**Virginia Polytechnic Institute and State University**

**Virtual Textbook Developer Guide**

**Modeling a concept graph based statics textbook**

*Last Updated: July 9, 2012*

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**Background**

* **ZVTM**

The Virtual Textbook Application (VTA) is built using a graphics and animation toolkit called ZVTM (<http://zvtm.sourceforge.net/>). Although the ZVTM Developer’s Guide can be useful, it is merely a document that should be looked over and not referenced frequently; all of the basics that it describes from ZVTM have been implemented and wrapped in wrapper classes in the implementation of the VTA. ZVTM is mostly being used to help support the animation of the application, the graphics, which will further be referenced by the proper ZVTM name for the graphical components, glyphs, and the features of having a “world” that is zoomable and navigable.

To wrap the ZVTM components, we used the model.Node, model.Link, controller.VirtualTextbookApplet, and view.AppCanvas classes, as well as an implementation of the ZVTM listener interface ViewEventHandler in view.CameraMovementListener. The Node class utilizes most of the glyphs that are seen in the application. Although this class also contains all of the nodes’ information, it also contains a VText for the title, a VText for the description, and a VRectangle for the surrounding rectangle for each node. The AppCanvas class contains most of the camera variables such as the vSpaceManager, which is the all-encompassing and variable that stores almost all of the camera, views, perspectives, etc. for ZVTM, the detailedSpace, which is the space that the glyphs of the application reside in, and the detailedCamera, which is the actual camera of the application that is allowed to change to get different views of the detailedSpace. The Link class extends the VSegment class, which draws line glyphs, to implement the links from node to node in the application; the attributes of each link is stored within an instantiation of the Link class’ inner class LinkProperties. Finally, the VirtualTextbookApplet is a JApplet class that sets up the application to be run as an applet, as well as provides the Container for the application to be put in.

* **Content**

The content of the application is stored as an XML document within the src/content folder. This content is easily understood, but contains linktypes to declare what links are available and what attributes, such as name and color, each link type has. The content document also has chaptertypes which similarly declare which chapters are available and what attribute each chapter should have. Finally, the bulk of the content document is the actual node information that contains all of the details for each node. The document is parsed in the controller.XmlParser class in the following order, as can be seen in view.AppCanvas.populateCanvas():

* chaptertypes
* nodes
* linktypes
* links

**Basic Class Layout**

The VTA is laid out with the goal of utilizing a Model-View-Controller (MVC) design pattern. This has separated the project into three main packages. Below is the package hierarchy to supplement further explanation of the class layout and files associated to the applet.

1. content
   1. Graphviz auto-generated files.
   2. nodes.xml
      1. XML file read to create the Chapters, Nodes, and Links in the applet.
2. controller
   1. xml (directory)
      1. GridsGenerator.java
         1. **TODO**
      2. XmlParser.java
         1. Used to parse nodes.xml for use in the applet.
   2. Configuration.java
      1. Used to determine where necessary files should be pulled from.
   3. GraphViz.java
      1. Generates graphical information (**ADD MORE INFORMATION**)
   4. Main.java
      1. File used for generating graphviz data for the applet.
   5. VirtualTextbookApplet.java
      1. Main file for applet. Everything starts here.
3. fr
   1. **TODO**
4. model
   1. Link.java
      1. Link data structure created to connect nodes.
   2. Node.java
      1. Node data structure created to represent a block of information with both a full and short description drawn within a rectangle
   3. NodeMap.java
      1. A class to store nodes keyed by their chapters.
5. view
   1. AppCanvas.java
      1. Draws the app onto the ‘canvas’
   2. CameraMovementListener.java
      1. Listener class created to handle camera movement in the applet.

The controller package contains most of the setup methods to initialize an instantiation of AppCanvas with variables depending on if the application is being run as an applet or as a standalone application. The model package contains the bulk of the information for the application, including a static reference to all of the nodes (in Node class), as well as a static reference to all of the links (in Link class). The model package also has the wrappers for the ZVTM glyphs, which would be better put in the view class if they were planning to be changed or if it could be decoupled from the node and link information. Finally, the view class contains the listener class for the application as well as the canvas (in ZVTM terms, the cameras and views) that handles and displays the graphics for the application.

