Overall OOP Design:
The overall OOP design for the Generics Knowledge Base Application has different and separate classes GenericsKbArrayApp, GenericsKbBSTApp and GenericsKbBstAppGUI which have separate functionalities in terms of managing the knowledge base. The GenericsKbBSTApp has its own separate GenericsKbBSTAppGUI which has been done through composition and aggregation. The GenericsKbBSTApp implements Binary Search Tree operations for managing the knowledge base. When running the application it can be run as a text-based interface in the terminal or as a graphical user interface using the GenericsKbBSTAppGUI. The GenericsKbArrayApp uses a traditional array implementation instead. Each class has appropriately encapsulated its methods and data in order to ensure that the objects being used stay consistent. The statement class uses abstraction to represent the individual statements for both classes in the knowledge base by showing and encapsulating term, sentence and confidence scores.

Traditional Array Implementation:
The GenericsKbArrayApp program searches for items in the knowledge base by iterating through the entire array. The size of the array is changed dynamically when the statements are added, this ensures that the memory is used efficiently. The fluency in being able to manipulate the array and its data access is shown by the techniques of loading, adding and searching for statements. The GenericsKbArrayApp constructor initializes an array of Statement objects with a given capacity. The term, sentence, and confidence score of a single statement are all contained in one `Statement` object. The array-based knowledge base is filled via the `loadKnowledgeBase` method, which reads statements from a file. The 'addStatement' method ensures that users can update statements to the knowledge base. To find statements based on the term alone we use the 'searchTerm' method and to find the term and sentence together we use the 'Search' method until a match is found. These methods repeatedly go through the array, comparing the search index with the term and sentences of each 'Statement' object.

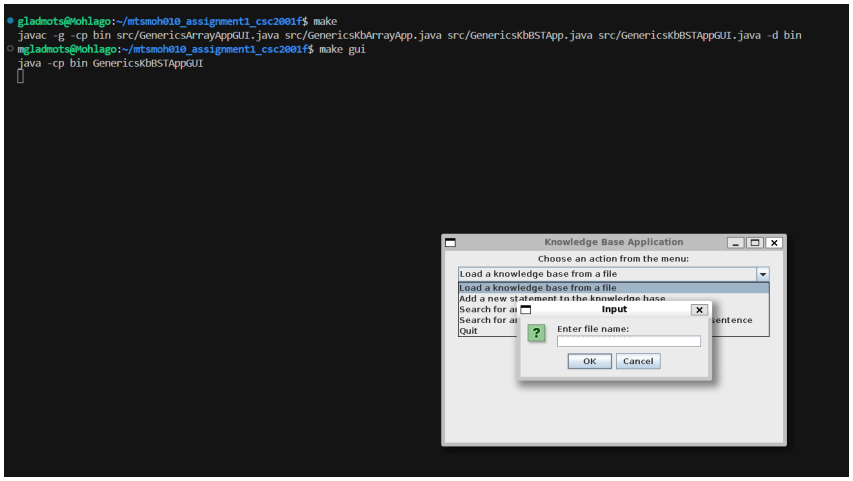
BST Implementation:
The GenericsKbBSTApp stores the statements in a Binary Search Tree (BST) data structure offering efficient insertion, deletion, and search operations with a time complexity of O(log n). The BST data structures are encapsulated as well as the methods for inserting, searching, and updating statements in the `GenericsKbBSTApp` class. A private inner class called `Node` is defined inside the as a representation of each BST node. The terms, sentences, confidence score, and references to the left and right child nodes are all stored in fields on each node. The `insert` method enables the BST to be inserted with new statements and the binary search trees properties are maintained by traversing the tree and inserting a new node recursively into the right position which is determined by the terms order alphabetically. The `insertRecursive` method is run recursively on the relevant subtree after deciding whether to update the old statement or insert the new statement into the left subtree, right subtree, or both.The BST property is maintained because of the recursive process which is, iIf the term node being searched for has a value less than the current node value then we recurse to the left subtree else if the term node being searched for has a value more than the current node value then we recurse to the right subtree. To search for statements based on either the term alone or both the term and sentence, the two search methods, 'bstTerm' and 'bstTermAndSentence', were built using the same methods. These techniques compare the search criteria as they recursively traverse the BST comparing the term being searched to the terms stored in each node until a match is found or the end of the tree is reached.The binary search tree features are preserved while reading statements from a file and inserting them into the BST using the `knowledgeBase` method. New statements can be added to the knowledge base using the 'addStatement` method. If the confidence score is higher and a statement with the same word already exists in the tree, the method then changes the current statement by updating the new information if not the confidence score remains the stays

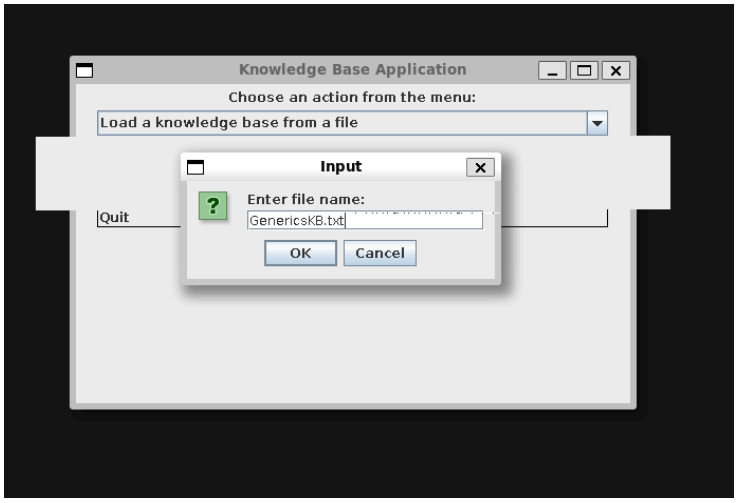
Experimental Tests (Core):

