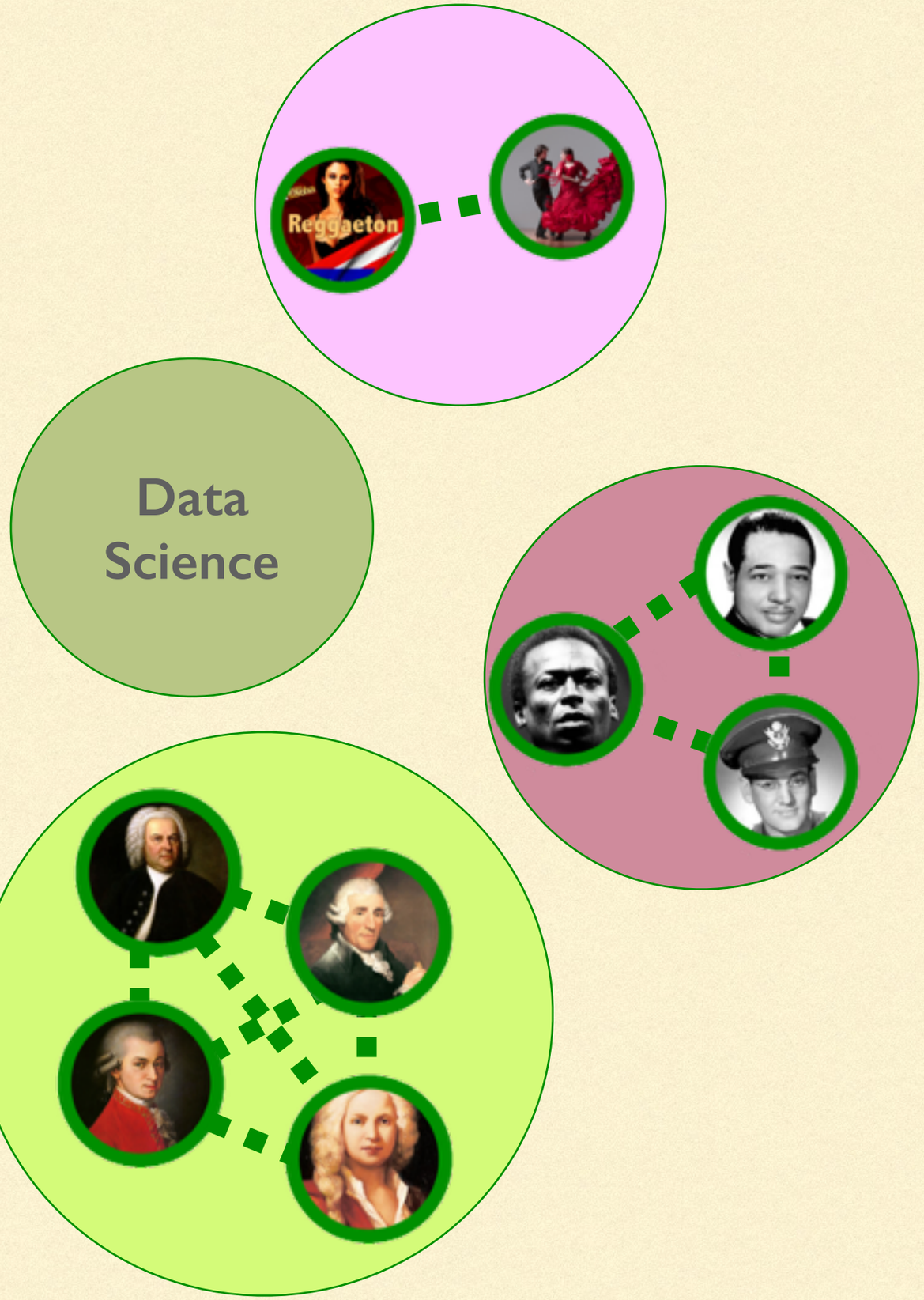
http://www.meetup.com/Algorithmic-Art-Visual-Musical-Composition-Quadrivium/

Visual art & randomness, music composed by AI, astrology and data science

Tonight meetup sponsored by:

livestream

The Quadrivium



QUANTITATIVE ANALYTICS & ART

BY

LUIS M. SANCHEZ

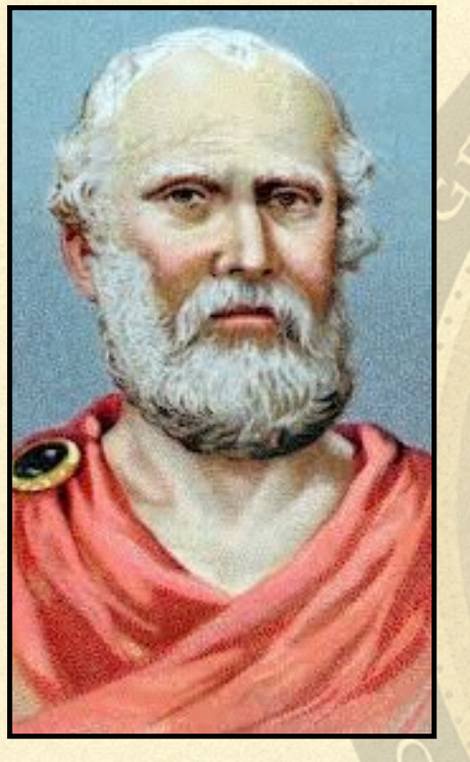
WHAT WAS THE QUADRIVIUM?

WHAT WAS THE QUADRIVIUM?

The quadrivium consisted of arithmetic, geometry, music, and astrology/astronomy. The quadrivium was considered preparatory work for the serious study of philosophy and theology.

At many medieval universities, this eclectic combination would have comprised the courses leading to higher degrees in education.

ORIGIN?



