

6.005 Project 2 Design Document (Revised)

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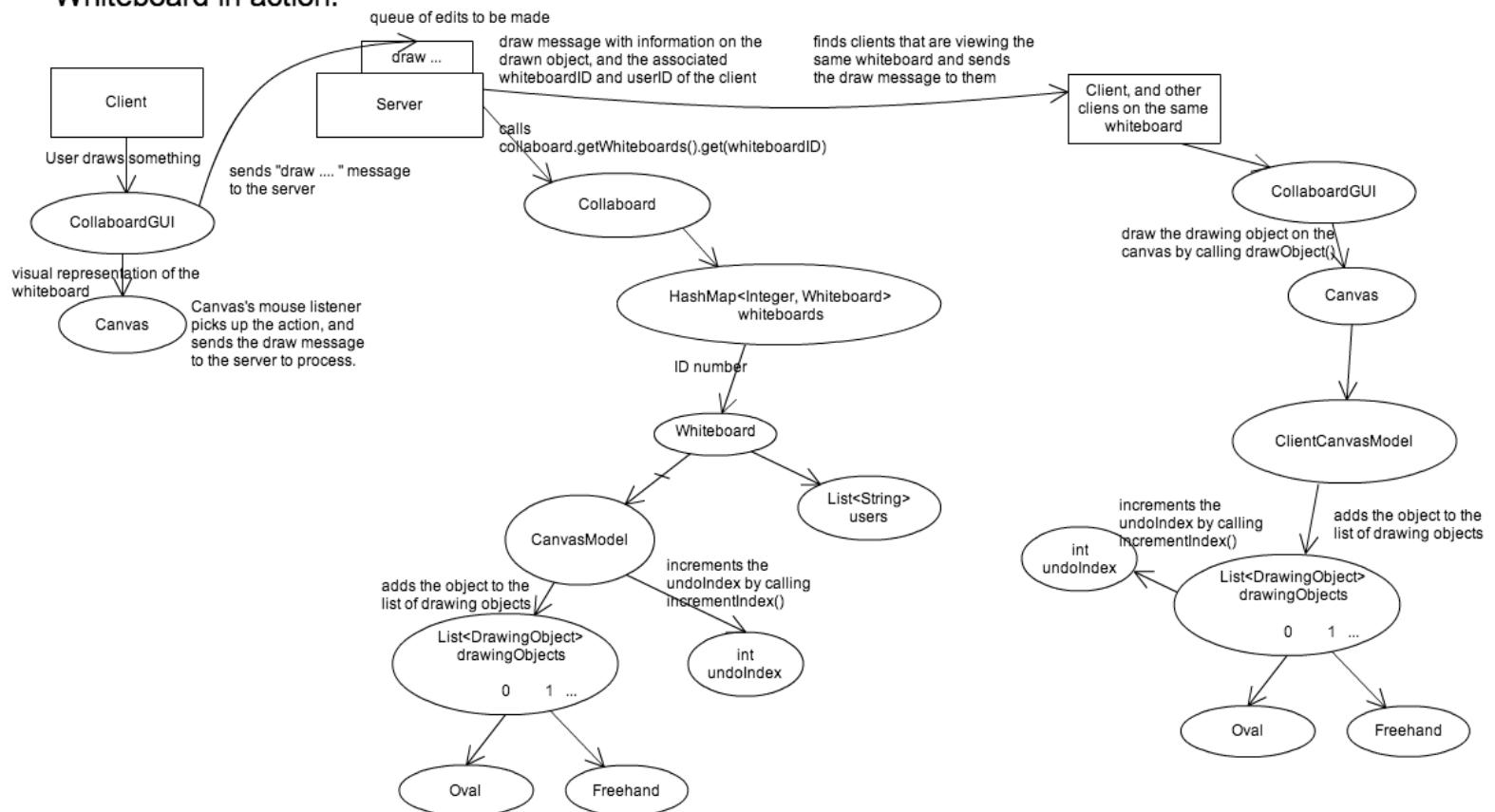
1 Overview/Implementation Choices

Our implementation of the collaborative whiteboard currently allows users to draw ovals and make freehand marks. We also allow users to undo and redo changes to each whiteboard. Each client has a reference to its own model that stores the state of a given whiteboard, but these models are not shared between clients, or client and the server. They are each altered the same way (given that they all pertain to the same whiteboard) through message passing and a shared edits queue in the server. All edits must be processed by the server before they are populated on a client's canvas, ensuring that no concurrency bugs occur.

