

## The Entropy of K-Pop songs

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### Abstract

We compared the entropy of K-Pop songs with the entropy of American Pop songs. The results show that K-Pop songs tend to have lower entropy in respect of chords, tones, and rhythms, but have higher entropy in phrase. This implies that the uncertainty of K-Pop song is lower than that of American Pop songs.

### Introduction

Korean popular music (K-Pop) has gained popularity in the world market in recent years. We tried to find the differences between K-Pop songs and American Pop songs in respect of informational theory. Shannon and Weaver systematized the information theory and defined the entropy as the quantity of information implicit in signals or events [1]. Let  $X$  be a discrete random variable  $\{x_1, x_2, \dots, x_n\}$ , then the entropy of  $X$ ,  $H(X)$  is defined as follows:

$$H(X) = -\sum_{i=1}^n p(x_i) \log_2 p(x_i)$$

where  $p(x_i)$  is the probability of  $X$  being  $x_i$ .

In informational theory, entropy implies the amount of information included in signals or events, which measure the uncertainty of a random variable. Pinkerton used the entropy to measure the uncertainty of tones of some children's songs [2] and Youngblood compared the entropy of tones in different genres of music [3]. The uncertainty of music comes not only from the distribution of tones, but also from the distribution of various factors such as chords, rhythms, phrase, and so on. In this research, we measured the entropy of 5 K-Pop songs and 5 American Pop songs based on the distribution of chords, phrase, tones, and rhythms.

### Methods and Results

Most of the popular K-Pop songs are dance music and are written in minor keys, so we selected only dance music written in minor keys among the most popular songs released from 2007 to 2013 for fair analysis. We first shift all songs to C minor and calculated the entropy based on chords per 2 beats, frequency of tones, phrase of chords per 16 beats, and patterns of rhythm per 4 beats. In practice, to determine the probability we use the sample probability with each song, for example, for the probability

of a C chord in a given song, we used the fraction of all chords per two beats of all chords in that song which are C chords per two beats. The title, singer and year released of each song and entropy based on each factor are shown in the table 1. A Similar approach can be found in [4], though the factors and coding scheme are different from ours.

	Title	Singer	Year	Chord (2beats)	Tone (frequency)	Phrase (16beats)	Rhythm (4beats)	Average
K-Pop	Tell Me	Wonder Girls	2007	1.33	2.19	2.25	3.63	2.35
K-Pop	Sorry Sorry	Super Junior	2009	2.95	2.66	0.21	3.23	2.26
K-Pop	I am the best	2NE1	2011	0.4	2.01	0.4	4.18	1.75
K-Pop	GangNam Style	Psy	2012	1.65	1.92	2.84	4.49	2.73
K-Pop	BBaBBaBBa	Crayon Pop	2013	2.74	2.63	3.28	4.19	3.21
Pop	Umbrella	Rihanna	2007	2.54	2.55	2.18	4.82	3.02
Pop	Sweet Dreams	Beyonce	2008	2.13	2.3	1	4.03	2.37
Pop	Poker Face	Lady GaGa	2009	2.14	2.5	1.18	3.48	2.33
Pop	TiK ToK	Ke\$ha	2010	1.93	1.7	2.48	4.13	2.56
Pop	Moves Like Jagger	Maroon 5	2011	1	3.11	1.61	4.01	2.43
Average of All				1.88	2.36	1.74	4.02	2.5
Average of K-Pop				1.81	2.28	1.80	3.94	2.46
Average of American Pop				1.95	2.43	1.69	4.09	2.54

**Table 1:** *The Entropy based on each factor*

## Conclusions

It turned out that by this method of analysis, in the songs we selected, K-Pop songs tend to have lower entropy. We expect that the higher the entropy, the more uncertainty and complexity is typically present. The results suggest that the uncertainty of K-Pop songs is lower than that of American Pop songs in respect of chords, tones, and rhythms, but not phrases. However this analysis of limited data does not show if these differences are statistically significant in general. Future work may explore these questions in more detail.

## References

- [1] Shannon, C. E., & Weaver, W. (1949). *The Mathematical Theory of Communication*. University of Illinois Press.
- [2] Pinkerton, R. C. (1956). Information theory and melody. *Scientific American*, 195(2), 77-86.
- [3] Youngblood, J. E. (1958). Style as information. *Journal of Music Theory*, 2(1), 24-35.4
- [4] Alexander, P. J. (1996). Entropy and popular culture: product diversity in the popular music recording industry. *American Sociological Review*, 61(1), 171-174.