




# When Content Speaks Volumes: Podcastfy — An Open Source Python Package Bridging Multimodal Data and Conversational Audio with GenAI

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## Abstract

Podcastfy is an open-source Python framework that programmatically transforms multisourced, multimodal content into multilingual, natural-sounding audio conversations using generative AI. By converting various types of digital content - including images, websites, YouTube videos, and PDFs - into conversational audio formats, Podcastfy enhances accessibility, engagement, and usability for a wide range of users. As an open-source project, Podcastfy benefits from continuous community-driven improvements, enhancing its adaptability to evolving user requirements and accessibility standards.

## Statement of Need

The rapid expansion of digital content across various formats has intensified the need for tools capable of converting diverse information into accessible and digestible forms ([Chen & Wu, 2023](#); [Johnson & Smith, 2023](#); [McCune & Brown, 2023](#)). Existing solutions often fall short due to their proprietary nature, limited multimodal support, or inadequate accessibility features ([Gupta & Lee, 2023](#); [Marcus & Zhang, 2019](#); [Peterson & Allen, 2023](#)).

Podcastfy addresses this gap with an open-source solution that supports multimodal input processing and generates natural-sounding, summarized conversational content. Leveraging advances in large language models (LLMs) and text-to-speech (TTS) synthesis, Podcastfy aims to benefit a diverse group of users — including content creators, educators, researchers, and accessibility advocates — by providing a customizable solution that transforms digital content into multilingual textual and auditory formats, enhancing accessibility and engagement.

## Features

- Generate conversational content from multiple sources and formats (images, websites, YouTube, and PDFs).
- Customize transcript and audio generation (e.g., style, language, structure, length).
- Create podcasts from pre-existing or edited transcripts.
- Leverage cloud-based and local LLMs for transcript generation (increased privacy and control).
- Integrate with advanced text-to-speech models (OpenAI, ElevenLabs, and Microsoft Edge).
- Provide multi-language support for global content creation and enhanced accessibility.
- Integrate seamlessly with CLI and Python packages for automated workflows.

See [audio samples](#).

## Use Cases

Podcastfy is designed to serve a wide range of applications, including:

- **Content Creators** can use Podcastfy to convert blog posts, articles, or multimedia content into podcast-style audio, enabling them to reach broader audiences. By transforming content into an audio format, creators can cater to users who prefer listening over reading.
- **Educators** can transform lecture notes, presentations, and visual materials into audio conversations, making educational content more accessible to students with different learning preferences. This is particularly beneficial for students with visual impairments or those who have difficulty processing written information.
- **Researchers** can convert research papers, visual data, and technical content into conversational audio. This makes it easier for a wider audience, including those with disabilities, to consume and understand complex scientific information. Researchers can also create audio summaries of their work to enhance accessibility.
- **Accessibility Advocates** can use Podcastfy to promote digital accessibility by providing a tool that converts multimodal content into auditory formats. This helps individuals with visual impairments, dyslexia, or other disabilities that make it challenging to consume written or visual content.

## Implementation and Architecture

Podcastfy implements a modular architecture designed for flexibility and extensibility through five main components, as shown in Figure 1.

### 1. Client Interface

- Provides both CLI (Command-Line Interface) and API interfaces.
- Coordinates the workflow between processing layers.
- Implements a unified interface for podcast generation through the `generate_podcast()` method.

### 2. Configuration Management

- Offers extensive customization options through a dedicated module.
- Manages system settings and user preferences, such as podcast name, language, style, and structure.
- Controls the behavior of all processing layers.

