Iteration 2

Deadline: December 24th

CSE3063F20P1_RAD_GRP12 _iteration2.pdf

Contents

1 Introduction

1.1 Purpose

The modern world we are in right now is always looking for ways to categorize things, to put things into clusters, to box things. All of this is done to make dealing with differences easier. An example of this, is labeling sentences or words. Companies have long started collecting data and labeling them, then use the results of analyzing them into making their services or products better.

Our project will be a system that can be used to label data by assigning a predetermined labels/classifiers (Ex: positive, negative…etc.) to a group of instances (Ex: comments, text…etc.)
Furthermore, our software solution will also provide a report functionality, that is, user reporting. This functionality will track a user's performance on any given dataset. This will come very handy in analytics that might be applied to multiple users and the differences between their performances.

Our audience will be any system that wants to use the same process of labeling/classifying, For example : An online newspaper can use this system to label their news as sports, politics, finance…etc. OR to label customer comments in an e-commerce website as Positive or Negative.

1.2 Scope

This software product can be used to label anything (with labels like: positive/negative, sports/politics,..etc.)
In this iteration, our software will add an extra functionality of reporting/tracking user's performance in terms of labeling.

The goals of our project:

- Providing an easy method for the labeling of any number of datasets.
- Providing statistics about the behaviour of the users.
- Having the ability to use this tool with any dataset that matches our input format.

1.3 References

1. IEEE Computer Society. Software Engineering Standards Committee, & IEEE-SA Standards Board. (1998). *IEEE Recommended Practice for Software Requirements Specifications* (Vol. 830, No. 1998). IEEE.
2. https://classroom.google.com/u/0/c/MTgxNjU0NDIyNDBa
3. https://classroom.google.com/u/0/c/MTgxNjU0NDIyNDBa/m/Mzg4NzE2MTc2OTNa/details
4. https://www.toptal.com/
5. https://www.wikipedia.org

1.4 Overview

An overview of everything in the document could be summarized as the following:

- We organized the structure of this document to give the reader an understanding of the problem, then how we are going to fix, then go into detail of the product itself.
- What comes after this section is all concerning the product. We give an overall description of factors that might affect the software solution we are working on, then we talk about its functions, the constraints that would apply on those functions, and finally the assumptions we made based on the user characteristics we have.
- We also talk about the specific requirements including, but not limited to, Functional requirements, Performance Requirements, Design Constraints, Software System Attributes, and some other Requirements.

2 Overall Description

2.1 Product Perspective

This software is neither independent nor self-contained at this point in time. It will most probably in most use cases be a part of a bigger system. It can be used in various fields to analyze, and categorize pieces of information/news/reviews/ and so on. This software solution, however, needs to of course be related to some constraints.
Some of the constraints are but not limited to:

- User interfaces: the software is intended to be used to help humans manually label sentences/piece of information or news, this puts a constraint on the user interfaces as we need it to be as simple as possible and function in the most seamless way since it will be used to label (maybe) thousands of lines of data.
- Memory: As mentioned, the software will of course consume memory. However, a constraint on this amount of memory needs to be set as this piece of software will be a component of a bigger software. Because if not put, it might take up too much and make the system crash. **Within the second iteration, this constraint proposes a bigger threat since we will be given a dataset to test. We cannot know how big this dataset is that's why we will try our best to push the cap of the program.**

The constraints vary, however, they will become more clear with each iteration and with each time we increase the requirements and make them more concrete.

2.2 Product Functions

Our software starts first by loading a .JSON file into its internal structure. Let's call that file a *dataset* for simplicity's sake. Then, the software will randomly label each instance provided in that dataset with one of many predefined/pre-given labels. **For each user registered in the system, the software will loop over the dataset and label. Worthy of mention, the software will also randomly show pre-labled instances by the user to the same user to test performance and consistency.** Please note that the labels will also be included in the dataset file. After that, the software will continue to log each action it is taking. That is, logging what instance it labeled, and what label it gave it. **After all of this is done, the software generates a .JSON file as an output, and a report.**

The .JSON file contains the dataset definition, the instances, the labels, the label assignments, and user information. The report contains multiple metrics like consistency for each user, completeness percentage for each dataset, and so on.

2.3 User Characteristics

Our software could be used by any user, providing that they know what the dataset contains. For instance, a dataset that will include sentences that will require sentiment analysis, the label-er should know what to expect. Another example would include named-entity recognition in which multiple phrases or words can be categorized. Our system, with its simple interface, will make the task of labeling much easier, which is an important process nowadays. The users do not need any pre-training to be able to use our program. They only need to input a dataset in the expected format and start using our software right away.

2.4 Constraints

- Our program only accepts input datasets of the format .JSON.
- The dataset should match a specific structure that tells the program of the type of the dataset, maximum labels it can have, and possible labels.

