



TUNESCAPE

A Comprehensive System for Checking Copyright Infringement

Abstract

Empowering musicians to safeguard their creations with advanced audio analysis and similarity detection. Compare new tracks against a vast music database to prevent copyright conflicts and protect your artistry.

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Problem Statement:

The music industry faces significant vulnerability to copyright infringement disputes, as evidenced by a consistent rise in litigations. With Millions of songs being produced and released every year, the probability of unintentional similarities between new compositions and existing works is high. These similarities can lead to costly and time-consuming litigation processes, which is particularly burdensome for independent artists and small production houses.

The challenge is exacerbated by the complexity of musical elements and the subjective nature of judging similarity. TuneScape addresses this critical issue by offering a solution that analyzes and evaluates the melodic content of new compositions against a vast database of existing songs, providing a similarity score and a probability assessment of copyright infringement. This tool aims to protect creators from inadvertent legal conflicts and foster a more secure creative process.

Market/Customer/Business Need Assessment:

The global music industry, valued at over \$50 billion, is driven by continuous digital innovation and content creation. In this dynamic environment, copyright protection is crucial. Below are the key stakeholders that we aim to address with our technology:

1. Independent Artists:

- Independent artists often work on tight budgets and lack access to sophisticated tools for ensuring the originality of their compositions. They are usually more focused on the creative aspects of music rather than the legal intricacies of copyright laws. Many of them are self-managed or work with small teams that do not have legal expertise.
- Without proper tools, these artists are at risk of inadvertently producing music that may infringe on existing copyrights. Legal disputes can be particularly devastating, both financially and reputationally, for artists who are just starting out. This threat of lawsuits has the potential to discourage the creativity and hinder the growth of their careers.
- There is a significant need for affordable and user-friendly tools that can help independent artists verify the originality of their work before release. Such tools can provide peace of mind and allow artists to focus on their creative endeavours without constant fear of legal repercussions.

2. Small Production Houses:

- Small production houses receive numerous music submissions from various sources and need to ensure each piece is original. Manually checking each submission for potential infringement is time-consuming and requires resources that small companies might lack.

- These production houses operate under tight budgets and need cost-effective solutions that do not compromise on thoroughness.
- Tools that seamlessly integrate into their existing workflows without disrupting their processes are highly desirable. Efficient solutions that can quickly screen and approve music submissions are essential to maintain their production schedules.

3. Major Record Labels and Publishers:

- Major record labels and publishers manage extensive catalogues of music, which need ongoing protection against unauthorized use and infringement. Regular monitoring and checking for potential infringements across these large datasets are challenging.
- Solutions must be capable of handling the scale of their operations, with the ability to process and analyse vast amounts of data efficiently. The need for scalable and robust tools is critical to managing their catalogues without overwhelming their resources.
- Effective tools are, thus, needed to quickly identify and address the potential infringements, minimizing legal and financial risks. A proactive monitoring in this direction can be a big help to safeguard their assets and maintain the integrity of their brand.

4. Streaming Platforms and Legal Entities:

- Streaming platforms need to ensure that all uploaded content is legitimate and does not breach on existing copyrights. The volume of content uploaded daily makes it challenging to verify each piece manually, this is especially true for small platforms.
- Having a tool that can quickly and accurately flag potential issues to avoid costly legal disputes and reputational damage can be of immense help.
- Ensuring compliance with the copyright laws and maintaining transparent reporting mechanism is crucial for these legal entities. They need systems that provide detailed reports and audit trails to support their compliance efforts.

TuneScape seeks to address these aforementioned challenges by offering subscription models tailored for budding and independent artist, providing affordable access to powerful copyright checking tools. The platform can be designed with an intuitive interface, making it easier for even the non-technical users to perform the checks. Including resources and tutorials to educate the artists about copyright issues and how to navigate them effectively can also be done additionally.

TuneScape aims to provide automated, high-speed analysis of new music submissions, identifying potential plagiarism issues efficiently. Subscription model for small production houses can be

designed to offer comprehensive services at competitive prices. The platform can offer APIs and plugins that integrate with the popular music production software, streamlining the screening process.

By leveraging advanced Machine Learning algorithms, TuneScape can provide deep insights and high accuracy in identifying potential copyright issues. Furthermore, by integrating efficient data pipelines, we can achieve scalability of such humongous data which will be useful in analysing and monitoring, suitable for major labels in the market.

Users can avail the platform to generate comprehensive reporting, which will be based on real-time content verification services backed by detailed analytics to maintain compliance and to have necessary documentations.

