Comparison of Music Composing Software: Nyquist IDE, Audacity, and Garage Band

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Abstract: The art of music composition got great leaps forward with Nyquist IDE, Audacity, and GarageBand applications. In the present work, it will be valuable to compare them and work out how they correspond to various user needs. Nyquist IDE is very powerful for controlling sound synthesis by codes, but this system has a very high learning curve for beginning users. Audacity is less complicated, having a simpler interface, and is more apt for basic editing, though it does not have the variety of advanced functions necessary for professional production. GarageBand is then more accessible, with its good balance of ease of use, though not professional due to a shortage of advanced tools for manipulation and mixing. Adding machine learning into the feature set for these platforms could exponentially increase their functionality, i.e., Nyquist autocompletion, AI modification and cleanup for Audacity, and adaptive instruments for GarageBand. These results underline a future where a choice between the toolset has to be made based on creative needs but points to a future of development in which the bridge between casual and professional users would be mended and the advanced music production toolset would become more accessible to all.

1 INTRODUCTION

The origin of computer music reaches back into the early 20th century well before the widespread use of digital technologies. Early experimentations in electronic sound prefigured more formal developments in the mid-century, especially in the post-war era (1945-1970s). The initial program for computer music was developed in the 1950s, which marks a new era in creating sound digitally. Computer music made important progress in the 1960s and 1970s with the development of analog synthesizers and music programming systems. These early systems allowed composers to input instructions for sound synthesis that computers could follow, and that lays the groundwork for future developments. These systems not only introduced the possibility of real-time sound synthesis but also are the basis for digital audio tools in use today by composers and sound designers. Later, the big jump came in the 1980s with the introduction of the MIDI standard, whereby electronic instruments could talk directly to computers. Suddenly, musicians were able to manipulate sounds to a much greater extent using digital audio workstations. As personal computers became powerful and widely available, the same musicians were able to both create and perform digital music without recourse to specialized studios (Lazzarini, 2013; Manning, 2013).

In recent years, evolutionary computation has introduced a new approach to computer music (Miranda & Biles, 2007; Gorbunova & Hiner, 2019). By using algorithms, composers can transform simple musical ideas into more complex compositions. This method has led to the creation of new music and a deeper understanding of how musical ideas grow and spread across different contexts and cultures (Burlet & Hindle, 2013). Historical foundations of computer music have developed into the advanced systems used today while recent technological and educational innovations go on to further expand the way in which music is composed and taught. Throughout the past several decades, professional and educational contexts have increasingly integrated computer music technologies. With the development of synthesizers, multimedia computers, and software created for that purpose, traditional methods within music pedagogy were able to integrate advanced technology. These digital tools have enhanced music education through an even more interactive and learning process for the students. It offers new ways of blending classical methodologies into digital

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platforms, thereby expanding the possibilities for teaching music in the digital era.

On the other hand, the rise of musicians as "end-user programmers" has grown. These artists take advantage of visual programming languages such as Max/MSP and Pure Data, through which they can perform a different type of process in music creation. Even though computer musicians alter fewer codes, they still contribute to improve the software by reporting bugs. Instead, their focus tends to lean more to the creative rather than efficiency (McPherson & Tahiroğlu, 2020).

Besides technological developments, creative procedures from computer music languages arise. The different programming languages influence the pathways taken in composition by musicians many times based on ease of accomplishing a certain task. Tasks that are easier to perform in one programming language than another can influence musicians' creative choices. This interplay between the language being used and the resulting music places the designers of the programming languages used by digital composers in a position of great influence over the ultimate artistic result.

In modern days, the way of using digital software to create music has become more and more popular. Due to the improvement of computer music, using the software to make music is convenient and flexible. The advantages of such tools include accessibility, ease of use, and the ability to create music anytime and anywhere, without the need for expensive equipment. Therefore, it's important to provide different groups of people with appropriate composing apps that can fulfill their specific needs. Hence, the following research will be conducted to describe three of the popular music software applications: Nyquist IDE, Audacity, and GarageBand. Since each one has a function that is unique from the others, the research will touch on the differences related to user interface, sound editing, personalization, and hardware integrations. Through the study of those features, this paper aims to give an idea about how those tools could meet various types of users demands for the selection of the most appropriate software by musicians in view of their creative aims.

2 DESCRIPTIONS OF MUSIC COMPOSING BASED ON SOFTWARE

Software music creation rests on the premises of digital sound synthesis, signal processing, and algorithmic composition. Such tools provide the composers with abilities for digital creation, modification, and manipulation of sounds, offering immense flexibility and control over their musical ideas. Nyquist IDE is a code-based application that allows the user to have very fine control over sound synthesis. Actually, it enables users to program the behavior and transformations of a sound right at its source, fitting those composers' needs working with algorithmic processes. Coding will allow the composer to specify the parameters of the sound and build highly complex, dynamic compositions with a very high degree of custom specificity. Nyquist will be ideal for those who want to plunge into the technical details in creating music and meet their requirements since they are in control of the generation and manipulation of sounds.