2.5 Assumptions and Dependencies

- How big the datasets are.
- What kind of datasets we are going to be labeling.
- Fixing a mistake in labeling on a large scale will be very costly in terms of time.
- Requirements of our software might change, since the client might need to multi-classify an instance. Meaning, both give it a sentiment-analysis-label, *and* categorize it.

2.6 Apportioning of Requirements

- User Interface

3 Specific Requirements

3.1 External Interface Requirements

3.1.1 User Interfaces

The customer doesn't require a user interface at the moment. However, the requirements will increase with time, and a user interface is expected to be implemented. So this section of the document is to be rewritten.

3.1.2 Hardware Interfaces

For this iteration the software only requires an operating system with a framework able to run Java programs. For starters, we will limit the devices that will use the software to Computers/Laptops only.

3.1.3 Software Interfaces

For this iteration the following software products are required:

1. JSON Simple:
    - Name: JSON Simple
    - Version number: 1.1
    - Source: http://www.java2s.com/Code/Jar/j/Downloadjsonsimple11jar.htm
    - Purpose: This package is used to parse JSON files.
2. JUnit:
    - Name: JUnit
    - Version number: 5
    - Source: https://junit.org/junit5/
    - Purpose: This package is used to design and manage unit tests in java.
3. Gson:
    - Name: Gson
    - Version number: 2.8.6
    - Source: https://mvnrepository.com/artifact/com.google.code.gson/gson/2.8.6
    - Purpose: This package is used to create ordered and easily readable JSON outputs.

3.1.4 Communication Interfaces

Within this iteration, the software will run offline so there is no need for any communication interface.

3.2 Functional Requirements

3.2.1 Data Labeling System

Data Labeling System is the central class in our object-oriented modelling. It is responsible for creating instances of other classes inside itself and call their corresponding operations when necessary. Overall, Data Labeling System is a “Doing Responsibility” class.

3.2.1.1 Functional Requirement

The first operation which is done by this class is to parse the configuration file, and use the information available in that file to invoke User(s) creation, then load the Datasets that were added by the DataManager.

3.2.1.2 Functional Requirement

This class is capable of loading the previous label assignments, which will allow us to make a comparison between the previous and the current assignments in terms of consistency.

3.2.1.3 Functional Requirement

Once all available users and datasets are parsed and stored, this class initiates the process of data labeling. That is, for every user and for every instance available in a dataset, it assigns some label(s) to the corresponding instance.

3.2.2 Data Manager

DataManager class is responsible for the management of the data, from accessing, to validating, and finally to storing the data that our program will use. This is a “Doing Responsibility” domain class because it has access to encapsulated data.

3.2.2.1 Functional Requirement

The function of this class is to parse and store the dataset json files. It reads all the necessary data from a list which was filled during the data labeling phase.

3.2.2.2 Functional Requirement

The class will then add the parsed Datasets into our program, where the DataLabelingSystem class will take over. It is also capable of, if needed, adding Users and Labeling Assignments manually and assigning them to any dataset.

3.2.3 **Data Updater**

Data Updater class's responsibility is connected to the work done by Data Manager class, it is responsible for the updating of our output data. It is a "Doing Responsibility" domain class.

3.2.3.1 **Functional Requirement**

This function of this class is to wait for the labeling process to finish, then to update the output Data JSON file with the new assignments. It is also responsible for updating the performance reports.

3.2.4 **User**

User is a class used as a creation tool for users given in the datasets that are loaded to our software. It provides an id attribute, a name attribute, and a type attribute for each user. In general, this class is a "Knowing responsibility"-class. Its responsibility is to carry the user's type, name, and id.

3.2.4.1 **Functional Requirement**

This class's functional requirement is to store the id, the name, and the type of the users.

3.2.4.2 **Functional Requirement**

The class is now also capable of calculating its completeness percentage (percentage of the dataset's instances the user has labeled), the unique labels it has assigned, and the consistency percentage in which the user is consistent on labeling an instance with the same previous label in all of the assignments.

3.2.5 **Dataset**

Dataset is a class which is used as an abstract for a real-world dataset. It includes the necessary attributes which defines a dataset. Moreover, it also keeps a list of all labels and instances it contains. Overall, this class is a "Knowing Responsibility"-class. Its responsibility is to store dataset attributes and lists of labels and instances.

3.2.5.1 **Functional Requirements**

The only operation which is done by this class is to parse dataset related information, process it, and add it to the corresponding fields. It is also capable of assigning new Users to itself.

3.2.5.2 **Functional Requirement**

The class is now also capable of calculating the user completeness percentage (how much of the dataset did each user label), number of unique instances, and the consistency percentage in which the user is consistent on labeling an instance with the same previous label in this specific dataset.

