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Capstone Design I

Artificial Instructor Design Specification

To put it simply, the “Artificial Instructor” hopes to bring the knowledge, and advantages, of a personal bass instructor into the convenience of the user’s home. To develop such a system there needs to be lesson plans in order to have a structured learning process. The system needs to be able to track the notes, rhythm, and accuracy of the input from the user in order to be able to see how the user plays. Finally, the system needs to be able to give the user feedback on their input in order to simulate the advantages of a personal instructor by highlighting the areas where the user was correct and incorrect. If these basic requirements can be met then the Artificial Instructor can evolve and add additional features such as sound manipulation that simulate expensive hardware, create more advanced lessons so the user may become more advanced, and allow for different lessons suited to different tunings, other than the standard [E, A, D, G]. By doing this the system is useful to a wide range of users and ensures it is effective in the learning process for musicians of many different skill levels.

Such users are people who want to learn to play the bass as their first instrument but do not have access to lessons. Many people have other events that take priority over learning to play an instrument, but this does not mean they should not still have the resources to learning an instrument if they can dedicate time. Children are often dependent on their parents to drive them to lessons in between school, sports, and any activities their siblings or parents have. Inversely, adults and parents may have children or other family members they must help out that takes up much of their time so they are unable to make it to lessons. Adults have long work days that may make it hard to schedule a lesson or even may be too tired after work to sit down and practice an instrument for an hour or two. Finally, many people may not have people to teach them the basics for free and may

not be able to afford lessons. This system will be give them an alternative way to learn an instrument if they do not have access to the typical methods.

Another type of users are people who want to learn the bass as a hobby but do not have the patience to teach themselves or the time to take lessons. Not everyone wants to become a profession musician, however that does not mean that they do not want to learn an instrument as a profession. People who are simply learning to play the bass a hobby most likely are not willing to spend a lot of money on lessons. Additionally, if they are trying to learn the bass as a hobby they will have other activities that may make scheduling a lesson with an instructor extremely difficult. The Artificial Instructor will offer the ability for these users to practice, and learn, different lessons and skills at the time that is convenient to them and for whatever duration they have to devote. So for people who have a very spontaneous lifestyle, are on-call with work, or have a different schedule every week will still have the ability to learn the bass while still continuing their everyday life.

One of the most important types of users the system was designed for are people that are interested in testing out bass to see if it is the instrument they would like to devote more time to it. Before people know which instrument is right for them it is sometimes better to give them a “taste” of some basic lessons to see if it is something they will be able to pick up relatively quick or if it something they will like. Currently, people have to choose to choose an instrument they want to learn before even giving it a try, but by offering a system that is inexpensive the Artificial Instructor will provide a way of allowing users to learn basic lessons it will give them an idea of the progression they should expect and an opportunity to see if they are actually interested before spending excessive money on lessons and textbooks. Because the only additional equipment is a bass guitar, the user only has to supply the bass and may be able to rent a bass and try it out with the system rather than spending a lot of money on something they may discover they are not as interested in after some lessons.

The system is not only useful for people that are trying to learn but people who may already have some skill set with playing the bass. People who are looking to “fine-tune” their skills, rather than starting from scratch, by brushing up on fundamentals may utilize the system and the lessons to do so. Music requires an immense amount of practice to become an expert. Even if a user is an intermediate, or even advanced, level of skill it never hurts to practice even the most basic fundamentals. These users may use the system to practice lessons they may feel they need additional practice in, or even try different lessons and look at the feedback to discover areas that may need improvement.

Finally, the final types of user that the system aims to benefit are both children, teenagers, and adults that need a set of warm up exercises before practicing more advanced songs and lessons. Like many professions and activities, playing the bass requires some warm up so the musician may prepare both physically and mentally to play more complex lessons. If a user is not interested in learning the lessons, because they already know how to play, they may still use the lessons in order to warm up before they begin playing other songs or writing their own material. Having a wide variety of lessons and exercises already set up in a very easy to use system can make warming up much easier and more effective, so the system is not only intended for teaching but also supporting users even when they advance through all of the levels in the system.

