Deep Pedal reveals the deep secrets of expressive piano playing through analysis and modelling of the pedalling gestures and techniques. Informed by piano acoustics and music theory, it deeply elaborates on the studies in the sensor and audio domains, applying signal processing and deep learning techniques to better event detection.

**Signal Processing Method:**
A method of measuring sympathetic resonance is developed using the weak co-excitation of damped notes in order to detect the legato-pedal onset.

- **A. Transcription for Specific Piano**
  - music piece
  - 88 isolated notes

- **B. Partial Estimation**
  - 88 isolated notes

- **C. Sympathetic Resonance Measure (SRM) Based on Residuals**
  - music piece
  - partial estimation
  - partial frequencies
  - residual

In every residual segment, it may contain:
- background noise
- the sound of hammer-string strikes from note attacks
- piano tones whose note events were not correctly transcribed
- effect of sympathetic resonance induced by legato pedalling

**Deep Learning Method:**
A novel method for piano sustain-pedal detection based on Convolutional Neural Networks (CNN).

- Effectively capture subtle acoustic characteristics
- Decision fusion is used for better performance
- Localise portions played with the sustain pedal

**Contributions:**
A. Datasets
Specifications with different pedalling conditions were recorded as MIDI files.

- **B. Piano Pedaller**
  - A dedicated measurement system enables synchronously recording the pedalling gestures and the piano sound.
  - Recognition based on the sensor data can return the onset and offset times of each pedalling technique, which can be visualised in an audio-based score following application.

- **C. Potential Applications**
  - Incorporate our pedal detection methods into a system for full transcription of piano music with the help of the state-of-the-art note event detection.
  - Increase the accuracy of related tasks, such as note offset detection and score following.
  - Help to investigate pianists’ individuality in the performance.
  - Facilitate mastering of the piano sound using our visualisation application in piano pedagogy.

**Main Publications:**