Target Specification and Characterization:

- **Independent Artists:** Solo musicians or small bands looking for cost-effective ways to verify the originality of their music.
- **Small Production Houses:** Studios producing content for various clients, needing tools to screen multiple tracks efficiently.
- **Major Record Labels:** Large entities managing extensive catalogues of music and seeking comprehensive solutions to safeguard their assets.
- **Legal Firms:** Firms specializing in intellectual property laws and interested in tools to identify and pursue infringement cases.
- **Streaming Services:** Collaborate with the existing streaming services to induce penetration of TuneScape in the market.

External Search – Online Information Sources:

1. **Spotify Developer API Documentation-** <https://developer.spotify.com/documentation/web-api/>) : Provides Extensive metadata and audio feature data for tracks.
2. **MusicBrainz-** <https://musicbrainz.org/> : A comprehensive, community-maintained database of music metadata.
3. **Discogs-** <https://www.discogs.com/> : A detailed music Database with metadata on releases, artists and labels.
4. **Librosa-** <https://www.discogs.com/> : A Python package for music and audio analysis, comes with a detailed documentation for easier understanding.
5. **Google Patents-** <https://patents.google.com/> : For researching existing patents related to audio analysis and copyright detection.
6. **WIPO “Guide on Copyright and related rights”** [Guide to the Copyright and Related Rights Treaties Administered by WIPO and Glossary of Copyright and Related Rights Terms](#) : A trusted resource to understand the legal frameworks that govern the copyrights on an international scale.
7. **Indian Music Industry (IMI) “Understanding Copyrights in Music”-** [IMI \(indianmi.org\)](http://indianmi.org) : A comprehensive guide to understand legalities in Indian context.
8. **Research papers and articles on music similarity detection and copyright law-**
 - [“Automating Music Similarity Analysis in ‘Sound-Alike’ Copyright Infringement Cases”](#) by Charlotte Tschider

- [“Perceptual and automated estimates of infringement in 40 music recordings”](#)
 - [“Striking Similarities: Towards a Quantitative Measure of Melodic Similarity”](#) by David J. Kapp
 - [“An adaptive meta-heuristic for music plagiarism detection”](#) by M. G. Speranza et al
9. Industry reports on the impact of Copyright Infringement in the music sector-
- The True Cost of Sound Recording Piracy to U.S. Economy: [Report](#)
 - High Profile Copyright Battles: [Report](#)
 - Contributory Copyright Infringement: [Report](#)
 - Copyright Industries’ contributions to U.S. Economy: [Report](#)
 - Digital Piracy Statistics in India: [Report](#)
10. Case studies of past copyright infringement disputes and their outcomes (must read)-
- [Nine most notorious copyright cases in music history](#)

Benchmarking Alternative Products:

1. Spotify’s “Plagiarism Risk Detector And Interface” (patent):

Spotify provides various tools and frameworks for music analysis and content verification, but it has some lacunae when it comes to comprehensive plagiarism detection and user accessibility.

- These tools are primarily designed for internal use or for integration with their own services, limiting access for external developers and users. This is where TuneScape aims to strike by offering API and flexible integration options that allow independent artists, small production houses and other external users to seamlessly use the service.
- Spotify primarily focuses on streaming services rather than the detection of music ownership issues or potential for infringement during the creation phase. TuneScape on the other hand, is primarily envisioned considering the pre-release analysis, helping artists and producers verify the originality of their compositions before they are distributed or published.
- Spotify does not directly offer tools or services that connect users with the legal support in case of detected infringements. TuneScape seeks to establish partnerships with the law firms and provide direct legal consultation services for the users.
- The Scalability of Spotify’s tools may not be suitable for individual artists or small production house due to cost or complexity. Whereas, our technology has the aim of offering cost-effective solutions that cater to needs of the small users, providing accessible and affordable options.

2. YouTube’s Plagiarism Checker (Content ID):

YouTube’s Content ID system is designed to detect and manage copyright issues on its platform, but yet again it has notable limitations that TuneScape seeks to improve upon.

- Content ID is specifically designed for its platform, limiting its applicability outside of YouTube. But our technology has designs of platform-independent solution that works across various distribution channels and not just a single platform.
- TuneScape follows a proactive approach for analysis, where producers can verify the originality of their compositions during the creation and pre-release phases, reducing the risk of post-release disputes, which is not the case for Content ID which primarily functions reactively.
- Content ID is driven by algorithms which can sometimes be overly aggressive or inaccurate, leading to false positives that affects legitimate content. On the other hand, TuneScape is build on advanced Machine Learning techniques to improve the accuracy and reduce false positives, providing more reliable and nuanced decision on similarities.