### 3. Content Extraction Layer

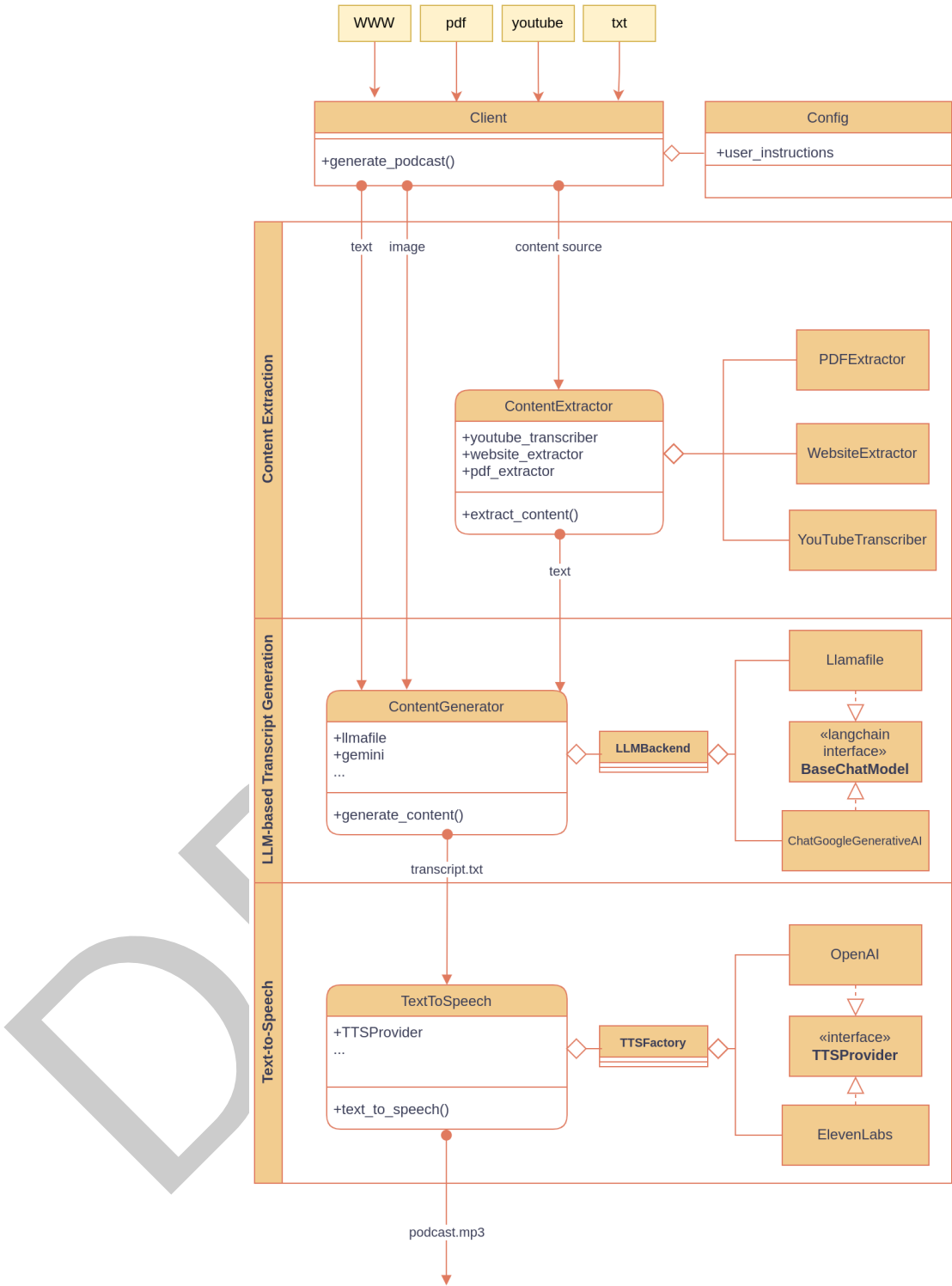
- Extracts content from various sources, including websites, PDFs, and YouTube videos.
- The `ContentExtractor` class coordinates three specialized extractors:
  - `PDFExtractor`: Handles PDF document processing.
  - `WebsiteExtractor`: Manages website content extraction.
  - `YouTubeTranscriber`: Processes YouTube video content.
- Serves as the entry point for all input types, providing standardized text output to the transcript generator.

### 4. LLM-based Transcript Generation Layer

- Uses large language models to generate natural-sounding conversations from extracted content.
- The `ContentGenerator` class manages conversation generation using different LLM backends:
  - Integrates with `LangChain` to implement prompt management and common LLM access through the `BaseChatModel` interface.
  - Supports both local (`LlamaFile`) and cloud-based models.