For all types of users there exists one action to the system that is necessary, creating a profile. Before a user is able to interact with the system they will have to create a profile with identifying information so the system is able to track their specific progress and make available content that they should have access to. This information requested is fields such as; username, password, a 4 digit pin-code, a secret question, and the type of user they want to register as. The username and password are simply used to login each time the program is executed and a profile is loaded. The pin-code and secret question are used for account retrieval, if a user ever forgets or loses their password for a profile. The need for a login to the system is because if there are multiple

users on one system we do not want people intentionally, or accidentally, logging in and taking lessons under another user's profile. Finally, the two categorizations the users may classify themselves as are a "student" and "recreational" account. The difference in these two types of accounts is what is offered initially by the system and how the system works with the user.

For users learning to play their first instrument, looking to learn the bass as a hobby, who may not be able to afford or have a flexible schedule to take normal lessons, and intermediate users looking to sharpen their skills will use the system in relatively the same way, by making a "student" account. When a person creates this type of account they are letting the system know that they would like feedback on lessons, a score for their attempt, and the requirement of unlocking content based on the scoring system. Users will use the system, by first loading their profile and configuring an instrument. This will be done by selecting the option "Add/Select Instrument" on the main menu page of the application. If this is their first time using the system, then there will be no configured instruments for them to select, therefore they will have to add an instrument, otherwise they may select a previously configured instrument.

When configuring an instrument, these users will enter information so the system can identify which bass they are using and supply the appropriate lessons based on that instrument. Each user may have up to 10 bass guitars configured under on profile. When configuring an instrument the user will be required to enter the nickname of the instrument, the manufacturer, model, number of strings, and default tuning for that instrument. The nickname is simply used to make it easy to identify the instruments in the "Select" page, and the manufacturer and model are used as a backup way of identifying the configured instruments if the user forgets the nickname they gave certain instruments. The default tuning will be used in order to map notes and frequencies during lessons if the user begins lessons without tuning an instrument during each execution of the application. Finally, the number of strings is required to alert the program to supply appropriate lessons based on

the number of strings. For example, if a user is using a 4 string bass it would not be appropriate for the system to allow them to play a lesson that was created for a 5 string bass.

Next these users will be able to tune their instrument using the built in tool, found on the main menu page of the application. In order to navigate to this page the user will be required to have an instrument selected, if they have not done so they will be prompted “to select an instrument” before trying to enter this feature of the application. Once a user enters the tuning page they will be asked to first enter the tuning they would like to apply in four different text boxes at the top of the page. If they do not enter a tuning the application will assume they are attempting to tune their instrument to the instrument’s default tuning that was set when configuring the instrument.

Once the user prompts the system to start tuning they will being by being asked to strum the first, or “lowest”, string. While strumming the user will see the note value that string is currently outputting along-side the expected note value for that tuning. All users, especially users that are looking to learn how tuning works and the different values of the expected notes, may also select the “Play Note” button to have the program output the expected sound of the note they are trying to tune. However, this feature is not necessary to the tuning process it was simply added to give the users an idea of the sounds of different notes while tuning, so they may learn to tune without the system. After the users have completed strumming the current string and adjusting the tension of the string to match the expected note they will select the “Next String” button so they may tune the next string. The will repeat the same process for this string and all of the others until every string has been tuned. Once the tuning is complete the user will return to the main menu.

The final option, and most important, offered in the main menu is the option “Enter the Classroom”. When a user selects this option, by clicking it, they will be navigated to the “Select Level” page of the classroom where they will be asked to select the level of lessons they would like to attempt. For first time users, that are of type “student”, they will only have level 1 available for selection. If these users try to click any of the other levels the system will prompt them that they must

earn “X” amount of points to unlock this level, where “X” is the preset score deemed fit to participate in the lessons of that particular level. For the type of users that are “recreational” they will have no score restriction on the levels available. These users are the ones simply using the system in order to warm-up or tune their instrument rather than use the system to learn how to play the bass. Because the users are not using the system to learn they will have all levels unlocked from the beginning so they may practice any lessons they believe are appropriate to warm up with.

After selecting a level, a user will enter the “Available Lessons” page of the application where they will be shown a list of available lessons, that have been both attempted and not attempted, and asked to select which lesson they would like to begin. For “student” users they will be able to see a score located next to an attempted lesson so they may be able to know which lessons they may want to retry. For “recreational” users there will be no score next to each lesson but will still show them which lessons they have attempted so they know which they have experienced.

