

Concept Progression Map Tool: User Manual

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1 Basic Introduction and Overview

This document outlines the usage of the web-based tool along with basic scenarios the authors believe this tool can be used. This document merely contains recommendations regarding the usage of the tool in the hope that the tool can be as useful as possible without more significant intervention into the existing advising procedure.

All images of the webpage tool are rendered on Microsoft Edge Version 87.0.664.66 (Official build) (64-bit).

There is a second document that contains less common information, including research notes regarding the state of the tool, and other scenarios that are unlikely to be a part of the advising intervention. That document may be accessed in the same location as where this document was originally found (in the research Box folder.)

2 Glossary and Basic Visualization

2.1 Introduction

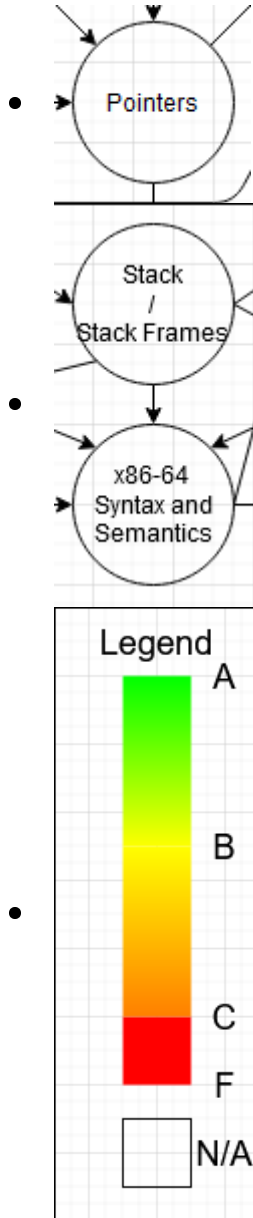
This section provides basic information regarding the terms and basic images that are used in this document.

2.2 Glossary

- **Concept:** An abstract item that can be taught within a class. Classes typically contain tens of concepts (which can be combined into larger topics).
- **Concept Map:** A set of relationships among concepts within a given course. This mapping has been approved by the instructors themselves.
- **Concept Progression Map (CPM):** The grades/performance of a student projected onto the class' Concept Map. The performance of a concept is based on a student's completed graded assignments that are related to the concept and that have already been published to the student.
- **Unweighted Concept Progression Map:** A student's CPM based on the raw scores received by that student. This assumes that all graded portions of assignments are given equal point values, and thus this is similar to counting student correctness over the total number of graded items.
- **Weighted Concept Progression Map:** A student's CPM based on the weights for the assignments, as found in the instructors' syllabi, to indicate the importance of a given type of assignment on the final grade.
- **XML File:** A file for loading a class' Concept Map to the tool.

- **CSV File:** A file with the student's scores/performance for a course, used to load the full Concept Progression Map.

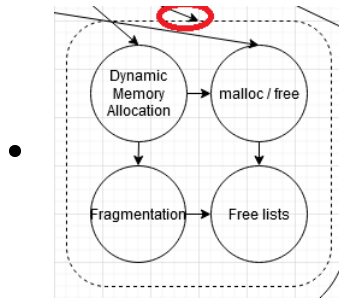
2.3 Visualization Items



A node in the CPM. The text inside the node denotes the name of the concept, which in this case is "Pointers". In addition, the color is determined by the student's Performance (in the CSV File), if such a file has been loaded onto the tool.

An arrow in the CPM. Each arrow denotes a prerequisite concept to another concept, to indicate the relationship between concepts and how they are presented in the slides for the course. In this case, the concept "Stack / Stack Frames" is one of several prerequisites for "x86-64 Syntax and Semantics". Rarely, there will be 2-sided arrows to indicate that the two concepts are interrelated and taught in parallel or cyclically.

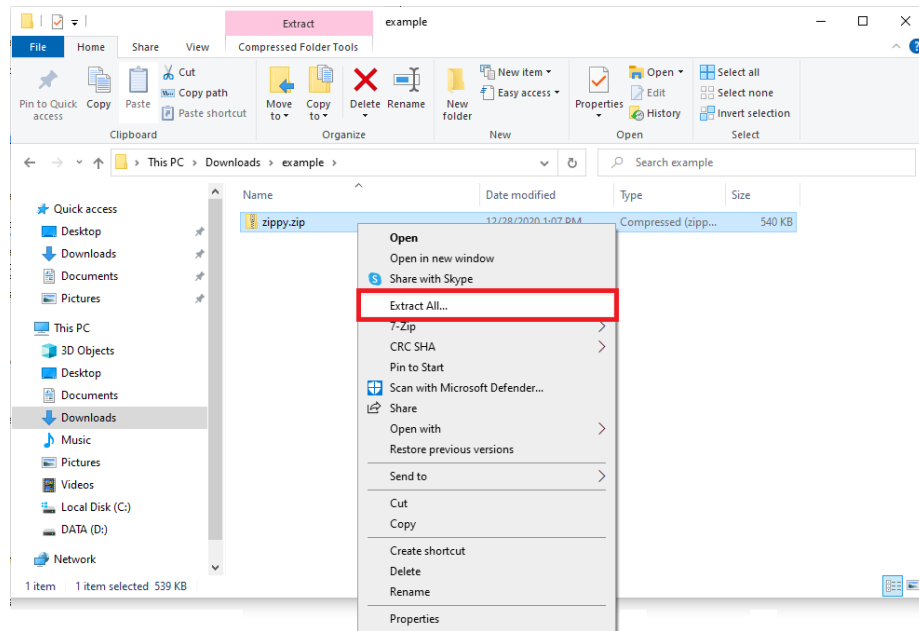
Legend. Shows the colors associated with the student's performance of a given concept. Green is associated with A (100%), Yellow is associated with B (85%), Orange is associated with C (70%), and Red is anything below (<70%). If a student has not yet had any assessments on a given concept, then the color assigned is White.



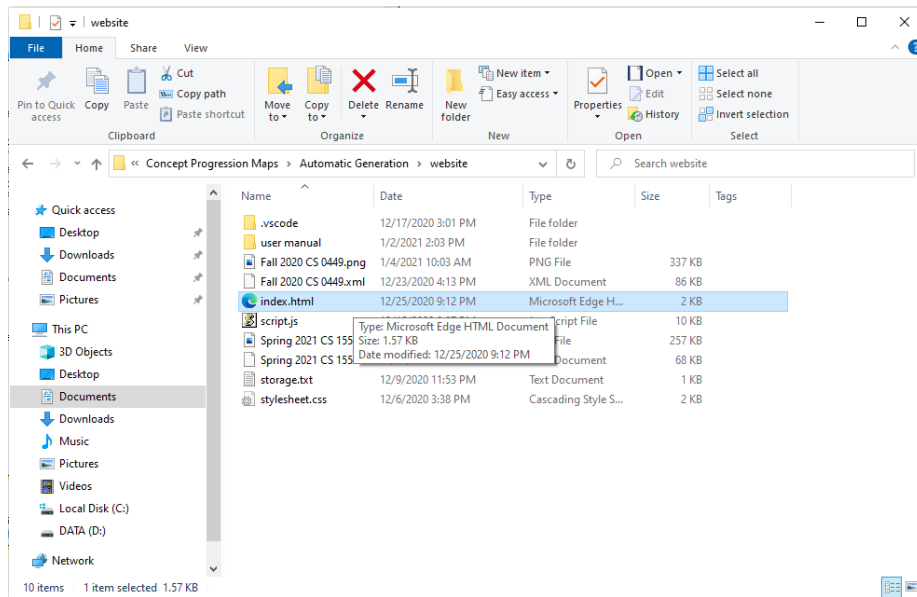
Concept Groups. To reduce the clutter of several relationship arrows, some concepts are grouped together in a bordered rounded rectangle, and any concept with a relationship arrow that points to the rectangle is a prerequisite concept to all of the concepts in the rectangle.