3. Others:

- **Shazam** – Primarily used for identifying songs by their audio fingerprint. It is not designed for checking Copyright Infringement.
- **Musixmatch** – Focuses on lyrics matching and synchronization services. Lacks comprehensive melody analysis for copyright purposes.
- **Pandora's Music Genome Project** – Users Extensive music analysis for personalized recommendations but not specifically for copyright compliance.

Applicable Regulations:

1. **Indian Copyright Act, 1957** - Governs the protection of literary, dramatic, musical and artistic works. It grants the exclusive right to reproduce, distribute, perform and create derivative works.
2. **Information Technology Act, 2000** - Provides legal recognition for electronic transactions and digital content, including protection against copyright infringement online.
3. **Digital Millennium Copyright Act (DMCA), USA** – Protects digital content and provides safe harbour provisions for online service providers.
4. **Copyright, Designs and Patents Act, 1988, UK** - Regulates copyright law and protects the rights of creators in UK.
5. **EU Copyright Directive** – Harmonizes copyright law across EU member states and introduces measures for protecting digital content.

Major Constraints:

1. **Initial Development Costs and Operational Costs** – The initial stages which involve research, prototype development and building initial version of the TuneScape platform, advocates for securing Funding. The costs include salaries for skilled professionals, technology stack acquisition (software licenses, tools, hardware) and setting up necessary infrastructure. In the later stages, operational cost is also going to add on top of this, which includes expenses such as server hosting, API usage fees, data storage, regular maintenance and platform updates.

2. **Data Acquisition and Storage** – Large Datasets of audio files that cover various genres, languages and styles and maintaining high data quality across all samples are essential for our analysis, necessitating reliable storage solutions and data management practices. The costs associated with acquiring song data, either through licensing or partnerships, and storing these large volumes of data can be substantial.
3. **Challenges in Data Access** – Accessing and using large datasets of songs for analysis involves navigating both legal constraints and logistical hurdles. In terms of legalities, Copyright laws can be complex and may vary by jurisdiction making it challenging to ensure all data usage is compliant. This challenge is compounded by the need for obtaining permissions from the rights holders, which is difficult and time-consuming. Furthermore, handling diverse data formats, ensuring data integrity and managing large-scale data storage are significant logistical challenges.
4. **Scalability** – Maintaining system performance and speed with larger datasets with the growing user base could be challenging. This also requires taking into account management of high user traffic without performance degradation. Along with this, we also need to ensure our platform can evolve and expand in capabilities to meet the future needs and technological advancements for which designing a flexible system architecture that can integrate new features and accommodate the changes is yet another necessity for the product development.

Possible Solutions:

- Secure Funding through mix channels, such as venture capital, government grants and partnerships with the industry stakeholders. Also, adopting lean startup methodologies can help minimize initial expenses by focusing on building a minimum viable product (MVP) and iterating based on feedback.
- Implement cost-effective cloud solutions with a pay-as-you-go models, optimize resource usage through efficient coding practices and establish a clear financial plan with revenue generation strategies such as subscription or premium services.
- Use cloud-based storage solutions that offer scalability and cost-effectiveness. Partner with music databases and leverage public domain or Creative Commons licensed music to reduce data acquisition costs.
- Consult with legal experts specializing in intellectual property to navigate copyright laws and secure necessary licenses. Focus on using music that is in the public domain or licensed under flexible agreements like Creative Commons to simplify legal compliance.
- Partner with multiple music data providers to obtain a wide range of songs, and use data augmentation techniques to enhance the dataset's diversity. Regularly review and clean data to maintain quality.
- Standardize data formats for interoperability, implement scalable data storage and processing solutions. Implement load balancing and auto-scaling features to manage traffic spikes. Use Caching and content delivery networks to reduce server load and improve response times.
- Continuously monitor system performance using metrics and logs, conduct regular performance testing and optimizer code and infrastructure based on insights. Prioritize

critical functions and implement fallback mechanisms to maintain service continuity during high loads.

- Adopt a modular architecture with microservices that can be independently updated and scaled. Stay agile in development practices to quickly respond to new opportunities and challenges. Keep abreast of emerging technologies and trends to incorporate innovative solutions.

Business Model (Monetization Plan):

TuneScope aims to provide a comprehensive solution for detecting and managing plagiarism in the music industry. To sustain and grow our platform, we have developed a multi-faceted monetization strategy that aligns with the diverse needs of our target users. This strategy includes subscription services, freemium model, partnership with legal firms, and API licensing.