Plato
428–348 BC

Philosopher, as well as mathematician. Considered an essential figure in the development of philosophy, founded the Academy in Athens, the first institution of higher learning in the Western world. Proposed the "Quadrivium" as part of curriculum for the Academy

Pythagoras
570–495 BC

Often revered as a great mathematician and scientist and is best known for the Pythagorean theorem which bears his name. It is said that the Egyptians taught him geometry, the Phoenicians arithmetic, and the Chaldeans and the Magians the principles of religion, astrology, and other knowledge

Euclid of Alexandria
323–283 BC

Greek mathematician who compiled and systematically arranged the geometry and number theory of his day into the famous text Elements. Considered the father of geometry. Other contributions are Number theory, Euclid's lemma Euclidean algorithm, Euclid-Euler theorem. etc. Astronomy, data analysis

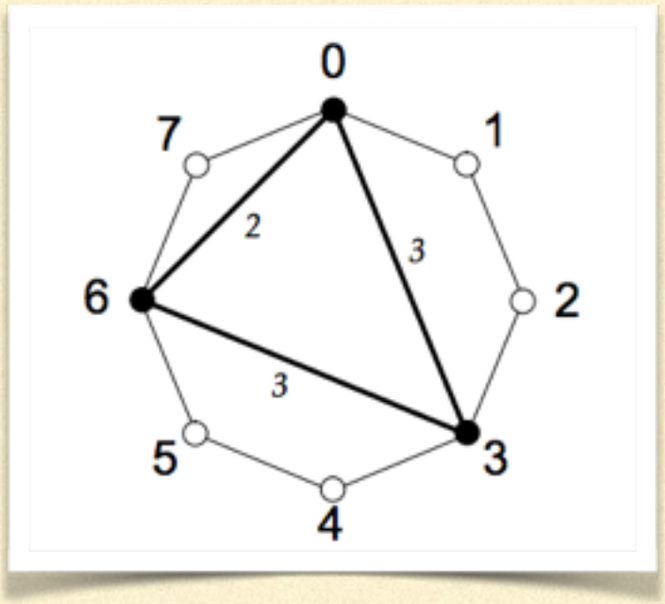
Magians: followers of Zoroaster, who was perceived by the Greeks to be the founder of the Magi and practitioner of magic, astrology, alchemy and other forms of esoteric knowledge

SOME CONCRETE CONNECTIONS WITH MUSIC
EUCLIDEAN RHYTHMS

The Euclidean rhythm in music was discovered by Godfried Toussaint in 2004 and is described in a 2005 paper "The Euclidean Algorithm Generates Traditional Musical Rhythms".

http://cgm.cs.mcgill.ca/~godfried/publications/banff.pdf

The greatest common divisor of two numbers is used rhythmically giving the number of beats and silences, generating almost all of the most important World Music rhythms, in a sort of 'dial-in' fashion.



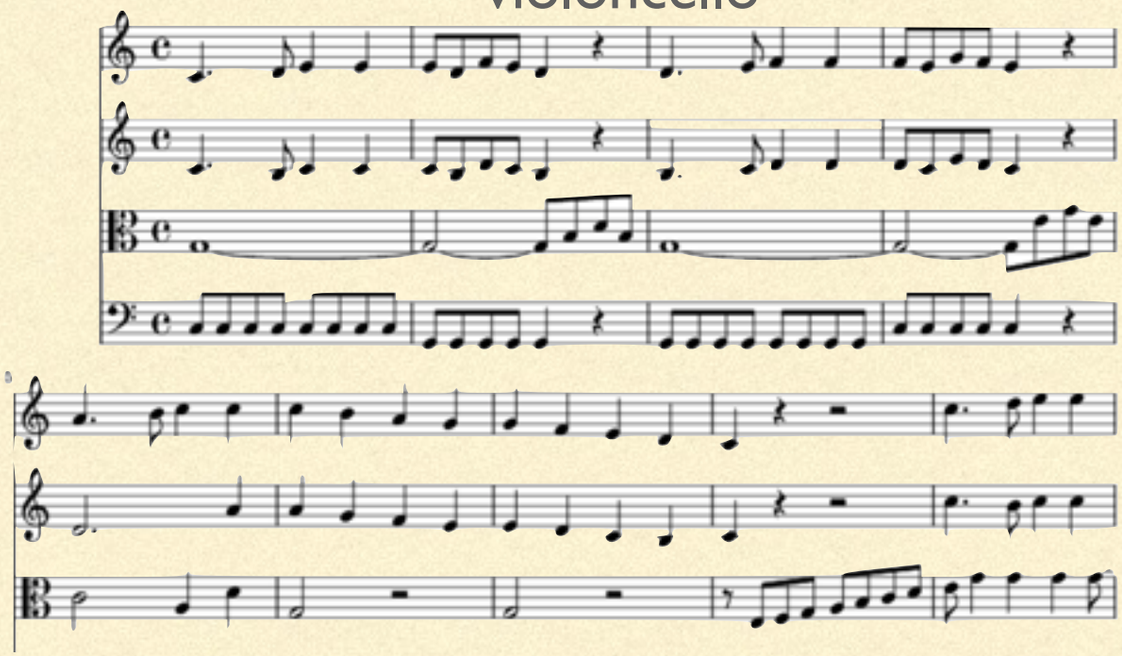
Cuban tresillo pattern

Let's switch to some Java Code to listen to a trelliso pattern

MUSIC/VISUAL ART & DATA SCIENCE

How can this music or this image:

Mozart - Quartet N.4 for 2 violin, viola, and violoncello



be transformed into something like this:

$$\begin{pmatrix} a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n \\ a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n \\ \vdots \\ a_{n1}x_1 + a_{n2}x_2 + \cdots + a_{nn}x_n \end{pmatrix} = \begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{pmatrix}$$

MUSIC/VISUAL ART & DATA SCIENCE

- ✓For images, many Open Source libraries out there: OpenCV, Python PIL, numpy, etc.
- ✓For music, not so many, and they don't necessarily cover transformation into matrix form.

Proprietary MusicQuant library can do transformations, sonification of any type of data, structural analysis of genres/composers, music classification, and automatic music composition.

Let's explore 1) Sonification 2) Music classification and 3) Analysis & Music Generation

SONIFICATION

Sonification is the use of non-speech audio to convey information or perceive data.

Auditory perception has advantages in temporal, spatial, amplitude, and frequency resolution that open possibilities as an alternative or complement to visualization techniques.