**Other Useful Information**

* **Node Focus Algorithm**

Node positioning is handled by the NodeMap class, specifically through the Graphviz related functions. See the section of Graphviz data for more information on how this is created. The CameraMovementListener handles catching user interaction, and sends calls to AppCanvas, which then determines which view needs to be shown (chapter or overview), shows/hides nodes, and calls the layout function in NodeMap through the method showSelectedChapter(). Of note is that CameraMovementListener keeps track of the currently highlighted node, not AppCanvas.

* **Realigning Node Information**

Although the glyphs that make up the nodes are “stuck” together using ZVTM’s Glyph.stick() method, the actual rectangle and the positioning of the glyphs is updated dynamically, when necessary using Node.realignNodeText(), which is called using draw whenever the graphics are updated and whenever a move event is called for the node. As draw events are called very frequently, a performance boost might be achieveable if this method is only called when the node is moved, and might be worth looking into if runtime performance becomes too slow. This is not entirely straightforward though, as simply removing the call from draw and only having the call in all node movement methods does not correcly refresh the text.

* **Drawing Node Title and Description Text**

So for us to handle creating multiple lines of text for a node's title and description, we had to edit some ZVTM code. All the edited code is in VText.java located at "fr\inria\zvtm\glyphs\VText.java". Initially, only one line of text would be created. ZVTM uses the drawString() of AWT. On lines 427 and 430 we replaced the call to drawString() with a call to our method drawTheString().

The drawTheString() method will take the VText protected String text and split it into an array of the words. The AWT drawString() method will be called for each row of words. The number of words in a row is determined by the number of characters in each words, and respects the static variable MAX\_CHARS\_PER\_LINE. This method is also where the textContainerHeight and textContainerWidth are determined based on the longest row and the number of rows. These variables are also new additions to the original ZVTM code. Note that the minimum node width set in Configuration.java is always respected despite this calculation. For multi-nodes, all node name strings will be placed on their own line.

**drawTheString()** basically works as follows:

* The string is split into an array of words
* If the number of total characters is greater than the max characters per row (MAX\_CHARS\_PER\_LINE), then multiple rows need to be drawn
* While the endIndex is not at the end of the words array
* If the current index is the last index, draw the all the words from the last line to the current index, and break
* Otherwise if the number of total characters from the words at startIndex to the word at endIndex is less than MAX\_CHARS\_PER\_LINE, add the number of characters from the word at endIndex to the current character count.
* Otherwise, draw the words from startIndex to endIndex in the current row, and move to the next row, moving startIndex and endIndex to the next unused word.
* After the loop, the textContainerHeight is determined by the height of the characters multiplied by the number of rows
* Otherwise just draw the string
* **Navigating to Web Pages ( Chapter level view, specifically)**

The navigation to web pages is handled by the AppCanvas.navigateTo() method, and is primarily called by the CameraMovementListener.click1() method when a selected node is clicked. Webpages are addressed relative to the application folder on the server, and by convention are kept in the webpages folder. Webpages can be either an absolute address (determined by a string starting with http), or as a string relative to the current directory on the server, which on the test server turns out to be “<http://adaptivemap.me.vt.edu/AdaptiveMap/>”.

* **Multinodes**

Multinodes are nodes that represent many nodes with the same link type grouped together. These are created only for nodes not in the current node's chapter, and only if there are 3 or more nodes to group. These nodes are treated as part of a regular node, and code relating to them can be found in Node.java.

* **Generating GraphViz data**

Graphviz data is generated by running the application as a standard java application. To do this export as 'Runnable JAR file', and run the application. The graphviz data will be created in the directory where you run the jar. NOTE: Graphviz must be installed, the location is determined in the GraphViz.java file:

// private static String TEMP\_DIR = "/tmp"; // Linux

**private** **static** String *TEMP\_DIR* = "c:/temp"; // Windows

// Where is your dot program located? It will be called externally.

// private static String DOT = "/usr/bin/dot"; // Linux

**private** **static** String *DOT* = "C:/Program Files (x86)/Graphviz 2.28/bin/dot.exe"; // Windows

Make sure the temp directory exists, or graphviz will not be able to execute. The generated files are then placed in the content folder on the server. NOTE: The current server is not a 64-bit OS, and the path will have to be changed for the generator to work.

* **HTML Code to prevent browser window scrolling when zooming**

This code should be placed in the html below the applet tag, and the applet should have the id='Adaptive Map' and name='Adaptive Map' parameters.