Following is the detailed breakdown of each monetization approach:

1. **Subscription Service** – To generate steady revenue by offering value-added (tier-based) services tailored to different user segments. Our subscription plans will cater to a variety of user groups, including independent artists, small production houses and major record labels.

Subscription Tiers:

- **Basic Plan**
 - **Target Users** – Independent and budding Artists and hobbyists.
 - **Features** – Access to basic Similarity checks, limited song comparisons per month and basic reporting tools.
 - **Pricing** – Affordable monthly fee, designed to be accessible to individuals and small-scale users.
- **Professional Plan**
 - **Target Users** – Small production houses and Indie Labels.
 - **Features** – Enhanced similarity analysis, higher comparison limits, access to advanced reporting and analytics and priority customer support.
 - **Pricing** – Mid-Tier monthly fee, suitable for small businesses and semi-professional users.
- **Enterprise Plan**
 - **Target Users** – Major record labels, large music publishers and streaming platforms.
 - **Features** – Unlimited comparisons, custom analytics, API access for integration, dedicated account management and compliance tools.
 - **Pricing** – Premium pricing, tailored for large-scale operations with extensive needs.

Benefits:

- By employing Subscription fees, we can have a reliable income source.
- Having tiered plans can encourage long-term user engagement and loyalty as per the requirements of the users.
- We can also ensure customer satisfaction with the tailored features and services to specific user requirements.

2. **Freemium Model** – Using a Freemium model can help in attracting broad user base by providing free access to basic features while encouraging upgrades to premium subscriptions for advanced functionalities. A basic version of TuneScape will be available at no cost, which would offer essential features that are valuable to users but, of course, with limitations. As per the requirements of the users, they can unlock advanced capabilities through a paid subscriptions from one of the tiers mentioned in the point above, providing more powerful tools and expanded usage limits. We can have Periodic promotions and discounts to encourage free users to upgrade.

Benefits:

- Low barrier to entry attracts a wide range of users, increasing brand awareness and market penetration.
- Free users have the opportunity to experience the value of TuneScape, which can drive them to upgrade to premium plans for additional benefits.
- Allows the platform to grow user engagement organically and adapt to varying user needs.

3. **Partnership with Legal Firms** – This is in consonance with one of those distinguishing features of TuneScape i.e. to provide the users who identified the breach of their rights with appropriate legal assistance. Having this component provides a valuable service to users facing copyright issues while generating additional revenue through referral commissions. For this we need to establish partnerships with a network of legal experts and firms specializing in copyright laws and then connect the users with legal professionals for assistance with potential copyright litigation and compliance issues.

Partnership Structure:

- **User Support** – Offer users access to legal advice and representation through out platform, helping them navigate copyright challenges.
- **Commission-Based Revenue** – Earn commissions from the partner firms for each user referred to them through TuneScape.
- **Value Addition** – Provide an integrated solutions that not only identifies potential infringements but also helps users resolve them, enhancing the overall service value.

Benefits:

- Commissions from the legal referrals provide another income source beyond the subscription fees.
- Offering access to legal support portrays TuneScape as a more comprehensive and trusted service.
- Strengthening ties with legal professionals can open up further collaboration opportunities and enhance our industry presence.

4. **API Licensing** – To extend TuneScape’s capabilities to external platforms and businesses we have API services which can be yet another revenue from the usage fees. By creating robust APIs that allows external platforms like streaming services, music libraries to integrate TuneScape’s similarity checking and analysis mechanism into their own systems. We can

establish licensing terms and usage fees based on the level of API access and the volume of data processed.

Licensing Model:

- **Usage-Based Fees** – Charge partners based on the number of API calls or the volume of data processed, providing a scalable pricing model.
- **Subscription Plans** – Offer Subscription-based API access with different tiers, allowing partners to choose a plan that fits their usage needs.

Benefits:

- API Licensing extends TuneScape technology to a broader audience through partnerships with other platforms.
- Generates additional revenue streams from API access fees, complementing subscription and referral income.
- Potential to increase TuneScape's presence in the music industry as more platforms integrate our tools into their services.

Combining these monetization strategies provides a diversified revenue model that supports TuneScape's growth and sustainability. Each approach targets different market segments and leverages unique opportunities to create value for our users and partners. By implementing Subscription Services, a Freemium Model, Partnership with Legal Firms and API Licensing, TuneScape can establish a strong financial foundation while delivering comprehensive and scalable solutions to address copyright infringement in the music industry.

