# ECSE 321 - Tutorial 6

## CSV and Serialization

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Comma
Separated
Values!

# What's that?

- CSV is a popular format for storing data in text form.
- "Easy" to convert an object to a text file and back.
- **Serialization** describes a mechanism used to convert an object/structure into a series of bytes and back.
- Why is this useful? Where would it be useful in your project?

# Simplest Format

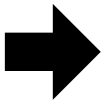
- Note that CSV is not standardized.
- Each row represents an object.
- Each field is separated by a comma.
- Suppose we had objects containing a first name, a school name, a degree name, and a graduation year. This could be saved like so:

```
Dominic,McGill,Bachelor of Science,2015
John,Concordia,Bachelor of Arts,2016
Laura,UQAM,Bachelor of Commerce,2017
```

# Spreadsheet Example

- CSV is a great format for storing spreadsheet data in a file.
- Most spreadsheet software let you import data from CSV.

```
1,3,19.00
2,5,18.200
3,6,17.300
```



| | A | B | C |
|---|---|---|---|
| 1 | 1 | 3 | 19 |
| 2 | 2 | 5 | 18.2 |
| 3 | 3 | 6 | 17.3 |

# Data Headers

CSV lets us optionally use the first row as headers, naming each field/column.

These names are formatted like a regular CSV row.

```
Name,Program,Age
Dominic,Computer Science,22
Michael,Engineering,22
Jennifer,Math,21
Annie,Management,19
Fred,Art History,20
```

But what if my data has commas?!

# Quotes Fields

If we have commas in a field, we can wrap the entire field in double-quotes.

This tells CSV parsers that any comma within the double quotes is meant to be part of the data!

```
Name,Program,Age
"Charley-Roy, Dominic",Computer Science,22
"James, Michael",Engineering,22
"O'Connor, Jennifer",Math,21
"Panini, Annie",Management,19
"Lestrange, Fred",Art History,20
```

But what if my data has "quotes"?!

# Escaping Quotes

To do this, we have to wrap a field in quotes and, for any quote which is part of the data, add a quote in front of it.

```
Name,Program,Age
"Dominic ""Nickname"" Charley-Roy",Computer Science,22
"Michael ""Nickname"" James",Engineering,22
"Jennifer ""Nickname"" O'Connor",Math,21
```

But what if I don't like commas... :(

# The Delimiter

- The delimiter is the character which separates fields in CSV files! By default, it is a comma.
- Most parsers let you specify the character. Note that this should be a character and not more!
- Some common examples: |, tab, space

```
x|y
1|10
2|20
3|30
```

# Apache Commons CSV


http://commons.apache.org/proper/commons-csv/download_csv.cgi

# Apache Commons CSV

- Java library
- Easy to use!
- It's super flexible! Supports both reading from a CSV file and writing to one!
- **Installation:**
  **1.** Download and unzip the zip file
  **2.** Move the jar file to your project
  **3.** Add the jar to your project's build path.

# Reading time!

Reading from a file using ACC (Apache Commons CSV) is super simple!

The first step is to build a **CSVFormat**, which will describe the formatting of our file (delimiter, are headers present, etc.).

We then create a **CSVParser** based on the format and a **FileReader**.

The **CSVReader** provides us with a list of **CSVRecord**s!

# Creating the CSVFormat

The default format uses commas as a delimiter, supports double quotes, and does not have the first row as headers.

```
CSVFormat myFormat = CSVFormat.DEFAULT;
```

To enable a header row, we **call a method on the format**. This will build a **new** format.

```
CSVFormat myFormat = CSVFormat.DEFAULT.withHeaders();
```

We can also hard-code headers instead of putting a header row.

```
CSVFormat myFormat = CSVFormat.DEFAULT.withHeaders(
    "Name", "Age", "Location");
```

# More CSVFormat Tricks

If we want to change the delimiter to a pipe (|):

```
CSVFormat myFormat = CSVFormat.DEFAULT.withDelimiter('|');
```

These can also be chained! Suppose we want the pipe delimiter and a header row:

```
CSVFormat myFormat = CSVFormat.DEFAULT
    .withDelimiter('|')
    .withHeader();
```

There's a lot more options, so I encourage you to check them out! For example, we can have comments in CSV files...