Once a user selects a lesson, they will navigate to that specific lesson’s page, which is the same appearance for both type of users. All lessons will have the same basic layout, displaying; both expected and user’s attempt of note value played, a graph of that note, a start lesson button, view lesson layout button, listen to lesson button, and “Return to Available Lessons” button. A user may select the “Listen to Lesson” button to have the program play the lesson so they may get a feel for rhythm of the expected lesson. The “View Lesson Layout” button will display the notes, tabbed out, in order for the user so they can get an understanding of what notes and strings they are expected to strum. Finally, the “Start Lesson” button will give the user a five second countdown in order to get ready, and then will begin the lesson. Once the lesson begins the user will play the notes at the times they are expected for the lesson. During their attempt the lesson will not be playing audio output of the expected lesson but the system will be playing the users attempt, in real-time, so they can hear their attempt as they are playing.

After the lesson attempt is complete the users of type “student” will be navigated to the “Scoring and Feedback” page. This page will give the user their score for their attempt and the breakdown of their attempt. The breakdown of the attempt will show number of correct notes, number of incorrect notes, and a display of which notes were correct or incorrect in order to show the user parts they may have done well in and the ones which they need improvement. Additionally the feedback will give the user graph of the user’s input, regardless of note value, at different time stamp as opposed to the expected input at the correct time stamps so the user can understand at which points their rhythm was off and how to correct it. Finally, if the score from this attempt has unlocked a new level the user will be alerted that a new level has been unlocked. After a “recreational” user has completed a lesson they will simply be returned to the lesson page in order to select a new lesson, without being given a score and any feedback. This is so these users may spend more time warming up as opposed to analyzing their attempt.

For all use cases; users looking to just tune an instrument, practice lessons with feedback, or just practice lessons as a warm up there will be some shared functional components. These functional components will be the configuring and creating of different “instruments” used by each user, real-time audio input and output from the bass guitar to the system, playback of audio output, ability to tune an instrument in order to improve accuracy of note tracking, lessons that allow the user to play an expected exercise, and feedback on those exercises.

Selecting certain instruments is important because different users may have more than one instrument or even several different types of bass guitars. The system will have to have a way of allowing the user to create and add new instruments to their profile. Also, the system will have to allow the users to view a list of instruments that have been configured and allow them so select the one which they are using.

For tuning the system needs to be able to utilize the tarsoDSP library in order to detect the pitch of the input, use that pitch to map to a note, and compare to the expected note value. This

component will also need some user input to prompt when to start tuning each string and when to move on to the next string. While the user is tuning an instrument the system will have to manipulate the “expected” array of pitch values to match the user's tuning in order to give an accurate analysis of the notes they are playing. For example, if the expected pitch of an open E strummed on the first string is 44Hz-48Hz and the user tunes open E to 50Hz, the range will have to be changed to match this in order to make sure they get credit for strumming the right notes, even if their tuning is incorrect. This will eliminate some the system from limiting the user even if the errors are due to incorrect user input. However, this feature, of adjusting the expected array value, is not set in stone for the system because it is not the intention of the system to promote bad tuning practices for users.

In order to facilitate audio input and output the system will utilize the JavaSound API in order to set the input to the default audio input line, where the user plugs their audio jack into, and set the output to the default audio output line, where the user wants to hear their attempts and the lessons played out to. For lessons the system will also use the JavaSound API in order to program frequencies to output at different time frames in order to, both, compare the user's input to the expected results and allow the user hear the lesson before playing. Playback of audio output will require the system to retrieve the information of different lessons and connect to the output stream in order to play over the user’s choice of output(speaker system, headphones, or internal speaker).

A GUI will have to be developed, using the Java Graphics Library, in order to allow for a user to interact with the system. Some necessary factors of the GUI are menu options, return buttons, start lesson buttons, preview lesson buttons, and select instruments. These functions will be used by all the different use cases because they will facilitate the different capabilities of the system to the user. This will allow the user to navigate through the system in order to use the entire system or just use specific features they are interested in. These components will be widespread through the system and therefore are essential to the user’s experience but do not have an effect on the analysis of a user’s input.

Users that are trying to use the system as a simple warm up or to just preview the bass there will need to be a type of account where there is no scoring system and level of lessons. This will allow them to view, and attempt, any and all lessons without having to unlock them. These users will not be using the system in order to learn just to utilize the lessons so they will not need the feedback to help them correct themselves but need the availability to play different lessons depending on what they are trying to warm up to or test out. To do this, the users will have to create an account that is categorized as “recreational user” so the system knows not to assign a score and to not waste system resources on tracking accuracy.

