CSci 5801: Software Engineering I, Fall 2018
Project 1 – Waterfall Methodology (Updated Version: Tuesday, September 25, 2018)
Software Requirements Specification (SRS) Document for Voting System
Due Date: Monday, October 8th at 11:55 p.m.
100 points total

Special Instructions: You will be working in your small groups to complete this homework assignment. You should meet, skype, or talk on the phone (if unable to meet in person) about the requirements for the assignment. You will only turn in one assignment per group. You must include all names on your assignment with X500 names included (e.g. Shana Watters, watt0087). Please use the name that is listed on the class roster so we will know who you are. You will upload your work to your GitHub along with any supporting documents.

Special Instructions:

- Name this document **SRS_Team#.xxx** where the # is your team number and the XXX is the documents formatting extension (e.g. docx, pdf).
- If you have additional documents, name them using a similar naming convention (e.g. UseCases_Team1.pdf).
- Create a subdirectory under your repo-Team# called SRS. This will be where you put all documents generated for this assignment. Do not put your files on Moodle.

We will have an assignment location on Moodle to record your each team's scores and to store this project description. You will not upload your work to Moodle but put all documents for this assignment in your team repository under the SRS subdirectory.

We expect you to turn in your **typed** Software Requirements Specification document and your use cases that also must be typed. You can either incorporate your use cases in your SRS document or as a separate document. Please make clear in the document where to look for the use cases if they are not incorporated in the document itself. This portion of first portion of the Waterfall project is due at **11:55 p.m. on Monday, October 8th**. If you are not done, turn in what you have to GitHub by the due date and time. Anything received late will be given a 0. We can give you partial credit even if you are not fully finished.

The Problem

There are numerous types of voting algorithms and in the United States, we typically use plurality voting where each voter is allowed to count for only one candidate, and the candidate who polls the most votes is elected. It is rare for an election to be tied but if that occurs, there is typically a runoff between the tied candidates. For example, there have been three cases in history where there was a tie in the Electoral College for a presidential election. The House of Representatives then decided who was president by voting. For small sized, local elections a run-off may occur or even a coin flip can decide the outcome in some cases.

Much research has been performed on voting, and there are three types of voting systems: 1) Plurality/majority, 2) Proportional representative, and 3) Semi-proportional systems. We will be implementing 2 of these voting algorithms for this Waterfall project.

You are tasked with creating a voting system that is capable of performing two types of voting:

1) Instant Runoff Voting (plurality/majority type). The following overview is from FairVote.org and is taken directly from their website.

Instant Runoff Voting

Instant runoff voting is also known as "IRV," and "majority preferential voting." In Australia, where this system is used to elect their lower house of parliament, it is called the "alternative vote." Like two-round voting, this majority system a minor variation of single-member district plurality voting that was developed to ensure that the winning candidate enjoys the support of the majority of the voters in the district. It was also thought to be an improvement over the two-round system because it does not require a separate election--it provides an "instant" runoff.

How It Works. In IRV voting, like plurality voting, all candidates are listed on the ballot. But instead of voting for only one candidate, voters rank the candidates in the order of their preference. This ranking process is illustrated in ballot below. It is an

AccuVote ballot, which allows ballots to be scanned and tabulated by computer. It is similar to marking answers on the standardized tests used in schools. On this ballot, voters fill in numbered boxes to indicate their ranking of the candidates. The mark a "1" for their most preferred candidate, a "2" for their second preference, and so on.

Instant Runoff Ballot

Official Ballot
Municipal Elections

INSTRUCTIONS TO VOTERS

Mark Your Choices by Filling in the Numbered Boxes Only

Fill in the number one [1] box next to your first choice; fill in the number two [2] box next to your second choice; fill in the number three [3] box next to your third choice, and so on. You may fill in as many choices as you please. Fill in no more than one box per candidate. Fill in no more than one box per column.