3.2.6 **Instance**

Instance is a class used as a creation tool for instances of the data pieces given in the datasets given by the user. It provides an id attribute, and a text attribute for each instance. In general, this class is a “knowing responsibility” class. Its responsibility is to carry the instance’s id and its text.

3.2.6.1 **Functional Requirement**

This class’s only functional requirement is to store the id and the text of the instance/piece of information that is being labeled.

3.2.6.2 **Functional Requirement**

The class is now also capable of calculating the number of unique label assignments given by a user to it, the class label distribution which shows the probabilities of an instance being labeled with a specific label, the frequent label percentage which shows from all the assignments what is the most frequent label, and the entropy which shows us the level of uncertainty that we have in the labeling process of this instance.

3.2.7 **Label**

Label is a class used as a creation tool for instances of the labels provided in the datasets given by the user. It provides an id attribute, and a text attribute for each label. In general, this class is a “knowing responsibility” class. Its responsibility is to carry the label’s id and its text.

3.2.7.1 **Functional Requirement**

This class’s only functional requirement is to store the id, text, and the dataset of the label.

3.2.8 **Label Assignment**

Label Assignment is a class used as a Label assigning tool for Instances provided in the datasets given by the user.

3.2.8.1 Functional Requirements

The first responsibility is done by the method assignLabels which invokes the Labeling mechanism object passed to it, to label the given instance.

3.2.8.2 Functional Requirements

It holds the following information of a labeling process: a User that does the assigning, a Label to be assigned, an Instance to do the assignment on, and the time spent for labeling.

3.2.9 Labeling Mechanism

Labeling Mechanism is an interface that includes one method that needs to be implemented. The method is called labelInstance and it will be implemented in each class depending on how that certain mechanism works.

3.2.9.1 Functional Requirement

The method labelInstance will take in an instance, an ArrayList of possible labels to choose from, and an integer defining the maximum number of labels allowed per instance. Then, it will return another ArrayList that includes all the labels generated for that instance.

3.2.10 Random Labeling Mechanism

Random Labeling Mechanism is a class that implements the Labeling Mechanism interface. It implements the labelInstance method and adds a new one called getRandomElement.

3.2.10.1 Functional Requirement

This class chooses random labels (based on the maximum number of labels allowed) from the list of available labels and returns an ArrayList of label(s) for each Instance.

3.2.11 Log

Log is a class used for getting a logger object. Upon the creation of an object, a logger is instantiated and attached to a specified file, which is formatted in a readable way. The class contains one method, getLogger, which returns the instantiated logger.

3.2.11.1 Functional Requirements

The class's only responsibility is to instantiate and return a logger.

3.3 Other Requirements

3.3.1 Non-functional Requirements

3.3.1.1 Usability

The product should be easy to use. The user should get the labeled instances only by uploading the data into our system.

3.3.1.2 Reliability

The product will be developed using a random labeling mechanism. So in this iteration, there is no certain reliable percentage that can be measured.

3.3.1.3 Performance

The performance of a product depends on how big the data is. The bigger the dataset, the more time the model takes. Overall the model calculation and response time should be as little as possible.