3 Installation

Follow the steps below to install the tool. Directions given are for Windows machines.



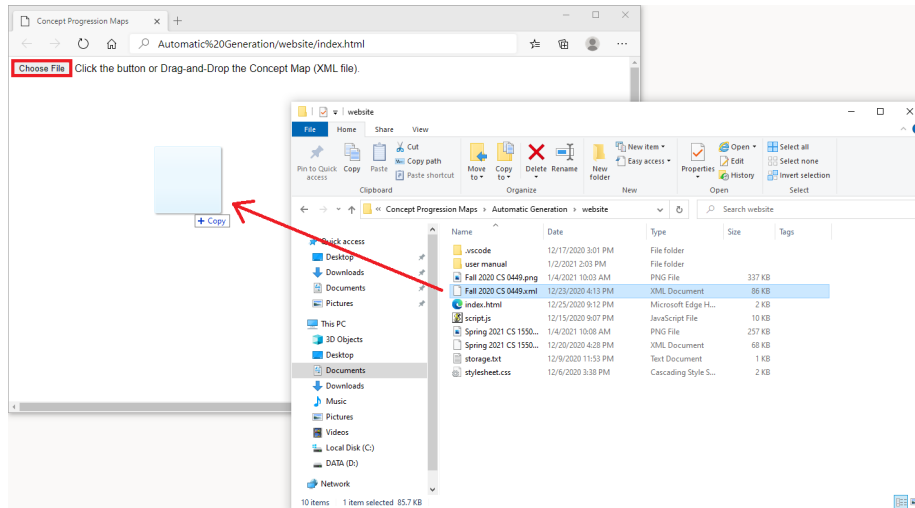
Step 1: From the Box folder, download the zip folder (located in the Box Folder under Tools → Concept Progression Maps) into a folder on your computer. Unzip it by right-clicking and selecting “Extract All...”, then follow the unzip wizard prompts.



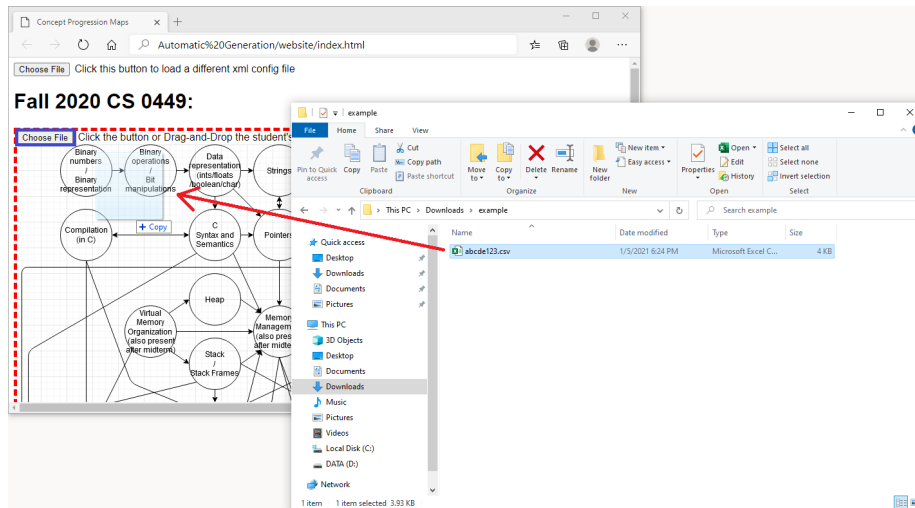
Step 2: Once the zip folder is extracted, double click on “index.html”, and your internet browser will load the page.

4 Typical Usage Walkthrough

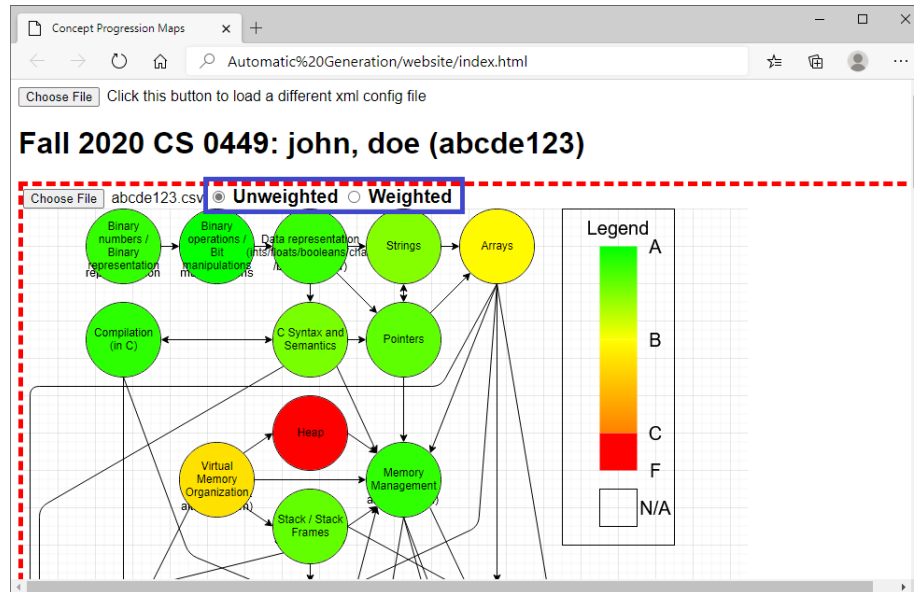
The following steps provides general directions for using the tool.



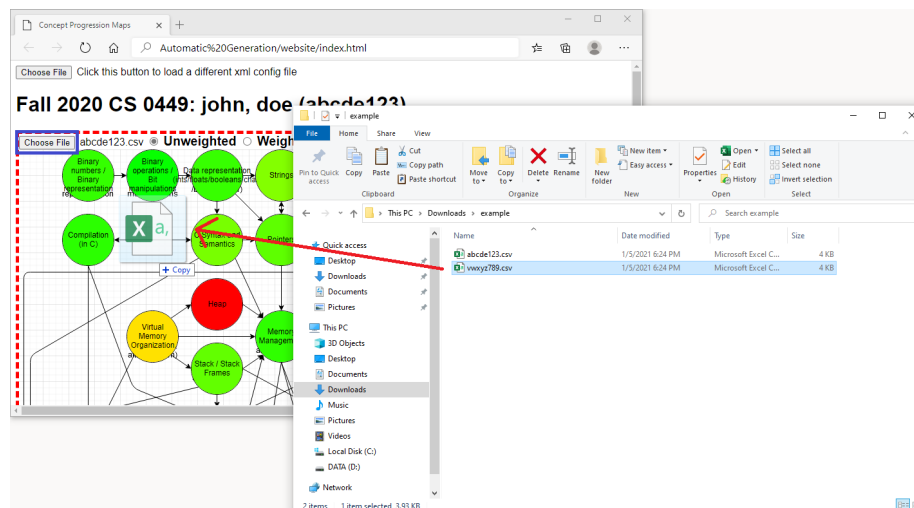
Step 1: After opening “index.html”, there will be a blank screen with a button and some text. The tool is requesting that you load an XML File that represents the Concept Map of the given class. Click the button to select the XML File, or drag-and-drop the XML File onto the webpage. An image corresponding to the concept map of the chosen course (as determined by the XML File) will appear (see next figure). The name of the course should appear at the top of the page.