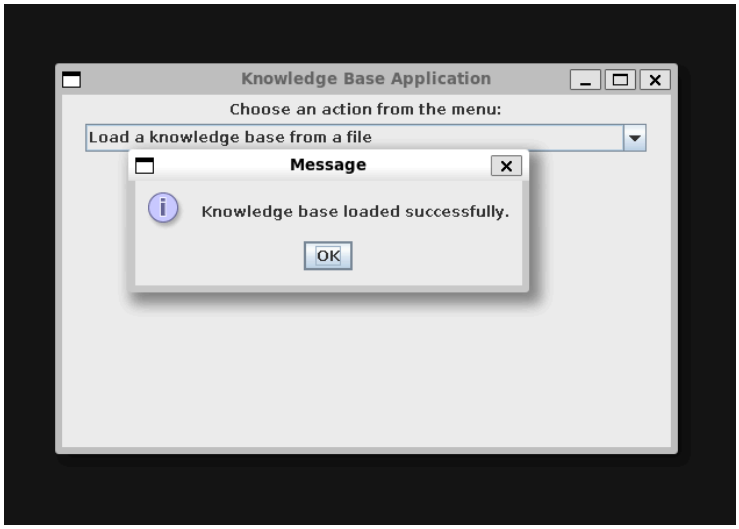
Description of the Testing Protocol:
How both the programs were tested. I evaluated both of the applications functionalities using predefined test cases. This includes the tests for populating the knowledge base, as well as tests for updating the knowledge base and validating the updates for searching for terms and sentences in the knowledge base as well as searching for already existing items in the knowledge base. Using the Makefile, in the terminal I ran 'make', then afterwards depending on the application that needs to be ran, choose between the option for 'make run' to run the GenericsKbBSTApp (This is the text-based interaction), 'make array' to run the GenericsKbArrayApp and the 'make gui' to run the GenericsKbBSTAppGUI (This is the graphical user interface interaction of the project). These specifications of how to run the applications are specified within the makefile.

Test Populating the Knowledge Base:
The test for populating the knowledge base evaluates the application's ability to load statements from a file into the data structures either array or BST. It verifies that statements are correctly parsed from the input file and stored in the knowledge base. The test validates the correctness of the file reading and data insertion processes.

Running the GenericsKbBSTAppGUI:
To run the GenericsKbBSTAppGUI, with the following commands of 'make' then 'make gui' to run. The graphical user interface displays a drop-down menu providing the choice of choosing between 5 options. To populate the knowledge base, I selected option one and entered the name of the text file. A confirmation message providing feedback ensures that the knowledge base has been loaded successfully.

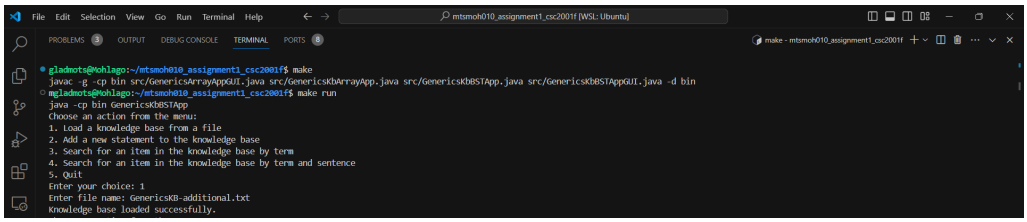






GenericsKbBSTApp:

To run the GenericsKbBSTI, with the following commands of ‘make’ then ‘make run’ to run. The text-based user interface displaying the menu provides the choice of choosing between 5 options. To populate the knowledge base, I selected option one and entered the name of the text file. A confirmation message providing feedback ensures that the knowledge base has been loaded successfully.



```
gladmots@Mohlago:~/mtsmoh010_assignment1_csc2001f$ make
javac -g -cp bin src/GenericsArrayAppGUI.java src/GenericsKbArrayApp.java src/GenericsKbBSTApp.java src/GenericsKbBSTAppGUI.java -d bin
gladmots@Mohlago:~/mtsmoh010_assignment1_csc2001f$ make run
java -cp bin GenericsKbBSTApp
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 1
Enter file name: GenericsKB.txt
Knowledge base loaded successfully.
```

ArrayApp:

To run the GenericsKbArrayApp, with the following commands of ‘make’ then ‘make array’ where run. Populate the knowledge base the same way as the GenericsKbBSTApp.

