Sample solution for the tutorial: Spectral display with Sonic Visualiser

https://analyse.hfm-weimar.de/doku.php?id=en:tutorium_spektral

Aphex Twin: *Bucephalus Bouncing Ball* (selection)

How does the accuracy of the spectrum change with different window sizes? Pay particular attention to the low frequency range.

The smaller the window size, the more diffuse the low frequency range is displayed; in an extreme case only a long straight line can be seen (e.g., with a window size of 512 samples only up to just below 100 Hz). If the window size is larger, there are increasingly jagged lines in the low frequency range, which allow a differentiated assessment of the frequency components there.

Now move the transport window (under the waveform) with the cursor to the right or left. How does the displayed spectrum change?

Depending on how fast the transport window is moved, the line of the spectrum "jitters" to different degrees. If it is shifted very slowly, sometimes certain mountains or peaks appear that seem to be fixed for a while (e.g. second 15.0 to 15.4). This is an indication for frequency components (fundamental and harmonics) that sound unchanged for some time.

At certain times the whole curve lifts completely, the peaks blur. These are the regularly sounding percussive impulses. From about 0:28 on, these peaks become rarer overall - as the sounds are now very percussive.

How can the start of the track be characterized in terms of rhythm? What happens from 0:28 on?

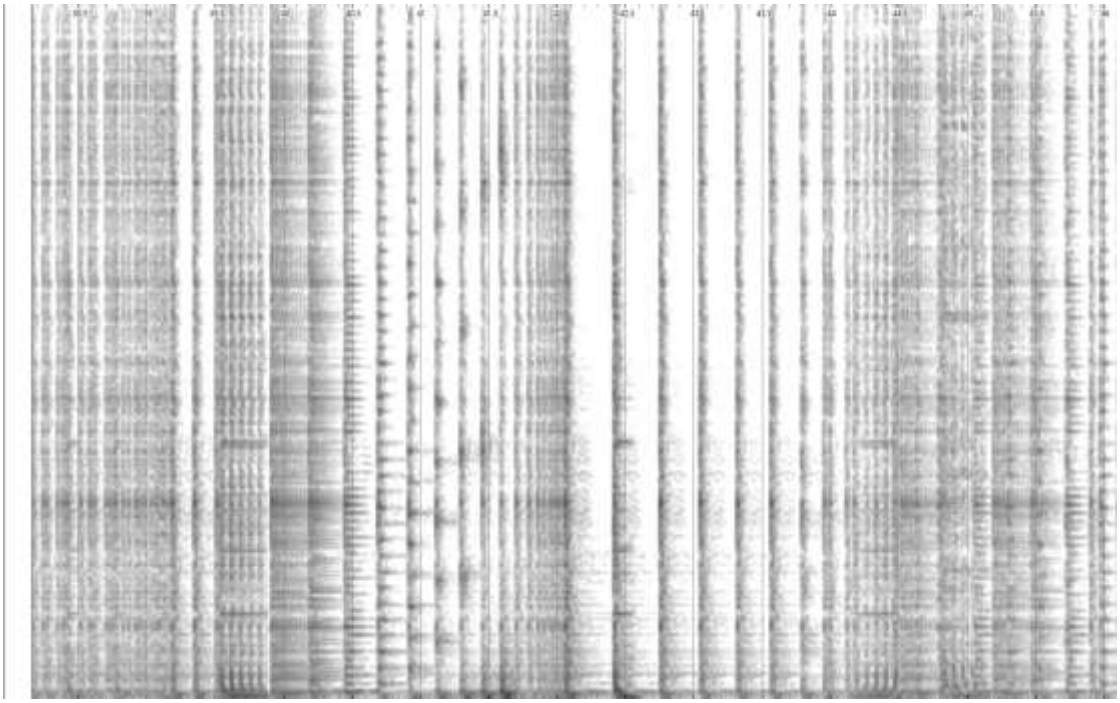
After a quiet introduction with only a few percussive impulses, a complex rhythmic structure begins at 0:23. From 0:28 on, chains of impulses sound, with increasingly shorter intervals in between, which creates the impression of an acceleration.