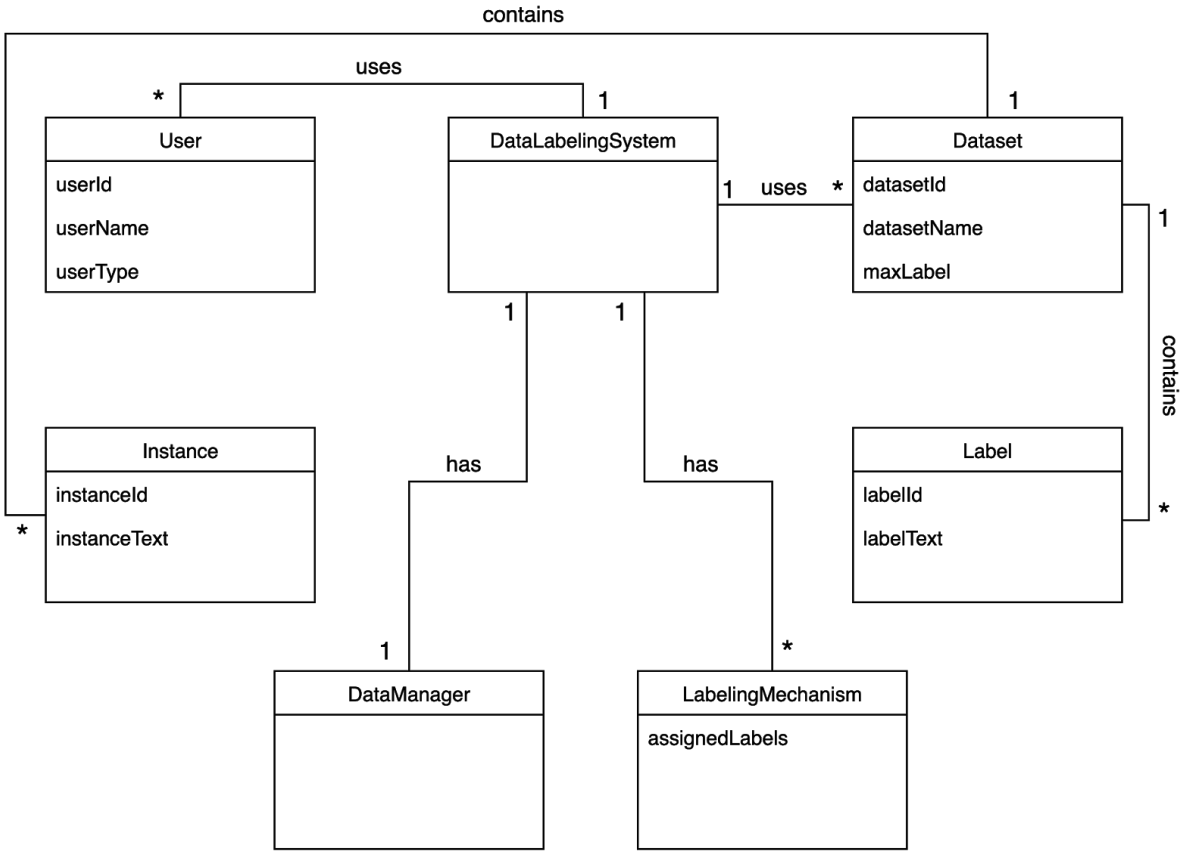
3.3.1.4 Portability

Our product works on all platforms that have terminals and runs java.

3.3.1.5 Maintainability

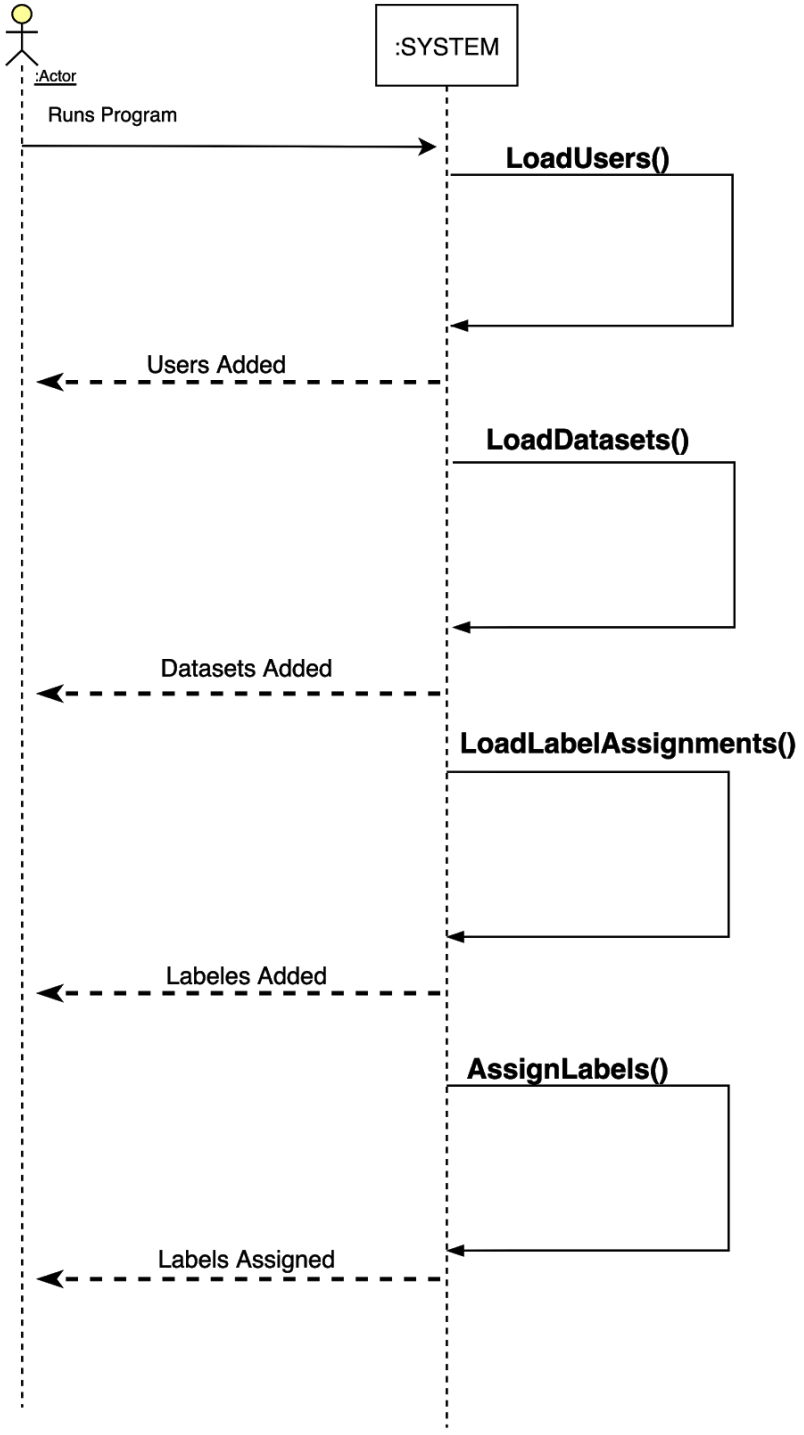
Our product is very flexible and can work with many kinds of labeling mechanisms and different datasets and labels.