*<script type="text/javascript">*

*window.onload = function() {*

*var applet = document.getElementById("Adaptive Map");*

*applet.onmouseover = function(e) {*

*window.onscroll = function(e) {*

*//scroll where you want to be (the top)*

*scroll(0,0) ; }*

*}*

*applet.onmouseout = function(e) {*

*//replace with empty function*

*window.onscroll = function(e) {} }*

*};*

*</script>*

* **Problems with applet refresh**

For most systems, the applet seems to break when the page is refreshed, or the user navigates away and back to the applet. This doesn't happen on a linux system using an open-java browser plugin, and thus must be related to the windows standard java plugin. The problem is that the ZVTM animation system seems to break, which might be related to the fact that ZVTM initializes the virtual space manager as a static variable. Static variables are preserved between applet sessions, and it seems when the applet terminates, it must call the virtual space manager's deconstructor, which turns off the animation system. This is a tough problem to solve, and it might be worth looking into whether using java web start can circumvent this problem. Currently, the user can fix this problem by clearing their browser cache.

**Uploading the Applet and Server Setup**

* **First-Time server Setup**

To run the applet on the server you need java and tomcat installed and running. The files that go on the server can be found in the Tomcat Supplementary Folder. Create a new folder called AdaptiveMap in the Tomcat 7.0/webapps folder, and copy all the files over. When compiling the new jar file, export as 'JAR file', save it as adaptive-map.jar and tick the following options:

* Export generated class files and resources
* Compress the contents of the JAR file

IMPORTANT: Before exporting run a clean on the project, to insure the exported file is as small as possible. Also, make sure to only export the necessary source files, be sure to uncheck the documentation and content folders if they are in your project's src directory.

To get the custom browser icon to work, you must also copy it to the webapps/ROOT folder.

The index.html file should also be editted so that the icon shows up and users are correctly redirected to the applet. Add:

<head>

<meta http-equiv="refresh" content="0;URL=http://adaptivemap.me.vt.edu/AdaptiveMap/index.html">

</head>

<link rel="icon"

type="image/ico"

href="icon/favicon.ico">

to the index.html file located in the ROOT folder.

**XML Generator**

The XML Generator is a java application that was created to make it easy to edit large XML files. The application was created using standard java library GUI classes.

1. controller
   1. EditorXMLParser.java
      1. Parses xml file to be edited.
   2. Main.java
      1. Runs the java application used to edit XML files.
   3. XMLFilter.java
      1. TODO
2. view
   1. EditorSplitPane.java
      1. View for the application.

**Changes**

**(Between May 22, 2012 and August 6, 2012)**

**From newest to oldest**

Made node names have their own lines in multi-nodes.

Hid link text on overview links.

Fixed link text problems in long link text.

Fixed multi-nodes not resizing font.

Changed link descriptions color and shape.

Fixed overlapping link descriptions by making descriptions not centered.

Default zoom bar affects zooming in on nodes.

Made options menu look neater by centering all elements

Changed button titles to Overview: Cluster View: Topic Page

Adding chapter colors to multi-nodes.

Added selecting from multi-nodes directly.

Added start screen.

Made it so only you can only highlight 1 link description at a time/

The related link is highlighted when the link description is highlighted.

Disallowed highlighting link descriptions when a node is highlighted.

Allowed for using absolute website addresses.

Made link text background always visible so its easier to find by the user.

Fixed bug with entering nodes not registering clicks.

Replaced legend with 'hover over link' functionality.

Reverted to Java 6 to better support mac users (currently no official support for java 7 on macs).

Made background color less saturated.

Made multi-nodes also go back under their chapter node when switching to overview.

Fixed algorithm for distance from current node.

Added chapter color to node selection pop-up list.

Make sure GraphViz data is cached.

Multi-nodes focus when clicked on.

Made list in multi-nodes give a new row between each node.

Made back button also go back to overview nodes.

Made node gradient more noticeable.

Fixed borders of nodes sometimes starting bolded when they shouldn't be.

Nodes change gradient based on distance from selected node.

Disabled zooming on nodes when moving around overview.

Default zoom level bar affects chapter view.

Increased default font size.

Changed pointer into default arrow.

Fixed placing all first-level nodes on right side.

Made GraphViz layout width dependent on number of nodes.

Fixed first-level nodes being placed in reverse order.

First level nodes now placed on left or right side to take up least horizontal space.

Made arrowheads color match the link color.

Fixed multi-node description including in-chapter nodes.

Added titles of nodes to multi-nodes.

Changed multi-nodes border color to be more noticeable.

Made multi-nodes always show full description.