Look for tones in the spectrogram! Where do you find horizontal lines? How do the corresponding passages sound?

Horizontal lines can be found in the first part until 0:28. They refer to the synthesizer sounds heard in this section. In the percussive passage that follows, similar longer horizontal lines are absent.

Listen to the short passage 0:40-42. Here the sound of a percussive sound changes very quickly. What can be learned about the sound character from the spectrogram?

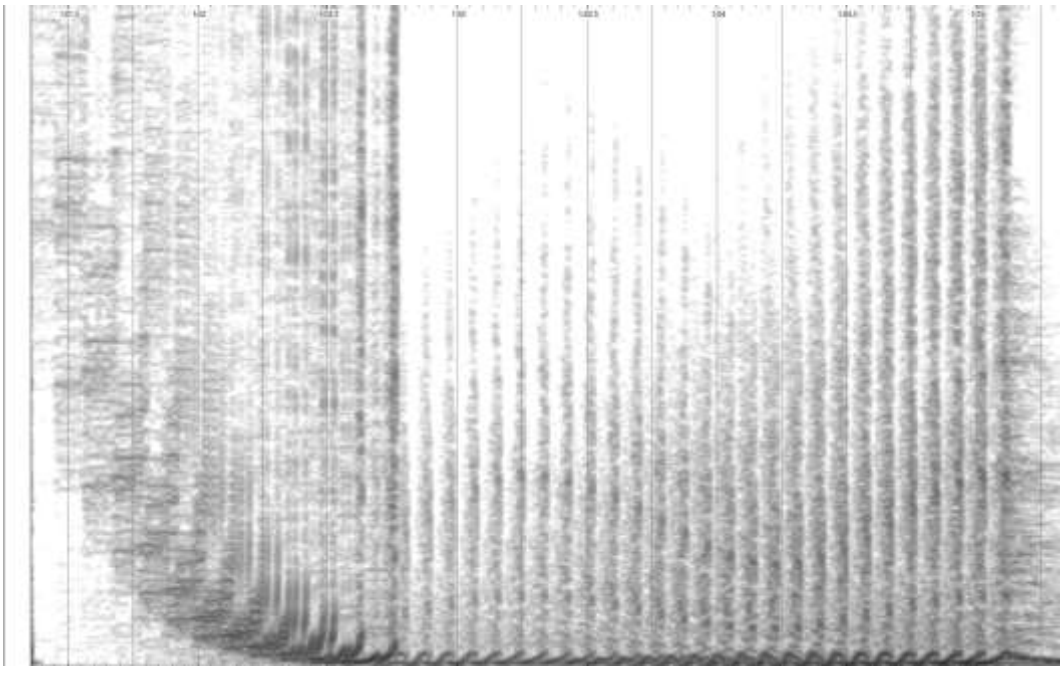
In this passage, each individual sound event sounds different, and certain pitches can be discerned despite the percussive character of the sounds. Short parallel lines are recognizable in the spectrogram, the position and number of lines change from sound to sound (similar from 0:45).



Spectrogram 0:38 - 0:46, 10 Hz to 10 kHz, window size 4096 samples

Now consider the passage 1:01-05. What can be concluded from the visual representation about the tonal character of the passage?

The sound impression is difficult to describe: At first, a sound glides with descending pitch that is "rippled" or "staggered". Afterwards, short impulses can be heard whose sound changes fluidly in the frequency spectrum - the strength of the gray coloration in the middle frequency range changes accordingly.