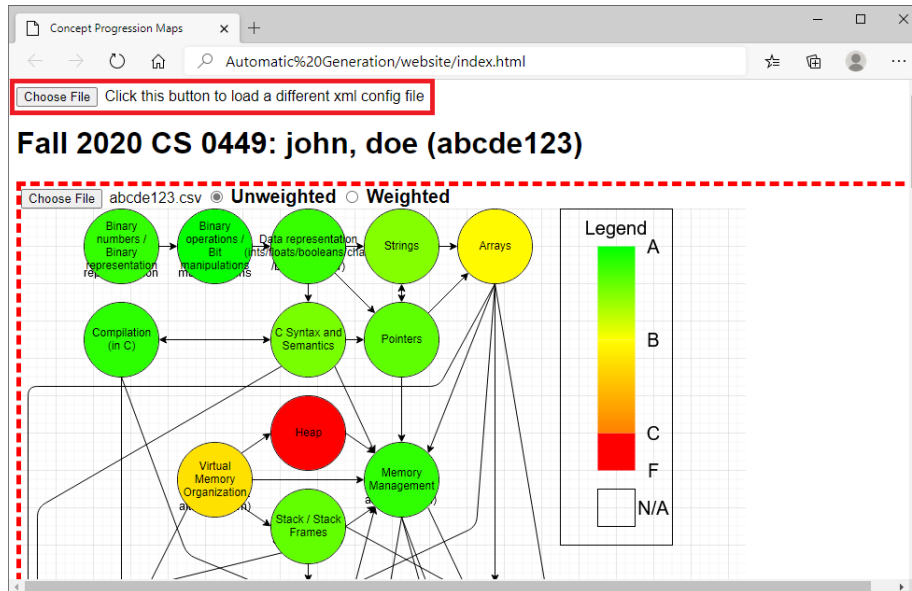
Step 2: After loading the Concept Map, a student’s CSV File can be loaded by clicking the second button to select a file, or by dragging-and-dropping into the red-bordered area; both methods will update (color code) the Concept Map with the student’s performance. The name and computing username of the student should appear at the top of the page, next to the course number.



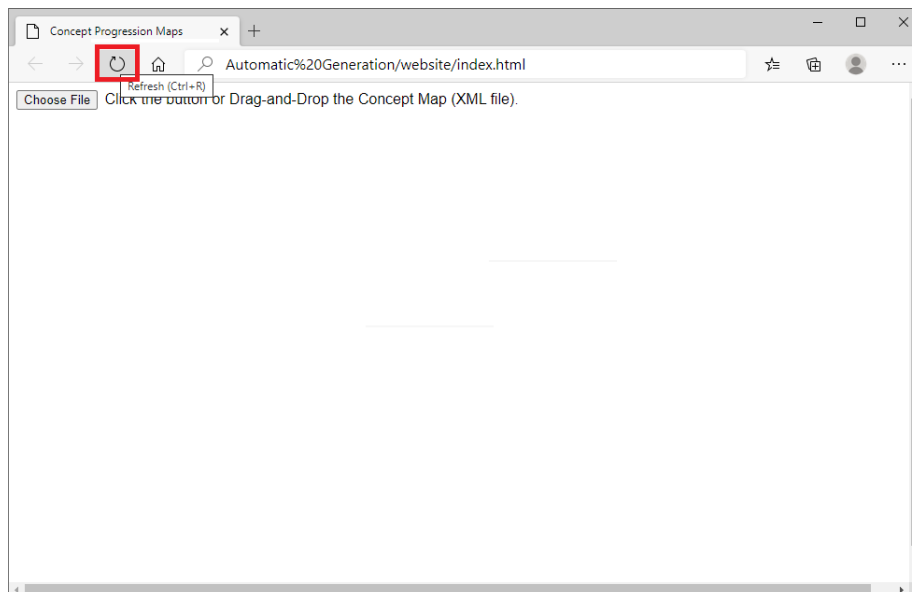
Step 3: Selecting the “Unweighted” or “Weighted” radio buttons will change the type of performance display for the loaded student’s CPM.



Step 4: (OPTIONAL) Loading a different student’s CPM for the same class is as simple as using the second button or dragging-and-dropping the new student’s CSV File into the red-bordered area, as before.

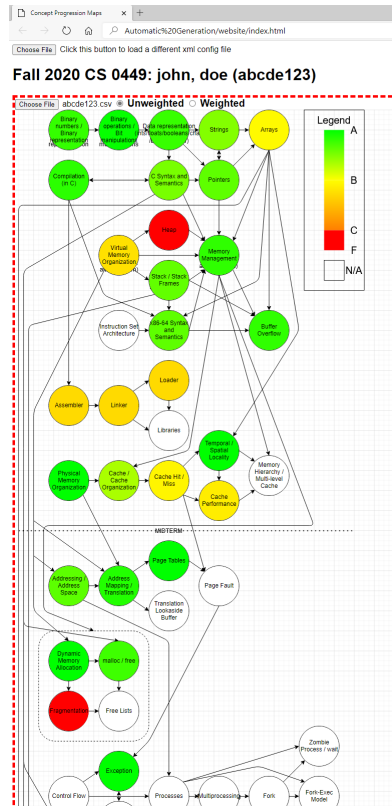


Step 5: (OPTIONAL) Loading a different class' Concept Map requires clicking the first button and loading a new XML File.



Step 6: (OPTIONAL) Refreshing the webpage (e.g., pressing F5) will revert the screen back to bare initial page.

5 Interpretation of Information



As shown in the image above, the webpage will show a Concept Progression Map based on the given class and student in the class. The image is cut-off at the bottom in order to reduce the space used, and for the purposes of this example, assume all concepts below the cut-off are white in color (meaning no performance information is available for those concepts at this moment).

We first note the general organization of the CPM. Concepts are generally organized from top to bottom, from left to right. What this means is concepts found at the top and to the left are generally taught (and assessed) earlier than those to the bottom and to the right. The relationship arrows typically follow the same flow. With the assumption that concepts below the cut-off are white in color, this would imply that based on the current state of the course, the instructor is unlikely to have taught or assessed those concepts after the cut-off.

We further note that assessments are extremely unlikely to examine only one concept. Each color that is ascribed to each concept is an amalgamation of the grades assigned to each assessment that utilizes the concept. In other words, a concept's performance is likely determined by several assessments, where those assessments likely assess other concepts at the same time. As a result, it is not

possible to simply take all of the colors that you see in the CPM, take a visual average color, and assume that the grade of the student is equivalent to that average.

Furthermore, graded items that do not have concepts attached to them, such as attendance, or extra credit, are not incorporated into the CPM. We strongly advise not to use the CPM as a replacement for asking the student how they believe they are doing in the class, not just for the student's own preference, but also for the possible inaccuracy of the full standing in the class.