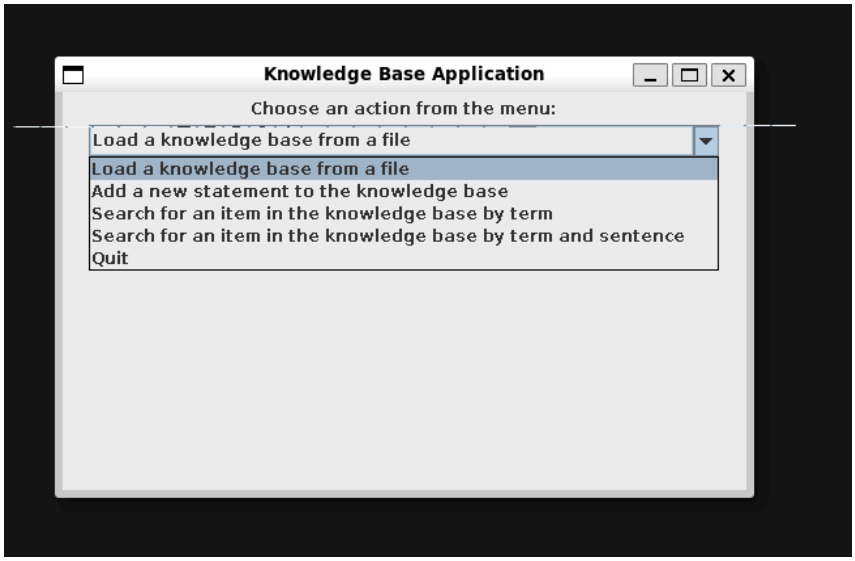
```
gladmots@Mohlago:~/mtsmoh010_assignment1_csc2001f$ make clean
rm -f bin/*.class
gladmots@Mohlago:~/mtsmoh010_assignment1_csc2001f$ make
javac -g -cp bin src/GenericsArrayAppGUI.java src/GenericsKbArrayApp.java src/GenericsKbBSTApp.java src/GenericsKbBSTAppGUI.java -d bin
gladmots@Mohlago:~/mtsmoh010_assignment1_csc2001f$ make array
java -cp bin GenericsKbArrayApp
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 1
Enter file name: GenericsKB.txt
Knowledge base loaded successfully.
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 1
Enter file name: GenericsKB-additional.txt
Knowledge base loaded successfully.
```

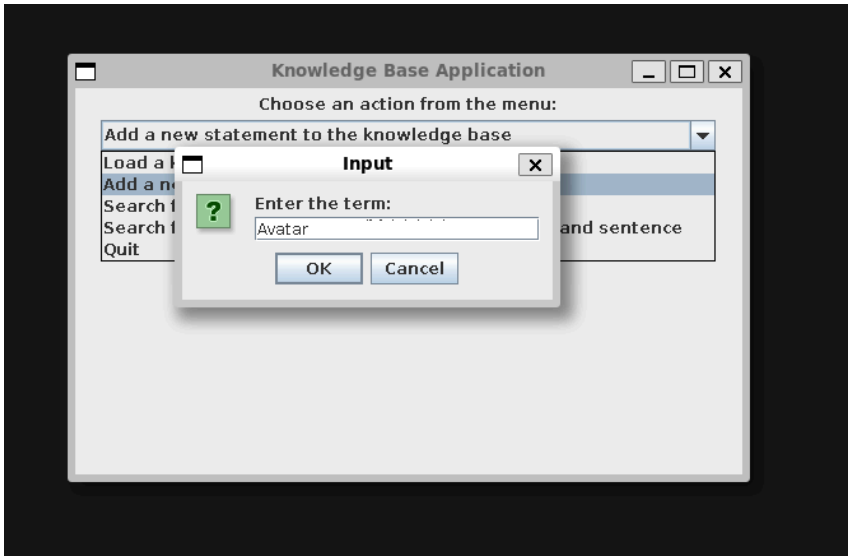
Test Updating the Knowledge Base (3/3):

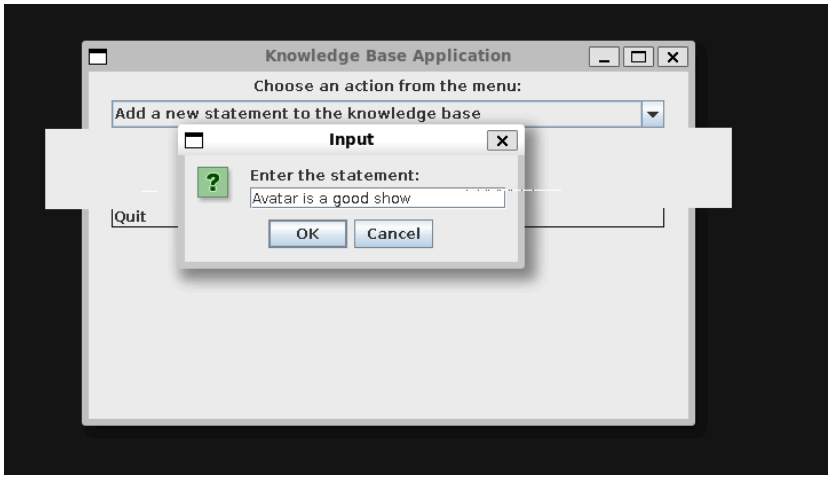
The test for updating the knowledge base assesses the application's capability to add new statements and update existing ones. It verifies that new statements are properly added to the knowledge base, and existing statements are updated if necessary. The test ensures that confidence scores are appropriately considered when updating statements, maintaining data integrity.