Spectrogram 1:01 - 1:05, 10 Hz to 10 kHz, window size 4096 samples

Sample solution for the tutorial: Spectral representation of vocal recordings

https://analyse.hfm-weimar.de/doku.php?id=en:tutorium_singing

Ray Charles: *Come Back, Baby*

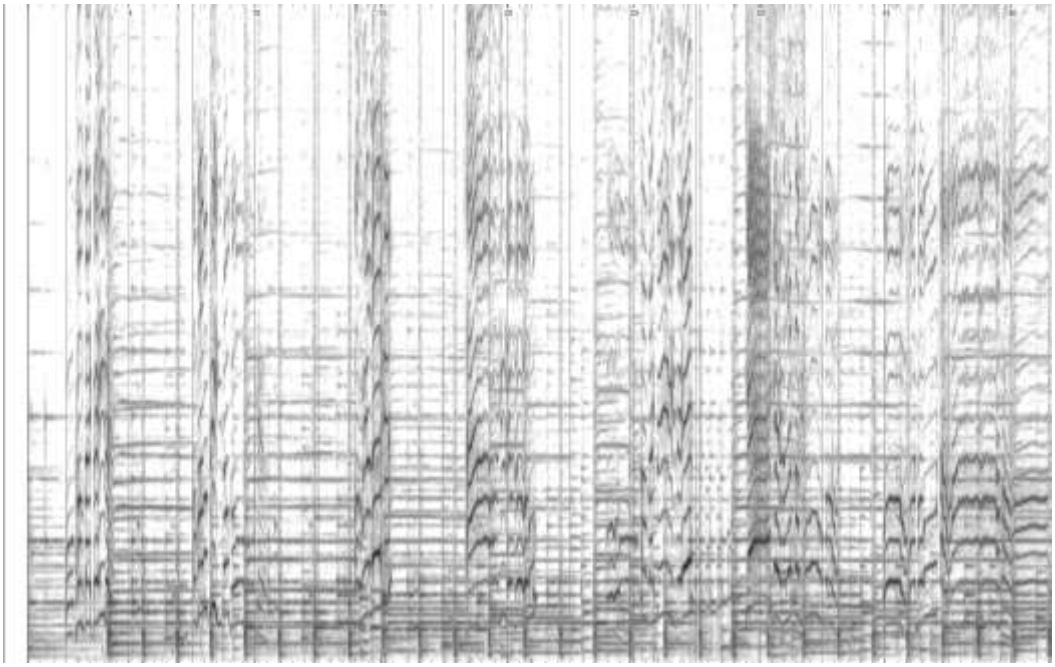
What stands out when you look at the vocal line?
How do the wind chords in the background compare?
In the recording, look for passages with
- a strong glide of the voice
- vibrato
- various ornamentations

Within the spectrogram passages with vocals can be clearly distinguished from those without: The vocals are visualized as curved, parallel, mostly diagonal or only approximately horizontal lines (fundamental and harmonics), while in the passages without vocals only parallel, strictly horizontal lines of the winds / brass as well as percussion impulses (vertical lines) are visible. In addition, more frequency components in the higher range (incl. gray "clouds") are visible in the vocal passages - these are completely absent in the much quieter brass and wind chords.

A strong glide of the vocal part can be detected in almost all vocal phrases; often phrases begin with a strong upward glide.

A fast, irregular vibrato is evident, for example, from 0:38; a short vibrato at about 0:19 and 0:24.5; later in the piece, for example, from 0:43 and 0:54.

Individual syllables are sung with rapid melodic ornaments that are recognizable as curved lines; for example, at 0:20 ("you never kno-o-ow") or immediately afterward from 0:24 ("o-o-oh come back ba-a-by-y")



Spectrogram up to 0:40, 10 Hz to 5 kHz, window size 4096 samples

Please enlarge the lower range of the spectrogram 0 - approx. 4000 Hz. Can you recognize the different formant ranges F1 and F2 in (loudly) sung vowels?