Inversely, users that are trying to develop their skill the system will have to have the account for “students” so they may be scored on their attempts of the lessons, their ability to tune accurately, and their progression through the lessons. The system will have an algorithm in order to properly assign a score based on the correct notes played, the correct timing of the notes, and the combination of both the correct note played at the correct time. As a user’s score increases the system will start to unlock new lessons for the user to attempt. Additionally, because the user, in these use cases, is trying to learn the system will also have to provide feedback to the user based on their attempts. This will require the system to not only play back the attempt but store the input in order to compare to the expected results. After the lesson is complete the system will have to give the user a detailed feedback to show the user what they did incorrect and what they did correct so that the user may attempt the lesson and improve their skills.

The functional requirements for the tuning component will be the user input of the tuning they desire, the sound input from their guitar, the input to start the tuning, and the input to move on to the next string. The non-functional requirements for the tuning component will be the accuracy and ease of use. The tuner does not need to be extremely fast, because it relies on mainly input from the user rather than calculations by the system. The other non-functional requirement is the accuracy. The

tuner must be accurate so that the user get the best results and the system is able to give the absolute best feedback possible.

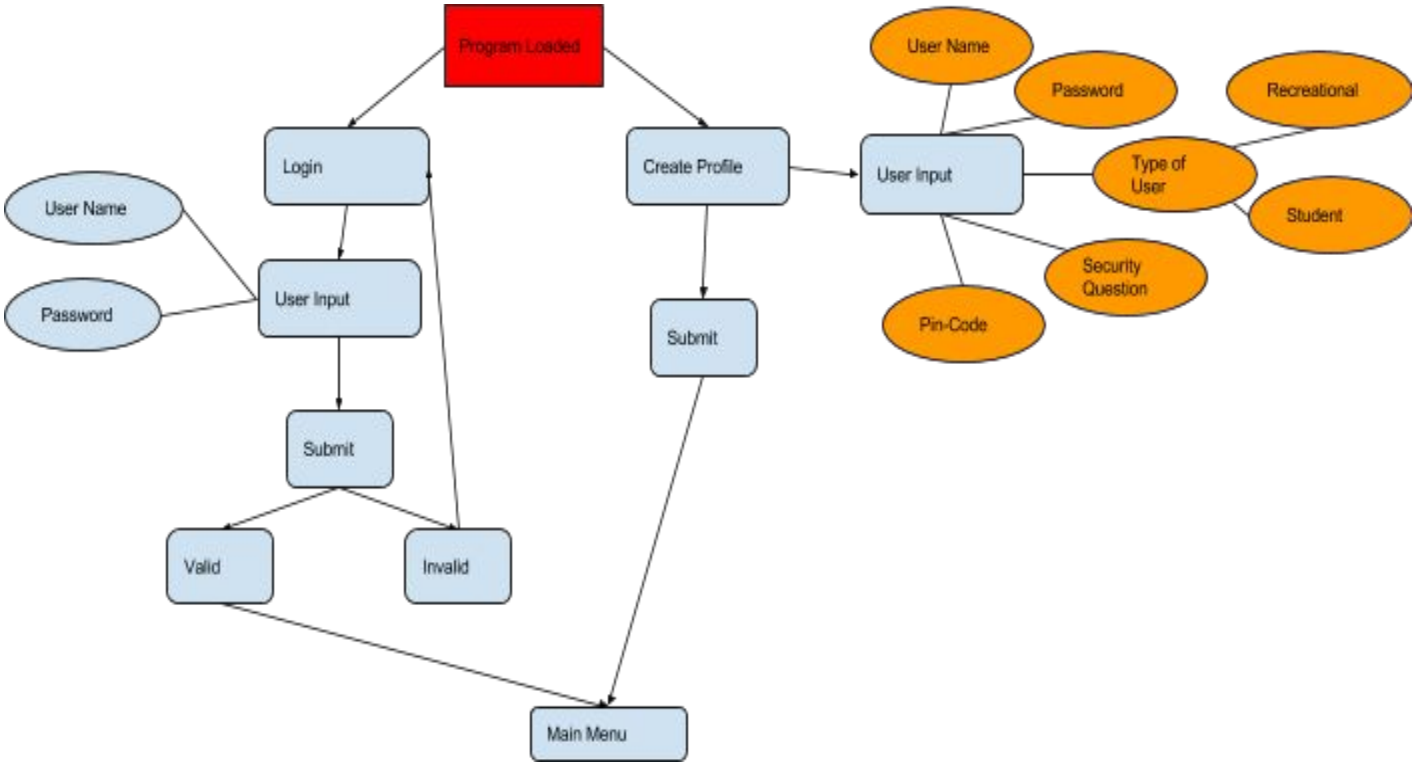
The functional requirements for the account creation will simply be the information needed to identify the user. This information will be the username, password, pin code and security question. At this point there is no sound input require, as the users are simply creating the account to use the system. The non-functional requirement for the component of the system is simply the ease of use. It needs to be easy to figure out what the users need to input and needs to be only the required information so there is not excessive input from the user.