Candidates for City Council District One	*Only one vote per candidate* Only one vote per column			
Susan Rosen (Democrat)	[1]	[2]	[3]	[4]
Nina Kleinberg (Republican)	[1]	[2]	[3]	[4]
Thomas Chou (Independent)	[1]	[2]	[3]	[4]
Edward Royce (Libertarian)	[1]	[2]	[3]	[4]
Write-In	[1]	[2]	[3]	[4]

To Vote for a Write-In Candidate: Next to the name you have written in, mark a numbered box to indicate your choice of number for that candidate.

Do Not Use Red To Mark Ballot

The counting of the ballots is also different from plurality voting. First, all the number one preferences of the voters are counted. If a candidate receives over 50% of the first choice votes, he or she is declared elected. If no candidate receives a majority, then the candidate with the fewest votes is eliminated. The ballots of supporters of this defeated candidate are then transferred to whichever of the remaining candidates they marked as their number two choice. (It is as if you told the supporters of the last place candidate, "Your candidate cannot possibly win, so which of the remaining candidates would you like your vote to go to?) After this transfer, the votes are then recounted to see if any candidate now receives a majority of the vote. The process of eliminating the lowest candidate and transferring their votes continues until one candidate receives a majority of the continuing votes and wins the election.

This transfer process is illustrated in the table below. In this hypothetical election, there are 100,000 votes cast and no candidate receives over 50% of the vote in the first round. So the lowest candidate--Royce--is eliminated and his ballots are transferred to their second choices. 1,000 of Royce's supporters gave Chou as their second choice, and 6,000 indicated Kleinberg as their second choice. The new totals show that no one yet has a majority, so Chou is eliminated. 4,000 of Chou's votes are transferred to Kleinberg and 5,000 are given to Rosen. (If some of Chou's ballots had listed Royce as the second choice, they would have been transferred to their third choice, since Royce had been eliminated.) After this latest transfer is it clear that Kleinberg now has over 50% of the vote and she is declared the winner. As this example illustrates, this system essentially operates as a series of runoff elections, with progressively fewer candidates each time, until one candidate gets a majority of the vote.

Vote Counting in Instant Runoff Voting

	First Count	Second Count		Third Count	
Candidates & Parties	Original First Choice Votes	Transfer of Royce's Votes	New Totals	Transfer of Chou's Votes	New Totals
Susan Rosen (Dem.)	43,000	+ 0	43,000	+ 5,000	48,000
*Nina Kleinberg (Rep.)	42,000	+ 6,000	48,000	+ 4,000	52,000
Thomas Chou (Ind.)	8,000	+ 1,000	9,000	-------	-------
Edward Royce (Libert.)	7,000	-------	-------	-------	-------

*Winning candidate

2) Party List Voting using Open Party List (proportional voting type). The following overview is from FairVote.org and is taken directly from their website.

Party List Voting

Party list voting systems are by far the most common form of proportional representation. Over 80% of the PR systems used worldwide are some form of party list voting. It remains the system used in most European democracies and in many newly democratized countries, including South Africa.

How It Works. Legislators are elected in large, multi-member districts. Each party puts up a list or slate of candidates equal to the number of seats in the district. Independent candidates may also run, and they are listed separately on the ballot as if they were their own party (see below). On the ballot, voters indicate their preference for a particular party and the parties then receive seats in proportion to their share of the vote. So in a five-member district, if the Democrats win 40% of the vote, they would win two of the five seats. The two winning Democratic candidates would be chosen according to their position on the list.

There are two broad types of list systems: closed list and open list. In a closed list system--the original form of party list voting--the party fixes the order in which the candidates are listed and elected, and the voter simply casts a vote for the party as a whole. This is shown in the first ballot below, which illustrates an election for the House of Representatives in a five-seat district. Voters are not able to indicate their preference for any candidates on the list, but must accept the list in the order presented by the party. Winning candidates are selected in the exact order they appear on the original list. So in the example here, if the Democrats won two seats, the first two candidates on the pre-ordered list--Foster and Rosen-Amy--would be elected.