- 87                   – Uses ChatGoogleGenerativeAI for cloud-based LLM services.
- 88           ▪ Allows customization of conversation style, roles, and dialogue structure.
- 89           ▪ Outputs structured conversations in text format.
- 90   5. **Text-to-Speech (TTS) Layer**
- 91           ▪ Converts input transcripts into audio using various TTS models.
- 92           ▪ The TextToSpeech class implements a factory pattern:
- 93               – The TTSFactory creates appropriate providers based on configuration.
- 94               – Supports multiple backends (OpenAI, ElevenLabs, and Microsoft Edge) through
- 95               the TTSPProvider interface.
- 96           ▪ Produces the final podcast audio output.

DRAFT



**Figure 1:** Podcastfy’s simplified architecture and workflow diagram showing the main components and their interactions.

97 The modular architecture enables independent development and maintenance of each compo-  
98 nent. This pipeline design ensures a clean separation of concerns while maintaining seamless  
99 data transformation between stages. This modular approach also facilitates easy updates and

100 extensions to individual components without affecting the rest of the system.

101 The framework is offered as a Python package, with a command-line interface as well as a

102 REST API, making it accessible to users with different technical backgrounds and requirements.

## 103 Quick Start

### 104 Prerequisites

- 105     ▪ Python 3.11 or higher
- 106     ▪ `$ pip install ffmpeg` (for audio processing)

### 107 Setup

- 108     1. Install from PyPI `$ pip install podcastfy`
- 109     2. Set up [API keys](#)

### 110 Python

```
from podcastfy.client import generate_podcast

audio_file = generate_podcast(urls=["<url1>", "<url2>"])
```

### 111 CLI

```
python -m podcastfy.client --url <url1> --url <url2>
```

## 113 Customization Examples

114 Podcastfy offers various customization options that make it versatile for different types of

115 content transformation. To accomplish that, we leverage LangChain's ([LangChain, 2024](#))

116 prompt management capabilities to dynamically construct prompts for the LLM, adjusting

117 conversation characteristics such as style, roles, and dialogue structure. Below are some

118 examples that demonstrate its capabilities.

### 119 Academic Debate

120 The following Python code demonstrates how to configure Podcastfy for an academic debate:

```
from podcastfy import generate_podcast

debate_config = {
    "conversation_style": ["formal", "debate"],
    "roles_person1": "main presenter",
    "roles_person2": "opposing viewpoint",
    "dialogue_structure": ["Introduction", "Argument Presentation", "Counterarguments"],
}

generate_podcast(
    urls=["PATH/T0/academic-article.pdf"],
    conversation_config=debate_config
)
```

121 In this example, the roles are set to “main presenter” and “opposing viewpoint” to simulate an

122 academic debate between two speakers on a chosen topic. This approach is especially useful

for educational content that aims to present multiple perspectives on a topic. The output is structured with clear sections such as introduction, argument presentation, counterarguments, and conclusion, allowing listeners to follow complex ideas easily.

## Technical Tutorial

In this example, the configuration is optimized for creating technical tutorial content.

```
tutorial_config = {
    "word_count": 2500,
    "conversation_style": ["instructional", "step-by-step"],
    "roles_person1": "expert developer",
    "roles_person2": "learning developer",
    "dialogue_structure": [
        "Concept Introduction",
        "Technical Background",
        "Implementation Steps",
        "Common Pitfalls",
        "Best Practices"
    ],
    "engagement_techniques": [
        "code examples",
        "real-world applications",
        "troubleshooting tips"
    ],
    "creativity": 0.4
}

generate_podcast(
    urls=["https://tech-blog.com/tutorial"],
    conversation_config=tutorial_config
)
```

The roles are set to “expert developer” and “learning developer” to create a natural teaching dynamic. The dialogue structure follows a logical progression from concept introduction through implementation and best practices. The engagement\_techniques parameter ensures the content remains practical and applicable by incorporating code examples, real-world applications, and troubleshooting guidance. A moderate creativity setting (0.4) maintains technical accuracy while allowing for engaging explanations and examples.