Concept Generation

The inception of the idea behind TuneScape originated from an article discussing a renowned artist becoming embroiled in legal disputes over copyright infringement allegations. This led to further research to have a bird's eye view of the current scenario surrounding such legal disputes and the conditions faced by small artists. As our idea began to take a solid shape the research went on to focusing on the following points:

1. Identifying Market Needs:

- **Identifying Stakeholders Requirements** – Going through countless number of articles to understand the clear picture of the industry (refer 3), common concerns were brought into light i.e. about unintentional copyright infringement and the lack of accessible tools to pre-emptively check for potential conflicts.
 - Independent Artists** often struggle with limited resources and knowledge to check for possible breach, leading to vulnerability to legal disputes.
 - Small Production Houses** need cost-effective tools to screen new music submissions for originality and avoid costly legal disputes.
 - Major Record Labels** require scalable solutions to protect extensive music catalogues from infringement and manage their legal risks efficiently.

Renowned artists who have to go through such disputes suffer by these litigations hampering their brand value and loyalty among their fans, could be significant taint to their images.

- **Analysing the Trend** – Studied trends in the music industry, which includes the rise of digital platforms and user-generated content, which have increased the incidences of copyright conflicts. Identified the growing demand for automated tools that can provide quick and reliable assessments of the music originality.
- **Legal Implications** – A thorough research and consultation with some acquaintances in legal field to understand the nuances of copyright laws and how they impact various stakeholders. These insights significantly aided in shaping the legal risk assessment component of TuneScape.

2. Researching Existing Solutions:

- **Tools – Spotify and YouTube Plagiarism Checkers** were researched about to understand their underlying working mechanisms. It was found out that these tools often lack the capability to assess the originality of new compositions. (Refer 1 & 2). Also, investigated **Shazam** and **ACRCloud** for their audio fingerprinting technologies which are excellent for matching exact copies but not of detecting melodic similarities or derivative works. Our research also expanded to tools like **Tunefind** and **Musiio** that offer music similarity searches and found that they primarily focused on song discovery rather than proactive copyright infringement checks.
- **Gap Analysis** – As mentioned in the previous point, a gap was identified where the existing tools don't provide for pre-emptive detection of potential breach issues during the music creation process. It was also observed that many existing solutions are either too expensive or complex for independent artists and small production houses for them to integrate these technologies in their workflow.

3. Defining Features: This marks as the most crucial step which demonstrates how TuneScape is envisioned to be a solution to the aforementioned problems.

- **Melody Analysis** – Developing advanced algorithms to extract analyse melodic features from audio files. This includes extracting information like Pitch, Tempo, Rhythm, Harmonic Content and Mel-Frequency Cepstral Coefficients (MFCCs) from the audio files. After extraction, by implementing advanced Machine Learning Algorithms the audios will be compared. This will be complemented by employing NLP techniques to compare the lyrics components of the songs (kept for later phase of development to save the complexity). Having compared on the basis of these features, we will generate Similarity scores to justify the claim for originality of the input song.
- **Legal Risk Assessment** – As we generate a similarity score for a given input song, we will gauge the probability of copyright infringement and provide the users with a risk assessment. This will be done with detailed reports that explain the findings and

potential legal implication, helping users make informed decision about their composition.

- **User Interface and Experience** – It has been observed that if the platform isn't user-friendly and complex to operate, it could be a discouraging factor for any user to continue with our platform. This Advocates for designing an intuitive interface that allows users to easily upload and analyse their music, even if they come with minimal technical knowledge. Another major factor is that we need to ensure that our platform can handle varying volumes of data, from individual artists to large catalogues managed by major labels.
- **Integration and Partnership** – To enhance the utility and reach of TuneScape providing API access to allow integration with other platforms and services is crucial as we move ahead. Furthermore, by building partnership with legal firms, offer users with seamless access to professional legal advice and support.

With this detailed breakdown of identifying problems and working towards developing efficient solutions, TuneScape has evolved from a very basic idea into a well-defined product that has the potential to address significant gaps in the market. This comprehensive approach ensures that TuneScape will not only prevent copyright infringement but also support and protect the creative processes of the artists and other users.

Concept Development

TuneScape will be developed as a web-based platform and API service that allows users to upload their music for analysis. The system will process the uploaded tracks using advance audio signal processing and machine learning algorithms to extract relevant features and later compare against a comprehensive database of existing songs to generate a similarity score, probability of copyright infringement and risk assessment report. Platform will also provide recommendations on how to mitigate potential copyright issues as has been discussed in previous segments.