From this example/image, we can see that this example student is around an unweighted B level for the concept labeled "Arrays" (first row, right-most concept). This might imply that the student is likely struggling with the concept of Arrays, but upon further examination of the student's performance on prerequisite concepts ("Strings" and "Pointers") and subsequent concepts ("Memory Management", "x86-64 Syntax and Semantics", "Buffer Overflow", "Temporal and Spatial Locality", and others after the cut-off), it is likely that the student eventually mastered the concept after the initial struggle.

Examining the concept labeled "Heap" (third row, middle concept), we see that it is colored red, while the sole prerequisite concept, "Virtual Memory Organization" (the concept to the left), is colored a yellow-orange. It is likely the student is having difficulty with the concept of Heaps, but it may be possible that the cause is due to their struggle in the concept of Virtual Memory Organization.

Looking towards the bottom of the CPM, the concept "Fragmentation" is red, but its two prerequisite concepts, "Dynamic Memory Allocation" and "Memory Management", are both green. This may be due to two factors. First, because it is a concept near the bottom of the map before the cut-off where the nodes are all white, the student may have only seen a few light assessments on the concept and gotten them wrong. Second, it may simply be a concept that the student just does not understand, despite knowing the prerequisite concepts.

As a whole, we expect that this information only serves as an aid to interpreting how the student feels about their own personal situation in the class. As mentioned previously, the CPM cannot provide a full picture about how the student is doing in the class, and should not be used as a substitute. Instead, if the student shows they are having difficulty or are asking for assistance, then it is certainly appropriate to use this information to provide more useful recommendations.

More detailed scenarios are provided in the next section.

6 Example Advising Scenarios

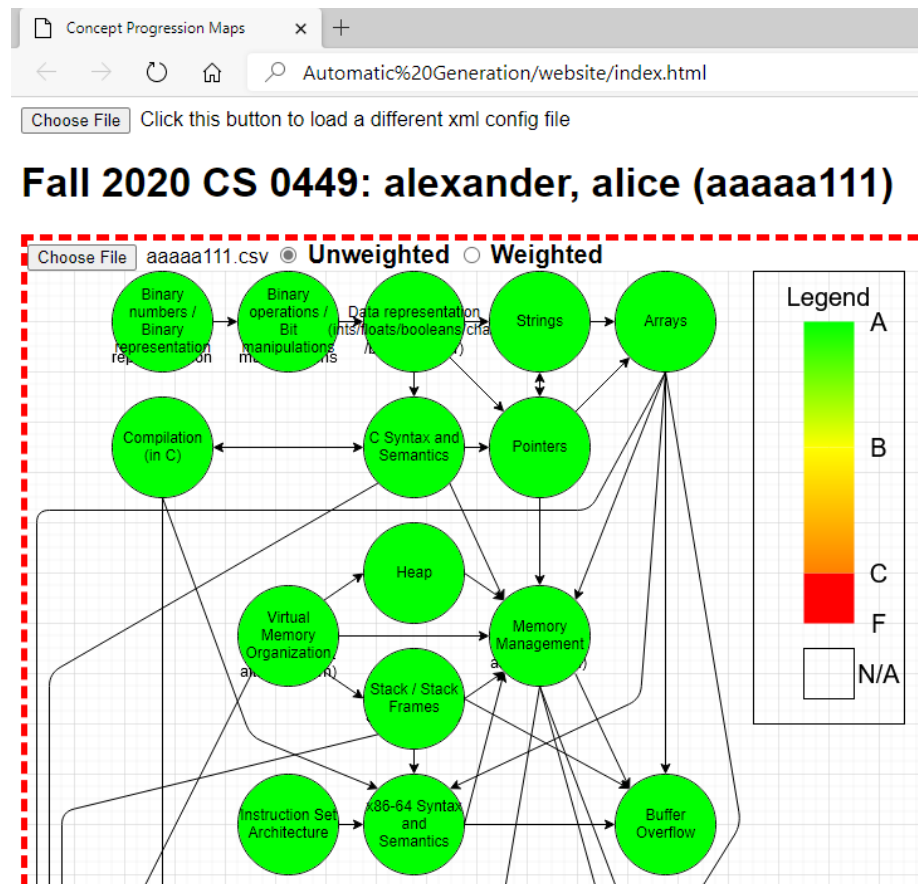
The following is a set of scenarios that we believe will showcase the most effective way to utilize this tool. Each scenario has an associated example student file that is located in the "Examples" folder, in the same place in the Box folder where this user manual is found. All examples use the "Fall 2020 CS 0449.xml" file, which can be found in the Box folder under Tools → Concept Progression

Maps → Class Files.

For the following examples, Unweighted and Weighted have no bearing, except for the last two examples, given that the colors are identical for both (except for the last two complex scenarios). Please note that there may be a difference of interpretation between the two, and the Glossary in Section 2.2 can assist with the meaning of each.