# Creating a CSVParser

Once we have our format, we can create our CSVParser! This will wrap around a **Reader** and a **CSVFormat.**

Note: Creating a FileReader can throw an exception, so we need to make sure to take that into consideration...

```
CSVParser parser = new CSVParser(
    new FileReader("data.csv"), myFormat);
```

When we are done with our **CSVParser**, we need to **close it** to prevent memory leaks. This will also close the **FileReader**!

```
parser.close();
```

# Extracting the Records!

CSVParser makes it very easy to get our data! We simply call **getRecords** to get a list of our CSVRecords!

**Note:** If we have a header row, this will not be included in the list if we set up our format correctly!

```
List<CSVRecord> records = parser.getRecords();
```

**Protip:** Since this is a list, this is iterable! So we can use the special for-each loop to go over each record!

```
for (CSVRecord record : parser.getRecords()) {
    // ... insert coolness here.
}
```

# The CSVRecord!

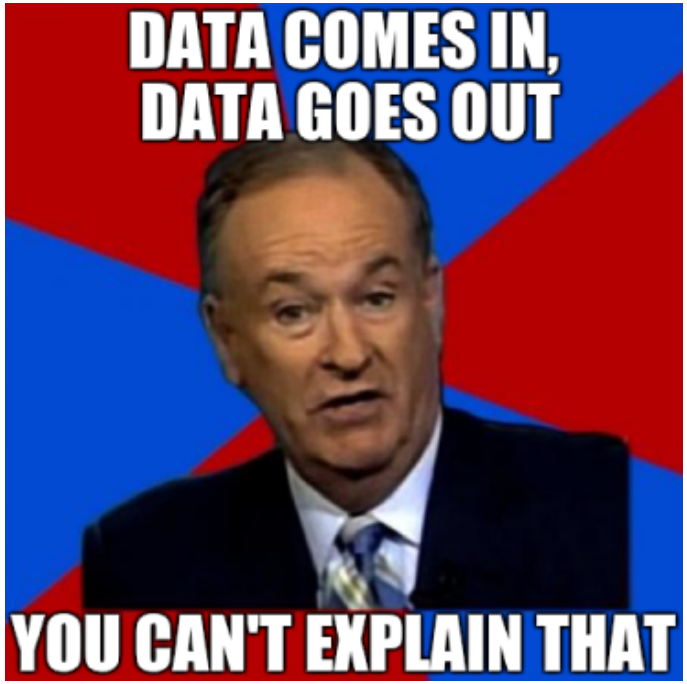
Each **CSVRecord** represents a row in our data file! It works like a 0-indexed array of strings, so if we wanted the third field we would do:

```
String thirdField = record.get(2);
```

If we are using headers, we can also use the header name of the field! Suppose we have a field named grade...

```
int grade = Integer.parseInt(
    record.get("grade"));
```

# Writing to CSV files...



# The Writing Process

1. Create our **CSVFormat** like before.
   *Note*: If you want headers, you have to hard-code them using *withHeaders*.
2. Create a **CSVPrinter** wrapped around a stream and a **CSVFormat**
3. Print our records to the **CSVPrinter**
4. Close the printer!

# Building a Printer...

Wait no...