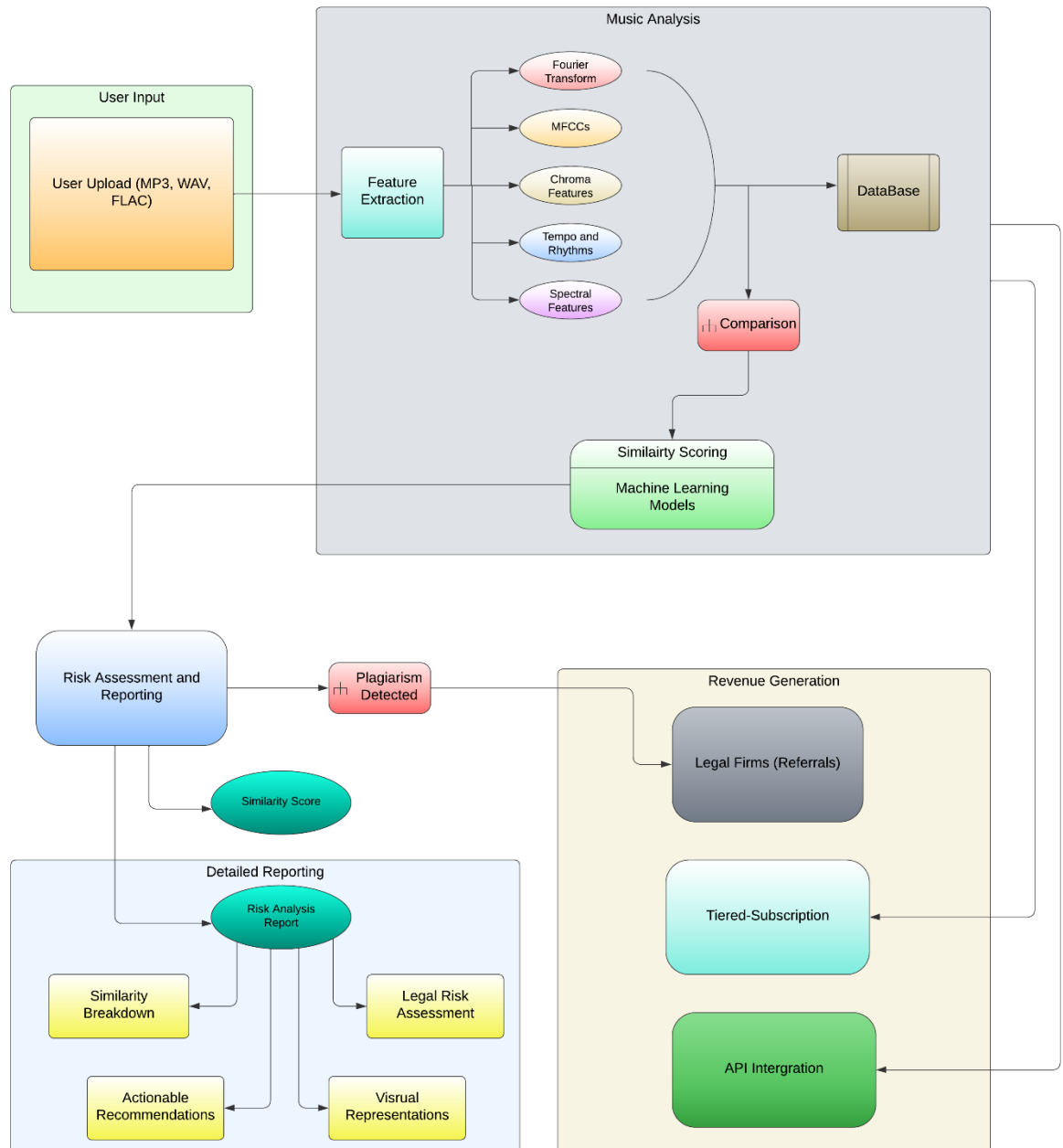
Final Product (Abstract)

TuneScape is an innovative platform designed to safeguard artists and producers against unintentional copyright infringement. By leveraging cutting-edge Audio Analysis and Machine Learning Technologies, TuneScape provides a comprehensive solution for assessing the originality of musical compositions. The platform features an intuitive interface where users can upload their music files for in-depth analysis. TuneScape, then, processes these files to extract detailed musical features such as Pitch, Tempo, Rhythm, Harmonic Content and Mel-Frequency Cepstral Coefficients (MFCCs). These features are then compared against a vast and continuously updated library of existing songs.