Audacity is a lighter audio manipulation program that contains fewer functions for synthesizing sounds but focuses more on manipulating those that are already created. The user interface allows musicians to slice and splice tracks and insert a variety of effects. Audacity contains very minimal technical overhead; in fact, it's used even in educational curricula and is ideal for those who want to edit audio files without getting mired in the details of sound creation.

GarageBand strikes a good balance between features and simplicity. It is pretty straightforward with its interface, pre-made loops, and virtual instruments, so any person without broad knowledge in music theory or sound engineering will easily manage it. With GarageBand, users can easily create tracks by combining loops and instruments, and that can make it an ideal choice for amateur musicians and a popular starting point for those learning music production. In contrast, apps like Logic Pro and Ableton Live versions are designed for professional work and have special features related to live performances, mixing, and mastering. Such platforms are developed for users requiring high level levers in sound production and often include physical hardware such as MIDI controllers or synthesizers.

3 NYQUIST IDE

Nyquist IDE, created by Roger B. Dannenberg, is a software for music composition and sound synthesis. It includes compositional structure and manipulations of sound into a single uniform context (Dannenberg, 1996; Dannenberg, 1997). Whereas most systems maintain a firm separation between score and sound synthesis, Nyquist supports interaction with score and sound synthesis interchangeably by the composer. Based on the Lisp programming language, it offers the composer a flexible environment where sound can be easily stored, modified, and reused in their compositions. This allows the user to store, edit, and reuse sounds in their composition with a lot of ease and hence work in a really flexible and efficient manner. Nyquist is mainly designed based on the concepts of functional programming. Composers enjoy extensive control over key parameters, including but not limited to, pitch, duration, timbre, and other properties of the sound through conceptually transparent means of abstraction. By directly coding the behavior and transformation of the sounds, composers can make elaborate and dynamic compositions with a high degree of customizing. Moreover, Nyquist supports real time audio processing so that immediate auditory feedback is provided to the composers. Therefore it will be convenient for users to find any potential bug and debug it. The most characteristic features of Nyquist concern its capabilities for behavioral abstraction; it allows the transformation of sounds depending on their context in a composition. There are several ways to apply time stretching to both synthesized and sampled sounds, since the method is generally flexible and allows various types of manipulations. The possibility of dynamic changes in the behavior of sounds opens a wide range of new creative possibilities for composers.

Fig. 1 gives a good overview of how composers would interact with Nyquist IDE. The user inputs the code that describes the behaviors of sound parameters, while the platform provides real time graphical feedback to help users refine their work in the process of composition. In particular, Nyquist is effective for manipulations of detailed sound, and that can combine coding and visual representation to give the user a more clear view. Additionally, the use of Nyquist has been involved in music schools such as Carnegie Mellon University and experimental music setups. In academics, Nyquist IDE can be an interesting tool for the students in additive and frequency modulation sound synthesis, among others. This focus allows students to not only learn about sound theory but also apply both their music and computer knowledge in a creative way, making it ideal for research and higher education where students can experiment with the technical.

Nyquist lends well to experiments, especially where composers rely heavily on algorithmic composition or real time sound processing. In practice, it has been applied to a number of generative music projects where compositions evolve algorithmically according to predefined rules. This use of Nyquist is particularly useful in composing works that react to change variables. Therefore, Nyquist is quite suitable for everything from experimental and algorithmic composition to traditional creation of music. its flexibility and interactive features make it a useful tool in sound design, composition, and live performances.

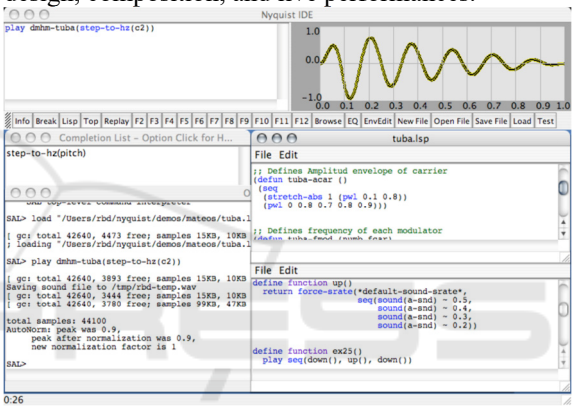

Figure 1: The Nyquist IDE (Roger B. Dannenberg-2008).

