RSA SYNCHRONY
MODELLING SYNCHRONISED BREATHING

Idea

Respiratory sinus arrhythmia (RSA) as a natural variation in the heart rate that occurs while breathing in and out. RSA synchrony can therefore be introduced by synchronous breathing. To model a case of RSA synchrony between an adult and a child based on this, two steady IBI sequences based on different heart rates are modified by a simplified breathing pattern that is the same for both sequences.

Algorithm

- create two steady IBI sequences for a heart rate of 100 BPM (600ms interval) for the child and 70 BPM (857ms interval) for the adult

- model a simplified breathing pattern as a sum of two sine waves
  - `wave0`: the base pattern of 20 breaths per minute (0.33hz)
  - `wave1`: the change pattern, slowly accelerating and decelerating the base pattern (1 period per minute; 0.0166hz)
  - combine the waves to obtain a signal that is used to speed up or slow down the IBI sequences: `breath = wave0 + wave1 + 1`

- use interpolation to create a continuous IBI function so that it is possible to introduce the changes through breath:

```
([(t, ibi), …]; samples at 5hz)
ibi_adult_intpl = [(0ms, 857ms), (200ms, 857ms), …]
ibi_child_intpl = [(0ms, 600ms), (200ms, 600ms), …]
```

- apply the change in IBIs through breathing:

```
([(t, ibi), …]; samples at 5hz)
ibi_adult_mod = [
    (0ms, 857ms ∗ breath(0ms)),
    (200ms, 857ms ∗ breath(200ms)),
…]
ibi_child_mod = [
    (0ms, 600ms ∗ breath(0ms)),
    (200ms, 600ms ∗ breath(200ms)),
…]
```

- now turn the continuous IBI functions into a discrete IBI sequence (in which every next IBI occurs after the previous one is over)

```
ibi_adult = [
    (0ms, ibi_adult_mod(0ms)),
    (ibi_adult_mod(0ms), ibi_adult_mod(ibi_adult_mod(0ms)),
…]
ibi_child = [
    (0ms, ibi_child_mod(0ms)),
    (ibi_child_mod(0ms), ibi_child_mod(ibi_child_mod(0ms)),
…]
```

- these IBI sequences now include RSA synchrony through breathing synchrony