

Does pop music exist?
Hierarchical structure
in phonographic
market.

by Andrzej Buda

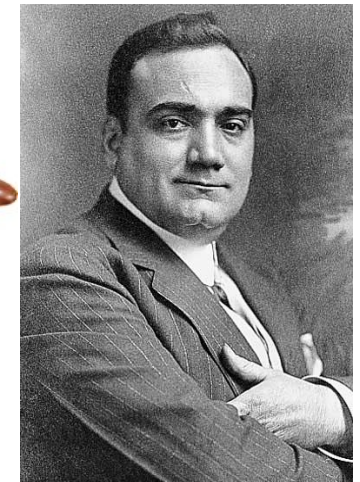
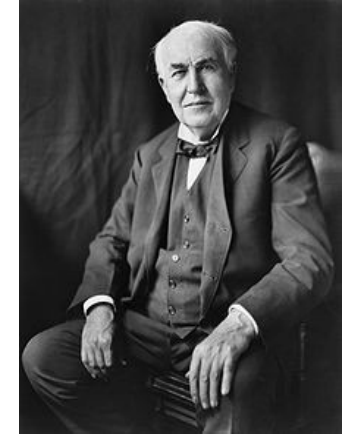


1. Introduction to phonographic market

1887 Thomas Edison (1847-1931)
The phonograph, record player, or gramophone is a device that was mostly commonly used from the late 1870s through the 1980s for playing sound recordings.

1904 Enrico Caruso (1873-1921)
was the first artist that sold over 1000000 records before The Beatles. He made approximately 290 commercial recordings of his voice, beginning as early as 1902 in Italy and continuing from 1904 until 1920 in the United States

1948 Columbia released the first ever long playing record



Library of Congress

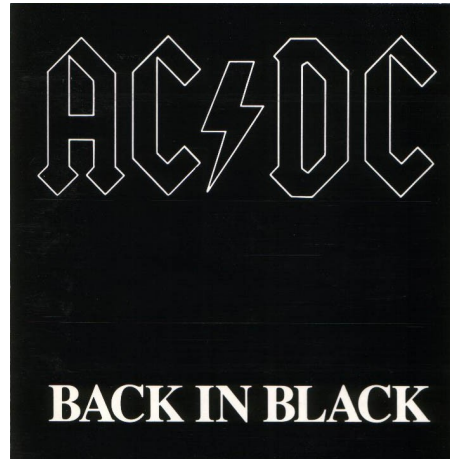
1967 Since The Beatles' *Sgt Pepper's Lonely Hearts Club Band* long playing records (albums) has dominated the whole phonographic market. There are also new formats - CDs (1982) and mp3 (1990), etc.



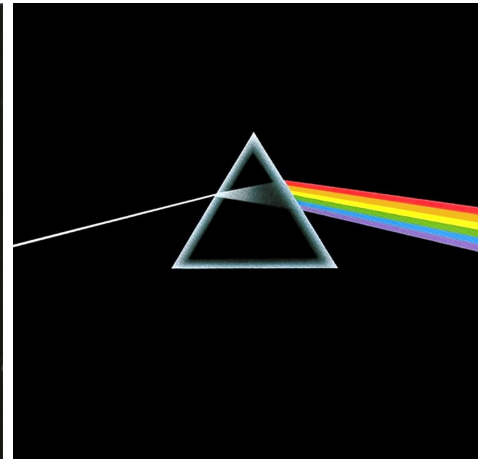
The best selling albums of all time are:



Michael Jackson – Thriller
sold over 110,000,000 copies



AC/DC – Back In Black
sold over 44,000,000 copies

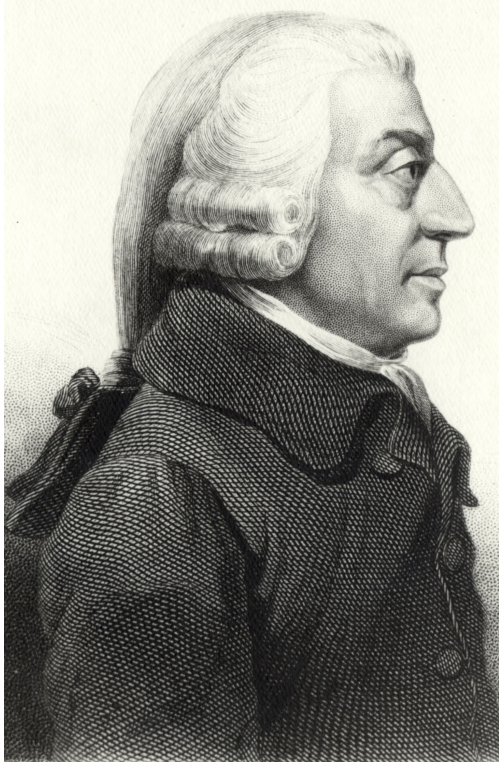


Pink Floyd – Dark Side Of The Moon
sold over 43,000,000 copies



Mazowsze śpiewa kolędy
Sings Christmas Carols
sold over 1,000,000 copies

Global music sales in **2009** fell by 7% to US \$17 billion. This is disappointing, but amid the decline there are some very positive points. No fewer than thirteen countries saw music sales grow in 2009, including important markets such as Australia, Brazil, South Korea, Sweden and the UK. Digital sales in some of those markets rose at very encouraging rates, reflecting the new opportunities of online and mobile channels.



Important factors:

- marginal utility
- product lifecycle

(especially in commodity markets)

80% of weekly record sales belongs to the four biggest record companies (Universal, EMI, Sony BMG and Warner Bros). All the world's most popular artists are signed to these companies. Thus, since 2003 it is possible to find their weekly record sales exactly.

The IFPI represents the recording industry worldwide, with a membership comprising some 1400 record companies in 66 countries and affiliated industry associations in 45 countries (USA, Japan, UK, France, Germany, Australia, Holland, Italy, Spain, Poland, etc.). China, India and Russia have small sales and are excluded because of piracy.



The phonographic market differs from financial and commodity markets because price of a record (LP, CD, mp3) is constant. Therefore, the value of an artist is defined by weekly record sales.

Financial market

stock prices

interest rate/price returns

correlation between stock prices

distance between stocks

life time of correlations between stocks

main indice portfolio

industry sectors and subsectors

Phonographic market

weekly record sales

change of record sales

correlation between artists

distance between artists

life time of correlations between artists

top selling artists

music genres

2 The correlation coefficient

The correlation coefficient defines degree of similarity between the synchronous time evolution of a pair of assets.

$$\rho_{ij} = \frac{\langle Y_i Y_j \rangle - \langle Y_i \rangle \langle Y_j \rangle}{\sqrt{(\langle Y_i^2 \rangle - \langle Y_i \rangle^2) (\langle Y_j^2 \rangle - \langle Y_j \rangle^2)}}$$

where i and j are the numerical labels of assets, Y_{ij} is the price return (or change of record sales).

$Y_i = \ln P_i(t) - \ln P_i(t-1)$ where $P_i(t)$ is the closure price of the stock i at the day t (or record sales at the week t)

I introduce 3 levels of correlations given by (1):

- | | |
|-----------------------------------------------|-----------------------------|
| 1.Strong (strongly correlated pair of stocks) | $\rho \in [\frac{1}{2}, 1]$ |
| 2.Weak (weakly correlated pair of stock) | $\rho \in [0, \frac{1}{2})$ |
| 3.Negative (anti-correlated pair of stocks) | $\rho \in [-1, 0)$ |

The correlation coefficient reflects similarity between stocks. It can be used in building the hierarchical structure in financial markets and finding the taxonomy that allows to isolate groups of stocks that make sense from an economic point of view.