4 AUDACITY

Audacity is free software that most people in the world use in recording, editing, and analyzing audio material. Because of its simplicity and its zero cost, many have applied it to the fields of education, research, and music making (Azalia et al, 2022; Washnik et al, 2023). Probably one of the main reasons for such popularity is the ease of installing it and using it. Its techniques are easily grasped by novices up to professional categories of people. Audacity requires the least amount of hardware to work with and comes with a very friendly interface wherein any user can easily see and edit the sound waves. It can support a range of audio formats. Users can import and export files in formats such as WAV, MP3, and AIFF. Once the audio has been imported, the user can edit the sound by cutting, copying, pasting, or applying effects such as noise reduction, equalization, and reverb. This visual representation of

sound waves allows users to edit and adjust the audio without having much technical knowledge. For instance, it enables the user to zoom in on a sound wave, piece by piece, making very little changes to enhance either the quality or the time of a recording. Furthermore, Audacity can normally be used for sound analysis, both in scientific and educational settings. The strong points feature the display of sound spectrograms showing the audio frequency content versus time and this offers a lot in terms of experiments dealing with waves of sound. In this setup, as shown in Fig. 2, a microphone is connected to Audacity and records sound from a source, such as a cat's meow. Then, the sound visually appears in Audacity and can be analyzed in characteristics such as frequency, amplitude, and time. Thus, Audacity can help students and researchers in finding important concepts of physics and acoustics about how sound waves behave, interact with one another, and take part in yielding different frequencies to result in an overall sound.

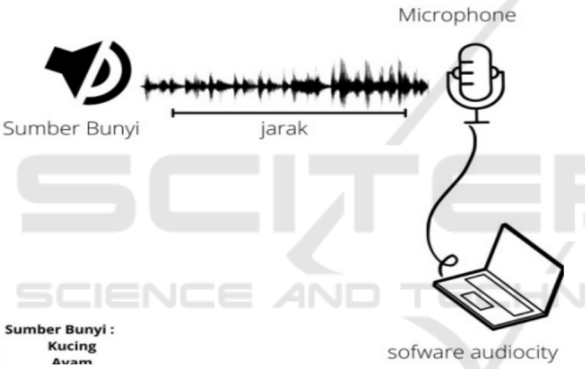

Figure 2: Implementation Process for Audacity (Aisha Azalia, Desi Ramadhanti, Hestiana, Heru Kuswanto-2022).

Audacity also has been used in actual scientific research. For example, one study focused on the aspects of sound frequencies within a variety of animals. In doing so, it utilized Audacity to record and, later, to analyze the vocalizations of several cats. The recorded sounds could be plotted as spectrograms with the software, which allowed the researcher to see variations in frequency and amplitude between the many vocalizations. This example with Audacity had shown how easily it could process and visualize such complex sound data and, therefore, support scientific experiments with acoustics and sound analysis.

In addition, Audacity is most commonly used by musicians and podcasters, even though it has important applications in education and research. This software provides multitracking editing features and that allows the user to layer multiple audio recordings. While Audacity is lightweight, its functionality allows users to work with it just as well as with many other more expensive audio production programs. Musicians will find it easy to record instruments or vocals, while podcasters can also easily record and edit shows without much hassle. Another great feature in Audacity is the ability to extend Audacity with third party plugins for specific needs in the creation of music, production of a podcast, or even a scientific experiment.

5 GARAGEBAND

GarageBand is a digital audio workstation that has taken vows to be simple and straightforward for beginning users, though it should also be powerful for advanced ones. As part of the Apple ecosystem, GarageBand is available on Mac, iPhone, and iPad. It is widely used by users looking to create music with minimal effort, making it a popular tool for beginners and hobbyists. One characteristic of GarageBand is an intuitively built interface with controls that allow people to make professional sounding audio. GarageBand simplifies the music production process, whether users are recording live instruments, using virtual ones, or arranging pre-recorded loops.

GarageBand has various basic functions in music production. Users can create and layer multiple tracks by using its preset virtual instruments that range from pianos to guitars and drums. It also boasts a massive library of loops, which are essentially pre set musical phrases that can easily be put together to create whole songs. For a beginning composer, it can be very helpful as an entry point, without requiring a deep understanding of music theory. For those who want to record live, GarageBand has the ability to hook up a microphone or other instruments, such as guitars or keyboards, and record right into the system.

In addition to its basic features, GarageBand offers tools that contain creative flexibility. One of these is the Smart Instruments feature, which includes tools like the Smart Drummer. This function allows users to integrate drum tracks into their compositions by selecting from a range of virtual drummers, each with different playing styles (seen from Fig. 3). These drummers can be customized to fit the specific needs of the composition, adjusting aspects like tempo and rhythm patterns. This feature simplifies the process of creating rhythm sections, even for users with no prior experience in programming drums (Bell, 2015; LeVitus, 2021).

Figure 3: The garage band drummers (Vincent C. Bates,Brent C. Talbot-2015).