Steps:

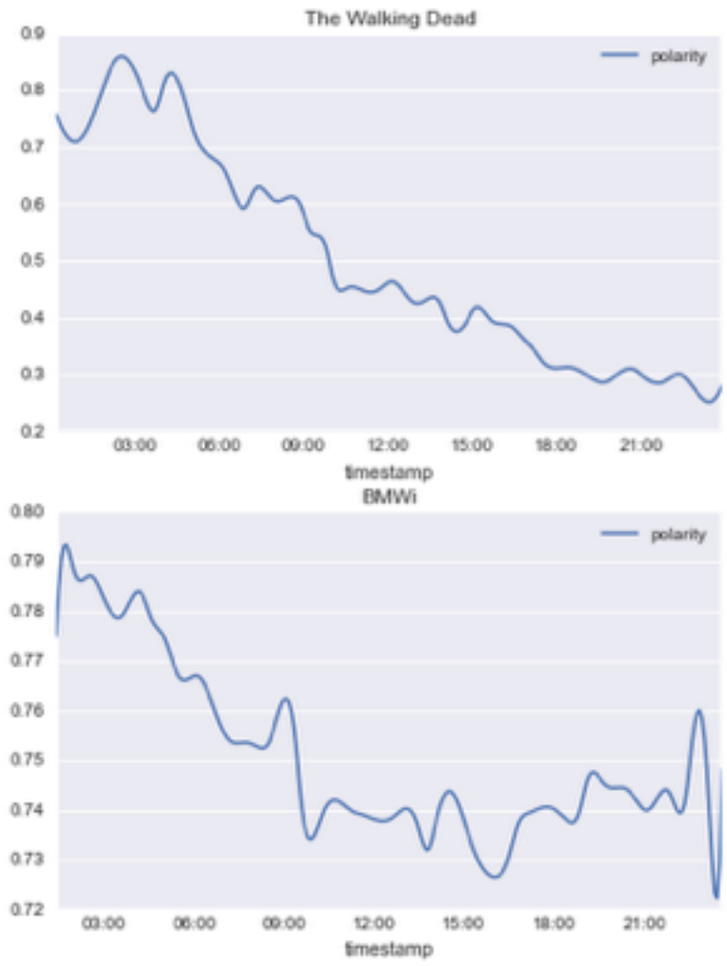
1) Find dataset
2) Normalize dataset to piano keyboard
3) Play it

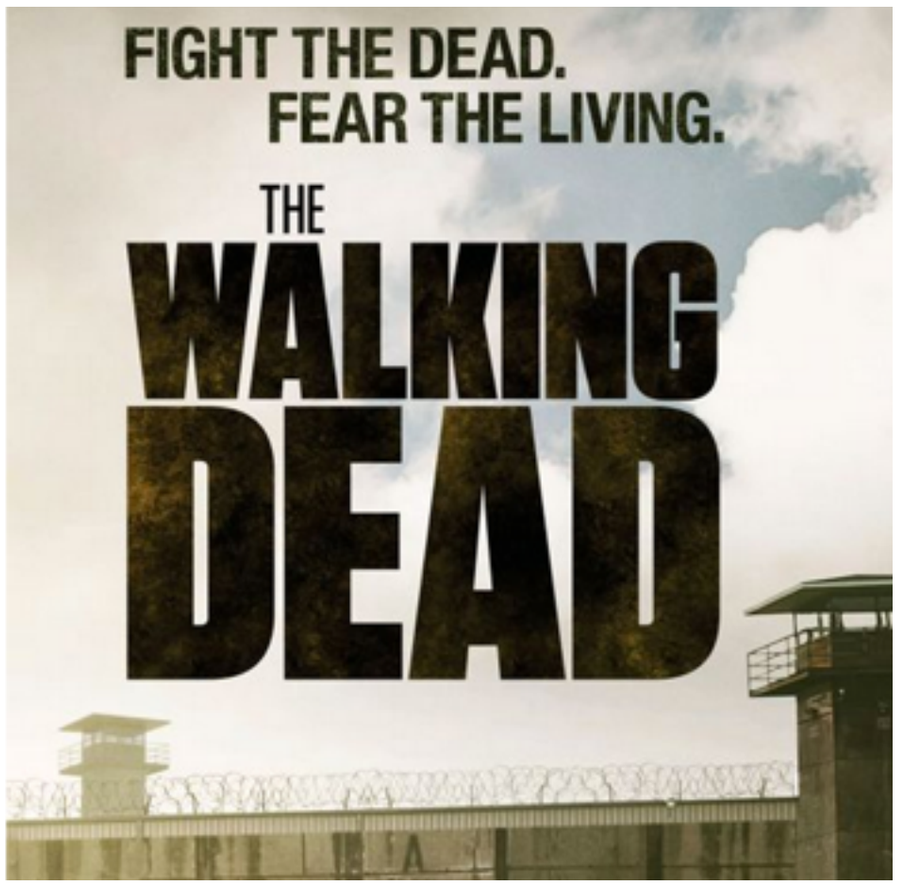
Case study: sentiment analysis for AMC's TV show "The Walking Dead"

THE WALKING DEAD SENTIMENT ON DECEMBER 22, 2014
DATA COLLECTED VIA TTWICK SEARCH ENGINE

Forecasting viral content and polarity by analyzing logs of social media search engine