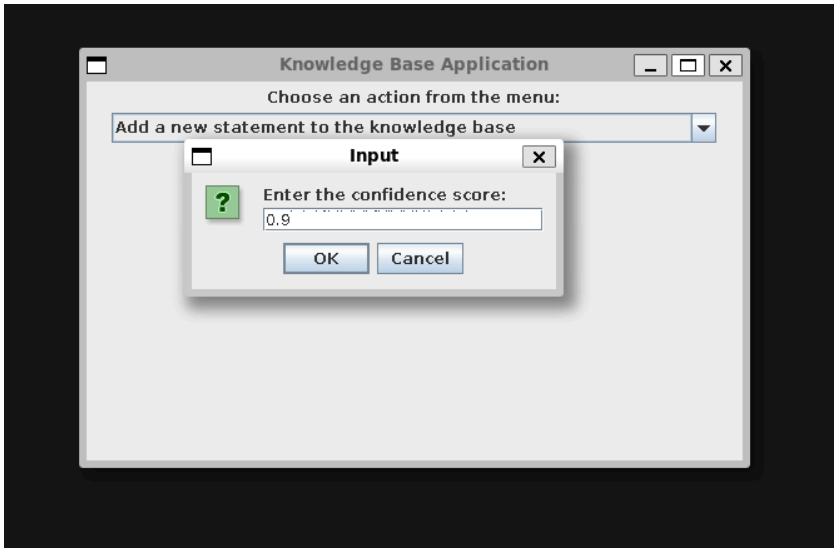
BSTAppGUI:

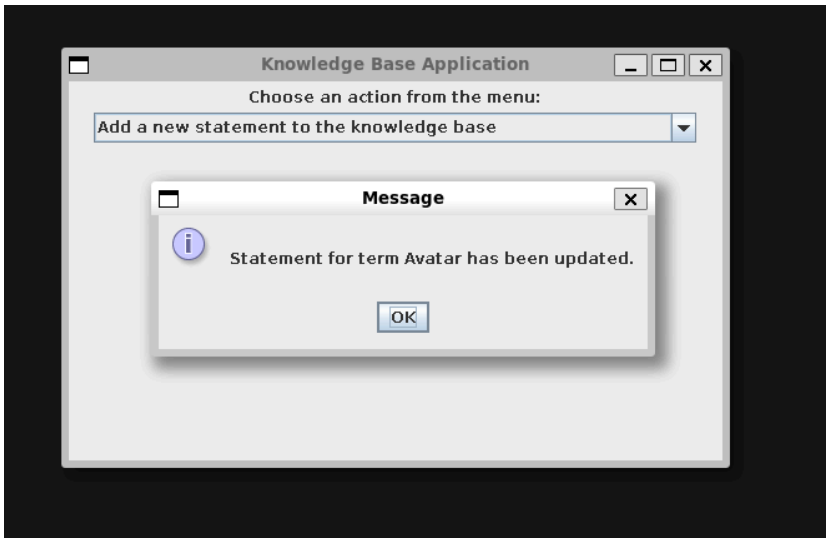
Select option 2 to add a new statement, where you will then be prompted to enter the term, sentence and confidence score. A confirmation message is displayed to verify this.




Knowledge Base Application
Choose an action from the menu:
Add a new statement to the knowledge base
Input
Enter the term:
Avatar
OK
Cancel
and sentence
Quit

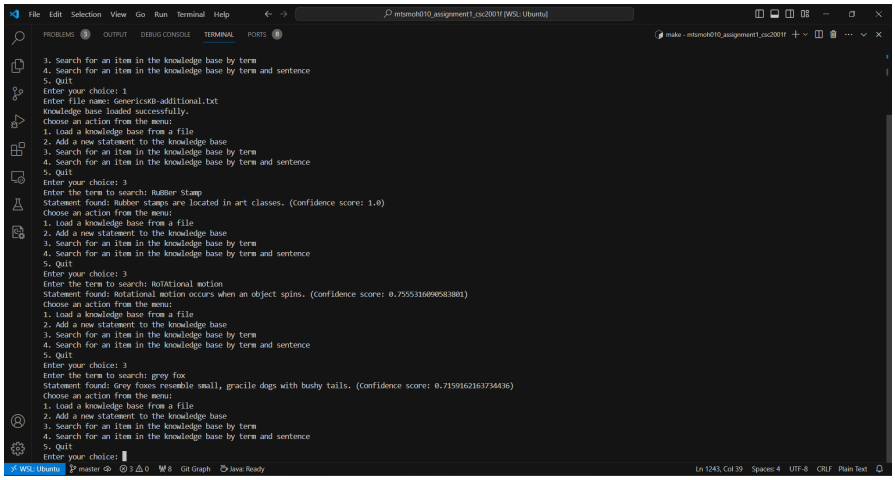

Knowledge Base Application
Choose an action from the menu:
Add a new statement to the knowledge base
Input
Enter the statement:
Avatar is a good show
OK
Cancel
Quit

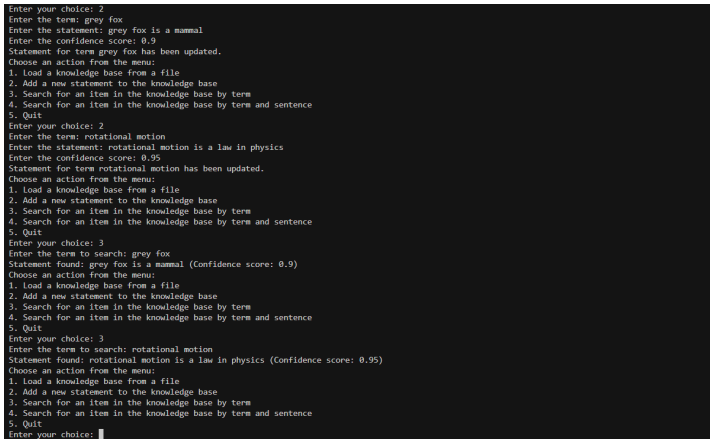




BSTApp:

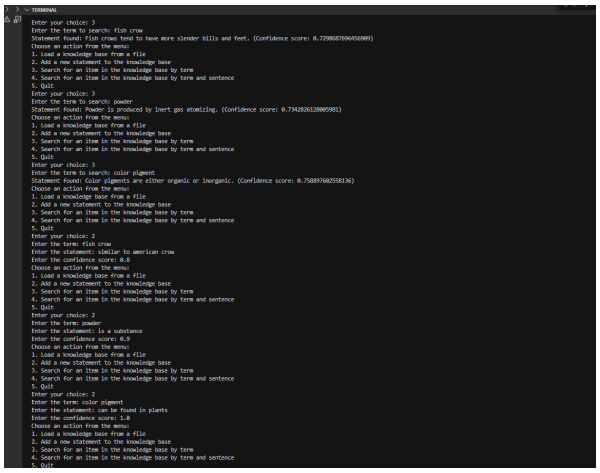
Before updating existing items I checked the Initial value of existing items e.g rotational motion and grey fox before updating. Now we will update the statement with a higher confidence score and see if it has been updated by then searching for the same terms using option 3



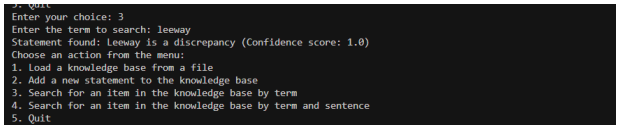


ArrayApp:

We will test update the array base by updating existing items. First we will search for those items then update them with a higher confidence score, we will then confirm in the next test case of test searching the knowledge base if it has been updated

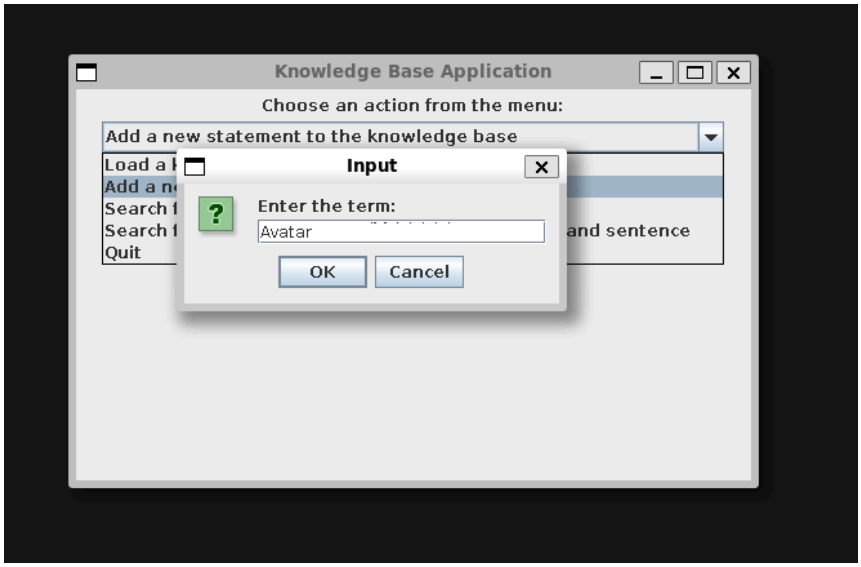


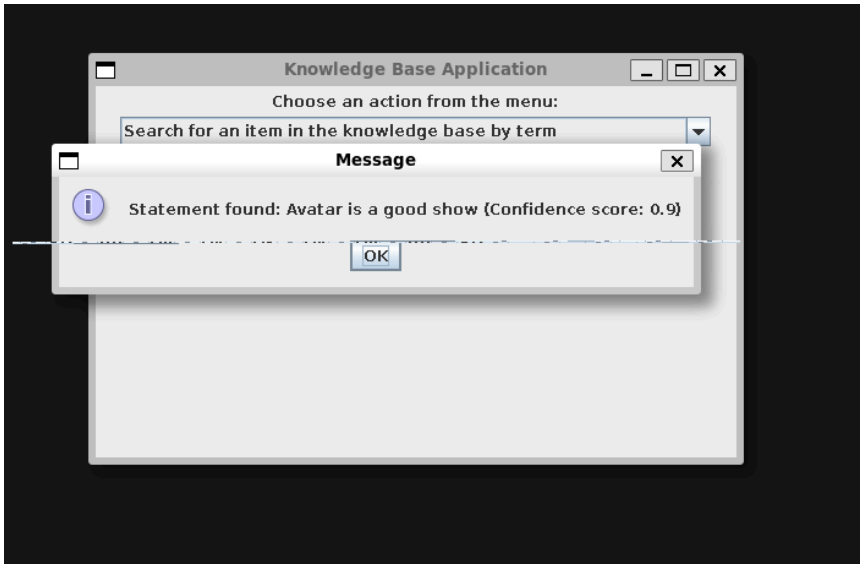
Can even search for an item regularly that we have not updated