Closed Party List Ballot

Official Ballot
Election for the United States House of Representatives
District One

Voting Instructions
1. You only have ONE vote.
2. Place an X in the box UNDER the party for whom you wish to vote.

Democratic	Republican	Reform	Green	Independent Candidate
☐	☐	☐	☐	☐
1. Benjamin Foster	1. Wendy Berg	1. Steven Wong	1. Tom Wartenberg	1. Robert Moll
2. Sam Rosen-Amy	2. Steve Grolnic	2. Deborah Gorlin	2. Juan Hernandez	
3. Colin Volz	3. Sarah McClurg	3. Brad Crenshaw	3. Beata Panagopoules	
4. Benjamin Pike	4. Gerald Epstein	4. Daniel Czitrom	4. Alice Morey	
5. Megan Gentzler	5. Fran Deutsch	5. Meryl Fingrutd	5. Sarah Pringle	

Most European democracies now use the open list form of party list voting. This approach allows voters to express a preference for particular candidates, not just parties. It is designed to give voters some say over the order of the list and thus which candidates get elected. One version of this is illustrated in the ballot below. Voters are presented with unordered or random lists of candidates chosen in party primaries. Voters cannot vote for a party directly, but must cast a vote for an individual candidate. This vote counts for the specific candidate as well as for the party. So the order of the final list completely depends on the number of votes won by each candidate on the list. The most popular candidates rise to the top of the list and have a better chance of being elected. In our example, if the Democrats won 2 seats, and Volz and Gentzler received the highest and next highest number of individual votes, they would rise to the top of the list and be elected. This example is similar to the system used in Finland and widely considered to be the most open version of list voting.

Open Party List Ballot

Official Ballot
Election for the United States House of Representatives
District One

Voting Instructions
1. You only have ONE vote.
2. Place an X in the box next to the candidate for whom you wish to vote.
3. Your vote counts both for your candidate and your party.

Democratic	Republican	Reform	Green	Independent Candidate
☐ Benjamin Pike	☐ Fran Deutsch	☐ Steven Wong	☐ Tom Wartenberg	☐ Robert Moll
☐ Sam Rosen-Amy	☐ Steve Grolnic	☐ Deborah Gorlin	☐ Juan Hernandez	☐
☐ Megan Gentzler	☐ Wendy Berg	☐ Brad Crenshaw	☐ Beata Panagopoules	☐
☐ Ben Foster	☐ Gerald Epstein	☐ Daniel Czitrom	☐ Alice Morey	☐
☐ Colin Volz	☐ Sarah McClurg	☐ Meryl Fingrutd	☐ Sarah Pringle	☐