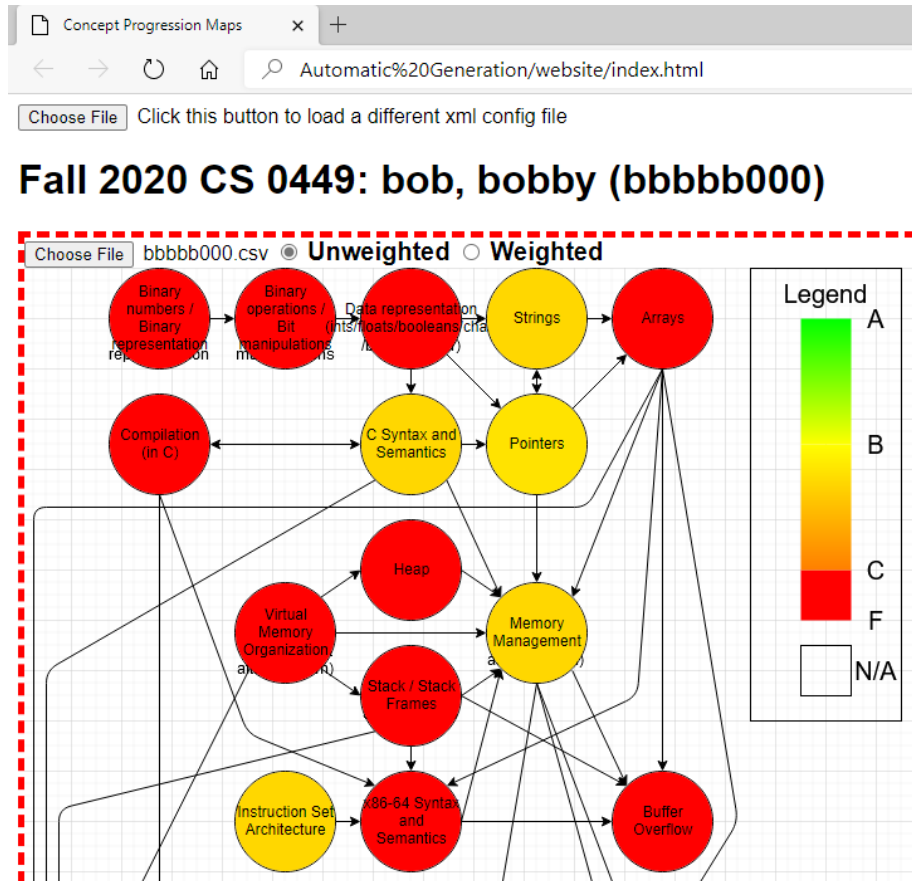
6.1 Simple Scenarios

6.1.1 aaaaa111.csv



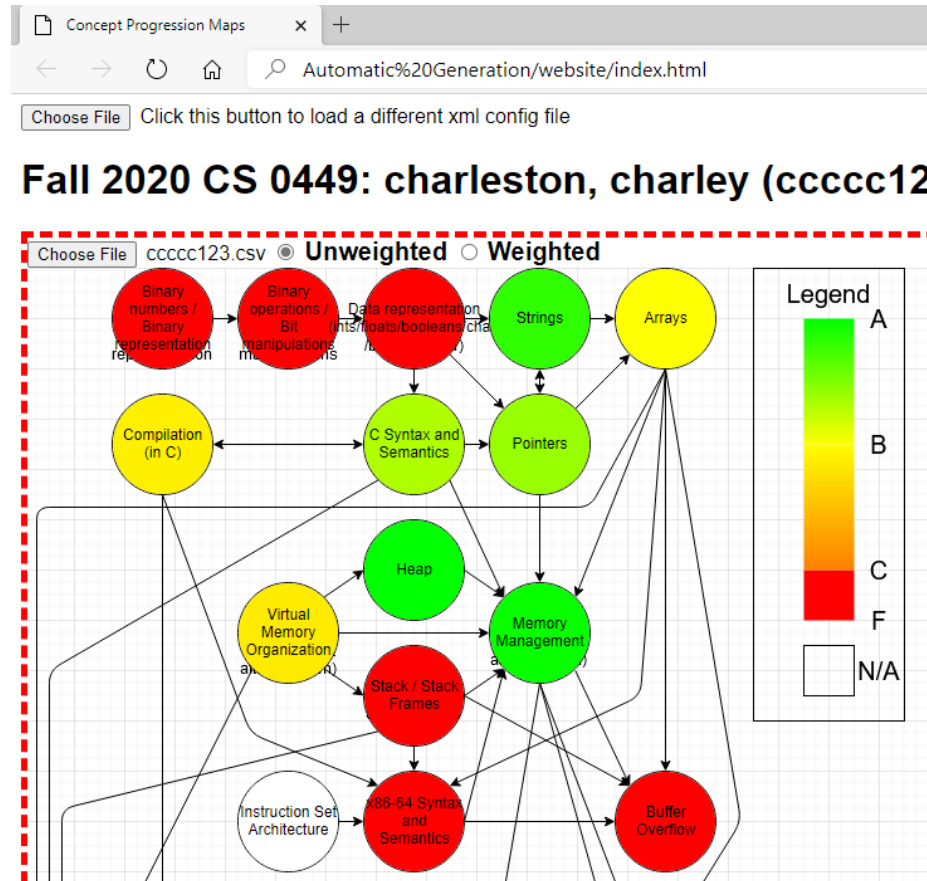
In this example, all concepts are colored green, indicating the student has been able to answer most or all of the assessments given to them correctly. This typically means that the student understands the concepts of the class, and any difficulty in the course would be attributed to non-course-content issues. It is still advisable to ask the student to see how they are doing, in order to be able to verify the information that is provided through the CPM.

6.1.2 bbbbbb000.csv



In this example, all concepts are colored red or orange, indicating the student has had significant difficulty answering most or all of the assessments given to them. It would be appropriate to ask the student about the issues they may be facing in the classroom, and based on their response, provide relevant information about resources they can utilize to improve their own situation. Further inquiry may be needed to understand the root of the problem, to properly provide a path for students to recover.

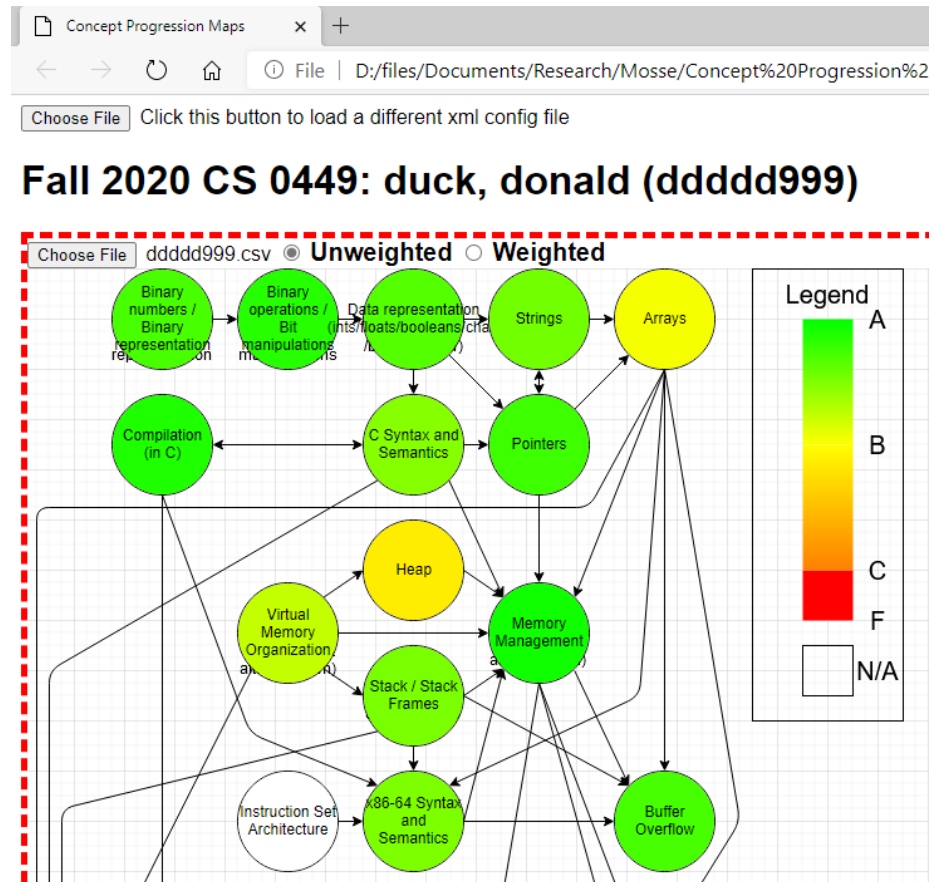
6.1.3 ccccc123.csv



In this example, it is not readily apparent how the student is doing in the class, given there are several colors all in different concepts. Upon further conversation/inquiry, the student might indicate they are content with their progress in the course. We believe that rather than attempting to provide information that the student is unwilling to listen to, it would be better to instead reaffirm the student's stated goals and support them in their intrinsically motivated pursuits.