On the other hand, companies offering substitute products might be negatively correlated when essentially compete over the same group of customers. Therefore, the success for one company often implies the failure for the others, indicating the market's reaction to the current situation (Furthermore, there is a fundamental negative correlation between gold-related stocks and the rest, indicating the complementary characters of these assets).

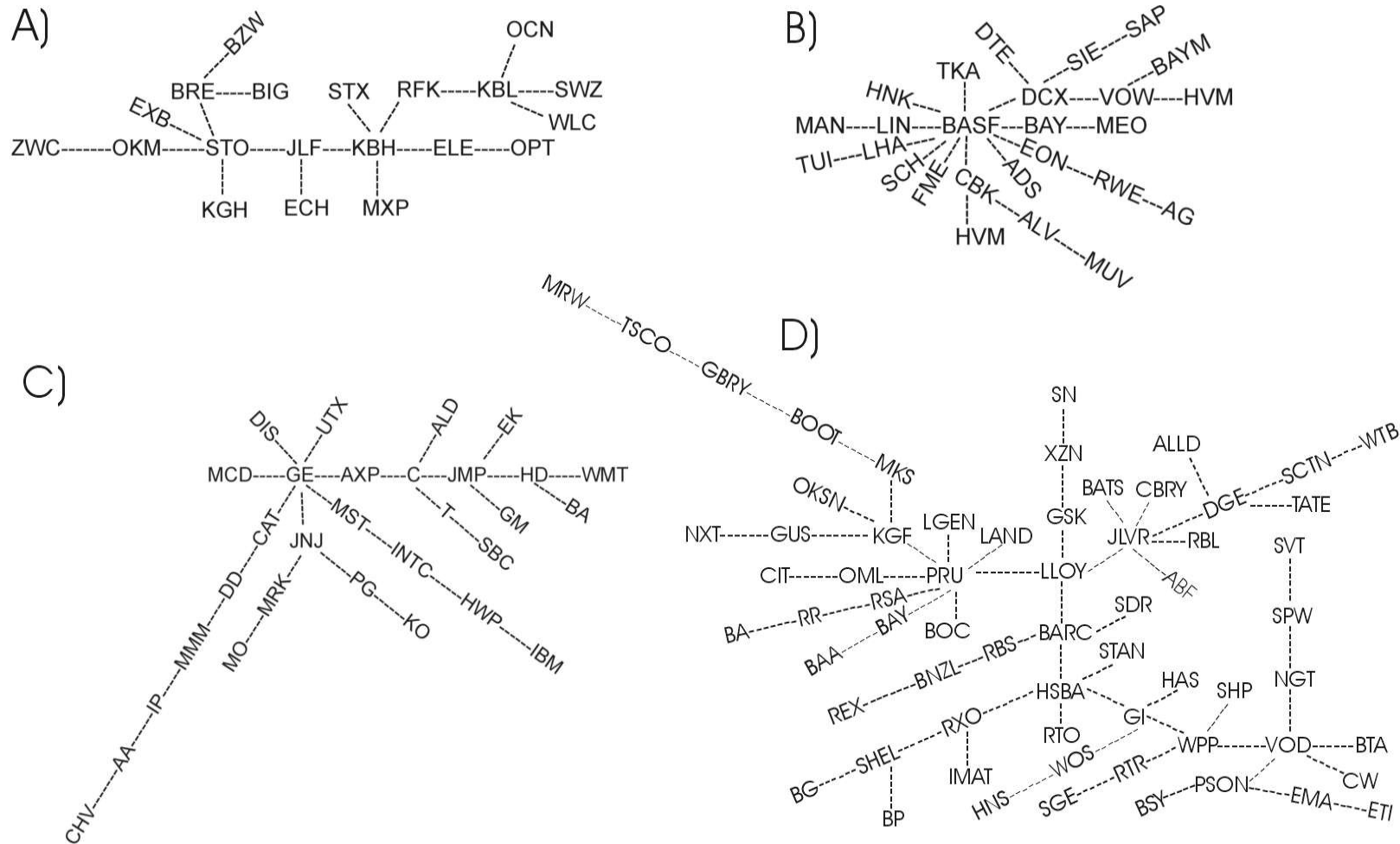


Fig. 1 Minimum Spanning Tree connecting the stocks used to compute
 A) Warszawski Indeks Gieldowy (WIG 20) B) Deutsche Aktienindex (DAX)
 C) Dow Jones Industrial Average (DJIA) D) FTSE 1000