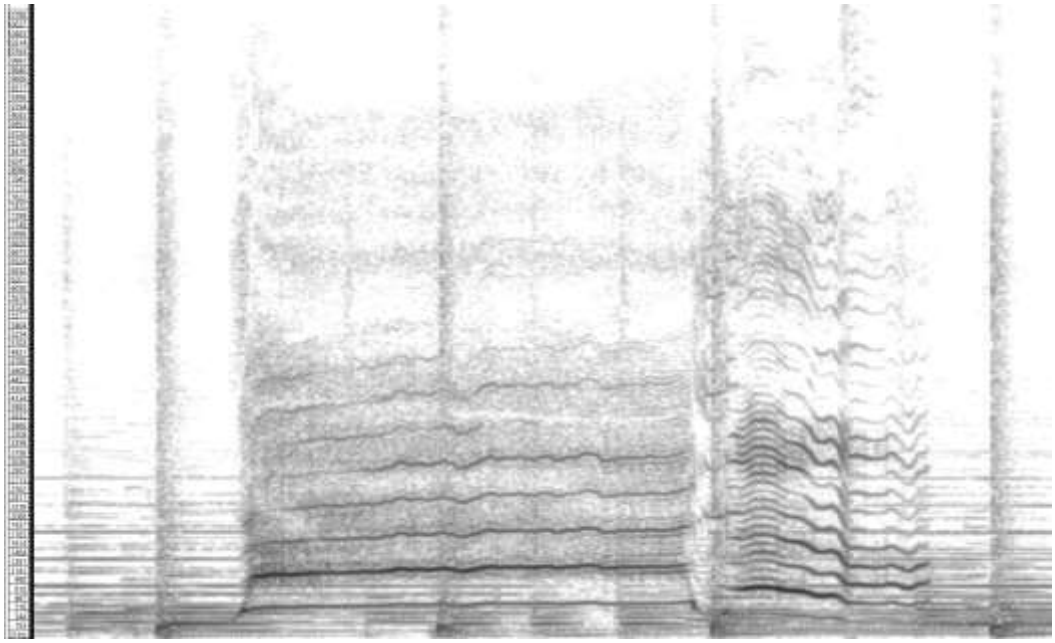
Since Charles sings very dynamically, it is difficult to detect major differences in the two formant ranges of the various vowels. On the other hand, higher formant ranges, e.g. between 3000 and approx. 3800 Hz, can be recognized very well, which are particularly prominent in the vocal passages and which provide a certain "brilliance" of Ray Charles' voice.

Where are sibilants clearly visible in the spectral representation of the recording?

Sibilants are relatively rare in the lyrics and therefore can only be detected in a few places in the spectrogram. Examples: At 1:18, the "ts" of "Let's talk it over" can be seen as a cloud in the 6-9 kHz range (likewise at 2:04, same lyric); at 1:32, the "s" of "say ..." can be seen in the 3-8 kHz range.

Take a closer look at the passage 1:42 - 1:46. What can be seen here?

From 1:42 on, the very noisy call ("yeah" in falsetto, visible as horizontal lines) is overlaid by a gray cloud (especially up to 5 kHz): a large share of roughness / noisiness covers the call. Afterwards (1:45) there are two additional lines between the partials of the second "ye-ah" call for a short time: the vocal tone is enriched here by so-called subharmonics and therefore sounds rough. These are two physiologically different ways of causing roughness in the singing.



Spectrogram 1:41 to 1:47, 20 Hz up to 1100 Hz, window size: 2048 Samples

What is the relationship between the rhythm of the vocals and the backing band?

The rhythmic playing of the accompanying band is very regular and exact. This can be seen above all in the regular basic beat of the drums (vertical lines), and in part also in its triplet subdivisions. But also the changes of the wind chords (parallel horizontal lines) and even the fills of the piano (e.g. at 0:28) very precisely and regularly placed.

In contrast, Charles breaks away from the metrical grid in many phrases, which supports the speech-like and expressive character of his singing. He places many vocal notes before or behind the beat, but on the other he also places some notes very precisely on the beat. His singing is therefore very variable in rhythmic terms.