The functional requirements for the selection and addition of the instruments are the input about the guitars and the selection of certain fields. When adding an instrument the user needs to enter in necessary, identifying information about the bass guitar they are adding so they may be able to select it in the future. Additionally, the selection of the instrument and the prompt to continue is required so the system knows which bass they intend to play in order to supply the appropriate lessons. The non-functional requirements for the selection and addition is, again, just the ease of use. This is just so that the users clearly know what to enter so the user does not enter any information that may confuse or be misused by the system.

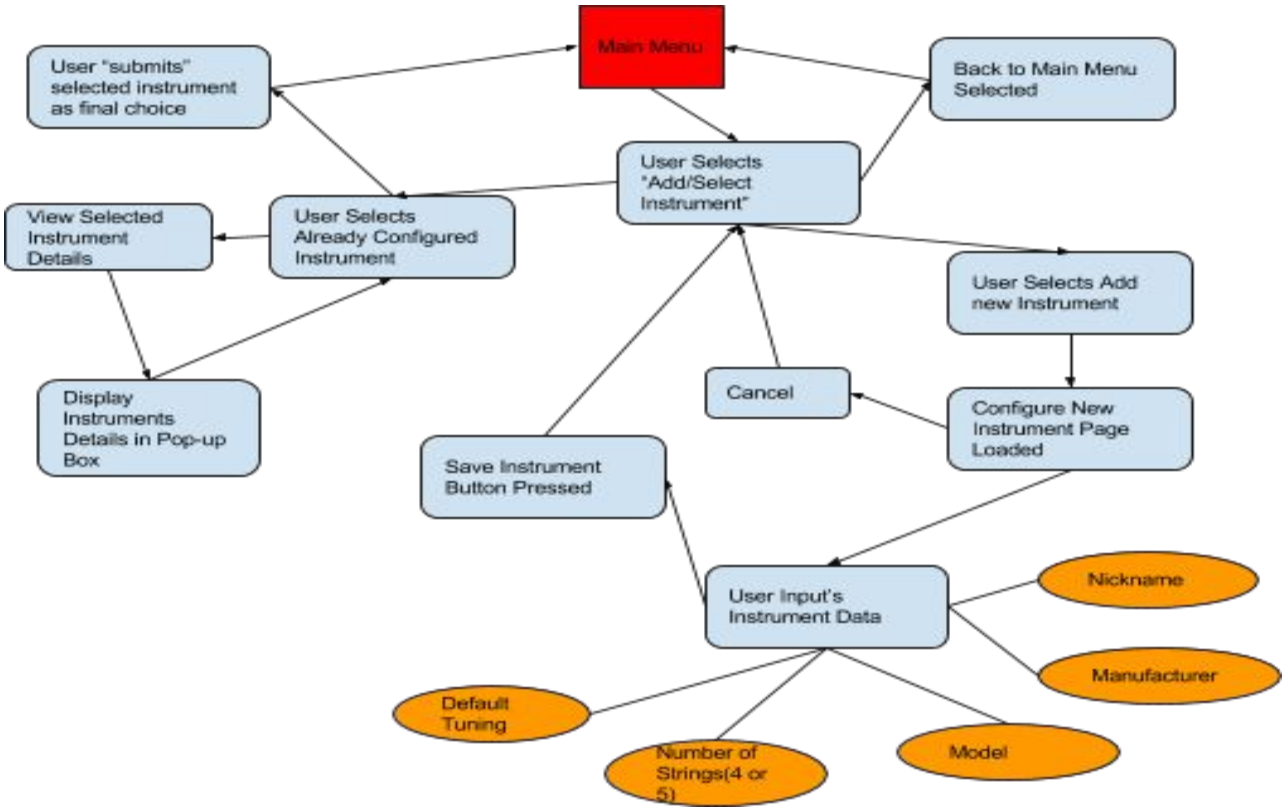
The functional requirements for the classroom are the selection of the lesson, the level, sound input from a guitar, prompt to play a lesson, and the prompt to play a lesson before. The selection of the lesson, level, and play lesson before are the inputs where the system requires the user to interact with it through the computer. The audio input is the only input from the user where the user will interact with the outside element of the system, their bass guitar. This will require them to make sure they have correctly connected their instrument. The non-functional requirements for this component is ease of use so that the user can navigate to the lesson and level they intend to play. The next is accuracy so that the output from the system will be that which is pertinent to the user. In order for the system to give the user feedback that will improve their ability the system must

