Motivation

- Crispy food textures = stimulating, fresh, pleasant & have highest impact on consumer preference and quality evaluation [1]
- Food industry and research requirements for quality control and development
- Crispiness evaluation = essential but causes persistent difficulties in practice, in particular for differentiating low-humidity crispness levels (10 to 20 % RH) [1]

Goals

- Optimizing crispy products = appropriately stiff and brittle during chewing & release pleasant rhythmic sounds of particular pitch and loudness avoiding use of sensory panels
- Improvement of available texture measurements and data analysis methods
- Freshness levels classification from instrumental data corresponding to sensory crispness grades, mimicking multisensory & temporal integration during oral breakdown

Multimodal texture characterization process

1. **Instrumental analysis**
   - Mechanical measurement
   - Acoustical recording
   - 1200 x 3418 mm/s
   - 23 % RH
   - Force magnitude
   - Time [s]
   - Compression test & sound recording at low and high velocities

2. **Sensory analysis**
   - Trained panel
   - Hedonic panel
   - Significant sound characteristics
   - Consumer preferences

3. **Data preprocessing**
   - Dynamic spectrograms & static spectra
   - Mechanical measurement
   - Acoustical recording

4. **Classification**
   - Feature extraction, Selection & Compression
   - STFT, CWT, HHT
   - ANOVA, Multcompare, PCA clustering, tree / SVM / kNN classifiers
   - Convolutional neural networks
   - Trained models

Conclusion

- Classification needs more than simple mechanical features
- Instrumental crushing sounds → perception of food freshness
- Dynamic spectral analysis → mathematical analytic description & display of whole complexity of foods’ signature
- Multimodal classification → multitude of modern methods & optimum not straightforward, but improved accuracy

Further Improvements

- Synchronized denoising & bone-conducted sounds using transfer function models of isolation box and human head

Fig. 1: Texture analysis set