Each whiteboard is identified by a numerical integer ID number. Users can access a specific whiteboard from the whiteboard selection pane upon first entry, or they can switch between whiteboards once they have already entered a whiteboard. A user can only be on one Whiteboard at a time, and usernames are unique (no duplicates are allowed), and we only allow alphanumeric characters and no spaces for usernames.

2 Snapshot Diagram

Whiteboard in action:



3 Datatype Design

CollaboardServer: Server class for our collaborative whiteboard.

- Stores the current instance of Collaboard, and current active UserThreads.
- Handles messages passed from each client thread.
- Has a BlockingQueue for requests to mutate a whiteboard to be put in and handled one at a time by a thread specifically dedicated to handling requests

Collaboard: Class that stores all the active whiteboards and active usernames during a given server session.

- has a Set of usernames in order to prevent users from creating duplicate usernames
- has a HashMap of WhiteboardIDs to whiteboards to prevent users from creating whiteboards with duplicate ID numbers
- Threadsafe through use of the monitor pattern

Whiteboard: Class representing the state of a given collaborative whiteboard.

- has a CanvasModel
- has a list of users currently accessing that whiteboard
- has a whiteboardID number

CanvasModel: Class representing the state of the canvas in a whiteboard.

- stores an ArrayList of DrawingObjects in the order that they are drawn on the canvas.
- stores an undoIndex to determine which objects should be displayed on the canvas

DrawingObject: An Interface implemented currently by Freehand and Oval.

- Each DrawingObject represents a new stroke or image added to a canvas.
- This makes it easy to add new features to our whiteboard, like the ability to draw other shapes like triangles or rectangles.
- Freehand: represents a freehand stroke made by a user. Contains a list of Line objects, which store a starting x and y coordinate, an ending x and y coordinate, a string representation of a color, and a string representation of a thickness.
- Oval: represents an oval made by a user. Contains a starting x and y coordinate, a center x and y coordinate, a string representation of a color, and a string representation of a thickness.

User: Class representing a user currently using the collaborative whiteboard system.

- has a userID - unique and assigned by the server upon connection. Used for identification purposes. (Also allows our code to be modified in the case that we allow users to change their usernames without disconnecting.)
- has a username: name that is displayed when the user enters a whiteboard.
- has a whiteboardID - ID of the Whiteboard the user is currently accessing.
- has a ToolbarModel: Class representing the Color and Thickness settings a given user has active.

UserThread: Class representing a client connection on the server.

- stores a username, userID, and currentWhiteboardID.

Client: Class representing a socket connection to the server. Also handles inputs from the server.

- stores a User object
- stores a reference to a CollaboardGUI in order to call methods accordingly to mutate the GUI according to inputs from the server.
- all of these such calls are made using `SwingUtilities.invokeLater()` to prevent concurrency issues with Swing.

CollaboardGUI: GUI class of the collaborative whiteboard. Populated upon connection to the server.

- The first panel the client sees is one in which they select a username. If the username is taken or invalid, an error is displayed. Otherwise, the username is stored client-side and by the server and the user is taken to the next window.
- The second panel the client sees is for whiteboard selection. The client can either choose to create a new whiteboard, or select an existing whiteboard from the list of existing whiteboard IDs.
- Once a valid whiteboard is created or selected, the main GUI is shown, consisting of a Canvas, a ToolbarGUI, a JScrollPane displaying active users, and a header that allows the user to switch whiteboards by inputting a new whiteboardID.
- ToolbarGUI: Has buttons that the users can toggle to select a drawing color and thickness of the user's ToolbarModel, as well as undo and redo changes to the Canvas.
- has a ClientCanvasModel (in the Canvas) - each client has its version of the Canvas-Model stored by the server.