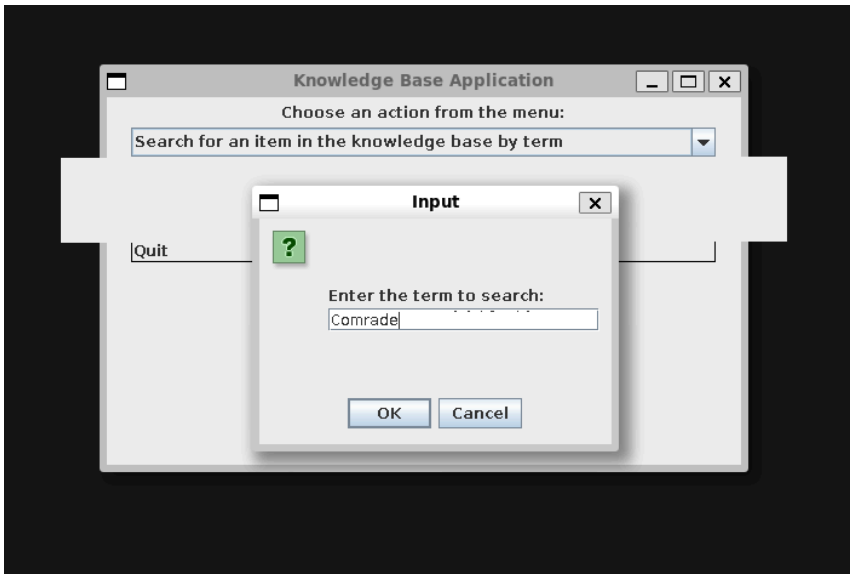


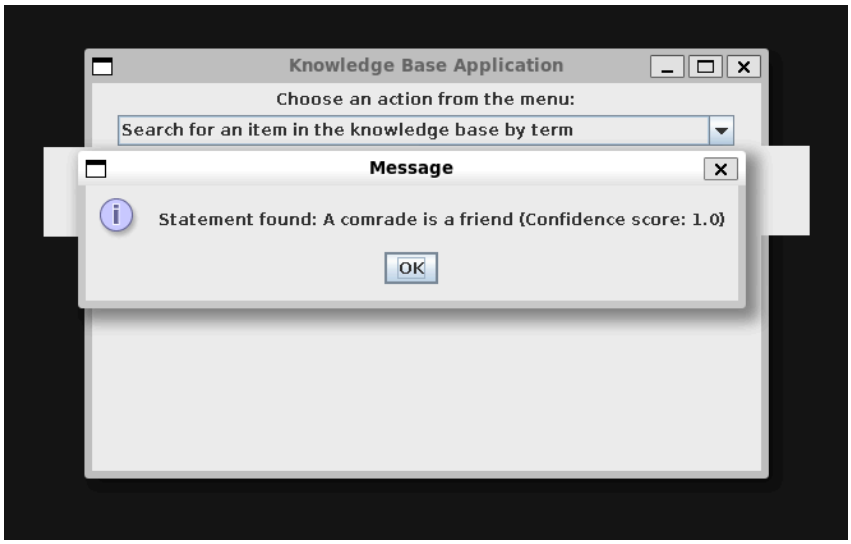
Test searching the knowledge base (3/3):
Search for items in the database using option 3 for the term and option 4 for the term and sentence where the term with the highest confidence score will be given in each program. Here are the specific searches conducted to verify searching the knowledge base as long as with feedback

BSTAppGUI:
Searching for the new term e.g Avatar that was added into the database previously to validate the addstatement method and weather data integrity has been maintained.




Knowledge Base Application
Choose an action from the menu:
Search for an item in the knowledge base by term
Message
Statement found: Avatar is a good show (Confidence score: 0.9)
OK


Knowledge Base Application
Choose an action from the menu:
Search for an item in the knowledge base by term
Quit
Input
Enter the term to search:
Comrade
OK
Cancel


Knowledge Base Application
Choose an action from the menu:
Search for an item in the knowledge base by term
Message
Statement found: A comrade is a friend (Confidence score: 1.0)
OK

BSTApp:

```
Enter your choice: 2
Enter the term: manchester united
Enter the statement: manchester united is the best team in premier league
Enter the confidence score: 0.95
Statement for term manchester united has been updated.
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 4
Enter the term: manchester united
Enter the statement to search for: manchester united is the best team in premier league
Statement found: manchester united is the best team in premier league (Confidence score: 0.95)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
```

```
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 2
Enter the term: cartweels
Enter the statement: i can do a very good cartweel
Enter the confidence score: 0.9
Statement for term cartweels has been updated.
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 3
Enter the term to search: cartweels
Statement found: i can do a very good cartweel (Confidence score: 0.9)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
```