be accurate in order to properly assess their attempt in comparison to the expected result. Finally, speed is a major non-functional requirement. In order fo the system to be able to be accurate it must be fast in processing the input and giving real time output in order to make it seem like the user is playing live. It is especially important so there are no consequences from using the system that would not exist in real life.

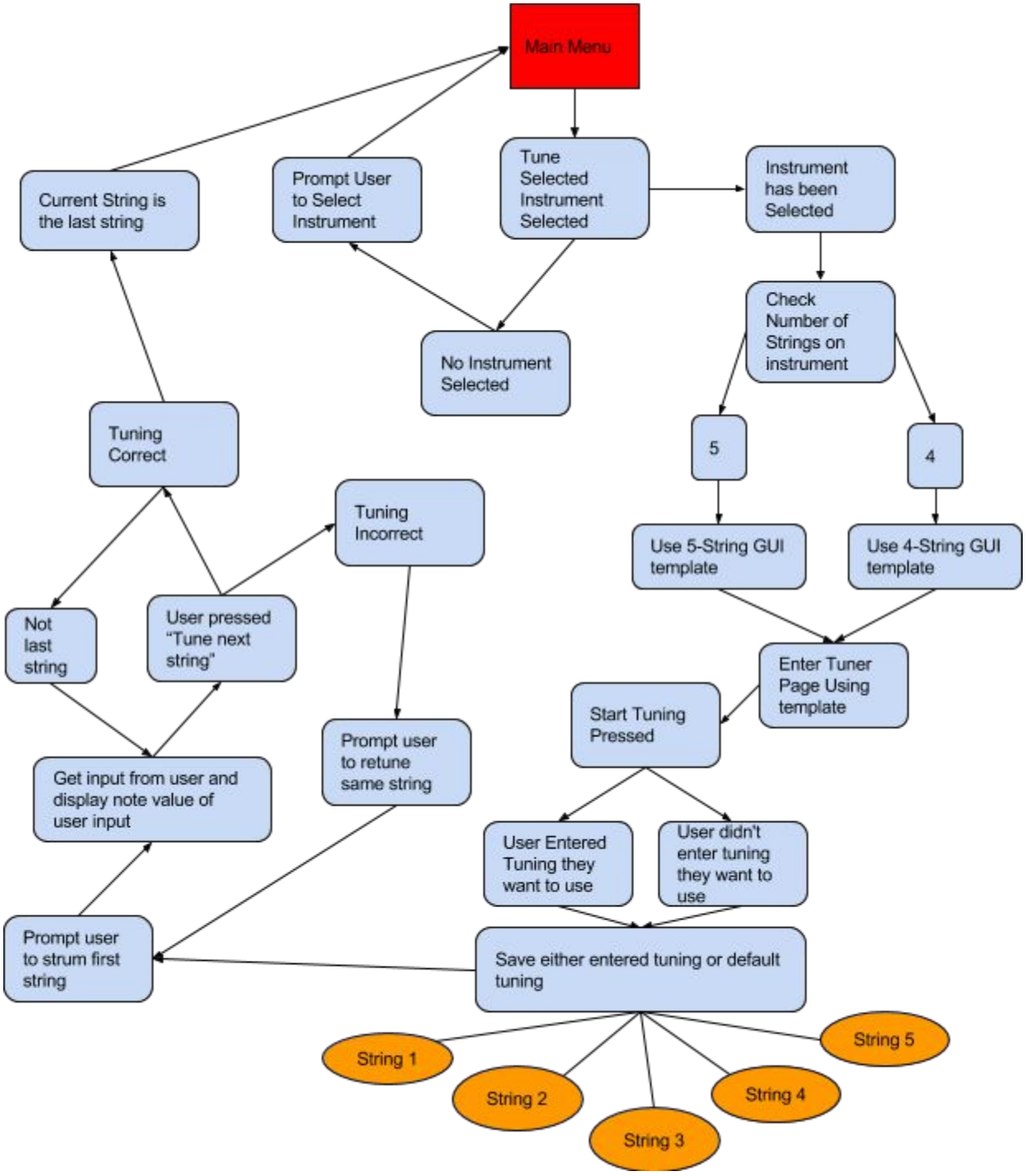
Below: Any Type of User Logging-in or creating new profile with the system