## Storytelling Adventure

The following Python code demonstrates how to generate a storytelling podcast:

```
from podcastfy import generate_podcast

story_config = {
    "conversation_style": ["adventurous", "narrative"],
    "creativity": 1.0,
    "roles_person1": "narrator",
    "roles_person2": "character",
    "dialogue_structure": ["Introduction", "Adventure Begins", "Challenges", "Resolution"]
}

generate_podcast(
    urls=["SAMPLE/WWW.URL.COM"],
```

```
        conversation_config=story_config
    )
```

136 In this example, Podcastfy creates an engaging story by assigning roles like “narrator” and  
137 “character” and adjusting the creativity parameter for richer descriptions. Using this con-  
138 figuration, Podcastfy can generate engaging narrative content. By adjusting the creativity  
139 parameter, Podcastfy can create a story involving multiple characters, unexpected plot twists,  
140 and rich descriptions.

## 141 Additional Examples

### 142 Daily News Briefing

```
news_config = {
    "word_count": 1500,
    "conversation_style": ["concise", "informative"],
    "podcast_name": "Morning Briefing",
    "dialogue_structure": [
        "Headlines",
        "Key Stories",
        "Market Update",
        "Weather"
    ],
    "roles_person1": "news anchor",
    "roles_person2": "field reporter",
    "creativity": 0.3
}

generate_podcast(
    urls=[
        "https://news-source.com/headlines",
        "https://market-updates.com/today"
    ],
    conversation_config=news_config
)
```

### 143 Language Learning Content

```
language_config = {
    "output_language": "Spanish",
    "word_count": 1000,
    "conversation_style": ["educational", "casual"],
    "engagement_techniques": [
        "vocabulary explanations",
        "cultural context",
        "pronunciation tips"
    ],
    "roles_person1": "language teacher",
    "roles_person2": "curious student",
    "creativity": 0.6
}

generate_podcast(
    urls=["https://spanish-content.com/article"],
    conversation_config=language_config
)
```

## 144 Working with Podcastfy Modules

145 Podcastfy's components are designed to work independently, allowing flexibility in updating or extending each module. The data flows from the ContentExtractor module to  
146 ContentGenerator and finally to the TextToSpeech converter, ensuring a seamless transformation of multimodal content into audio. In this section, we provide some examples of how  
147 to use each module.  
148  
149

## 150 Content Extraction

151 Podcastfy's content\_extractor.py module allows users to extract content from a given URL, which can be processed further to generate a podcast. Below is an example of how to use the  
152 content extraction component:  
153

```
from podcastfy.content_extractor import ContentExtractor

# Initialize the content extractor
extractor = ContentExtractor()

# Extract content from a URL
url = "https://example.com/article"
extracted_content = extractor.extract_content(url)

print("Extracted Content:")
print(extracted_content)
```

154 This example demonstrates how to extract text from a given URL. The extracted content is  
155 then passed to the next stages of processing.

## 156 Content Generation

157 The content\_generator.py module is responsible for generating conversational content based on textual input. Below is an example of how to use the content generation component:  
158

```
from podcastfy.content_generator import ContentGenerator

# Initialize the content generator
generator = ContentGenerator(api_key="<GEMINI_API_KEY>")

# Generate conversational content
input_text = "This is a sample input text about artificial intelligence."
generated_conversation = generator.generate_conversation(input_text)

print("Generated Conversation:")
print(generated_conversation)
```

159 Users can opt to run a cloud-based LLM (Gemini) or run a local (potentially Open Source)  
160 LLM model ([see local llm configuration](#)).

## 161 Text-to-Speech Conversion

162 The text\_to\_speech.py module allows the generated transcript to be converted into audio. Below is an example of how to use the text-to-speech component:  
163

```
from podcastfy.text_to_speech import TextToSpeech

# Initialize the text-to-speech converter
tts = TextToSpeech(model='elevenlabs', api_key="<ELEVENLABS_API_KEY>")
```



```
# Convert the generated conversation to speech
input_text = "<Person1>This is a sample conversation generated by Podcastfy.</Person1><P
output_audio_file = "output_podcast.mp3"
tts.convert_to_speech(input_text, output_audio_file)

print(f"Audio saved to {output_audio_file}")
```

164 This example demonstrates how to use the TextToSpeech class to convert generated text into  
165 an audio file. Users can specify different models for TTS, such as elevenlabs, openai, or  
166 edge (free to use).