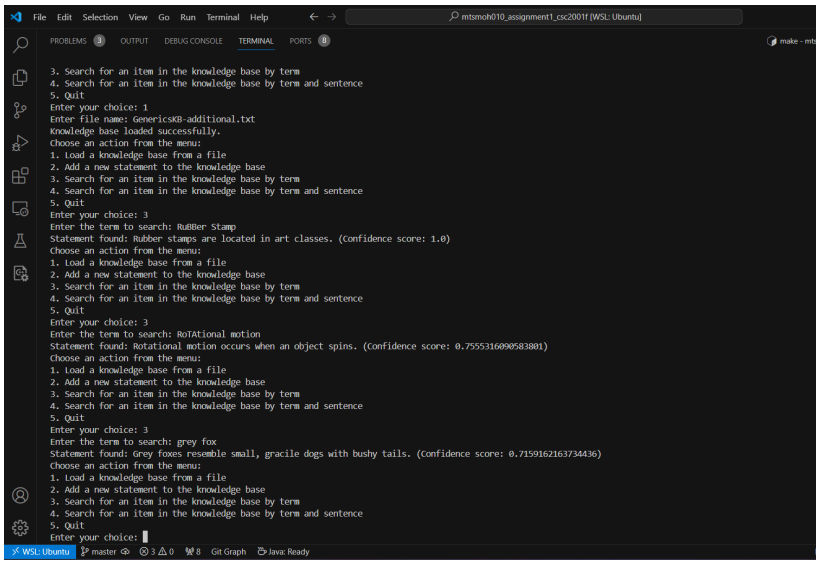
```
Enter your choice: 2
Enter the term: Mumps
Enter the statement: Mumps are very painful
Enter the confidence score: 0.9
Statement for term Mumps has been updated.
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 3
Enter the term to search: mumps
Statement found: Mumps are very painful (Confidence score: 0.9)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 4
Enter the term: Mumps
Enter the statement to search for: Mumps are very painful
Statement found: Mumps are very painful (Confidence score: 0.9)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 2
Enter the term: cheesecake
Enter the statement: Cheesecakes are really nice
Enter the confidence score: 0.95
Statement for term cheesecake has been updated.
```

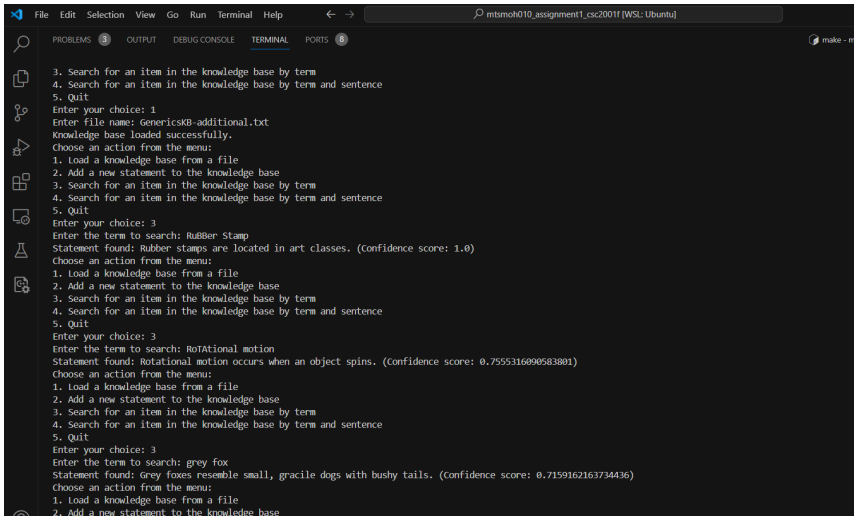
```
Enter your choice: 4
Enter the term: noble gas
Enter the statement to search for: A NOBLe gas IS a Gas
Statement found: A noble gas is a gas (Confidence score: 1.0)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 3
Enter the term to search: murrain
Statement found: A murrain is an animal disease (Confidence score: 1.0)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 3
Enter the term to search: sodium chloride
Statement found: Sodium chloride is the chemical name for common table salt. (Confidence score: 0.7680417895317078)
```

```
Enter your choice: 3
Enter the term to search: murrain
Statement found: A murrain is an animal disease (Confidence score: 1.0)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 3
Enter the term to search: sodium chloride
Statement found: Sodium chloride is the chemical name for common table salt. (Confidence score: 0.7680417895317078)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 4
Enter the term: scout
```

```
Enter your choice: 4
Enter the term: mump
Enter the statement to search for: Mumps is a viral disease.
Statement found: Mumps is a viral disease. (Confidence score: 0.7168781161308289)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 4
Enter the term: chrome yellow
Enter the statement to search for: chrome yellow is pigment
Statement found: Chrome yellow is pigment (Confidence score: 1.0)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 4
Enter the term: noble gas
Enter the statement to search for: A NOBLe gas IS a Gas
Statement found: A noble gas is a gas (Confidence score: 1.0)
```

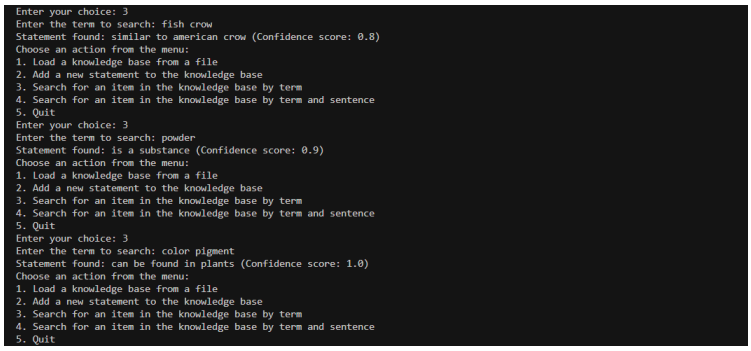
```
Enter your choice: 3
Enter the term to search: RuBBer Stamp
Statement found: Rubber stamps are located in art classes. (Confidence score: 1.0)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 3
Enter the term to search: RoTAtional motion
Statement found: Rotational motion occurs when an object spins. (Confidence score: 0.7555316090583801)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
Enter your choice: 3
Enter the term to search: grey fox
Statement found: Grey foxes resemble small, gracile dogs with bushy tails. (Confidence score: 0.7159162163734436)
Choose an action from the menu:
1. Load a knowledge base from a file
2. Add a new statement to the knowledge base
3. Search for an item in the knowledge base by term
4. Search for an item in the knowledge base by term and sentence
5. Quit
```