Source: A.Buda, *Life time Of Correlations And Its Applications In Physics, Economy, Sociology And History*, Wydawnictwo Niezalezne (2010), ISBN 83-915272-8-1

Correlated pairs	strongly	weakly	negatively
DJIA	9	426	0
DAX	205	119	1
WIG 20	1	188	1
Phonographic market	5	72	373 (!)

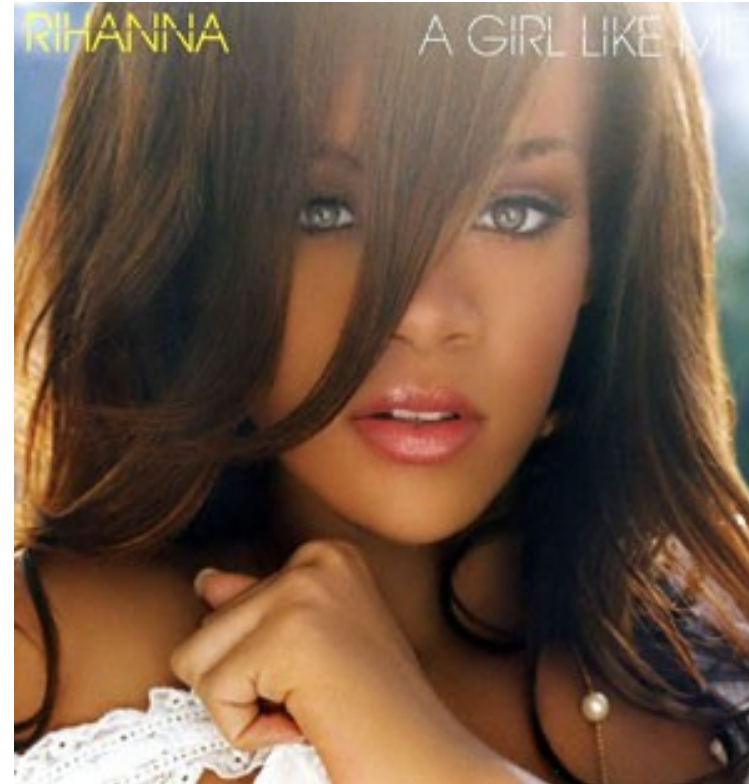
3. Distance between stocks (artists).