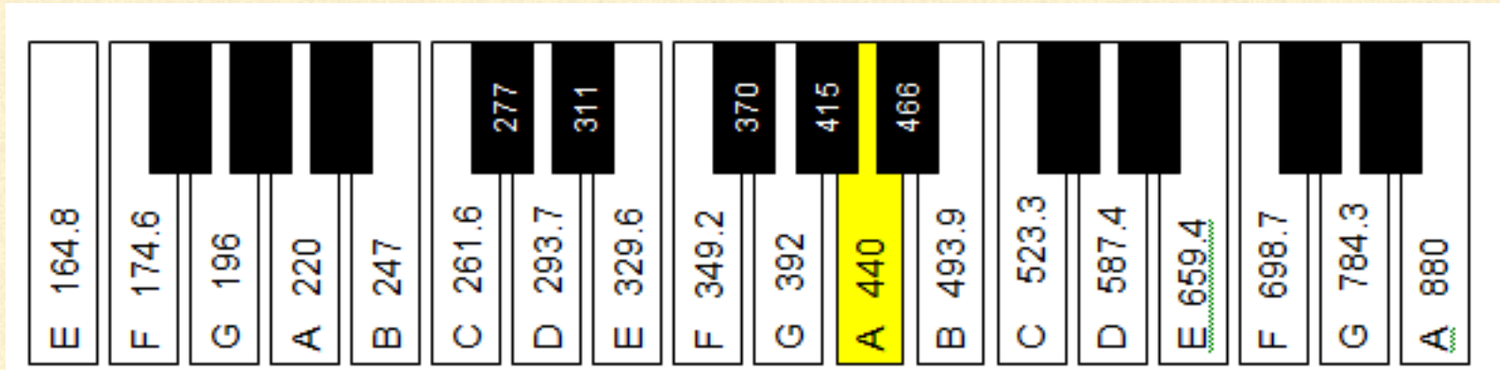
```
In [24]: fig, axes = plt.subplots(nrows=2, ncols=2)
         polarity_walking_dead.plot(ax=axes[0,0]); axes[0,0].set_title('The Walking Dead')
         polarity_henry_kissinger.plot(ax=axes[0,1]); axes[0,1].set_title('Henry Kissinger')
         polarity_bmwi.plot(ax=axes[1,0]); axes[1,0].set_title('BMWi')
         polarity_duran_duran.plot(ax=axes[1,1]); axes[1,1].set_title('Duran Duran')

Out[24]: <matplotlib.text.Text at 0x11453de90>
```

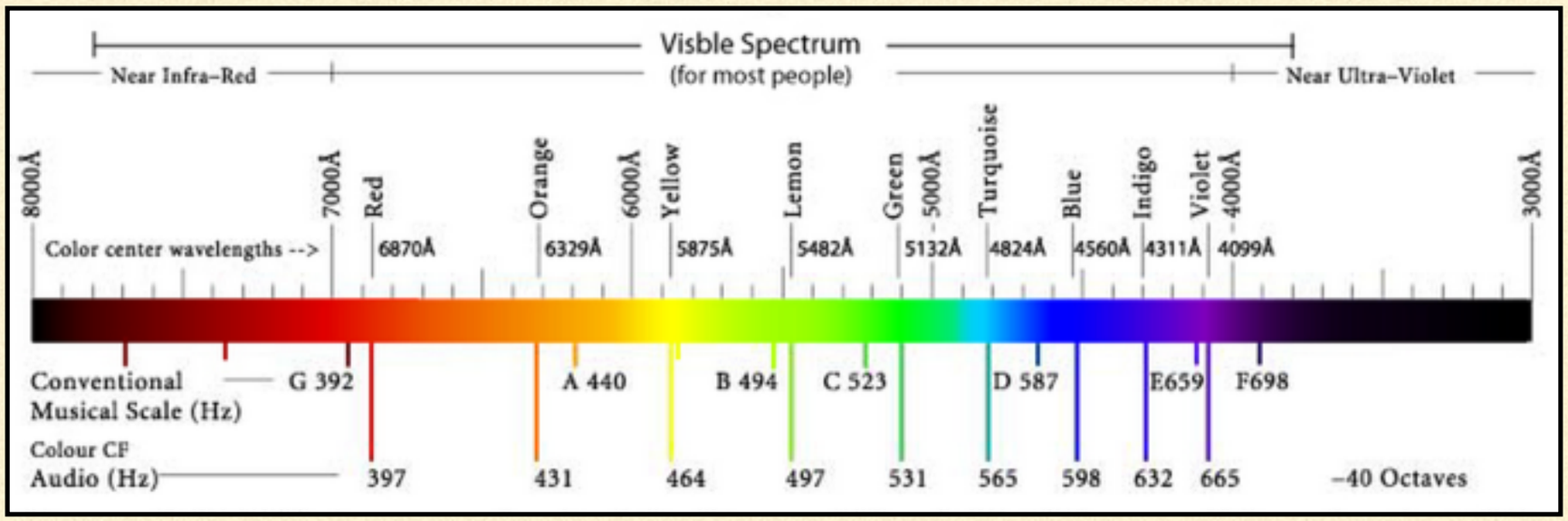




MUSIC CLASSIFICATION

The basic idea: transform a music time series into a graphical pattern and find out if genres, styles, etc. have similar patterns.





MUSIC CLASSIFICATION: TRANSFORM SOUND FREQUENCY INTO LIGHT WAVE LENGHT

The ‘frequency’ of visible light is 40 octaves up from the middle audio “frequency”, and is measured in wavelengths.

If we were to ‘raise’ middle ‘A’ (440 Hz) by 40 octaves, we will get a wavelength of 6195 Angstroms, which is in the orange area of the visible spectrum.

This is the formula:

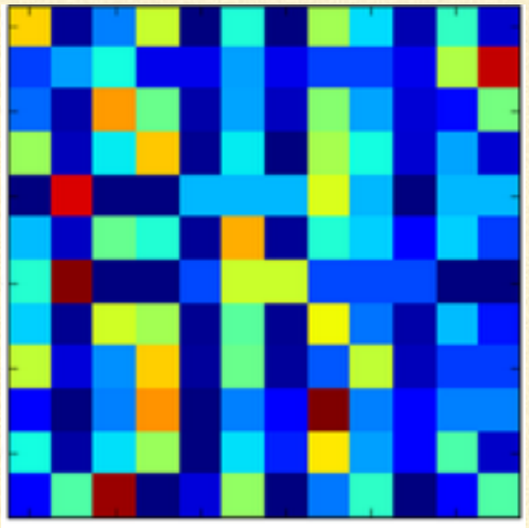
C is the speed of light
f is frequency
λ (lambda) is wavelength