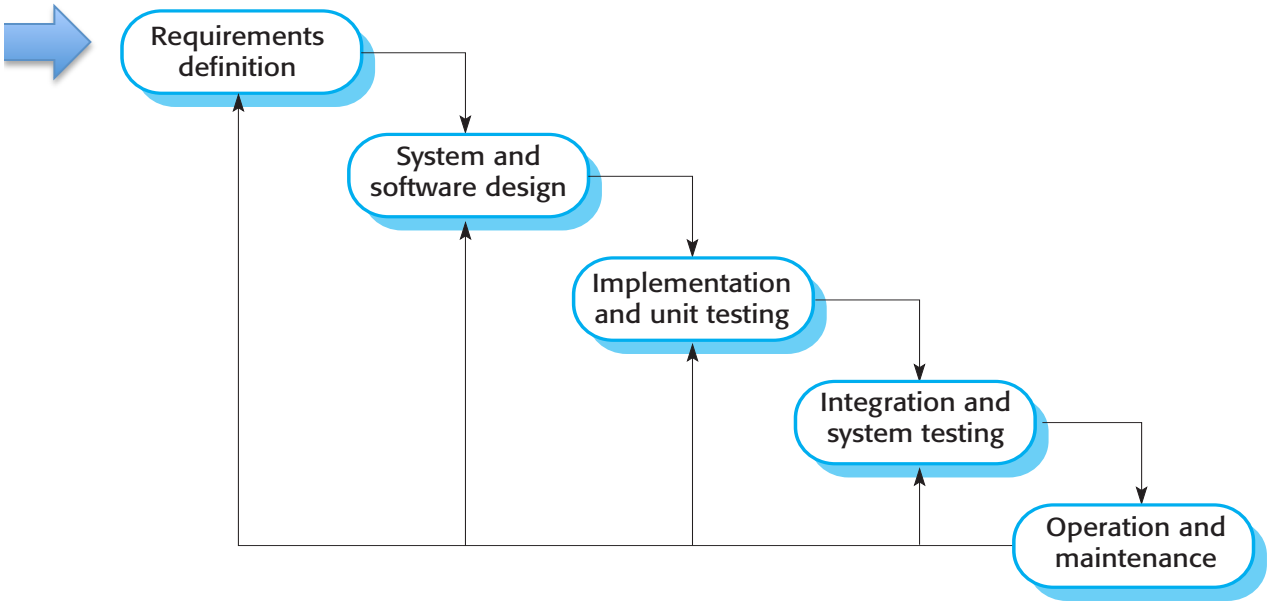
A variety of different formulas exist for accomplishing the actual allocation of seats to the parties. One of the simplest seat allocation formulas is the called the "largest remainder formula." In this approach, the first step is to calculate a quota, which is determined by taking the total number of valid votes in the district and dividing this by the number of seats. In the example in the table below, 100,000 votes were cast and ten seats are to be filled. 100,000/10 = 10,000 – which is the quota. The quota is then divided into the vote that each party receives and the party wins one seat for each whole number produced. So the Republican party received 38,000 votes, which is divided by 10,000 to produce three seats – with a remainder of 8,000. After this first allocation of seats is complete than the remainder numbers for the parties are compared and the parties with the largest remainders are allocated the remaining seats. In our example, two seats remain to be allocated and the Republicans and Moll, the independent candidate, have the largest remainders, so they get the seats. Ultimately all the parties end up with the number of seats that as closely as possible approximates their percentage of the vote.

Largest Remainder Approach to Seat Allocation

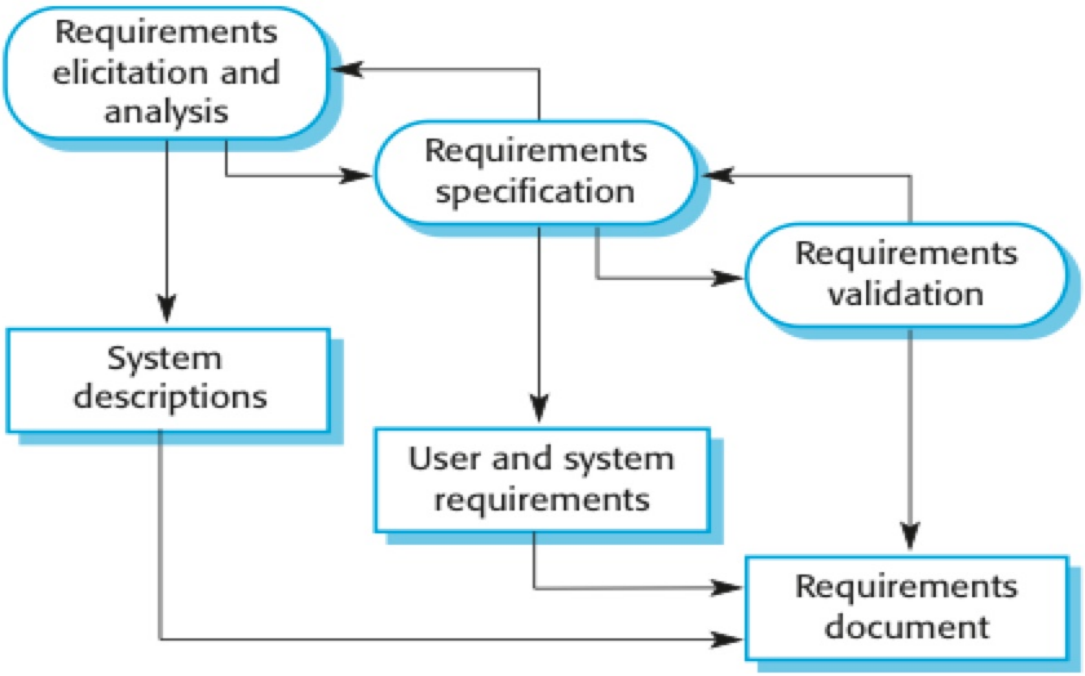
Parties	Votes	First Allocation Of Seats	Remaining Votes	Second Allocation of Seats	Final Seat Total	% of Vote to % of Seats
Republican	38,000	3	**8,000**	1	4	38% / 40%
Democratic	23,000	2	3,000	0	2	23% / 20%
Reform	21,000	2	1,000	0	2	21% / 20%
Green	12,000	1	2,000	0	1	12% / 10%
Moll	6,000	0	**6,000**	1	1	6% / 10%