$$d_{ij} = [2(1 - \rho_{ij})]^{1/2}$$

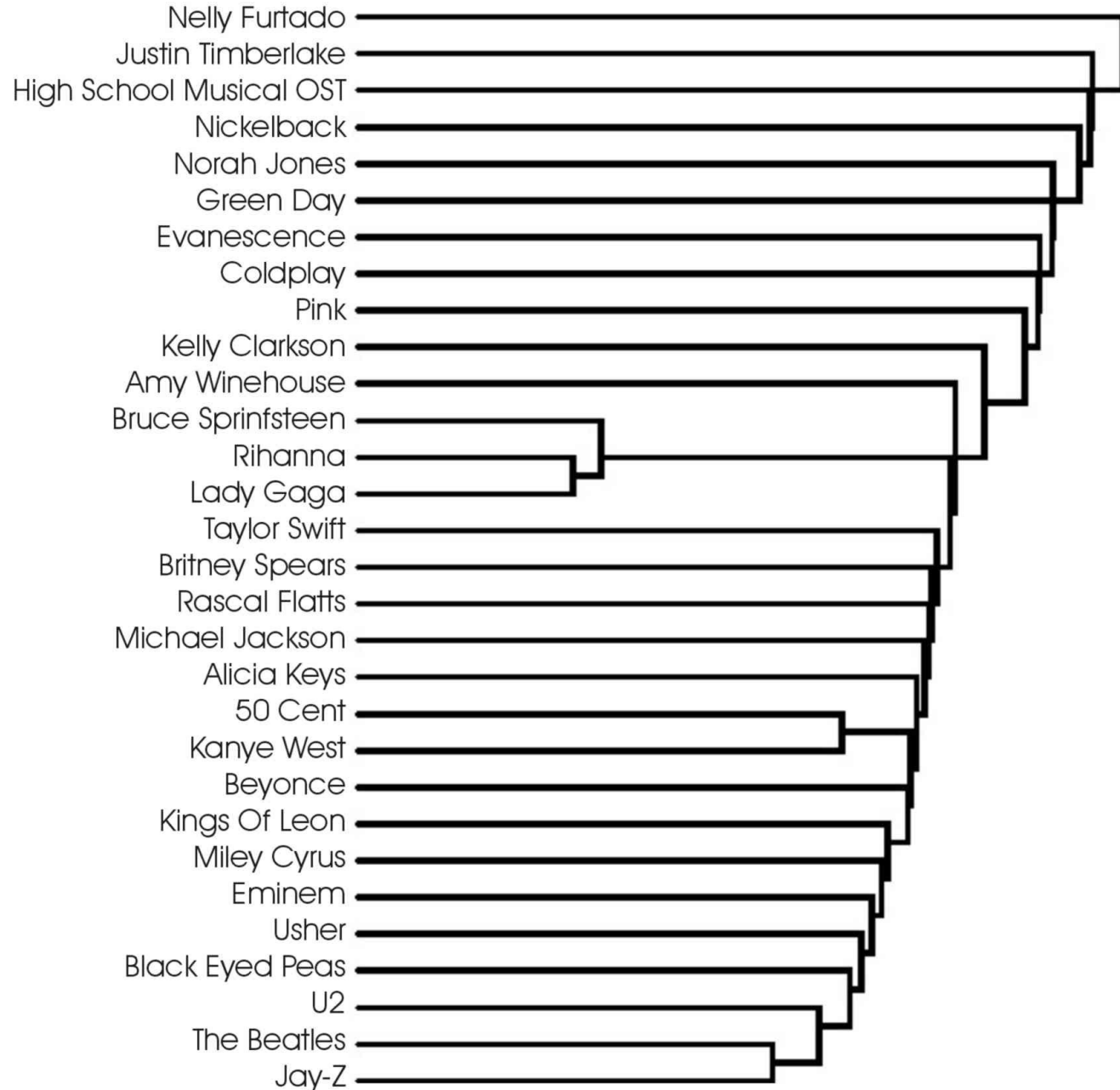
With this choice, d_{ij} fulfills three axioms of an Euclidean metric:

- (i) $d_{ij} = 0$ if and only if $i = j$
- (ii) $d_{ij} = d_{ji}$
- (iii) $d_{ij} < d_{ik} + d_{kj}$

The strongest correlated pair is:



- 0.73 Lady Gaga – Rihanna (d = 0.73)
- 0.69 The Beatles – Jay-Z (d = 0.78)
- 0.61 The Beatles – U2 (d = 0.88)
- 0.58 Kanye West – 50 Cent (d = 0.91)
- 0.54 Jay-Z – U2 (d = 0.93)