6.2 More Complex Scenarios

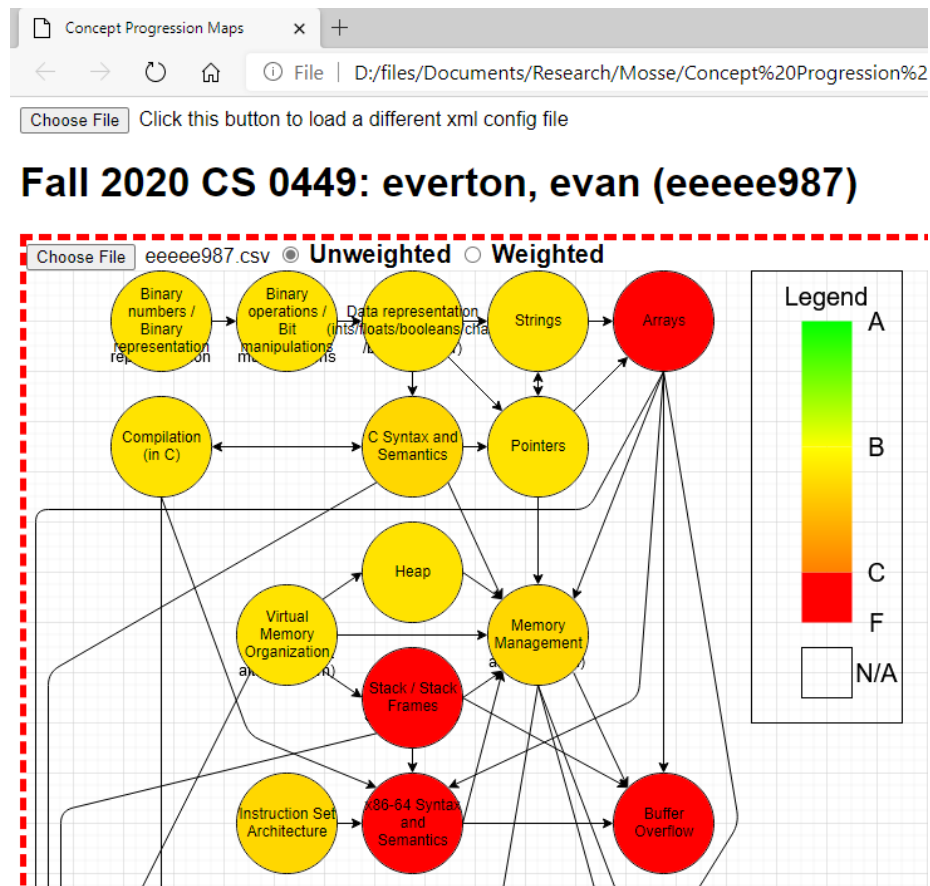
6.2.1 ddddd999.csv



In this example, we assume that the student has come into the advising session mentioning that they do not feel great about the course. Looking at the CPM, we can start to utilize the information in more robust ways to ensure the student is prepared to tackle the rest of the semester. We note three concepts in red (not pictured above, but can be found in the example file), “Physical Memory Organization”, “Page Tables”, and “Fragmentation”, which can easily be relayed to the student. An example script might be, “Based on a summary of your graded assignments, it appears that you may want to review ‘Physical Memory Organization’, ‘Page Tables’, and ‘Fragmentation’ before your next assignment or exam”. We recommend this type of explanation in the example script because we are running a single-blind test, meaning the students should not know which intervention group they are in. In addition, we note some concepts in yellow earlier in the course that are not as strong as most of the

others, specifically “Arrays”. Despite most subsequent concepts that come after “Arrays” are green, it may still be advisable to remind the student to review that concept before an exam, given that it is a prerequisite for many other concepts. Finally, a cluster of concepts are closer to orange (not pictured above, but can be found in the example file), specifically “Assembler”, “Linker”, and “Loader”. Given their relatedness, it’s likely that the student struggled with that section, which may also warrant a reminder for the student to review it. The follow-up might be, “That summary also indicated that you may want to consider reviewing ‘Assembler’, ‘Linker’, and ‘Loader’ too, even though you did better in those concepts than the others I mentioned previously”.

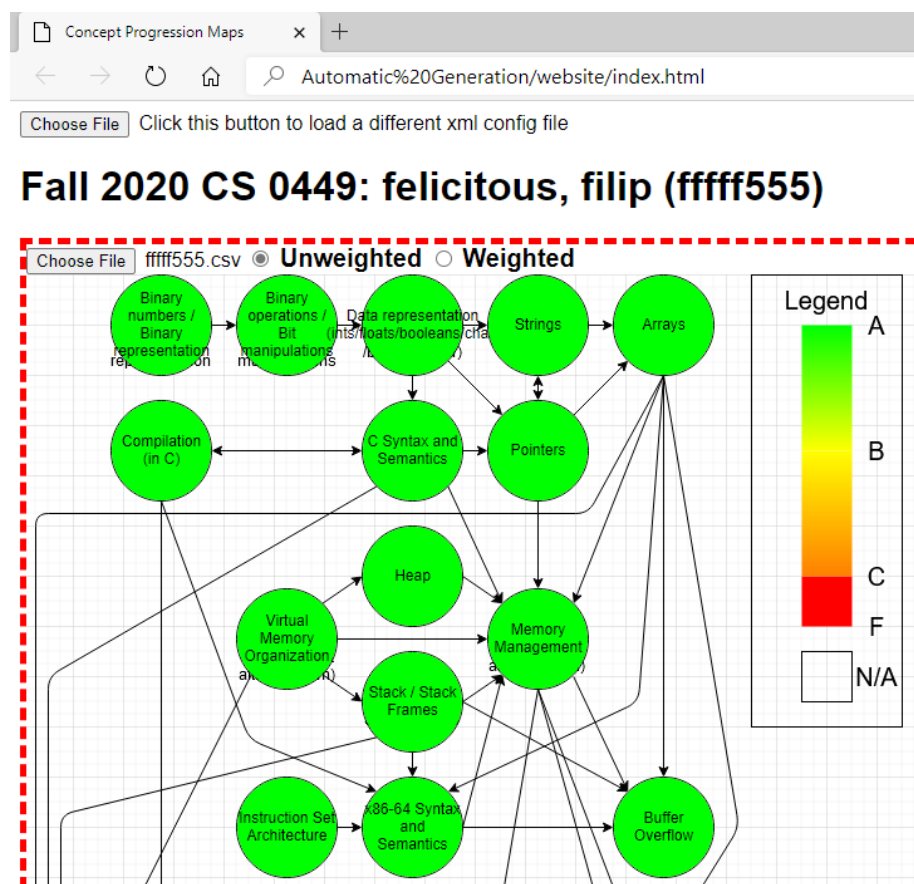
6.2.2 eeeee987.csv



In this example, the student has come seeking advice about what they can do to salvage the course in the final exam. From the CPM, it is clear that the student has been struggling since the beginning of the course, but there may be a possibility that the student can still pass. If desired, the CPM may indicate