Your Work for This Piece of the Project

You and your team have been assigned to the task of developing this voting system and you will be using the Waterfall methodology.



Notice, that the first task is the requirements definition. You and your team will create the software requirements specification (SRS) document for this proposed voting system. The requirements engineering process will be used to guide your work.



Voting System Requirements

You are provided the following information from the users about the proposed system and what it needs to do:

- The actual voting will be done separately from the voting system you are developing. Ballots will be cast online and a comma delimited text file will be provided to you. You may assume that there are no numbering mistakes in the file (e.g. a voter will not make any mistakes on the ballot.)

- When the program is run, the user can be prompted for any needed information but it could be extracted from the file. It is not a requirement for the Waterfall to be able to get all needed information directly from the file (e.g. number of votes, number of candidates, etc). You are encouraged to process only the file for information but file input can be very time consuming. For example, you will need to know how many parties there are and the candidates under these parties.

- If you prompt a user, you can have just text or a wonderful GUI--your choice.

- You can pass the name of the file into the program as a command line argument or ask for the name within the program itself.

- Programs written in either C++ or Java will be accepted.

  - If you provide a C++ program, you will need to provide all source files and a make file. The program will be run from the command prompt.
  - If you provide a Java program, you must provide all source files and class files. Java programs will be run either at the command prompt or through Eclipse.
  - Your programs must run on a CSE lab machine.

- You will need to read in the file. How you choose to do this is up to you. Remember, it will be a comma separated values (CSV) file where each row is separated by a newline. The file will be exported from Excel into the CSV format. All preprocessing of the file will be done before you receive it. The first line of the file will provide with the type of voting (i.e. IR, OPL).

- You will need to produce an audit file with the election information at the time (e.g. Type of Voting, Number of Candidates, Candidates, Number of Ballots, calculations, how many vote a candidate had, etc), you should list the winner(s), and you should show how the election progressed so that the audit could replicate the election itself. You should show the how got what ballot and its order of being received if applicable.

- For Instant Runoff Voting, will rank at least 1 person. You can rank from 1 to the number of candidates. Remember, we are not allowing write in candidates.

- You should display to the screen the winner(s) and information about the election (e.g. type of election, number of seats). You do not need to show an audit of the votes but showing the number of ballots cast, the winners and the stats for everyone such as number of votes received is needed.

- There will never be more than one file given to you per election.

- You need to write one program to handle both elections. Thus, need to be able to indicate the election type (i.e. through the file or through user input).

- For open party listing, all independents are grouped into one party.

- There will be no write in candidates for this system. It may happen in the future but not now.