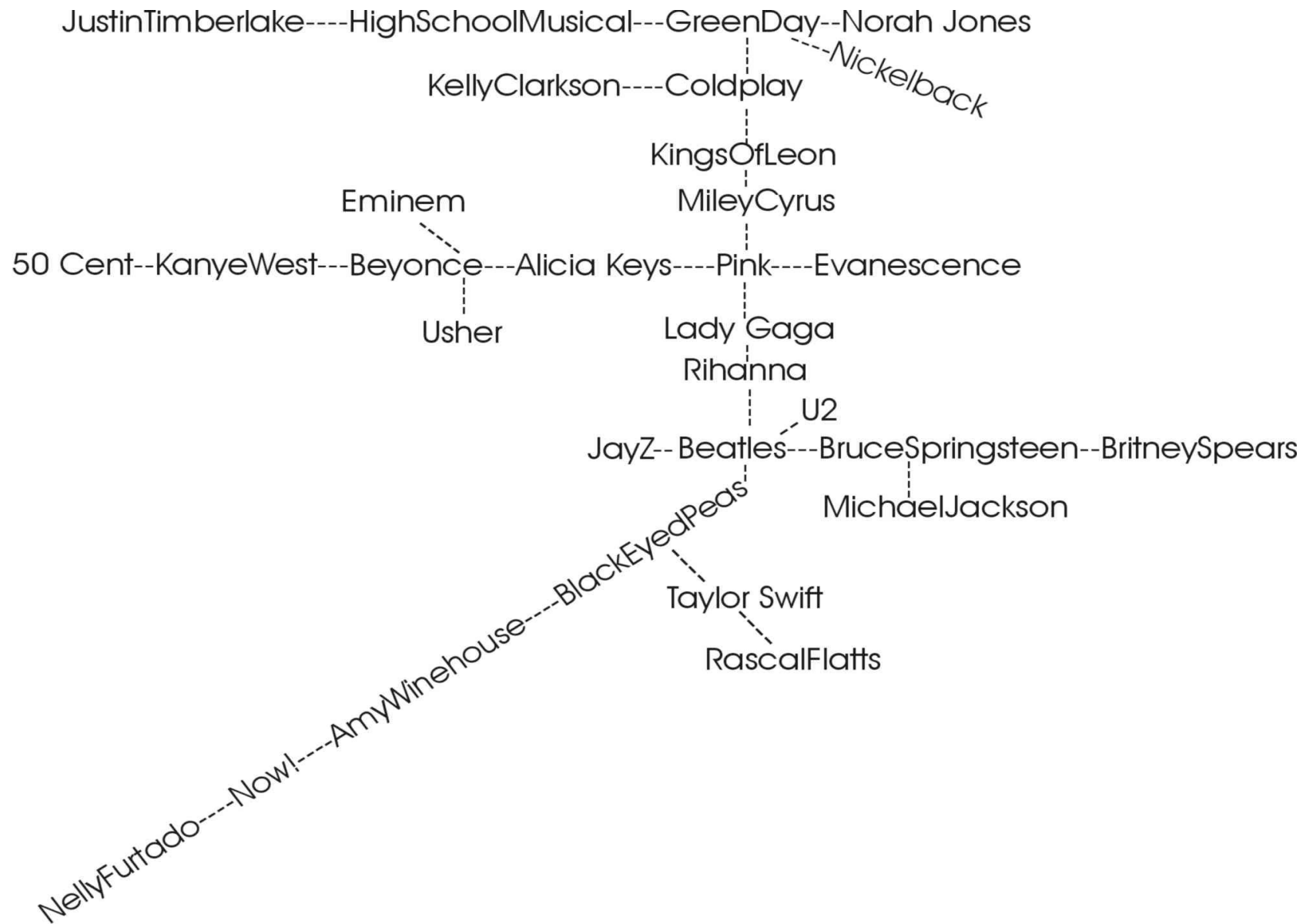


Fig.3 Minimal Spanning Tree connecting the world's most popular artists (2003-2010)