## 167 Limitations

168 Podcastfy has several limitations, including:

- 169     ▪ **Content Accuracy and Quality**
  - 170         – The accuracy of generated conversations depends heavily on the capabilities of the
  - 171         underlying LLMs.
  - 172         – Complex technical or domain-specific content may not always be accurately inter-
  - 173         preted or summarized.
  - 174         – The framework cannot guarantee the factual correctness of generated content,
  - 175         requiring human verification for critical applications.
- 176     ▪ **Language Support Constraints**
  - 177         – While multilingual support is available, performance may vary significantly across
  - 178         different languages.
  - 179         – Less common languages may have limited TTS voice options and lower-quality
  - 180         speech synthesis.
  - 181         – Nuanced cultural contexts and idioms may not translate effectively across languages.
- 182     ▪ **Technical Dependencies**
  - 183         – Reliance on third-party APIs (OpenAI, ElevenLabs, Google) introduces potential
  - 184         service availability risks.
  - 185         – Local LLM options, while providing independence, require significant computational
  - 186         resources.
  - 187         – Network connectivity is required for cloud-based services, limiting offline usage.
- 188     ▪ **Content Extraction Challenges**
  - 189         – Complex webpage layouts or dynamic content may not be accurately extracted.
  - 190         – PDF extraction quality depends on document formatting and structure.
  - 191         – YouTube video processing depends on the availability of transcripts.
- 192     ▪ **Accessibility Considerations**
  - 193         – Generated audio may not fully meet all accessibility standards.
  - 194         – Limited support for real-time content processing.
  - 195         – May require additional processing for users with specific accessibility needs.

196 These limitations highlight areas for future development and improvement of the framework.  
197 Users should carefully consider these constraints when implementing Podcastfy for their  
198 specific use cases and requirements.

## 199 Limitations

200 Podcastfy faces several key limitations in its current implementation. The accuracy and  
201 quality of generated content heavily depends on the underlying LLMs, with complex technical  
202 content potentially being misinterpreted. Additionally, while multilingual support is available,  
203 performance varies across languages, with less common languages having limited TTS voice

options. The framework also relies on third-party APIs which introduces service availability risks, and local LLM options require significant computational resources.

These limitations highlight areas for future development and improvement of the framework. Users should carefully consider these constraints when implementing Podcastfy for their specific use cases and requirements.

## Conclusion

Podcastfy contributes to multimodal content accessibility by enabling the programmatic transformation of digital content into conversational audio. The framework addresses accessibility needs through automated content summarization and natural-sounding speech synthesis. Its modular design and configurable options allow for flexible content processing and audio generation workflows that can be adapted for different use cases and requirements.

We invite contributions from the community to further enhance the capabilities of Podcastfy. Whether it's by adding support for new input modalities, improving the quality of conversation generation, or optimizing the TTS synthesis, we welcome collaboration to make Podcastfy more powerful and versatile.

## Acknowledgements

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## References

- Chen, R., & Wu, Y. (2023). Digital accessibility tools for multimodal content processing: A systematic review. *Digital Transformation Review*, 5(3), 91–109.
- Gupta, S., & Lee, A. (2023). Advances in adaptive user interfaces for enhanced accessibility. *Journal of Accessibility and User Experience*, 14(3), 203–215.
- Johnson, L., & Smith, K. (2023). Adaptive user interfaces for accessibility across digital content modalities. *Journal of Multimodal Accessibility*, 17(2), 43–58. <https://link.springer.com/article/10.1007/s12193-023-00427-4>
- LangChain. (2024). *LangChain: Building applications with LLMs through composability*. <https://www.langchain.com/>
- Marcus, A., & Zhang, T. (2019). Design for multimodal human-computer interaction. In *Lecture notes in computer science* (Vol. 1157, pp. 160–176). [https://link.springer.com/chapter/10.1007/978-3-319-52162-6\\_18](https://link.springer.com/chapter/10.1007/978-3-319-52162-6_18)
- McCune, B., & Brown, L. (2023). Accessibility of digital information: Standards, frameworks, and tools related to information literacy and information technology. *Journal of Information Literacy and Accessibility*, 9(4), 112–129.
- Peterson, L., & Allen, J. (2023). Web accessibility and multimodal digital engagement. *Technology Accessibility Journal*, 12(1), 23–34.