3.4 Domain Model

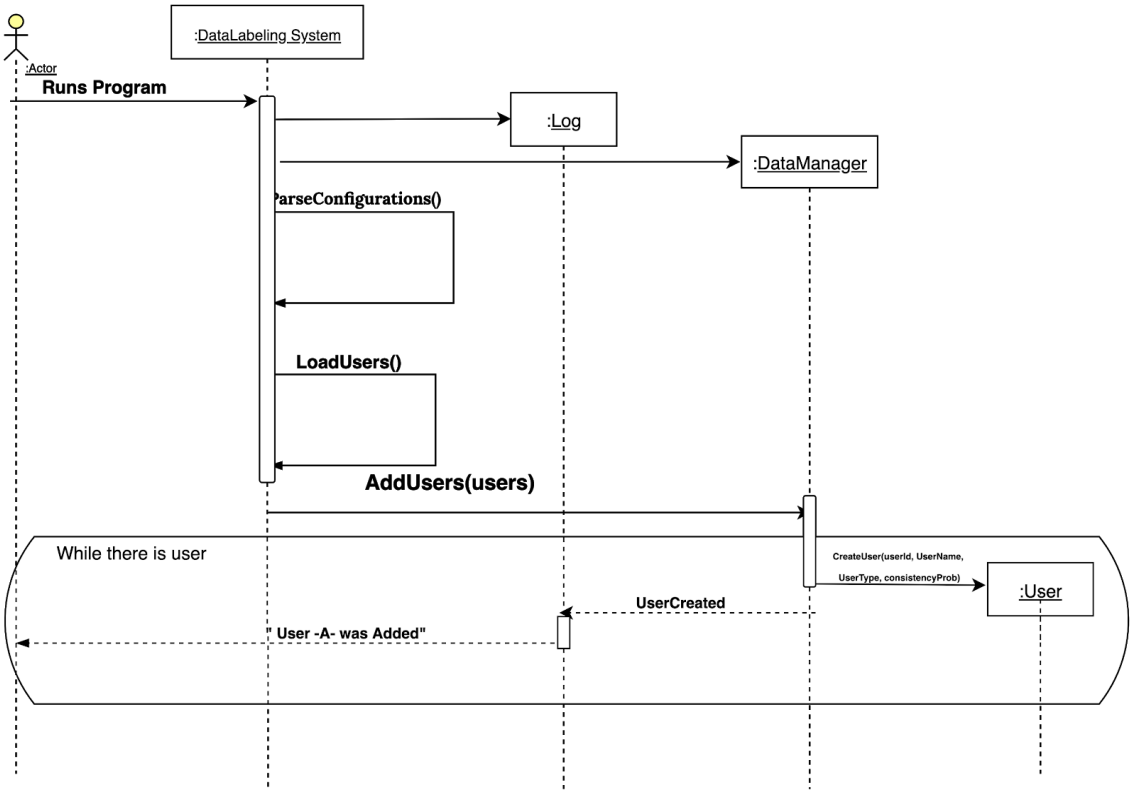


3.5 System Sequence Diagram

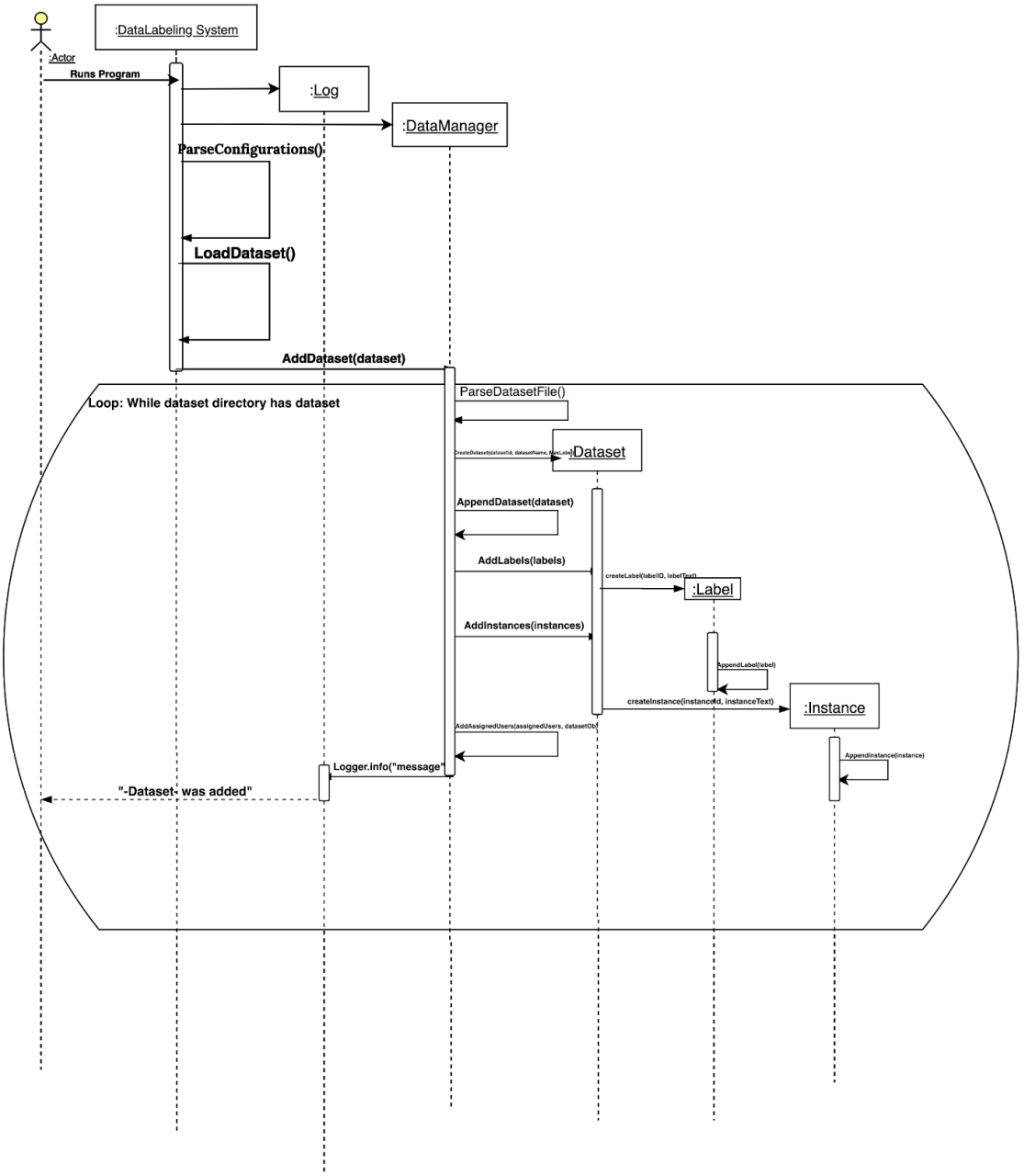
3.5.1 Parsing Configurations



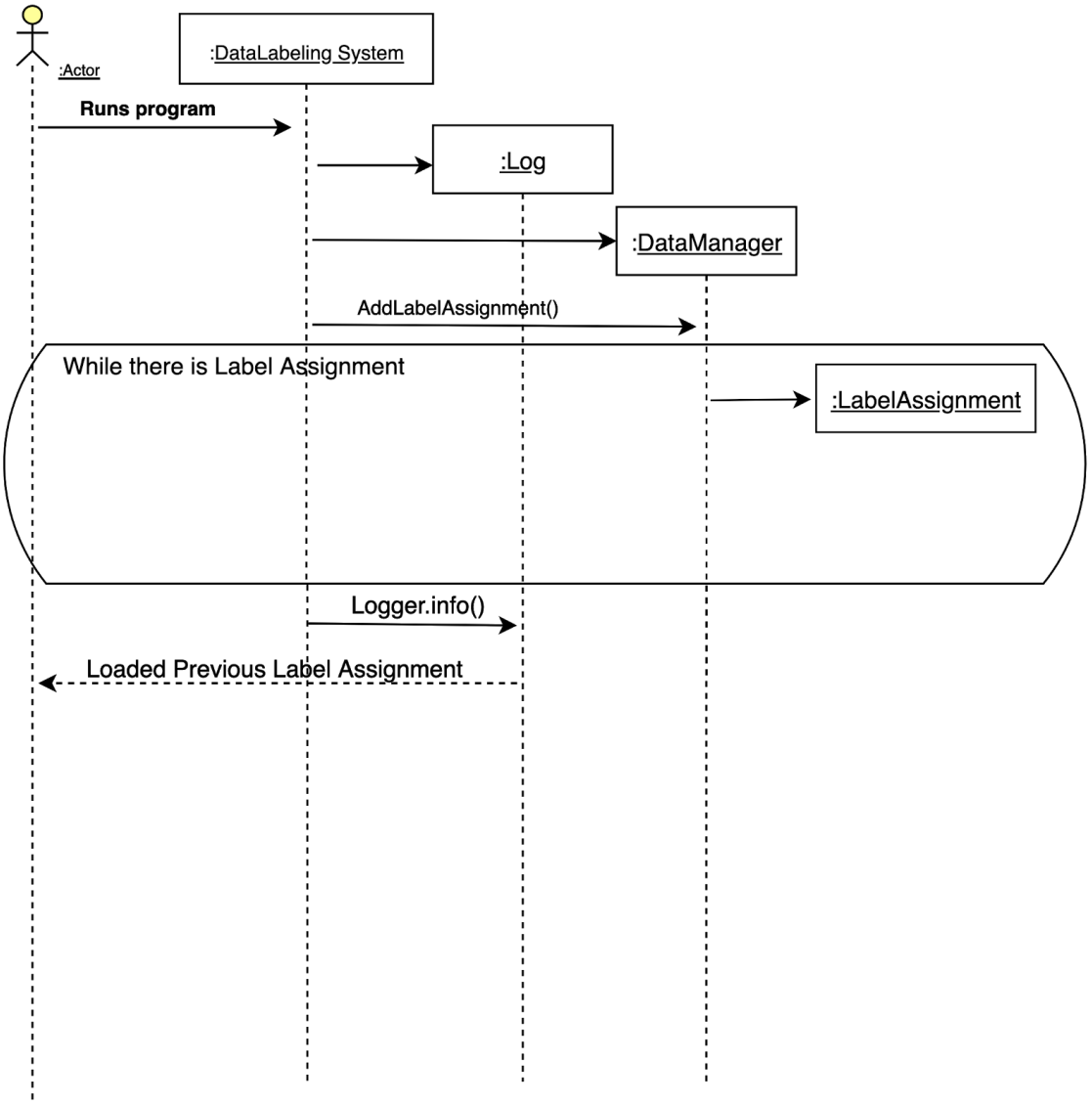
3.5.2 Loading Users



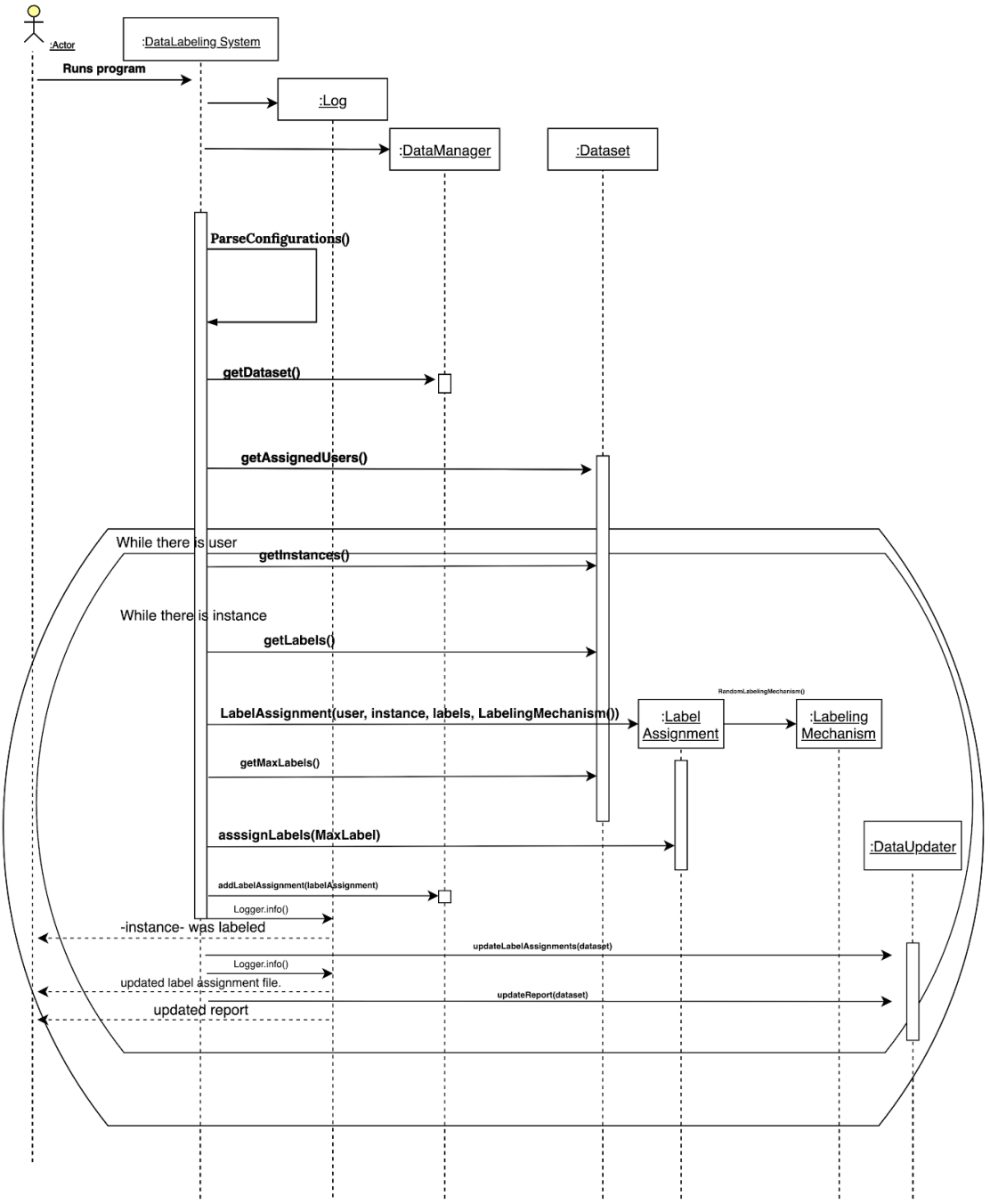
3.5.3 Loading Datasets



3.5.4 Loading Label Assignments



3.5.5 Assign Labels



4 Glossary

Functional Requirements: In software engineering and systems engineering, a functional requirement defines a function of a system or its component, where a function is described as a specification of behavior between outputs and inputs.

Non-functional Requirements: In systems engineering and requirements engineering, a non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviors. They are contrasted with functional requirements that define specific behavior or functions. The plan for implementing functional requirements is detailed in the system design. The plan for implementing non-functional requirements is detailed in the system architecture, because they are usually architecturally significant requirements.