Wavelength $\lambda = \frac{C}{f}$

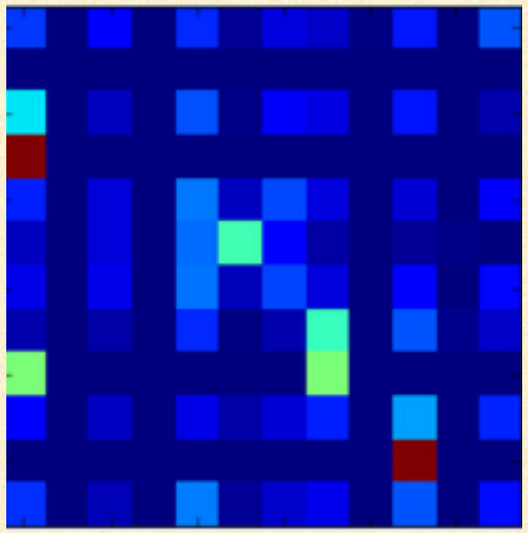
Frequency $f = \frac{C}{\lambda}$

C = 299,727,738 meters/sec (the speed of light at Earth's surface - through air)
C = 299,792,458 meters/sec (in a vacum).

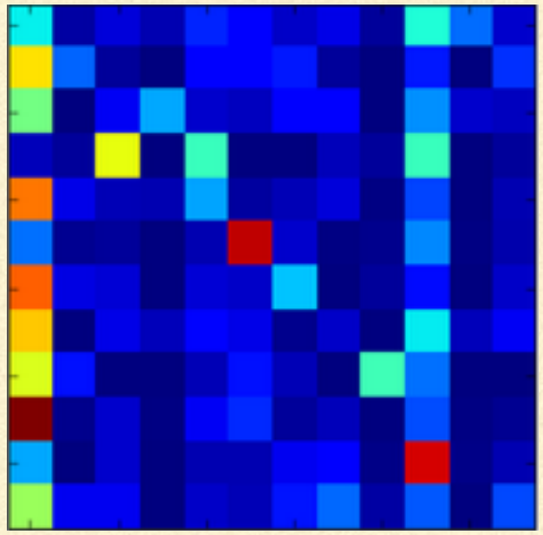
MUSIC CLASSIFICATION: SOME EXAMPLES



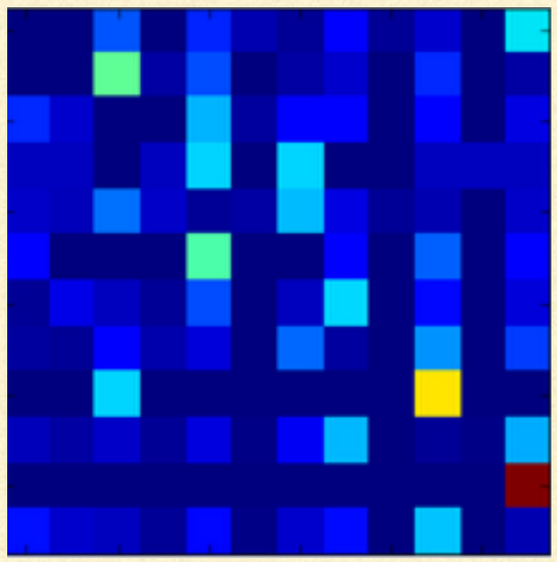
Miles Davis
81



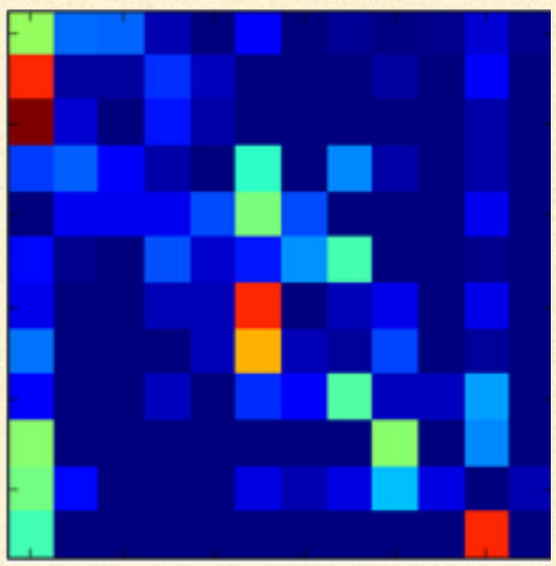
Bach's
BWV 1007



Van Halen
Hot for the teacher



Handel
Sarabande



The Beatles
Help

Based on these experiments and experience as an engineer working in several fields:

Can I create create machine learning code that, for example, learns structural components in music styles, genres, etc. and creates original compositions?

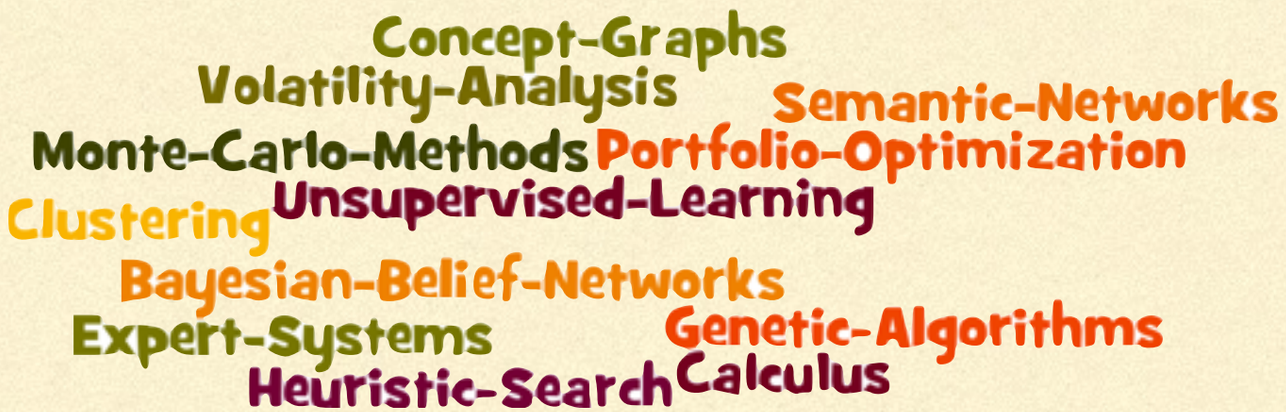
DATA SCIENCE & MUSIC

Not a simple task, however, not impossible. My approach involved a few quantitative disciplines: operational research (OR), structural engineering (SE), financial engineering (FE), and computer science (CS).

