Homework - Topic 6:

Analysis of HRV in Frequency Domain

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Data Preprocessing

- The raw BBI data was preprocessed using Grubbs' Test and median filtering.
- Missing data was handled using linear interpolation and bootstrap resampling.
- The smoothed BBI data was converted to RRI format and used for frequency domain analysis.

HRV Frequency Domain Analysis

Parameters and Results

The following frequency domain parameters were calculated based on the processed RRI data:

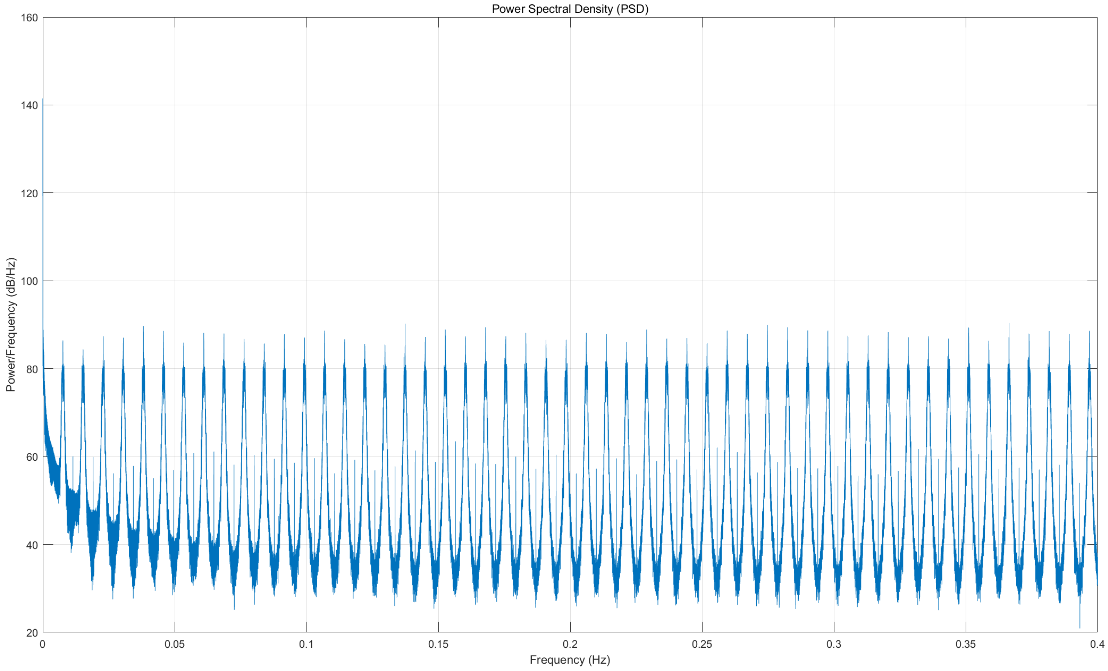
Parameter	Value
Total Power	1098099207.82 ms^2
VLF Power (0.003-0.04 Hz)	394052.09 ms^2
LF Power (0.04-0.15 Hz)	1158361.66 ms^2
HF Power (0.15-0.4 Hz)	2757832.19 ms^2
LF Norm (%)	0.11%
HF Norm (%)	0.25%
LF/HF Ratio	0.42

Key Observations

1. **Total Power**:
    - The total power (TP) is extremely high, which may indicate an unusually high variability in the dataset.
2. **LF and HF Power**:
    - Both LF and HF power values are relatively low compared to the total power, resulting in low normalized values.
3. **LF/HF Ratio**:
    - The LF/HF ratio is 0.42, indicating a dominance of high-frequency components in the dataset.

Power Spectral Density (PSD) Visualization

The PSD of the RRI data was estimated using Welch's method. The following figure shows the PSD distribution within the frequency range of 0-0.4 Hz.



Conclusion

- The frequency domain analysis revealed a dominance of high-frequency (HF) components in the dataset, as indicated by the low LF/HF ratio.
- The low normalized LF and HF power values suggest limited variability in the lower frequency bands.
- These results indicate a potential issue with the input data's scale or sampling rate, which may require further validation or correction.

Appendices: MATLAB Code

```
% Homework: HRV Frequency Domain Analysis

% ------------------------
% Step 1: Load Preprocessed Data
% ------------------------
[data_file, data_path] = uigetfile('*.txt', 'Select a preprocessed data file'); % Open file dialog
data = load([data_path, data_file]); % Load data
RRI = data(:); % Reshape into a single column

% ------------------------
% Step 2: Calculate PSD using Welch Method
% ------------------------
fs = 4; % Sampling frequency (Hz), adjust based on dataset
[pxx, f] = pwelch(RRI, [], [], [], fs); % Welch PSD estimation

% ------------------------
% Step 3: Extract Frequency Domain Parameters
% ------------------------
% Frequency bands (Hz)
```

```
VLF_range = [0.003, 0.04];
LF_range = [0.04, 0.15];
HF_range = [0.15, 0.4];

% Total Power (0-0.4 Hz)
total_power = bandpower(RRI, fs, [0, 0.4]);

% VLF Power (0.003-0.04 Hz)
VLF_power = bandpower(RRI, fs, VLF_range);

% LF Power (0.04-0.15 Hz)
LF_power = bandpower(RRI, fs, LF_range);

% HF Power (0.15-0.4 Hz)
HF_power = bandpower(RRI, fs, HF_range);

% Normalized LF and HF Power
LF_norm = LF_power / (total_power - VLF_power) * 100;
HF_norm = HF_power / (total_power - VLF_power) * 100;

% LF/HF Ratio
LF_HF_ratio = LF_power / HF_power;

% -----------------------
% Step 4: Display Results
% -----------------------
fprintf('HRV Frequency Domain Parameters:\\n');
fprintf('Total Power: %.2f ms^2\\n', total_power);
fprintf('VLF Power: %.2f ms^2\\n', VLF_power);
fprintf('LF Power: %.2f ms^2\\n', LF_power);
fprintf('HF Power: %.2f ms^2\\n', HF_power);
fprintf('LF Norm: %.2f %%\\n', LF_norm);
fprintf('HF Norm: %.2f %%\\n', HF_norm);
fprintf('LF/HF Ratio: %.2f\\n', LF_HF_ratio);

% -----------------------
% Step 5: Visualize PSD
% -----------------------
figure;
plot(f, 10*log10(pxx)); % Plot PSD in dB scale
title('Power Spectral Density (PSD)');
xlabel('Frequency (Hz)');
ylabel('Power/Frequency (dB/Hz)');
grid on;
xlim([0, 0.4]);
```