

# Extract tactile qualities from time series data

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## Abstract

We proposed the Tactile Score to describe time-varying tactile sensation by the time variation of vertical force. Tactile quality is essential in hardness/softness, roughness, and temperature. Hardness and softness can be extracted from the shape of the Tactile Score. Roughness can be extracted from the pattern of hardness and softness. The arbitrary time series data can be interpreted as a tactile score by considering the time variation of the vertical force, and the hardness and softness are extracted from the time series data interpreted as the tactile score. This method can extract different features from conventional data science methods.

*Keywords:* Data Science, Time series data, Tactile of Data, Tactile Score

## 1. Introduction

Sensitivity differs from person to person. The same greeting of "Good morning" may be perceived as cheerful by some and noisy by others. There is no correct answer to sensitivity, nor can it be generalized.

We can generalize if we take the average of many people's sensitivities. Sensitivities that deviate from the average should not be ignored or directed toward sensitivities closer to the average.

A general sensitivity search system is a system in which evaluation criteria for content are modelled for each individual through instructional learning, and each user's evaluation criteria model is used for searching.

The following algorithms have been used in a sensory search; color histogram A method to extract features of images and videos; impression analysis using the SD

method A method to quantify the impression received from contents by assigning degrees to impression words, learning correspondence between impression words and contents, extracting correlation coefficients between contents, and Extracting correlation coefficients, the distance between contents Projecting the quantified impression words and features of contents onto the feature space and measuring the distance between them.

## 2. Tactile Score

Why do we feel "cheer" from the children's "Good morning"? What is the difference between them? The difference is "the way you say it. How we say it can be characterized by the pitch and volume of our voice, but let us look at the volume of our voice.

When we think back to the children's "Good Morning," their voices gradually became louder and louder. So, let us describe the change in "loudness" by using the music notation. In musical notation, the higher the note is, the lower the note is, and the higher the note is, the lower the note is. The middle line (the third line) is the "normal" volume, and the lower the volume, the higher the volume, and the higher the volume, the lower the volume. The "rhythm of speech" is represented by the notes as they are. We call this notation to describe tactile sense as the Tactile Score [1] (Fig. 1).

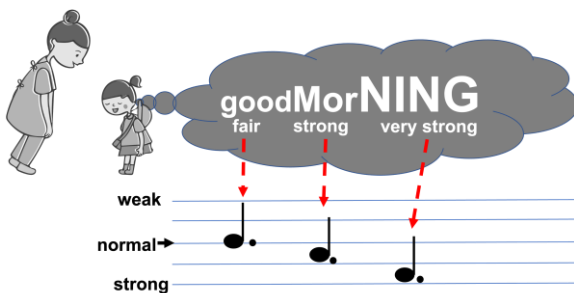


Fig. 1 Tactile Score

### 2.1. Tactile Quality

There are several essential factors in the sense of touch, the most crucial being "hardness" and the second most important being "roughness. These properties are called "tactile qualities. Is it possible to describe these tactile qualities in tactile notation?

Think of two kinds of "springs": a stiff spring and a soft spring. The softer spring will expand and contract more when these springs are pushed and pulled with the same force (difference in elastic force). Therefore, we call a tactile spring with a slight change in size "hard" and a tactile spring with a significant change in size "soft". If we consider this as a way of saying "good morning," "hard" is a way of saying "no intonation," and "soft" is a way of saying "full of intonation."

Now we can describe the most critical tactile quality, "hardness," in tactile notation. What remains is roughness. Roughness is described as "smooth" when there is little change in hardness and "rough" when there is a significant change in hardness (Fig. 2). If we are walking on the grass in a park and the hardness of the grass is constant, we will feel "smooth".

### 3. Extract tactile qualities from time series data

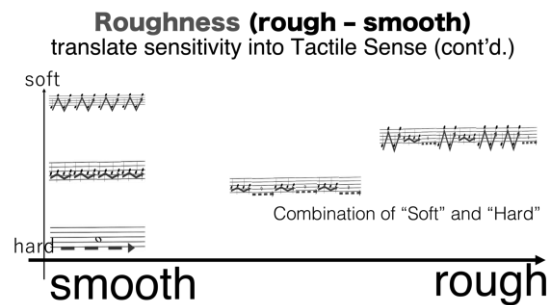


Fig. 2 Roughness, read from Tactile Score

When we press a key, the piano makes a sound as it is. It is impossible to adjust the sound later, as with a violin or trumpet. So, are all piano performances the same? Of course not. Even the same music can sound very different depending on the pianist. One crucial element that makes a difference in piano playing is the "sense of touch. It is often referred to as "the touch of the piano". The word "touch" includes the meaning of "tactile sensation". The sound of the piano, as this expression suggests, is the sound of the sense of touch.