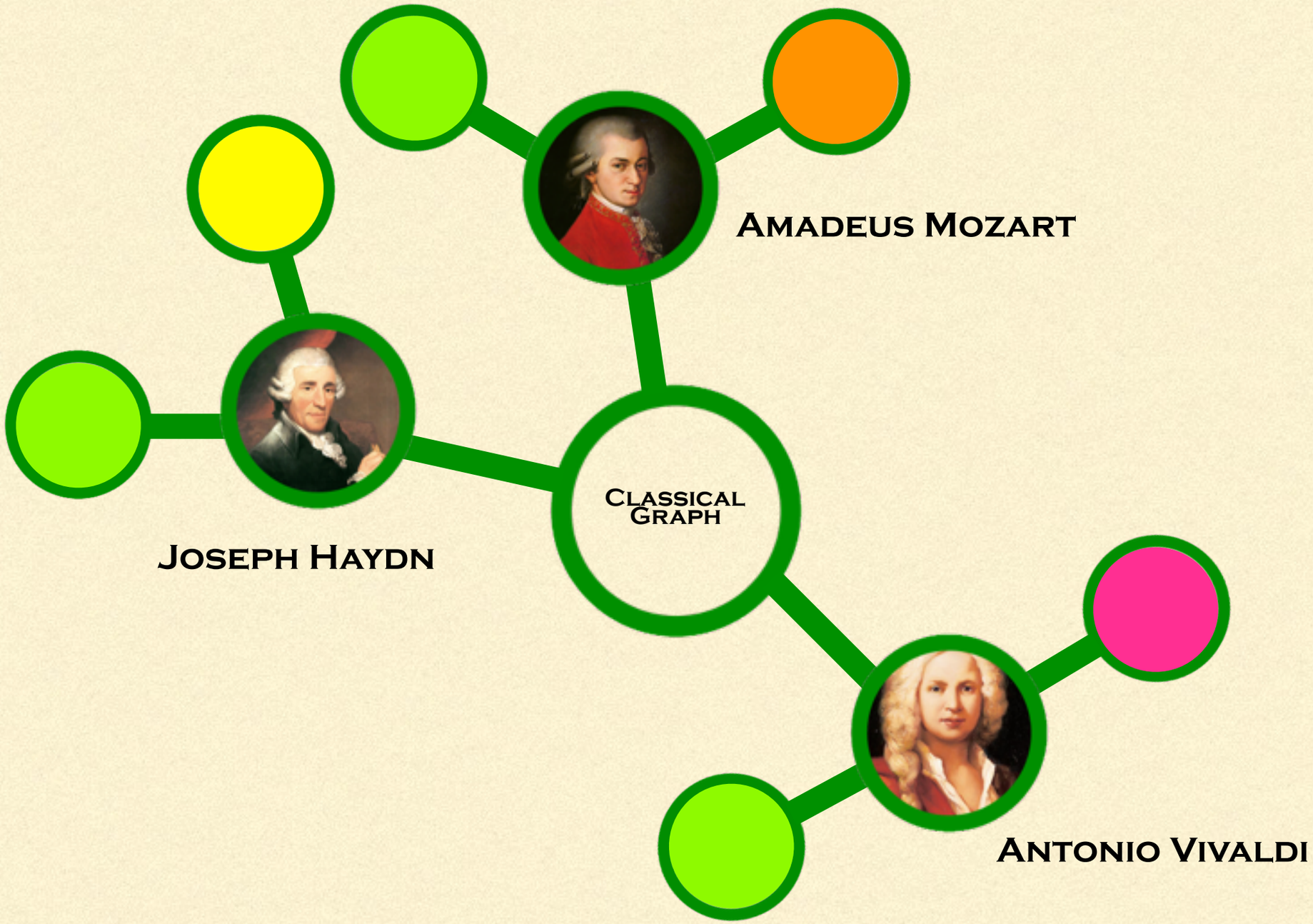
My goal is very ambitious and challenging: to create an artificial intelligence (AI) capable of a) analyzing and finding structure in music b) attempting to compose music in any style from self-derived grammar c) fast generation and acceptable sound "straight out of the enter key", and d) eventually capable of understanding Natural Language (i,e,: "give me a new Goldberg Variation"), for B2C mobile applications

