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**The Red Black Tree Manual**

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***Abstract***

The purpose of the red black tree tutor is to help students from computer science introductory classes understand the red black tree data structure. After using the tutor the hope is that the student would have improved their abilities to insert and remove values from the tree. There may be many ways of developing a tutor, however this particular one was developed using Adobe Flash and Cognitive Tutor Authoring Tools developed by Carnegie Mellon University.

**Things you’ll need**

* Adobe Flash (<https://www.adobe.com/>)
* Creative Cloud (<https://www.adobe.com/>)
* CTAT for Flash (<http://ctat.pact.cs.cmu.edu/>), <http://ctat.pact.cs.cmu.edu/index.php?id=download>
* TutorShop Account (<https://tutorshop.web.cmu.edu/>)
* DataShop Account (<https://pslcdatashop.web.cmu.edu/>)
* Adobe Extension Manager (<https://www.adobe.com/exchange/em_download/>)

**Requesting TutorShop Account**

In order to use your tutor it must be first uploaded to a website called tutorshop, this or create your own website where one can display the .swf and the .bdr files needed for the tutor. One must request an account by email, click on the “Contact Us” button at the home page.

**Activating a sample Insert Red Black Tree tutor**

1. Once you have been given a tutorshop account you must create your own package in order to upload your problems and create problem sets.
2. The website allows you to upload any problem created with CTAT. Once the package has been created go to the problem section of the package and click “New Problem” from there upload the .swf and appropriate .bdr files of a particular problem to create a problem in the tutorshop package. (Each state of the tree is treated like a problem in this case, a full problem is composed of multiple cases/.swf and .bdr files)
3. In order to test the tutor, upload the first five problems into the tutorshop package from the “Red Black Tree insert” folder provided. (Note that in order to use the full tutor all problems from the folder must be uploaded)
4. Once the problems are uploaded you can create a problem set where you can test/display, etc. your problems in the order you want and however many you want. To do this, go to the problem set section of your package and select “New Problem Set” this will allow you to create a new space to display your problems.
5. Click on the name of your problem set in order to add problems to it. Going to the problem section you can click “Add Problem” this way it will allow you to add problems from your package. (The problems are displayed in the order you uploaded them, however one can change this by dragging them up or down)
6. To test the problem set, click on the play button to the side of the name of the set and a test tutor will start.
7. Once the problem set has been created a class and student accounts must be created, a class holds all the students that are going to use the tutor. (Tutorshop request one gets in contact with them before doing this step)
8. Once the students and class have been created one can assign individual problems or a complete problem set to the students.

**Getting started From Scratch**

The first thing you’ll need to do is download the CTAT program from the CTAT website. It is free; all you have to do is provide some information about your project. Once that is done the next step is to download a program called Adobe Flash Professional, make sure it is the latest version. The adobe website will guide you through the process, this software is not free, but it does have a 30 day free trial. Next you will need to download a program called extension manager, you can download it for free from the CTAT website or the adobe website. This is all the initial setup needed in terms of getting all the software needed.

**Building the Tutor**

Depending on whether you want to build an example-tracing tutor or a cognitive tutor these steps would differ some. This tutor is an example-tracing one hence these steps will be for that type of tutor.

**Building the Interface**

The CTAT website has a more in depth tutorial on how to build the interface, I will provide some steps and tips that may help build the tutor in a clear way.

1. The first step is to open the flash IDE previously installed
2. Create a new flash document, Select **ActionScript 2.0** or **ActionScript 3.0**, depending on which version of the CTAT flash components you'd like to use. This tutorial assumes you are using ActionScript 3.0.
3. With the CTAT download there should have been some CTAT components downloaded for flash. To access them from flash you’ll need a program called Extension Manager. Open the application and add the flash components from the CTAT program to Adobe Flash. Once this is done the component window should have the CTAT components in every flash document.
4. In order to build the interface there a few components you must add in order for the interface to function. From the component window add the CommShell component and the done button component. The CommShell insures communication between the interface and the example-tracing code. The done button is to tell the code one is done with the interface/problem. After adding these components you can design the interface however you see fit using the flash and CTAT tools. Make sure to test the interface by selecting test movie in the control panel. (More on the CTAT website)

**Programing the Tutor**

1. After the interface has been completed it is time to program it. Open the CTAT for flash and create a new graph. Next open the interface that is going to be used. The two should sync automatically. To start go to the menu bar and on the graph menu select start state.
2. Once the start state has been created the programmer will use the interface to insert the correct answers to the problem in the order that the programmer wishes. These answers will get recorded in the CTAT software. Ensure that CTAT's **Author Mode** is set to **Demonstrate** so it records the solution. The Behavior Recorder records each demonstrated step as a 'link'—the line connecting two nodes—in its graph. There can be multiple corrects paths.
3. Now you will demonstrate an incorrect step in the problem, so that the tutor will be able to recognize this error when students perform it. In general, any student input that is not recognized by the tutor is marked as incorrect; but by defining incorrect steps in the graph, the tutor will be able to provide a customized error feedback message for the specified input. (CTAT) To change the action type from correct to incorrect simple right click the link and **Change Action Type > Incorrect Action (Bug)**
4. The last step is to customize the hints in each link providing custom feedback in every step.
5. You can now test the tutor you have created. Set CTAT's Author Mode to **Test Tutor**. To test your tutor from the beginning, click the start state in the behavior graph; then interact with the student interface. To test from any other step in the problem, click the desired state in the behavior graph—the student interface will update to reflect the problem-solving state—and then interact with the student interface. (CTAT)

**Analyzing the Data**

In order to analyze the performance of the students while using the tutor a good tool to use is DataShop. DataShop is on online tool that gets feed information from your tutor automatically and stores it in the website. Once it is in the website, one can use the tools available to analyze the data however one sees fit. Depending on the classroom size this option can be optional. For information on how to set up the automatic feed and data collection, get in touch with a DataShop representative, also there is helpful information on the website. Since all of these websites are free, it is requested by the developers that you contact them and tell them more about your work.

**References:**

Cognitive Tutor Author Tools, Carnegie Mellon University, Copyright 2003-2013, Retrieved on May 28, 2015 from: http://ctat.pact.cs.cmu.edu/