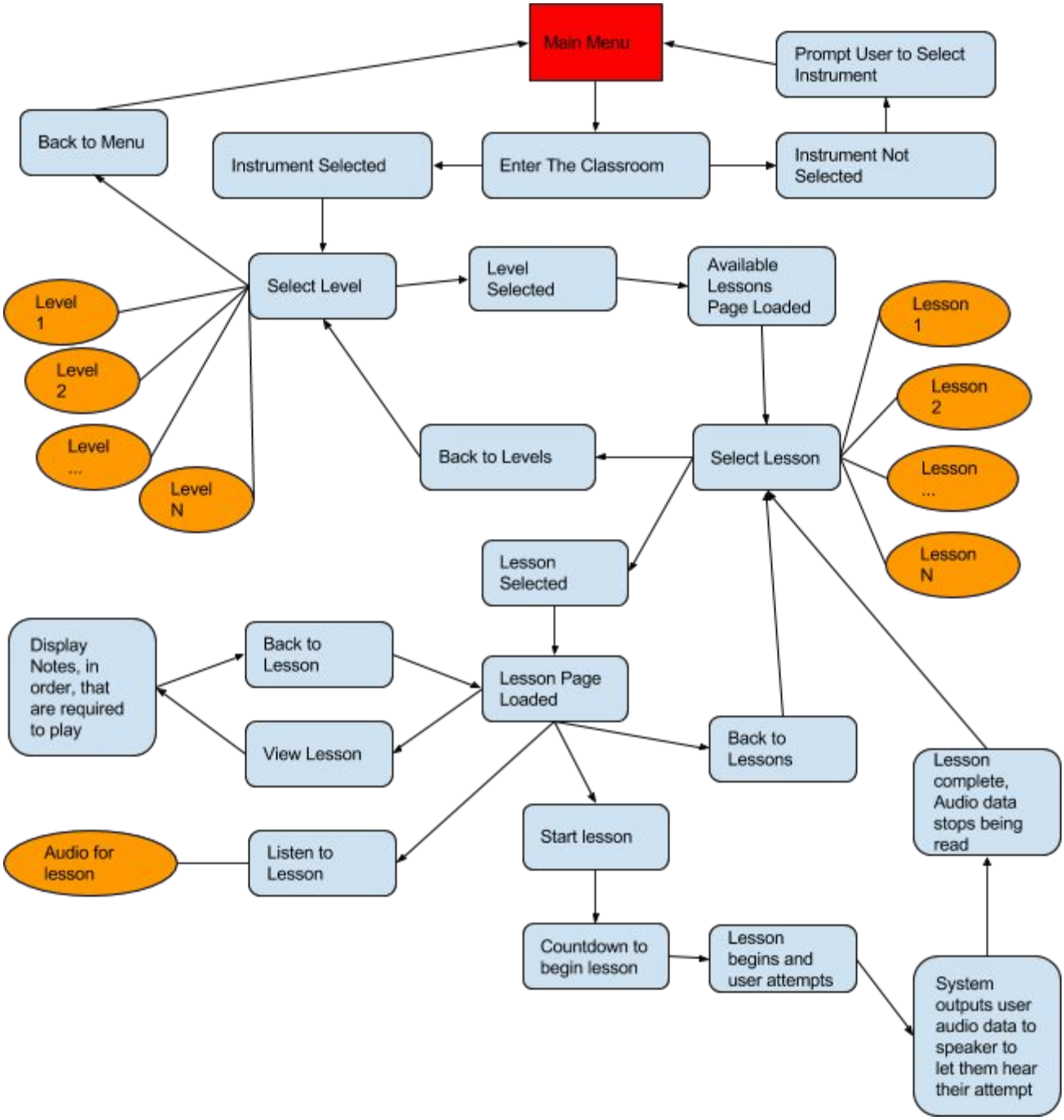
Below: Any Type of User Selecting/Adding Instrument in Profile