OR
SE
FE
CS

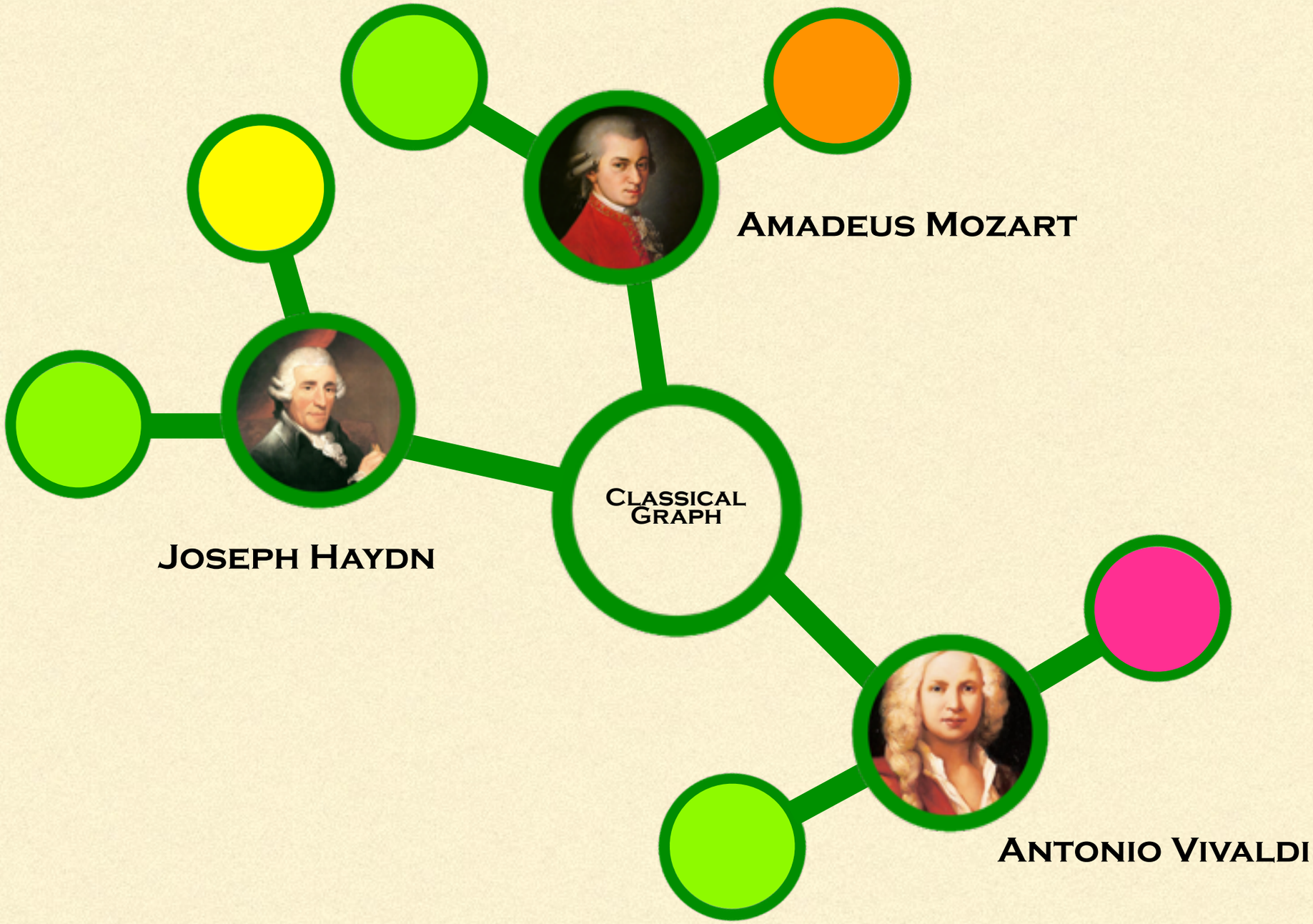
AI



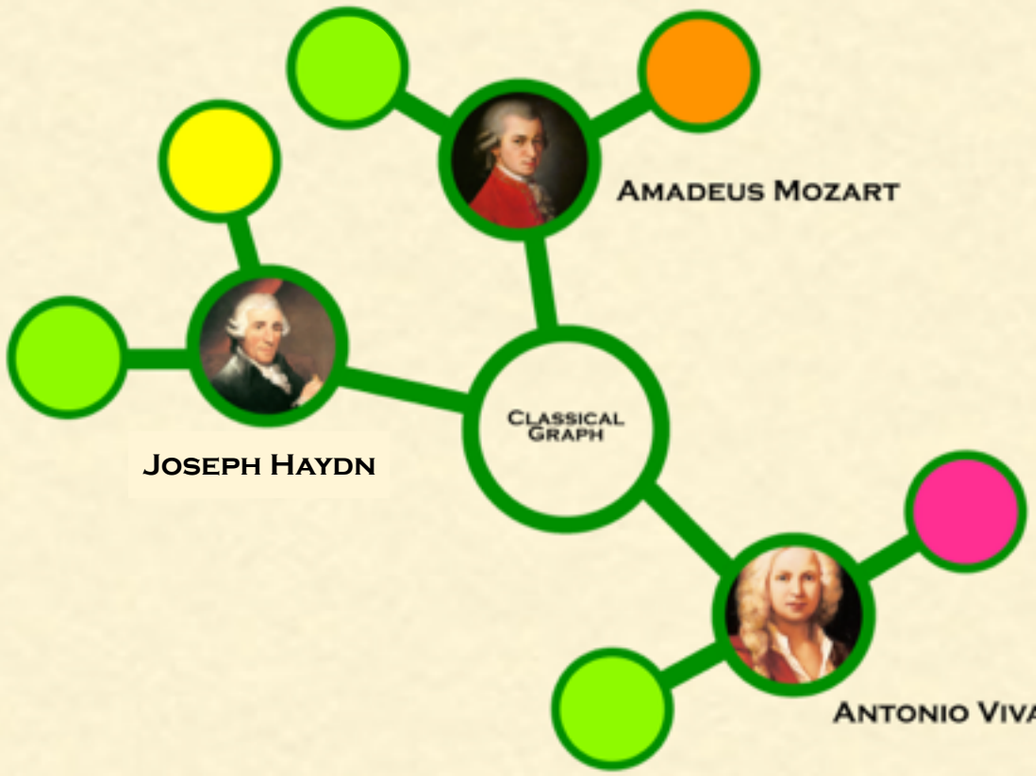
ANALYSIS AND MUSIC GENERATION:



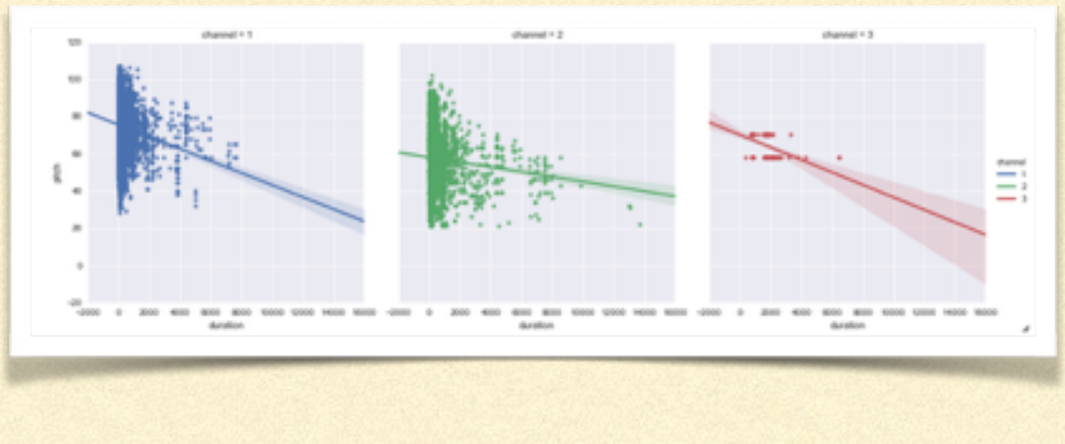
ANALYSIS AND MUSIC GENERATION: A CLASSICAL "PORTFOLIO" OF SIZE N

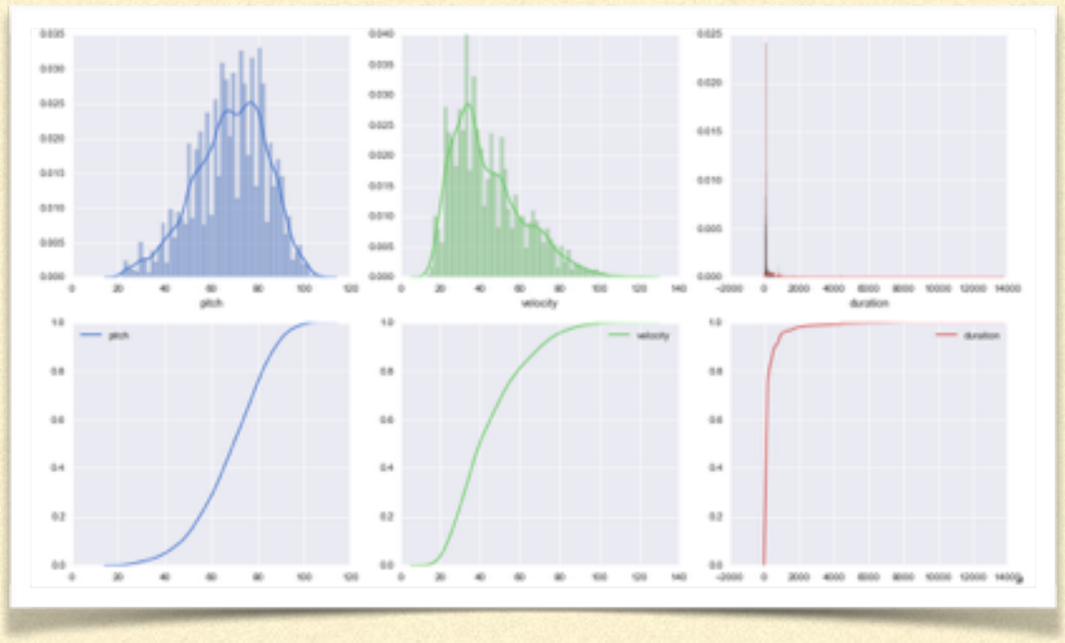


ANALYSIS AND MUSIC GENERATION: A CLASSICAL "PORTFOLIO" OF SIZE N



Unique analytics allow me to see musical structure in a different way. Let's listen to an ORIGINAL classical piece composed by my algorithms





100% algorithmic

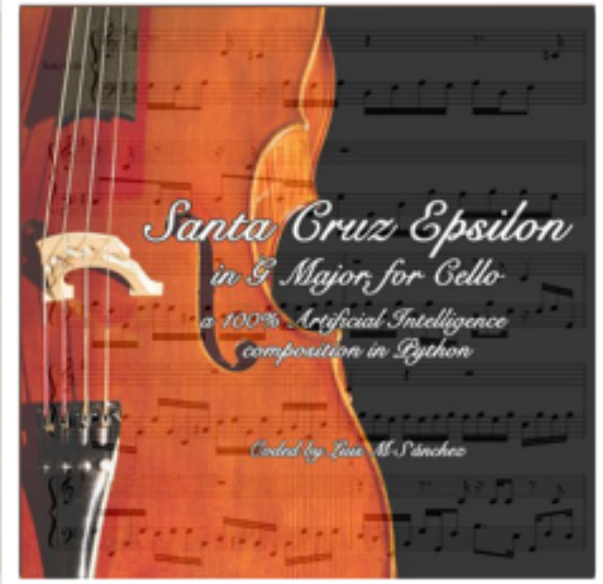
https://soundcloud.com/luis-m-sanchez-1/dont-give-me-constraints-please

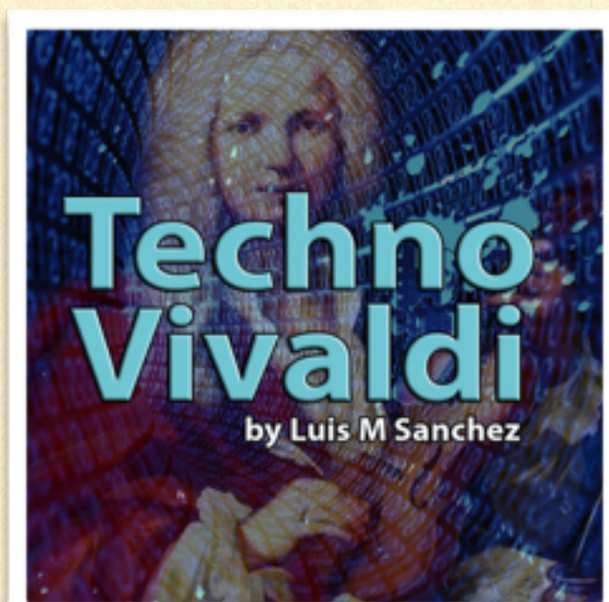
LET'S WALK THROUGH THE ANALYSIS OF A PARTICULAR STYLE AND THE CREATION OF AN ALGORITHMIC SONG

WHAT ABOUT MORE POPULAR GENRES?

OTHER ALGORITHMIC SONGS IN DIFFERENT GENRES

https://soundcloud.com/luis-m-sanchez-1





THANK YOU

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