- You cannot change the file structure outside of the program since the election files will come in the predetermined format.
- If there is ever a tie, flip a coin. You must randomly select the winner in a fair coin toss.
- If there is not clear majority in IR, than popularity wins after all votes have been handed out.
- You will have programmers, testers, and election officials running and using this program. The results of the election could be shared with media personnel.
- You can assume we will use the most up-to-date CSELabs machines.
- We are doing open party listing and not closed. The order of the candidates under a given party do not have any particular order. You will calculate the winner(s) based on number of seats and popularity of the candidates.
- Runtime constraints: An election should be able to run 100,000 ballots in under 8 minutes.
- The election file will be located in the same directory as the program.
- This program will be run multiple times during the year at normal election times and special elections.
- There are no special safety or security requirements. Security such as ensuring one vote for one person is handled at the voting centers.
- Your audit file is a strict requirement and an auditing should be able to follow the order of the ballots being assigned to the candidates. You should show the order of removal of candidates in IR and what ballots were redistributed. The file should show all of the steps.
- For an InstantRunOff ballot, each ballot must have at least one of the candidates ranked as their top choice. For this iteration, you may assume that if there is a ballot in the file, it will have at least one of the candidates ranked. As you will see, the more rankings you complete as the voter, the more likely your vote will actually be counted towards electing the candidate(s) that you have as your top rankings. The long-term goal is for this system to be part of an integrated online voting system and all preprocessing will be done via the voting system itself that you are developing. You do not need to do any preprocessing of the file. Instead of voting for one candidate, voter rank their candidates in order of preference. A candidate can be given only 1 ranking.

  Example File Generated for Instant Runoff voting:

```
IR
4
Rosen (D), Kleinberg (R), Chou (I), Royce (L)
6
1,3,4,2
1,,2,
1,2,3,
3,2,1,4
,,1,2
,,,1
```

  1st Line: IR if instant runoff
  2nd Line: Number of Candidates
  3rd Line: The candidates separated by commas
  4th Line: Number of ballots in the file

You can assume there are no errors in the ballots. Each ballot will have at least 1 rank and no person will have more than 1 ranking. The ranking numbers will not have issues (e.g.1,,3,4 : missing 2 will not happen).

- For an open party list ballet, voters express a preference for a particular candidate and a party. Each ballot will only have one candidate indicated as choice for the vote.

  Example File Generated for Open Party List voting:

```
OPL
6
[Pike,D], [Foster,D],[Deutsch,R], [Borg,R], [Jones,R],[Smith,I]
3
9
1,,,,,
1,,,,,
,1,,,,
,,,,1,
,,,,,1
,,,1,,
,,,1,,
1,,,,,
,1,,,,
```

1st Line: OPL for open party listing
2nd Line: Number of Candidates
3rd Line: The candidates and their party in [ ]. Notice the name and party are separated by commas.
4th Line: Number of Seats
5th Line: Number of Ballots
You can assume no errors in the ballots. Only a single 1 will be placed in the position of the given candidate selected.

Your Project Task

Your project task is outlined above—develop specific sections of a requirements document for the SRSS and make use of use-cases to help you find the requirements. You will use the template provided on Moodle as a guideline to write up your SRSS. You are allowed to change/add/remove from the template but remember this template highlights the information you should include when developing a specification document. Your write up must be readable, changeable, and capture all the essential information we have discussed in class. We do expect to see use cases.

You have a requirements document template and use case template available on Moodle for the class.

Asking Questions

If you questions, you should document these questions in the section that needs this information in the document. You will use these questions to elicit more information during our two in-class interviews to be held on Tuesday, September 25th (before the quiz) and Tuesday, October 2.

Deliverables

You are required to turn in the requirements document that you created using the IEEE Software Requirements Specification Document Template and your use cases that you created using the Use Case Template. You can incorporate your use cases in your requirements document, or you can submit it as a separate document. You must add all of your documents to github.umn.edu/umn-csci-5801-F18/repo-Team#/SRS We will only look in your team repository for your work. Due Dates

SRSS requirements specification document and use cases due on: Monday, October 8 at 11:55 p.m.