# Creating the CSVPrinter!

We wrap the CSVPrinter around a stream, usually a **FileWriter**.

```
CSVPrinter printer = new CSVPrinter(
    new FileWriter("data.csv"), myFormat);
```

Again we have to make sure to close the printer when we are done with it to prevent memory leaks (and make sure it saves!)

```
printer.close();
```

# Saving Records

There are two ways to save records! The first is to simply pass in all the arguments as arguments to the **printRecord** method. This can be done in two ways.

```
// Method 1
printer.printRecord("Dominic", 22, "McGill");
// Method 2
String[] fields = new String[] {
    "Dominic", "23", "McGill"};
printer.printRecord(fields);
```

The second is to record the fields one by one and then add the new line.

```
printer.print("Dominic");
printer.print(23);
printer.print("McGill");
printer.println();
```

# Making our code easily serializable!

# Possible Approach

We want to create some kind of general, consistent way to serialize our object. In a game, you may have a lot of object you want to serialize, so this is important...

1. Create 1 class which provides read and write methods for all of our objects.
2. Create an interface providing both a read and write method. Each class that we will want to serialize will have a corresponding interface implementation.

**This is important because field order matters in a CSV file, so we need to be consistent!**

# Sample Data Class 1

```
public class Person {
        private String firstName;
        private String lastName;
        private int age;

        public Person(String firstName, String lastName, int age) {
                this.firstName = firstName;
                this.lastName = lastName;
                this.age = age;
        }

        public String getFirstName() {
                return firstName;
        }

        public String getLastName() {
                return lastName;
        }

        public int getAge() {
                return age;
        }
}
```

# Sample Data Class 2

```
public class Course {
        private String name;
        private int enrolled;

        public Course(String name, int enrolled) {
                this.name = name;
                this.enrolled = enrolled;
        }

        public String getName() {
                return name;
        }

        public int getEnrolled() {
                return enrolled;
        }
}
```

# Approach 1

This approach has 1 class responsible for all of our serialization. It exposes methods for each class.

```
public class Serializer {
        public CSVParser createParser(FileReader reader) {
                // ...
        }
        public CSVPrinter createPrinter(FileWriter writer) {
                // ...
        }
        public Person readPerson(CSVRecord record){
                // ...
        }
        public void writePerson(Person person, CSVPrinter printer) {
                // ...
        }
        public Course readCourse(CSVRecord record){
                // ...
        }
        public void writeCourse(Course course, CSVPrinter printer) {
                // ...
        }
}
```

# Sample Implementation

```
public Person readPerson(CSVRecord record){
        return new Person(
                        record.get(0),
                        record.get(1),
                        Integer.parseInt(record.get(2)));
}

public void writePerson(Person person, CSVPrinter printer)
                throws IOException {
        printer.printRecord(
                        person.getFirstName(),
                        person.getLastName(),
                        person.getAge());
}
```

# Approach 2

This approach makes use of **generics** to define an interface which class-specific serializers will implement.

```
public interface CSVSerializer<C> {
        public C read(CSVRecord record);
        public void write(CSVPrinter printer, C object)
                        throws IOException;
}
```

# Sample Implementation

```
public class PersonSerializer implements CSVSerializer<Person> {
        @Override
        public Person read(CSVRecord record) {
                return new Person(
                                record.get(0),
                                record.get(1),
                                Integer.parseInt(record.get(2)));
        }

        @Override
        public void write(CSVPrinter printer, Person person) throws IOException {
                printer.printRecord(
                                person.getFirstName(),
                                person.getLastName(),
                                person.getAge());
        }
}
```

# Some pitfalls...

- Never forget to close both the **CSVParser** and the **CSVPrinter**. Forgetting might lead to memory leaks as well as data not being saved!
- If you want to read and write a data structure, make sure to always keep the expected field order consistent in both methods! Declaring constants can help for this...
- Be careful with automatic headers. They're fine when reading, but you need to specify them when writing!

# A Note on Sanitizing

# We want clean data.

Now that you are considering saving data potentially input by a user, there are some things you need to check for...

- Be careful if you are doing things like saving a user's data in a file named after their username. What if their username is too long, contains invalid characters, or is something like **..** (previous directory in Linux)
- Make sure to always validate data before writing. What if you forget to check if something is an integer when writing, and then on read we do Integer.parseInt?
- Note: **be careful with sensitive data**. Some things need encryption/hashing, such as passwords!