4 Protocol

From the Server to the Client:

- **LIST** List of current, active whiteboard IDs.
- **VALIDUSER** Allows the client to proceed to the whiteboard selection pane.
- **VALIDWHITEBOARD** Allows the client to proceed to the specified whiteboard.
- **USERTAKEN** The username the client selected is invalid. Prompts an error message on the username selection pane.
- **WHITEBOARDTAKEN** The whiteboardID the client tried to create a whiteboard with is taken. prompts an error message.
- **NEWBOARD** Encodes the whiteboard ID of a whiteboard that has just been created to update the list of current whiteboard IDs on the whiteboard selection pane.
- **READY** The canvas is ready to be initialized.
- **INITDRAW** Sent when a client enters a new whiteboard. Encodes a DrawingObject for the client to add to its ClientCanvasModel.
- **UNDOINDEX** Sent when a client enters a new whiteboard. encodes the undoIndex of the Whiteboard's CanvasModel. Prompts the client's GUI to be populated with DrawingObjects up until the undoIndex.
- **DRAW** Encodes a DrawingObject to be added to the client's ClientCanvasModel and to be populated on the Canvas.
- **ENTER** Contains the username of a client that has just entered the same whiteboard the current client is using. Prompts the GUI to update its list of users accordingly.
- **EXIT** Contains the username of a client that has just exited the whiteboard the current client is using. Prompts the GUI to update its list of users accordingly.
- **UNDO** Prompts the GUI's canvas to perform the undo action.
- **REDO** Prompts the GUI's canvas to perform the redo action.

From the Client to the Server:

- **MAKEBOARD** Desired whiteboardID. Checked for duplicates.
- **MAKEUSER** Desired username of the client. Checked for duplicates.
- **SWITCH** Client wants to switch whiteboards.

- **WHITEBOARDTAKEN** The whiteboardID the client tried to create a whiteboard with is taken. prompts an error message. Changes to a specific whiteboard - The server finds threads that are accessing the affected whiteboard and passes the messages back to them:
- **UNDO** Client wants to undo a change. Put on the shared BlockingQueue to be handled.
- **REDO** Client wants to redo a change. Put on the shared BlockingQueue to be handled.
- **DRAW** Client made a change to the canvas. Put on the shared BlockingQueue to be handled.
- **ENTER** Client is entering a new Whiteboard. Adds the client from the Whiteboard's list of active users.
- **EXIT** Client is exiting a Whiteboard. Removes the client from the Whiteboard's list of active users.

5 Concurrency Strategy

We will have a shared message blocking queue for the server. All edits will be stored in the queue to be handled by a dedicated edits-handling thread in order. Therefore clashing edits cannot occur. draw, undo, and redo messages are put in this queue, since they have the potential to clash. "Enter," "exit," and "switchboard" messages are also put on the queue to ensure that each user's GUI will display the correct list of users. All other messages are handled in each clients UserThread.

Collaboard, which stores a list of usernames and whiteboards, is threadsafe through use of the monitor pattern, to ensure that multiple threads won't be able to create the same username or whiteboard with the same whiteboardID. Whiteboards and CanvasModels can only be accessed by the request handler thread, and are therefore thread-safe by confinement.

On the client side, all edits to the GUI are made in the event handling thread through the use of SwingUtilities.invokeLater(). All client threads have their own instance of Client-CanvasModel, which ensures thread safety through confinement.

6 Testing Strategy

We have 3 levels of testing.

6.1 Testing abstract data types

Test methods that may mutate the state of each of our Data types (beyond getter and setter methods)

- CanvasModel/ClientCanvasModel: `preventRedoAfterThisEdit()` - make sure that if this method is called while the `undoIndex` \geq the length of the `DrawingObjects` array, the `DrawingObjects` array removes its members whose indices exceed the `undoIndex`.
- Freehand/Oval: Make sure that their `toString()` methods output a String representation consistent with our protocol's grammar.
- Collaboard: Make sure that when `addUser()` is called, it adds the inputted username to the list of active usernames and returns "validuser" if the username is not taken, and if it is taken return "usertaken."
- Whiteboard: `addUser()` and `removeUser()` function correctly.

6.2 Integrated Tests

Test the server-client protocol and the client-server protocol.