Continue looking at graph layouts

Made arrowheads dependent on link size.

Fixed inconsistent overview link widths.

Made link ends more distinct, different colors when highlighted.

Made smaller links go on top of larger ones.

Made sure text fits in it's rectangle.

Made it so the currently selected node is always highlighted.

Made current selected node stand out with a yellow, thicker border.

Made overview node rounded corners more round.

Made links disappear last when switching view.

Adjusted chapter link widths being too large, and changing wrongly depending on zoom level.

Disabled the page button in overview mode.

Fixed search breaking again.

Added ability to set a default chapter node, which is centered at start, using <defaultChapter>true</defaultChapter>

Added buttons for zooming.

Fixed broken zoom transitions.

Made chapter layout consistent. When adding new nodes, everything is not rearranged.

Added ability to set default chapter nodes in xml.

Fixed links bug not showing some first level nodes.

Fixed horizontal and vertical link heads not being correctly positioned.

Fixed chapter titles disappearing when you visit another chapter first.

Removed link types in overview.

Adjusted horizontal space between nodes.

Added slider bar for default default zoom levels for chapter and overview to options menu.

Added ability to change font sizes during runtime, through options menu.

Fixed overview node to correctly encompass it's whole text.

Add ability to determine node position by shift-clicking nodes.

Centered all nodes under their chapter when moving from overview to chapter view.

Fixed get searching to work with GraphViz.

Moved arrowheads behind nodes.

Fixed arrowheads so they move to the correct positions.

Added ability to toggle node dragging in options menu.

Added ability to set manual layout of nodes, used in overview.

Set a minimum node width.

Background color changes when moving between chapters in chapter view.

GUI Node maker:

Clicking ok after selecting node file with xml problem gives user notification

Change & -> &amp; automatically

Can now add links to existing nodes.

Drop down lists for chapter and node selection.

Warning message for overwritting existing files.

Can now delete existing items.

Added ability to save xml.

Created the program.

Server:

Made applet width based on window size.

Added java-script to prevent scrolling the web-page while the applet is focused.

Added a replacement for the tomcat icon.

Fixed IP showing in address bar.

Changed default port on server to port 80.

Removed:

Selected node links always highlighted.

Tried curved links, PROBLEMS: Getting arrowheads and text positioned correctly

Made links more distinct, assigning them different color grays.

**(Between December 13, 2011 and May 3, 2012)**

* General Changes
* Set up a github repository for version control (<https://github.com/mpascale/Adaptive-Map>)
* Set up server on ME machine to run the Adaptive Map (<http://128.173.188.251:8080/>)
* Created NodeMap data structure to store nodes according to chapters
* Made outer view accessible through right-clicking
* Made mid-view to overview transition clean (mid-level nodes move back to their original positions and disappear)
* Changed all textboxes to determine line length based on characters
* Added switching between overview/chapter view, remembering last selected node
* Set navigateTo(url) to use relative addressing scheme.
* Updated all comments and documentation
* Changes to Overview
* Added zoom/search buttons and legend
* Centered nodes at start
* Hide individual nodes when in overview
* Increase node size and prevent overlap
* Make strength of node gradient dependent upon number of nodes in chapter
* Do not allow chapter nodes to change view (except to become hidden)
* Realigned text
* Reversed order of buttons- Book/Chapter/Page
* Made background color based on current chapter color
* Links between chapters have weight dependent on # of links between nodes
* Graphing Changes
* Implemented graphing algorithm to place nodes in optimal positions so links do not cross as often
* Added 1-level out nodes to the mid-level view (placed them in empty spots left from the graph layout)
* Implemented Search Function
* Search any node in the map from the chapter view
* For searches that produce multiple results, allow user to select desired node from a pop up list
* Changes to Links
* Made links highlight and display their link type when connecting nodes are hovered over
* Changed link colors to be more visually appealing
* Fixed ghost links
* Changes to Nodes
* Color scheme
* Gradient colors
* Rounded edges
* Bolded titles/ non bold descriptions
* Created constant node size based off size of largest node text for the chapter

January – May 2013

* Search edit to show when no result found.
* Search edit made to search for each word individually in the xml file.
* Node transition error fixed.
* Page reload error attempted to be fixed, no success.
* XML Generator edited to add color changer.
* XML Generator edited to allow for keywords in nodes.
* XML Parser edited to accept new XML changes.
* Node chapter colors changed.
* Graphviz data creator robustness.