster));
```

Conclusion

In the sixth blog of this series, you learnt how Java 8 Date Time API can help you write clean code when working with dates. The API is clean, easy to use, and understandable. In the next blog, we will look at some other topic of Java 8 so stay tuned.