Another noticeable tool of GarageBand is its multitrack editing capability. The user can layer various sounds, apply effects, and mix tracks. This function will enable the user to create more complex compositions by recording each instrument separately and then combining them. Especially for musicians, this feature allows them to edit their recordings to a professional quality. Such functionality includes the Piano Roll Editor, which is able to edit MIDI tracks by changing individual notes themselves, as shown in Fig. 4. The editor will be especially appealing to people working with virtual instruments because it gives users precise control over timing, pitch, and duration of every note for exact editing and arrangement.

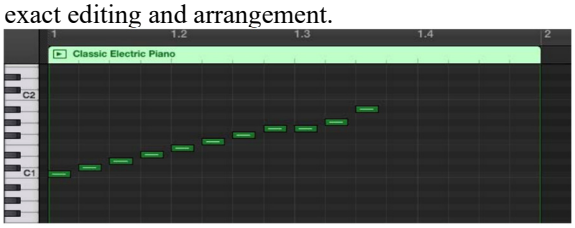

Figure 4: The piano roll editor view in Garage Band (Vincent C. Bates,Brent C. Talbot-2015).

Besides, GarageBand found its place in both professional and semi professional music production. Quite a number of people use the software for recording demos or even producing finished tracks. Sometimes composers will even choose Garage band over professional music making software like Logic Pro due to its simplicity and strong editing features. While it may not have all the advanced features of more expensive DAWs, GarageBand's versatility ensures that users can produce high quality music with minimal effort.

6 LIMITATIONS AND PROSPECTS

Limitations of each reviewed music software platform-Nyquist IDE, Audacity, and GarageBand-are associated with the scope of use and design. A major problem most of the tools are facing is that they need to choose between being easily accessible and being complex. While useful in providing features for some user groups, they often poorly try to fulfill larger or more advanced needs. For example, the Nyquist IDE, while it does grant an extremely customizable environment for sound synthesis and music composition, highly involves deep coding inside. This can be very discouraging to casual users or people with no experience in programming, therefore increase the time cost of use. The flexibility Nyquist offers with respect to real time processing of sound and behavioral abstraction is laudable but at a rather high learning price. This also makes it difficult to use in live performances or educational situations with people who are not used to programming. The lack of any more intuitive graphical interface restricts its use for live performance or education when non-programmers need an easier tool.

Audacity is widely praised for its simplicity but falls short for advanced features. It is really good at basic audio editing and recording but loses its potential whenever real time processing, complex multi-track editing, or sound synthesis comes into play. For a more advanced user who wants to do music production or sound design, the capabilities are somewhat limiting and need supplementation of their workflow with additional software or plugins. Also, its reliance on third party plugins introduces complications given that the integration isn't always smooth, and this software can feel a little fragmented.

For GarageBand, compared to professional DAWs such as Logic Pro or Ableton Live, it lacks more sophisticated features: detailed mixing and mastering capabilities, for example, or further developed sound manipulation. Perfect for hobbyists, the limitations are more apparent for professionals when they push the boundaries of sound production in live performances or more intricate compositions.

Going forward, some of the most promising features for music software platforms include aspects of machine learning. With this in mind, AI is

supposed to solve most of the deficiencies in the status quo and can automate mundane tasks, make intelligent suggestions, thus can provide tools at all levels of user expertise. For example, Nyquist IDE could use machine learning to make smart suggestions, auto completion features that would help a beginner to develop things using his tool more easily. Audacity will be able to embed AI audio enhancement capabilities, such as instant noise reduction or auto-mastering capabilities within the application. In this way, it ensures better sound quality without actually having to learn all the technical details involved. GarageBand might introduce adaptive virtual instruments or smart loops that, by user input interaction, adapt themselves for interactive creation rather than manual adjustments.

This could also mean more creativity in general, possibly opening new frontiers when machine learning would be integrated into such platforms. It would allow users to try out new genres, styles, and techniques by employing AI-driven algorithms that would automatically make suggestions regarding harmonies, rhythms, or even full composition. The gap between casual users and professionals would be closed by making music creation more accessible and providing advanced tools to all skill levels.

7 CONCLUSIONS

To sum up, a comparison between Nyquist IDE, Audacity, and GarageBand reveals how each is suited for different types of users from highly complicated sound synthesizers to more simple audio editors. Nyquist IDE is good at providing functionality for the users by granularly controlling the sound through codes; however, such complexity makes it difficult for a beginner to work with. While Audacity is simpler, it doesn't support all advanced features necessary in professional and complex music creation, whereas GarageBand strikes the midpoint between the two, providing a platform that is easy to use by casual creators but lacking in professional settings. Whereas the limitations mentioned here look ahead to the implementation of machine learning that will further the user experience into automation and intelligent suggestions, this study does stress the right tool choice based on the creative needs of the user. It points to some future technological developments that will make music production more accessible and efficient regardless of skill level.

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