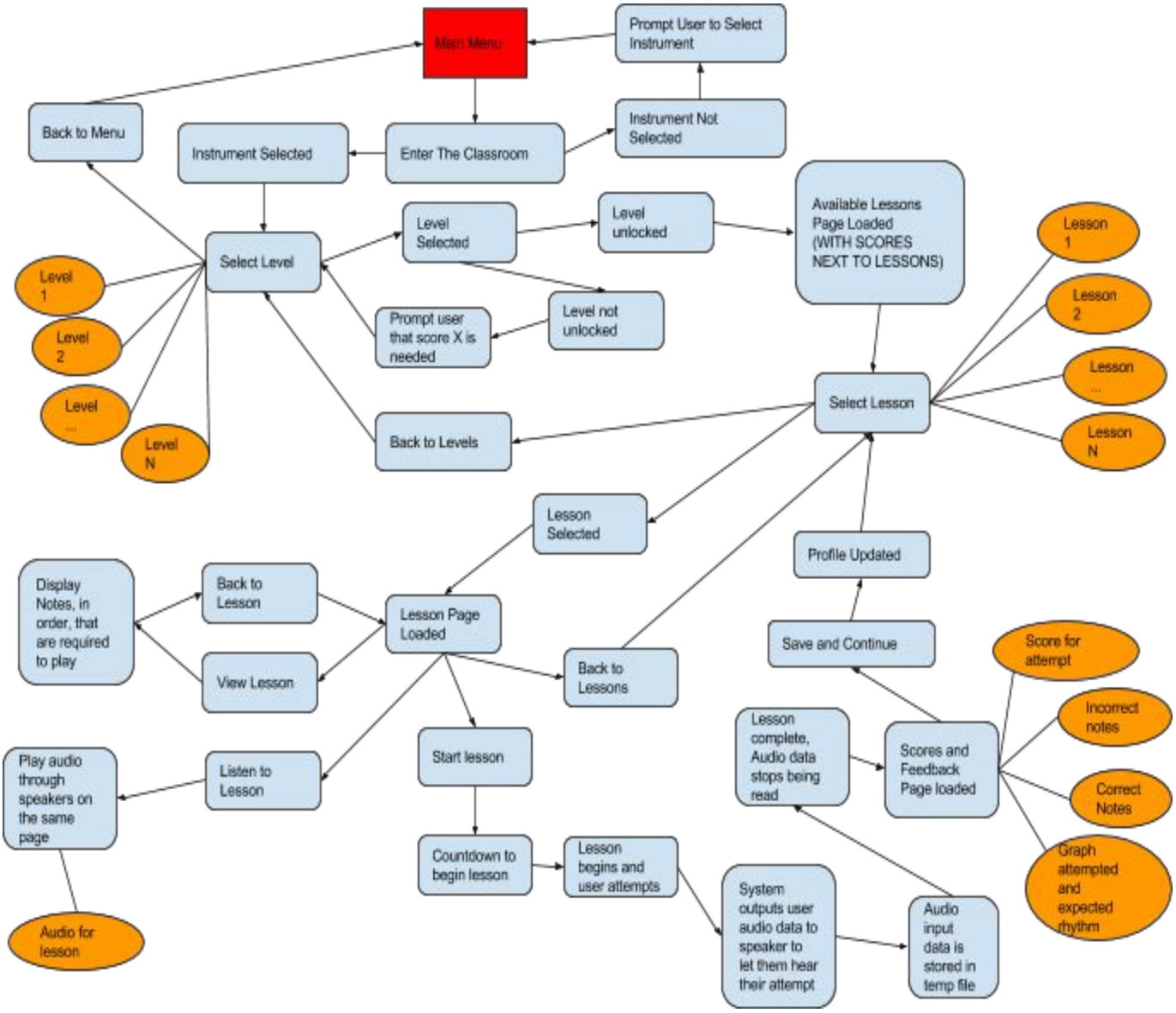
Below: User Tuning on a Selected Instrument



Below: “Recreational” User Using The Classroom



Below: "Student" User Using The Classroom



Below: Workflow between major functional components