- Client connect: make sure that a client can open a socket and connect to the server
- MakeUser: make sure that a user can create a valid username
- MakeUser: make sure that the server does not allow the user to create a duplicate username
- MakeWhiteboard: make sure that the user can create a valid whiteboard.
- MakeWhiteboard: make sure that the user cannot create a duplicate whiteboard.
- NewBoard: make sure that other connected clients are notified if another user creates another whiteboard
- Switchboard: make sure that the user can switch to a different whiteboard
- Enter: make sure that the user can enter a valid whiteboard
- Exit: make sure that the user can exit a whiteboard
- List: make sure the server sends a list of current whiteboard IDs to the client when the client connects

6.3 GUI Testing

Assume a new server is started at the beginning of each of these tests.

6.3.1 Basic Tests

Updating the list of active users - new user entering

- One person opens a client connection and creates whiteboard 1.
- A second person opens a new client connection and enters whiteboard 1.
- The first person should see their GUI update to show both his/her own username and the second person's username. The second person should see both usernames on the list of active users as well.

Updating the list of active users - user switching whiteboards.

- One person opens a client connection and creates whiteboard 1.
- A second person opens a new client connection and enters whiteboard 2.
- The second person switches to whiteboard 1.
- The first person should see their GUI update to show both his/her own username and the second person's username. The second person should see both usernames on the list of active users as well.

Users on the same Whiteboard can see each other's edits

- Two people each open a client connection and go to whiteboard 1.
- Person 1 draws something.
- Both of their GUIs should look identical and update in roughly real time.
- Person 2 draws something.
- Both of their GUIs should look identical and update in roughly real time. (To make sure that it works both ways)

Users on different Whiteboards won't see each other's edits

- Two people each open a client connection.
- The first person goes to whiteboard 1, and the second goes to whiteboard 2.
- The first person draws something. The second person's GUI should remain unchanged.
- The second person draws something. The first person's GUI should remain unchanged.

6.3.2 Testing concurrency

Edits to the Whiteboard will be the same on the GUIs of all users viewing the same whiteboard

- Two people each open a client connection and go to whiteboard 1.
- Person one draws a freehand, keeping the mouse held down. (The message won't be sent to the server until the mouse is released)
- Person two draws a freehand and releases the mouse.
- Person one releases the mouse.
- Both GUIs should look identical.

Users entering the same whiteboard at the same time will see the correct list of users.

- Create whiteboard 1.
- Two people each open a client connection.
- Both people enter whiteboard 1 at the same time by selecting it from the list of existing whiteboards.
- Expect them both to display the same (and correct) list of active users.

6.3.3 Testing invalid inputs

Invalid characters for usernames

- On the username selection panel, a user types in "hello 1" (no spaces are allowed) and "\$%&" (no special characters are allowed) (two separate sessions).
- An error message should be displayed.

Duplicate usernames

- One person opens a client connection and creates a user with the username "bob".
- A second person opens a client connection and tries to create a user with the username "bob".
- An error message should be displayed.

Invalid whiteboardIDs

- Once a person gets to the whiteboard selection screen, (s)he will enter "abc" (non numerical), "0.123" (non integer), "0" (zero is not allowed), and "-123" (negative integer).

- An error message should be displayed.

Duplicate whiteboardIDs

- The first person creates a whiteboard with ID 1.
- A second person tries to create a whiteboard with ID 1.
- An error message should be displayed.

6.3.4 Testing persistence of whiteboards

Single user

- Enter whiteboard 1.
- Draw something.
- Switch to whiteboard 2.
- Switch back to whiteboard 1. It should be in the same state as you left it.

2 Users

- A person enters whiteboard 1 and draws something, and leaves.
- A second person enters whiteboard 1. It should be in the same state as person one left it.
- Two people should try drawing and undoing things at the same time. The state of their boards after the series of actions should be the same.

3 Users

- A person enters whiteboard 1 and draws something.
- A second person enters whiteboard 1. It should be in the same state as person one sees the whiteboard.
- A third person enters whiteboard 1. It should be in the same state as person one and two see the board.
- The three people should draw on the whiteboard. The state of their boards after the series of actions should be the same.