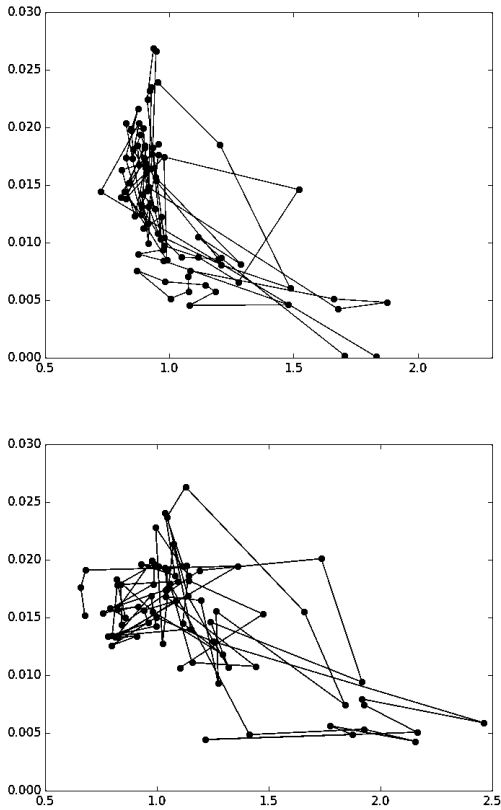
We examine the time series data of piano play and compare Arthur Rubinstein [1887 - 1982] and Stanislav Stanislavovich Bunin [1966-] playing Chopin's Polonaise in A-flat major, Op.53 with WAV format file.

We split the data by 0.1 seconds each and used the mean of the differences in the data as the hardness and the standard deviation of the differences in the data as the roughness.

### 4. Discussion and Conclusion

Rubinstein is one of the foremost authorities on Chopin. On the other hand, Bunin's style of playing is extremely unique and different from Rubinstein's (Fig. 3).

Fig.3. Tactile qualities of piano play, above) R. Stein, bottom) S. S. Bunin, where the vertical axis illustrates softness (the graph origin shows the hardest and far more upper shows softer and the horizontal axis illustrates roughness, the origin is the smoothest and far from origin means rougher.



Tactile quality analysis of sounds distinguished the differences in play style. In original music analysis, for example, the power spectrum of sounds cannot clearly show the difference (Fig. 4).

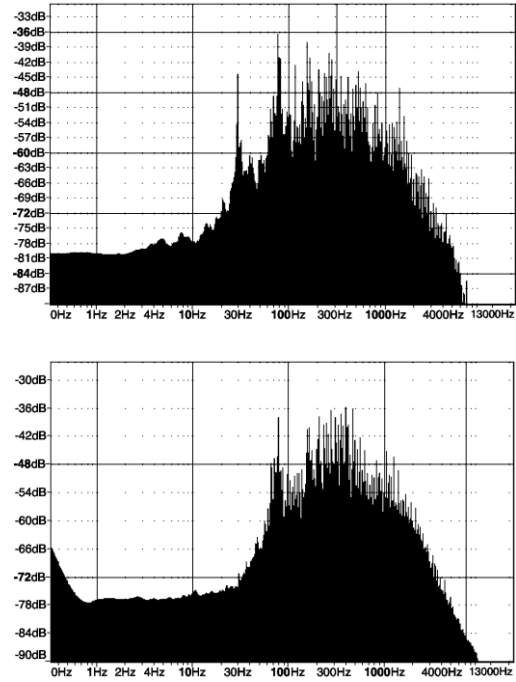


Fig.4. Spectrum distribution of piano play, above) R. Stein, bottom) S. S. Bunin, where the vertical axis illustrates frequency, and the horizontal axis illustrates power.

Wojciech Kocyan is a Polish pianist. He is most well known for his performances of Chopin, and for his 2001 album, which was named as one of the 50 best classical recordings ever made by Gramophone in 2007. He mentioned about the play style of Bunin.

*“there are laureates of the First Prize whose performance style does not fit easily into what would otherwise seem to be a quite clear picture of the stylistic preferences of Chopin Competition juries. They are the Russian pianists Stanislav Bunin (11th Competition, 1985) and Yulianna Avdeeva (16th Competition, 2010).”* (from [2] p32).

**References**

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