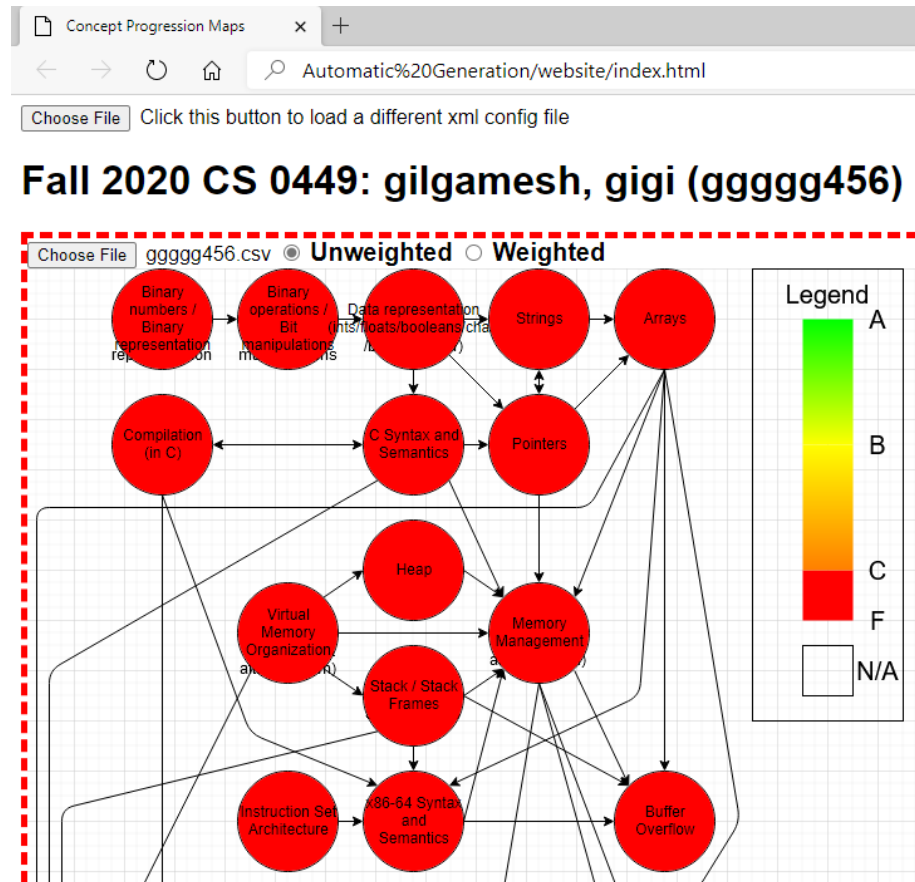
a probable list of concepts that the student can focus on, to improve their performance. The focus should be on concepts that have several arrows going out, which indicate that the concept is a prerequisite for many others. Examples include “Arrays”, “C Syntax and Semantics”, “Virtual Memory Organization”, “Memory Management”, and “Processes”. In addition, suggesting to review concepts that have several prerequisite concepts that feed into them would also be useful, given that those concepts are likely to be integrative ideas that combine multiple concepts together. Examples that are not also listed above include “Pointers”, “x86-64 Syntax and Semantics”, “Buffer Overflow”, “Memory Hierarchy / Multi-level Cache”, “Threads Memory Model”, “Producer-Consumer Problem”, “Reader-Writers Problem”, “Parallelism / Parallel Algorithms”, and “URLs”. An example script might be “Based on course information provided to me by the instructor, some important concepts to review might be [<List of Concepts>]”. We recommend this type of explanation in the example script because we are running a single-blind test, meaning the students should not know which intervention group they are in. Given that the CPM also has a line marking the midterm (not guaranteed in all CPMs), it may be advisable to ask the student if the final exam focuses on second-half material; this allows the list of concepts to be shortened, further reducing the burden the student might face. However, due to the connected nature of the course (as represented by the CPM), and the student’s relatively low performance at the first portion of the semester, it would still be important to remind the student to review those critical pre-midterm concepts.

6.2.3 ffff555.csv



In this example, upon first glance, the student appears to be doing extremely well in the course, given the green color of every concept. Yet, when selecting the “Weighted” radio button, the entire CPM turns red. This indicates that while the student is able to answer the majority of questions that are posed in the course, they were not able to do so in assignments that carried more weight. At this point, it is likely the case that the student does not have difficulty in understanding the material, but that there were barriers for successfully completing the higher weight assignments. The cause for this type of issue may be due to the type of assigned material (student does not understand the word problems given in the higher weight assignments), difficulty in time-management (unable to complete higher-weighted assignments on time), or difficulty in priority-management (spending too much time or effort on lower-weighted assignments). There may also be deeper underlying issues that may need to be resolved, and should be discussed during the advising session.

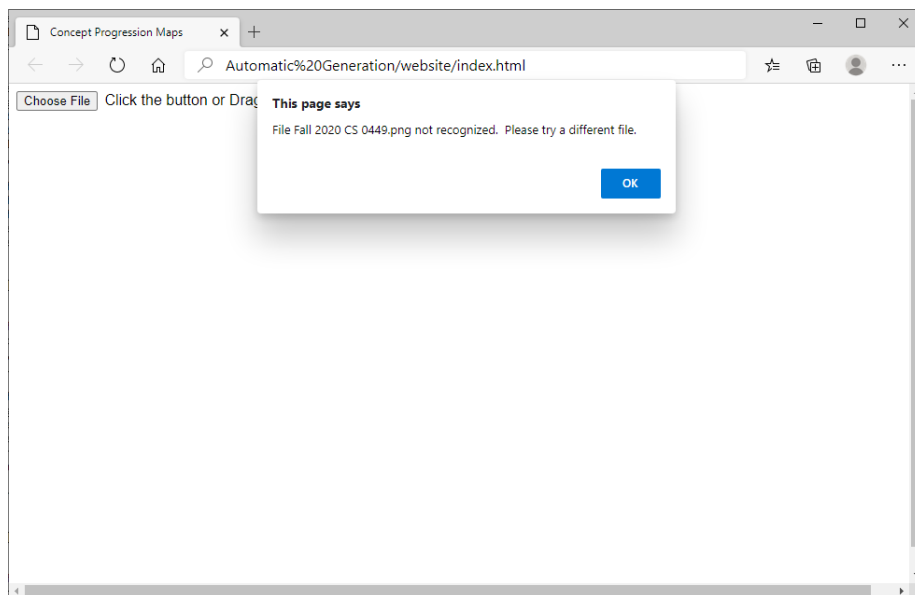
6.2.4 ggggg456.csv



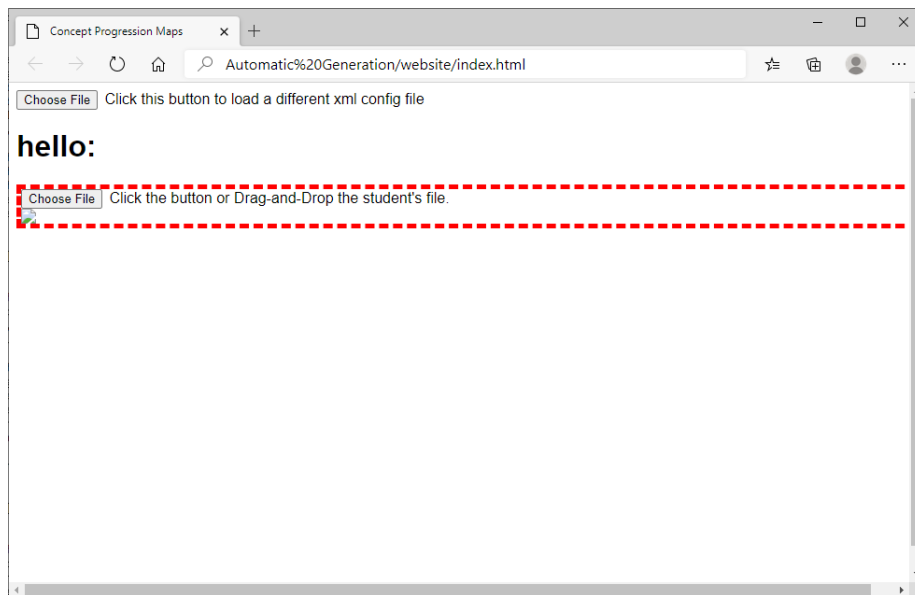
In this example, the student looks to be doing quite poorly in the course. Yet, when selecting the “Weighted” radio button, the CPM turns green. This type of CPM may be possible if the instructor assigns several low-weighted assignments, but assigns significant weight to a small number of assignments. In this example, it is likely that the student ignored all low-weighted assignments, and excelled at the high-weighted assignments. However, it is recommended to ask the instructor to verify the course’s structure.

