Call Spectrograms

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This document will present in detail the steps required to obtain echolocation call spectrograms from the waveforms of echolocation call recordings.

Install Packages

The following packages are required. They will be included as dependencies in the `batwork` package.

```
library(batwork)
library(tidyverse)
library(signal)
```

Call Data

Explicitly call the data from the `batwork` package.

```
df <- mexican_bat_calls
```

Spectrogram Function

A function which will return the spectrogram (log short time power spectral density) of the echolocation call is required. Further details on short time Fourier transform and power spectral density

```
x <- df$calls[[1]]

get_spectrogram_details <- function(x, n = 256, Fs = 500000,
  window = hanning(n),
  overlap = ceiling(7*length(window)/8),
  detail = 'list'){
   possible_details <- c('list', 'spec', 'time', 'freq')

  if(detail %in% possible_details %>% not){
     stop("User must specify output required, either 'spec', 'time', 'freq', or 'list'.")
   }

   y <- signal::specgram(x, n = n, Fs = Fs, window = window, overlap = overlap)

   if(detail == 'list') return(y)
   if(detail == 'time') return(y$t)
   if(detail == 'freq') return(y$f)
   if(detail == 'spec') {
     return(y$S %>% t)
   }
}
```

```
y <- get_spectrogram_details(x, detail = 'spec')

get_psd <- function(x, n = 256, Fs = 500000,
  window = hanning(n),
  overlap = ceiling(7*length(window)/8)){

  y <- get_spectrogram_details(x, n = n, Fs = Fs,
    window = window, overlap = overlap, detail = 'spec') %>%
    abs %>% raise_to_power(2)

  return(y)
}

y <- get_psd(x)
```

Apply to Data Frame

Given a function which provides the required output, this function can be applied over the calls in the dataframe.

```
df <- df %>%
  mutate(time = map(calls, get_spectrogram_details, detail = 'time'),
    psd = map(calls, get_psd))
```

Apply from package

Now that the set of functions to get the call spectrograms are up and running they can be written to the `batwork` package and called from there.

```
library(batwork)

df <- mexican_bat_calls
df <- df %>%
  mutate(time = map(calls, get_spectrogram_details,    detail = 'time'),
    psd = map(calls, get_psd))
```

This all seems to work and so can be included in the project overview.