CS 142: Program design and methodology
Spring Term, 2026

More design problems

The design problems below were created by students last term. Describe how you could solve each of them using data structures we've learned so far. Specify the ADTs (List, Stack, Queue, Iterator, Set, Map, Priority Queue) you would use and how to use them to efficiently support the required operations.

1. You want to create a system to verify that the brackets in a user's code are properly matched and nested. Brackets include parentheses, square brackets, and curly braces. The system must support the following operations:

   - Track an opening bracket: when the editor scans an opening bracket, record that it is waiting to be closed
   - Verify a closing bracket: when the editor encounters a closing bracket, check whether it correctly closes the most recently opened unmatched bracket
   - Confirm all brackets are closed: after scanning the entire file, check whether any unmatched opening brackets remain

   What ADT(s) would be best to implement this functionality?

2. In dance team practice we have many choreography parts, each with a name. During rehearsal we repeat them many times to "drill" dance moves. The teacher wants a simple program to help track what choreography we practice. Specifically, they want to add the names of each part as they practice it. Then after the practice, the system should be able to report the order of parts practiced (with duplicates for parts that were practiced repeatedly) and also the number of times each part was practiced. What ADT(s) would be best to implement this functionality?

3. A music streaming app allows users to create playlists for songs. The system should support adding a song, checking if a song is already in the playlist, removing the song, and displaying all the songs currently in the playlist. The system should prevent duplicate songs from being added so that each song appears only once in the playlist. What ADT(s) would be best to implement this functionality?

4. You are building a personal stock portfolio tracker. This lets you look up your holdings by giving the ticker symbol (e.g. NVDA). When you do this, it will give you the number of shares currently owned and your transaction history (all the purchases and sales of that stock in order of date and reporting the number of shares and price per share for each). In addition to reporting this information, the system also needs to take updates (a purchase or sale). What ADT(s) would be best to implement this functionality?

5. You are in charge of managing a concert of the Knox College Choir. The KKC will have a concert with all the members in it soon. In order to manage the concert as smoothly as possible, you have decided to make a program that you can use before the day of the concert. As each member arrives, they are registered into the system. It is important that members are only registered once so duplicate registration attempts for the same member should be ignored. Then, when all members have been registered, the system should print seat assignments, which are made starting from the front row of the stage in order of arrival to practice. What ADT(s) would be best to implement this functionality?

6. You are a game developer at Riot Games. You are tasked with implementing features within a game called Valorant. The game is basically a First-Person Shooter (FPS) game, where you eliminate opponents to win.

   You are responsible for developing a scoreboard system that displays game stats. This should tell a player's number of kills, deaths, and assists (where you only hit the opponent but your teammate gets the kill). To do that, the system needs to track players' activities in game. When they get a kill, the kill

attribute gets bumped and similarly for deaths and assists. Each player will get a view of the scoreboard that shows their stats and the stats of the three players with the most kills. In addition, the system should support looking up a specifec player (friend or enemy) to get their stats. What ADT(s) would be best to implement this functionality?

7. The university ITS Helpdesk manages technical support requests submitted by students and professors. Each ticket has a unique school email and a description of the problem. The system must process tickets based on priority rules. Normally, tickets submitted by students are handled in the order they arrive, meaning the first student to submit a ticket should have their issues resolved first. If multiple students submit tickets at the same time, the ticket that requires the least estimated time to resolve should be handled first. However, professor tickets have higher priority than student tickets, meaning they are resolved before any student tickets. Amongst professor tickets, if a professor indicates that they are about to teach a class, their ticket should be resolved before other professor tickets. What ADT(s) would be best to implement this functionality?

8. You are creating a system to pair students with tutors. The system will take requests, each a student asking for help in a specific course. It will also allow the creation of tutoring sessions, each for a specific course and with a maximum capacity. When a session is created, the first unmatched students looking for tutoring in that course will be matched with that session, up to its capacity. The system should also support queries about the need; given a course name, it will give the number of students waiting for a tutoring session in that course. What ADT(s) would be best to implement this functionality?

9. An event management company is organizing a highly classified international event with more than 500 elite guests arriving from all over the world. Each guest receives a one-time-use ID sent to their residences along with the invitation. For privacy reasons, organizers requested no human security at event check-in, but instead use a scanner to verify guests as they arrive. It's contactless and has no space for mistakes. The system must ensure that only guests can enter the event venue; it checks their ID and then checks the guest against their picture and other biometric data it has. Once they enter, that ID can never be used again to prevent sharing or fraudulent reuse. What ADT(s) would be best to implement this functionality?

10. You have to design a simple management system for the new Knox's Cafe shop [name idk]. The system will keep track of the menu information and sales. When a customer asks how much a drink costs, the barista will type in the name of the drink and instantly get the price (like a macchiato: $4.50). The system will also provide baristas with directions on how to make each drink and how many have been sold today. What ADT(s) would be best to implement this functionality?

11. An emergency room of a hospital requires a system that handles patients who are waiting to receive treatment. Each patient will have their patient ID, name, and the level of severity of their condition. This system should enable the staff to add new patients upon their arrivals and see who will be treated next. For the treatment order, the system should identify the patient with the most serious condition. What ADT(s) would be best to implement this functionality?

12. A college wants to organize study groups for students for their classes. Students are allowed to create their own study groups for their class or join one (identified by its name) that's already been made. However, there are a limited number of spots in each group so if it becomes full, additional students will be added to a wait list for that study group. Your management system should support creating a group, joining a group, displaying the members of a group, and displaying the wait list for a group. What ADT(s) would be best to implement this functionality?