Class: In object-oriented programming, a class is an extensible program-code-template for creating objects, providing initial values for state and implementations of behavior. In many languages, the class name is used as the name for the class, the name for the default constructor of the class, and as the type of objects generated by instantiating the class; these distinct concepts are easily conflated. When an object is created by a constructor of the class, the resulting object is called an instance of the class, and the member variables specific to the object are called instance variables, to contrast with the class variables shared across the class. In some languages, classes are only a compile-time feature, while in other languages classes are first-class citizens, and are generally themselves objects. In these languages, a class that creates classes is called a meta-class.

Function: A function is a unit of code that is often defined by its role within a greater code structure. Specifically, a function contains a unit of code that works on various inputs, many of which are variables, and produces concrete results involving changes to variable values or actual operations based on the inputs.

Method: A method in software engineering is somewhat similar to a function, except it is associated with objects/classes. Methods are very similar to functions except for two major differences.

- The method is implicitly used for an object for which it is called.
- The method is accessible to data that is contained within the class.

Instance/Object: In a computer system, any time a new context is created based on some model(its class), we say that the model has been instantiated. In practice, this instance usually has a data structure in common with other instances, but the values

stored in the instances are separate. Changing the values in one instance will then not interfere with the values of some other instance.

Attributes: Object specific properties are called, instance attributes. Think of it as the properties of instances.

Interface: In computing, an interface is a shared boundary across which two or more separate components of a computer system exchange information. The exchange can be between software, computer hardware, peripheral devices, humans, and combinations of these.

Dataset: A data set is a collection of data. In the case of tabular data, a data set corresponds to one or more database tables, where every column of a table represents a particular variable, and each row corresponds to a given record of the data set in question.

Java: An object-oriented programming language that we will use to compose the tools we use in this project.

Classifier: An algorithm used in Machine Learning areas to divide the data in two or more classes/labels.

Log: In computing, a log file is a file that records either events that occur in an operating system or other software runs, or messages between different users of a communication software. Logging is the act of keeping a log. In the simplest case, messages are written to a single log file.

Standard Deviation: Standard deviation is a measure of the amount of variation or dispersion of a set of values

Entropy: Entropy measures the expected (i.e., average) amount of information conveyed by identifying the outcome of a random trial.

Consistency percentage: The percentage amount of the recurrent instances are labeled with the same class

Completeness percentage: The percentage amount of the instances are labeled in a dataset