Utilizing sophisticated Machine Learning models, TuneScape computes a similarity score that quantifies how closely the new composition matches any existing work. The output includes a similarity score, probability of copyright infringement and a detailed risk assessment report that

outlines potential copyright issues and offers actionable recommendations to mitigate the risks. This proactive approach enables the user to address potential conflicts before they arise, preventing their creative integrity and protecting their work from legal disputes, rendering them to focus more on their artistic creativity than legal apprehensions.

- **Schematic Diagram:**



- **Schematic Diagram Description:** For understanding the flow of working of TuneScape, here is an illustration which portrays the journey from music upload to the final report. Below is a detailed breakdown of each step:

1. User Upload:

- **Interface** – Artists, producers or record labels log into the TuneScape platform using a secure and user-friendly web interface.
- **File Upload** – Users can easily upload their audio files in various formats (e.g. MP3, WAV, FLAC). The platform also supports batch uploads to facilitate the analysis of multiple tracks simultaneously.

2. Feature Extraction:

- **Audio Processing Tools** – Once a file is uploaded, TuneScape employs advanced audio processing tools to dissect the track. This step involves several key processes:
 - **Fourier Transform** – Converts the time-domain audio signal into a frequency-domain representation, capturing the harmonic content of the music.
 - **Mel-Frequency Cepstral Coefficients (MFCCs)** – Extracts features related to the timbral texture of the music, which are crucial for capturing nuances in sound.
 - **Chroma Features** – Analyzes pitch content and captures harmonic and melodic aspects by representing the energy distribution across the 12 pitch classes.
 - **Tempo and Rhythm Analysis** – Determines the tempo and rhythmic structure of the track, which helps in understanding the song's beat and pace.
 - **Spectral Features** – Include various measures like spectral centroid, bandwidth and contrast to analyse the tonal characteristics of the music.

3. Database Comparison:

- **Vast Song Library** – TuneScape's database includes a comprehensive collection of existing songs from diverse genres and periods. This library is regularly updated to ensure relevance and completeness.
- **Feature Matching** – The extracted features from the uploaded track are compared against those in the database. This step uses efficient algorithms to find similarities and matches within a large dataset.
- **Preprocessing** – Ensure that all songs, both in the database and the uploaded track, are standardized in terms of sample rate, bit depth and file format for uniform comparison.

4. Similarity Scoring:

- **Machine Learning Models** – TuneScape leverages advanced Machine Learning algorithms to evaluate the similarity between the uploaded track and the database entries. Key models include:
 - **Cosine Similarity** – Measures the cosine of the angle between two feature vectors, which helps in quantifying how similar the tracks are in terms of their feature profiles.
 - **Euclidean Distances** – Calculates the straight-line distance between feature vectors, offering another perspective on the degree of similarity.
 - **NLP techniques** – To analyse the lyrical component of the songs for comparison.
 - **Neural Networks** – Deep Learning models are used to capture complex patterns and relationships in the data that traditional methods might miss. These networks are trained on large datasets to improve accuracy and reliability.
 - **Convolutional Neural Network (CNN)** – Particularly efficient for analyzing the spectrograms, CNN help in identifying intricate patterns in the audio data that relate to melodic and harmonic content.

5. Risk Assessment and Reporting:

- **Similarity Score** – The system generated a similarity score for each pair of the uploaded track and database entries. This score ranges from 0 to 100 with higher scores indicating greater similarity.
- **Risk Analysis Report** – TuneScape provides a detailed report that includes:

Similarity Breakdown – An in-depth analysis of which aspects of music contributed to the similarity score.

Legal Risk Assessment – Evaluation of potential copyright infringement risks based on similarity score and legal precedents.

Actionable Recommendations – Practical advice on how to modify the composition to minimize the risk of infringement. This could include altering certain melodic lines, changing rhythmic patterns or adjusting harmonic structures.

Visual Representations – Graphs and charts that visually depict the comparison results, helping users to understand and interpret the analysis more effectively.

As we are implementing DL models for comparison, interpretation might be difficult. For this we can have deeper analysis report by using following methodologies:

- **Feature Importance Analysis:**
 - i. **Visualization Tools** – Use visualization techniques to show how different parts of a song contribute to its similarity score. Tools like Saliency Maps, Class Activation Maps (CAMs) or Gradient-weighted Class Activation Mapping (Grad-CAM) can highlight which segments of the audio or which features (e.g. specific notes or chords) are most influential in the model's decision.
 - ii. **Feature Contribution** – Calculate and display how much each extracted feature (e.g. pitch, tempo, timbre) contributed to the overall similarity score. This can help users understand which aspects of their music are most similar to the existing songs.