7 Typical Errors and Troubleshooting

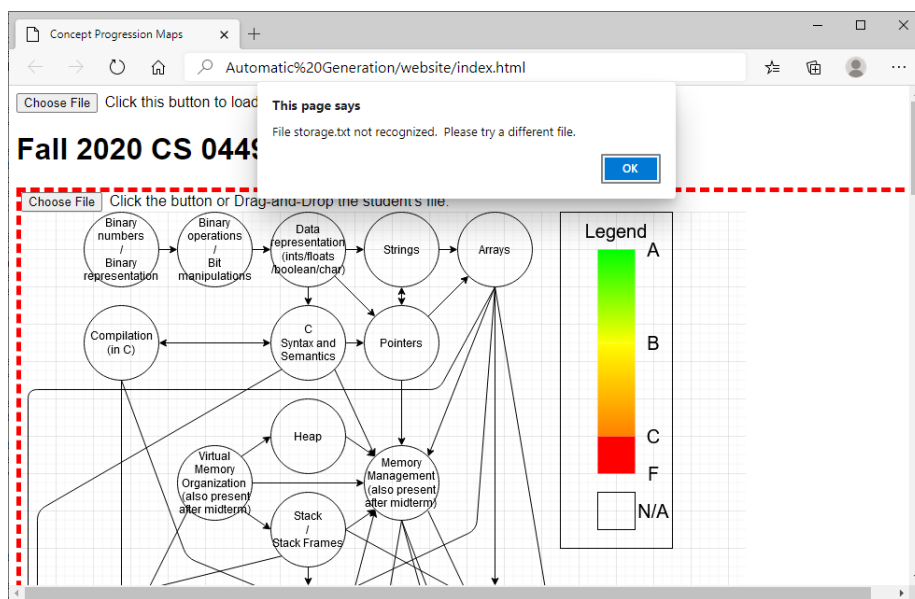
If any odd displays are appearing after a second loading of an XML or CSV File, simply refresh the display by clicking the browser’s refresh button or pressing the F5 key on the keyboard, and load the files as normal.



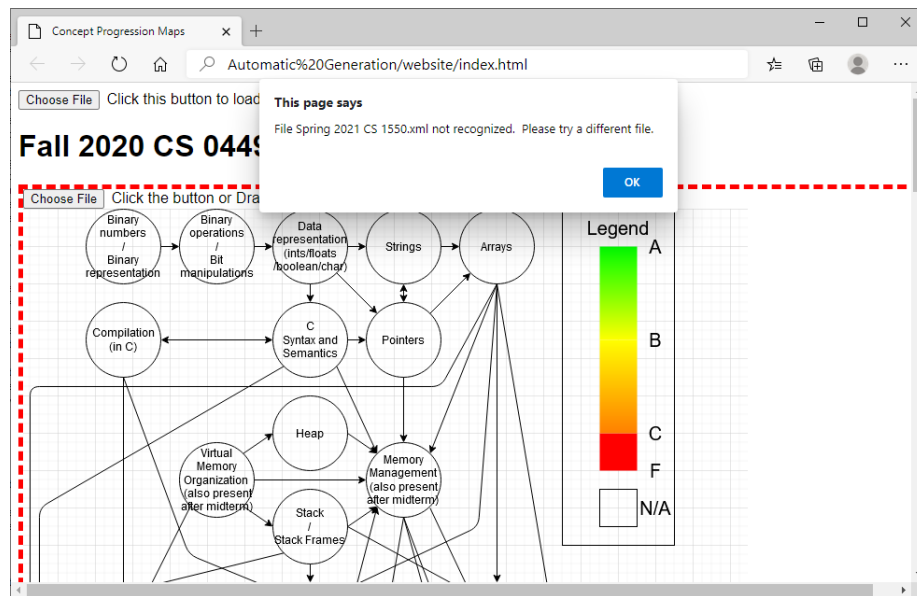
If an alert similar to the one above pops up at the starting screen, it means the file you are trying to load is not an XML File. Ensure that the file that is selected is one of the XML Files that was provided with the tool.



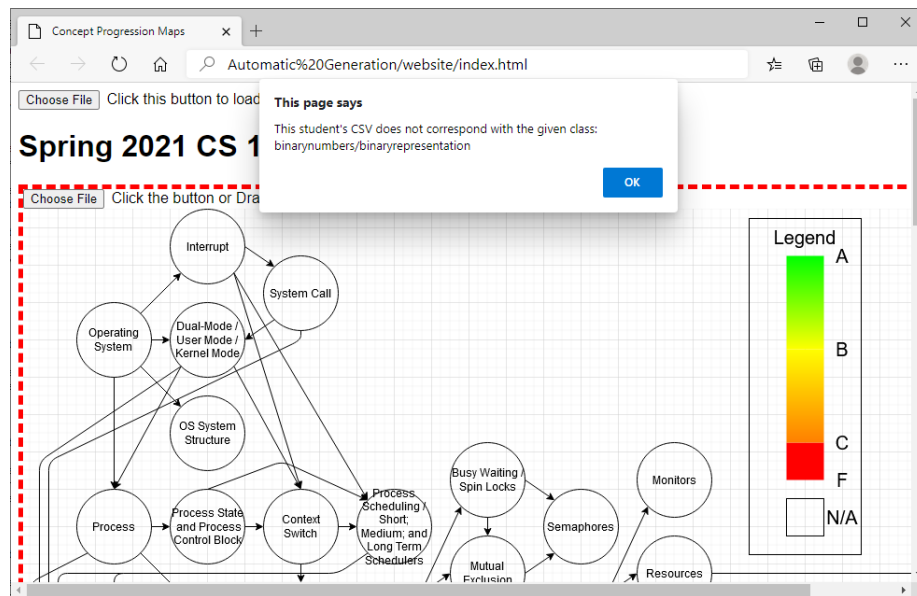
If the tool does not load the Concept Map image after loading an XML File, it means the XML File was not recognized. Either the wrong XML File was loaded, or the XML File was corrupted. Ensure that the file that is selected is one of the XML Files that was provided with the tool.



If an alert similar to this one pops up after successfully loading an XML File, it means the CSV File was not recognized. Either the CSV File was not recognized for the given class, or the CSV File was corrupted. Ensure that the file that is selected is one of the CSV Files that downloaded from the Box and corresponds to the course that is loaded.



If an alert similar to this one pops up after attempting to load a new XML File after successfully loading an XML File, it means the new XML File was not recognized, the XML File was corrupted, or the XML File was being loaded into the wrong loading screen by selecting the wrong button. Ensure that the top-most “Choose File” button was clicked to load the XML File, and that the file that is selected is one of the XML Files that was provided with the tool.



If an alert similar to this one pops up after attempting to load a CSV File after successfully loading an XML File, it means the CSV File was not recognized, loaded for the wrong course, or corrupted. Ensure the correct course is showing before loading the student's CSV File, the file that is selected is one of the CSV Files that downloaded from the Box, and the file corresponds to the course that is loaded.

8 Future Work

1. Allow cross-course display, and develop advising scenarios for them.
2. Allow better and more varied error messages.
3. Allow checking of XML File name to ensure that the corresponding image exists.
4. Convert local tool into actual web tool.
5. Remove unsightly text spilling out from the concept nodes.

9 Contact

Any questions, comments, suggestions, and/or concerns should be directed to Nathan Ong (nro5@pitt.edu) or Dr. Daniel Mossé (mosse@cs.pitt.edu).