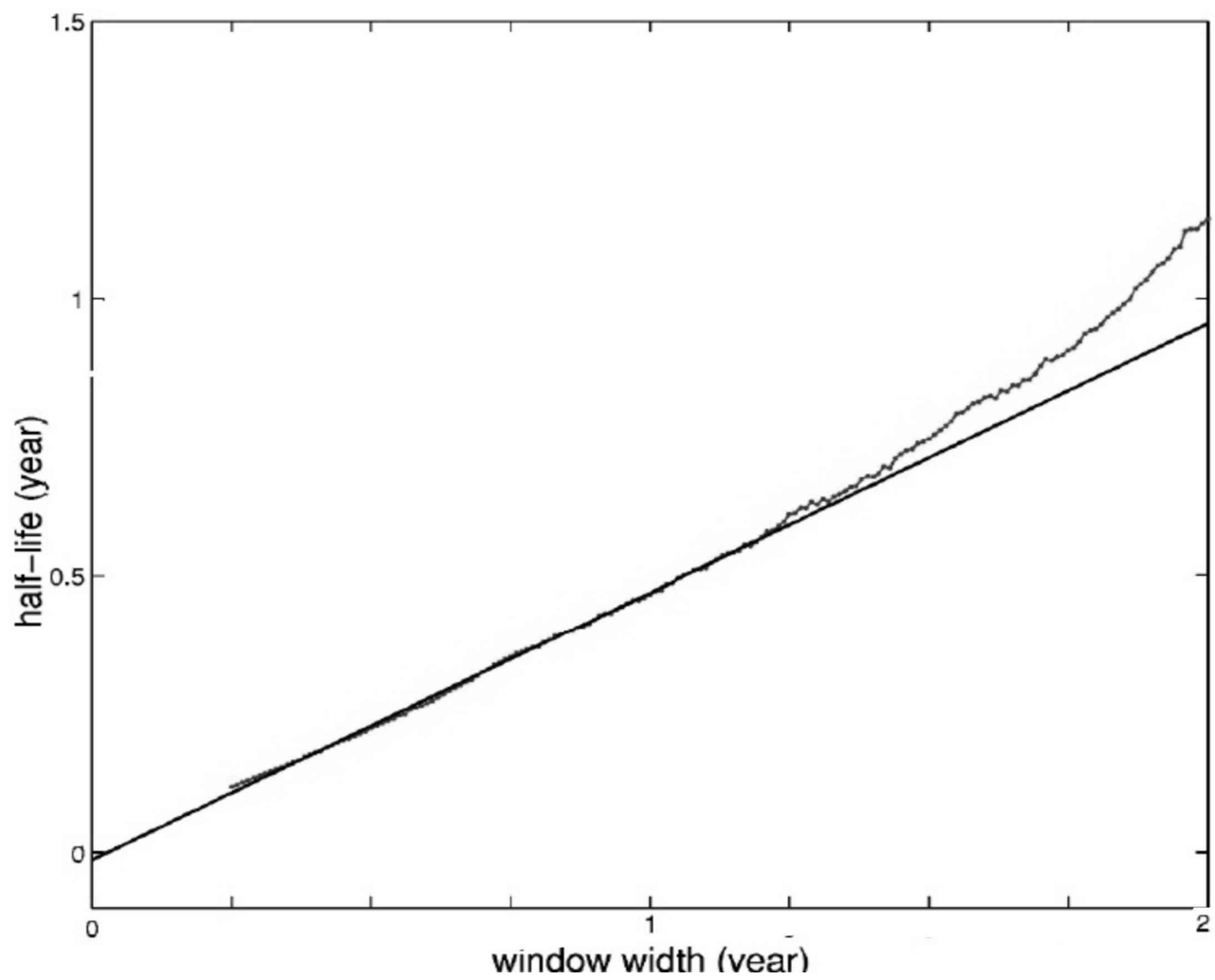


Fig.4 Plot of half-life $t_{1/2}$ as a function of window width

Minimal Spanning Tree built for political parties in Poland according to Greemius opinion polls (2006-2010):