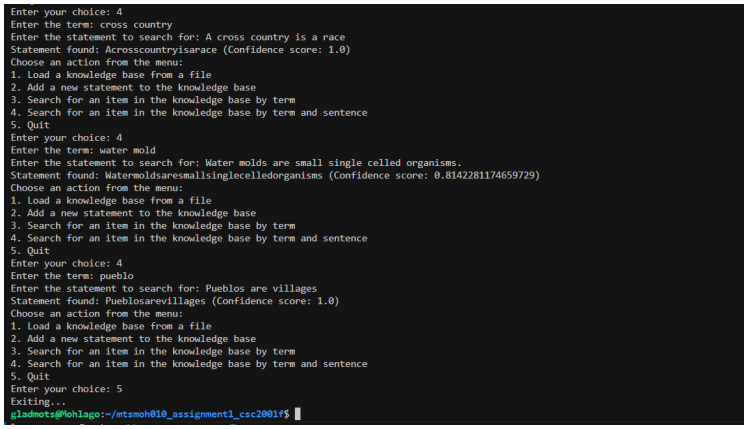




Array App

Searching for the data that we updated in the system, the search function works to search for the most recent update on the database as well as the statement and term with the highest confidence score. We are able like in the other program search for items in the ArrayApp based on the term and sentence which gives us the confidence score.





Description of Creativity:

GUI: The programme uses Java Swing components ({JFrame{, {JPanel{, {JLabel{, {JComboBox{, {JTextField{, {JOptionPane{) to create a graphical user interface (GUI) that gives users a more user-friendly and aesthetically pleasing way to interact with the knowledge base. The GUI design enhances usability and gives consumers a smooth experience by adhering to common rules for layout and user interaction.

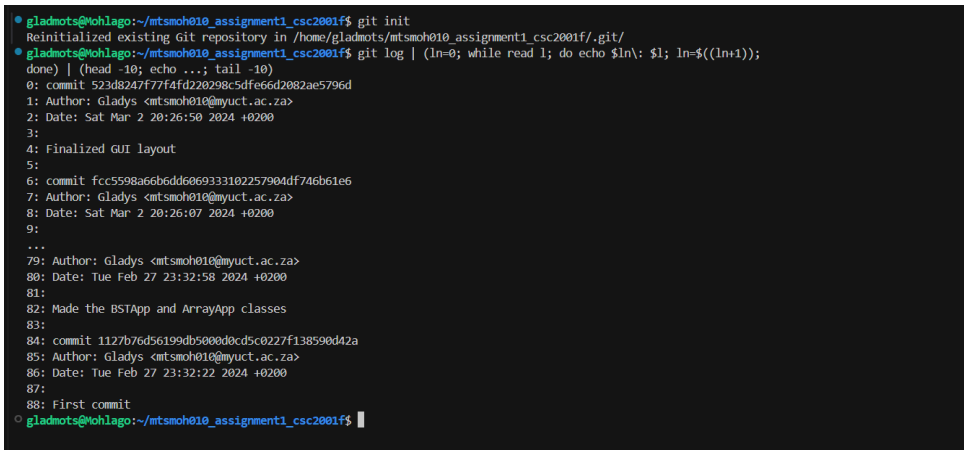
Dynamic User Input Handling: Event-driven programming is used by the application to handle user input dynamically. Action listeners are used to react to user input on GUI elements, making the system interactive and responsive.
Real-time validation and processing of user input is carried out, along with the implementation of suitable error management and feedback methods to assist users and guard against incorrect input.

Error Handling and User Feedback: To manage unusual situations like file not found errors, invalid input, or unexpected behaviour, the programme has strong error handling features.

Through dialogue boxes ({JOptionPane}), users receive helpful feedback messages that instruct them on what to do if they make mistakes or do improper actions.
The Switch Statement is used in the GenericsKBArrayApp, GenericsKbBSTApp, and GenericsKbBSTAppGUI. Following a successful parse of the input as an integer, the code inserts a `switch` statement to handle various scenarios according to the user's selection.**Default Example**: The {default} case is carried out if the user inputs a number that doesn't fit into any of the cases—that is, a number that isn't 1, 2, 3, 4, or 5. In this instance, a user-informing error message is printed.= {validChoice} is set to `false}, indicating that their selection was invalid.

User-Friendly Interface: To improve usability and user experience, the GUI's component parts have been carefully created. Users are guided through various tasks and functionalities with the provision of clear and simple instructions.
Effective usage of dialogue boxes and input prompts makes it easier for users to engage with the application and ensures that they can quickly become familiar with its capabilities.

Git log:



Conclusion:

Data structures and object-oriented programming concepts are well designed and implemented in the Generics Knowledge Base Application. It manages a knowledge base of assertions by efficiently using binary search trees and conventional arrays. The application's functioning is validated through experimental testing, which guarantee precise data storage, retrieval, and manipulation.

demonstrates an organized and effective method of maintaining a repository of assertions as a result. Users have easy access to the knowledge base thanks to the established functions, text-based interface, and graphical user interface. The application's durability and dependability have been shown by extensive testing, guaranteeing appropriate data handling in a variety of situations.