 - **Intermediate Feature Analysis:**
 - i. **Layer-wise Outputs** – Examine and visualize the intermediate outputs of the Neural Network layers. For example, in CNN, this could involve visualizing the activation or filters that responds strongly to certain parts of the audio input.
 - ii. **Spectrogram Analysis** – Present spectrograms or other transformed representations of the audio that the network uses for its analysis. Highlighting specific patterns in these representations can provide insights into what the model is focusing on.

 - **Simplified Model Insights** – Use simpler, interpretable models alongside Deep Learning models to provide additional insights. For example, train a simple model like a decision tree on the features learned by the deep network and use it to generate more understandable rules for explanations.

 - **Breakdown of Similarity Scores:**
 - i. **Component-wise Score** – Break down the overall similarity scores into component scores based on different features or aspect of the music. This could include separate scores for melody, rhythm and harmony, giving us a clear view of how the tracks compares in each dimension.
 - ii. **Comparative Analysis** – Provide a comparative analysis showing how the similarity score is distributed across different sections of the song. This can help users see if certain parts of their track are more similar to reference songs than others.
- 6. Combining Scores:**
- **Final Score Calculation** – The similarity scores from various models and features comparisons are then aggregated to produce a final similarity score. This multi-faceted approach ensures a comprehensive evaluation, taking into account different aspects of the music.
 - **Weighted Averaging** – Different Features and models may be given varying levels of importance based on their relevance and accuracy in identifying similarities. Weighted averaging allows for a balanced final score that reflects the combined insights from all analysis components.

7. **Connect with Legal Firms:** This step is for those who identify plagiarism and breach of their rights, as observed in the detailed report. From the pool of registered law firms that specialize in copyright infringement cases, users will get to choose on whom to connect based on their proven track records of these law firms.

Thus, this Final Product prototype outlined here not only addresses the immediate needs of its users but also sets the stage for continuous evolution and enhancement, ensuring TuneScape remains at the forefront of innovations in the music industry.

Product Details

Data Sources

1. **MusicBrainz** – A vital resource for obtaining detailed metadata and information on a vast array of songs and albums. This database helps in enriching the feature set used for matching and analysis.
2. **Public Domain Music** – Access to a collection of legally free and open-use music track. These tracks are essential for initial comparisons and for providing a diverse range of reference materials for analysis.
3. **Licensed Content** – Through agreements with record labels and music distributors, TuneScape can access a broader spectrum of songs. This licensed content expands the database, improving the system's ability to accurately detect the similarities and potential infringements.

Tech stack Used (Algorithms, Frameworks, Software)

1. **Librosa** – A powerful Python library used for audio and music analysis. It facilitates the extraction of musical features like Spectrograms, Chroma Features and Rhythm Patterns which are essential for the analysis process.
2. **Scikit-Learn/TensorFlow** – For developing and training Machine Learning models for similarity detection.
3. **Flask/Django** – Framework for developing the backend of the web application. They handle the core functionalities, such as processing uploads, managing database interactions and integrating Machine Learning Models.
4. **React/Angular** – JavaScript frameworks used to build the frontend of the platform. They ensure the user interface is responsive, interactive and easy to navigate enhancing overall user experience.

Team Required

1. **Musicologists** – Experts in music theory and analysis who will help define the musical features to be extracted and ensure that the comparisons are musically relevant and accurate.

2. **Data Scientists** – Professionals skilled in Machine Learning and Data analysis who are responsible for developing and fine-tuning the models that detect similarities and assess the copyright risks. Further, Data science team can also be employed to identify the current market needs to identify the appropriate user base for efficient delivery of services and maximize the reach of our platform.
3. **Software Engineers** – Developers who build and maintain both the frontend and backend of the web application. They ensure seamless integration of all the components and the system is scalable and robust.
4. **Legal Consultants** – Specialists who provide guidance on copyright laws and help shape the legal risk assessment framework. They also facilitate connections with the legal firms for needing further assistance with potential infringement.

TuneScape is poised to become a pivotal tool in the music industry, offering a proactive approach to managing and mitigate copyright infringement risks. By providing detailed analysis and risk assessment based on melodic content, TuneScape empowers artists and industry professionals to protect their creative works and avoid costly legal disputes. The platform's robust analytical capabilities and user-friendly design make it an invaluable asset for ensuring originality and legality of new music. As TuneScape evolves, it will continue to support the creative community, fostering a secure and innovative environment for music production.

“The only way to discover the limits of the possible is to go beyond them into the impossible”

- **Arthur C. Clarke**