UNDERSTANDING MUSIC WITH HIGHER ORDER NETWORK

CSSS 18

Josefine Bohr Brask
Ricky Laishram
Carlos Marcelo
Xindi Wang

QUESTION

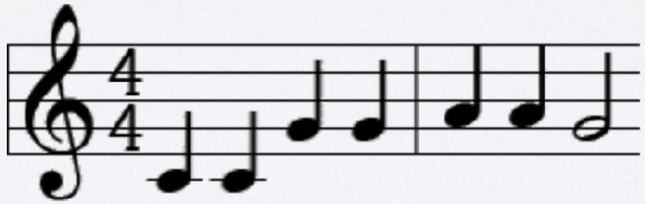
- Can we use machine to understand how music is composed and structured?
- What makes music different between different genres, eras, and composers?

DATA AND PROCESSING

- MIDI files from "The Largest MIDI Collection on the Internet"
- MIDI coding: 0 - 127, 12 notes across 11 octaves
- Using music21 to detect the tonal note, re-index each note relative to the tonal note

DATA AND PROCESSING

- MIDI files from "The Largest MIDI Collection on the Internet"
- MIDI coding: 0 - 127, 12 notes across 11 octaves
- Using music21 to detect the tonal note, re-index each note relative to the tonal note



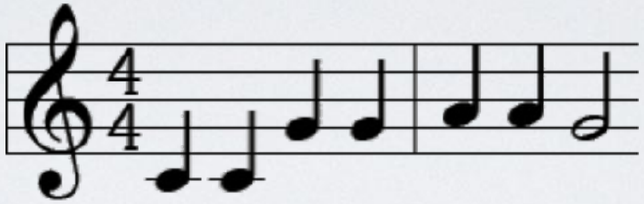
Snippet of *Twinkle, Twinkle Little Star*

Original coding: 60 60 67 67 69 69 67
Relative coding: 0 0 7 7 9 9 7

HIGHER ORDER NETWORK (HON)

Xu, Jian, Thanuka L. Wickramarathne, and Nitesh V. Chawla. "Representing higher-order dependencies in networks." *Science advances* 2.5 (2016): e1600028.

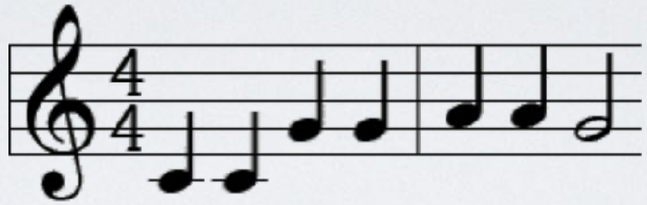
HIGHER ORDER NETWORK (HON)



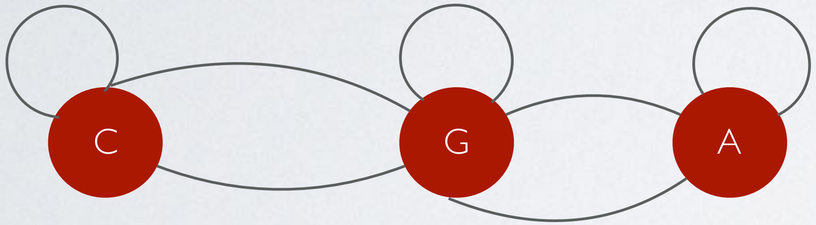
Snippet of *Twinkle, Twinkle Little Star*

Xu, Jian, Thanuka L. Wickramarathne, and Nitesh V. Chawla. "Representing higher-order dependencies in networks." *Science advances* 2.5 (2016): e1600028.

HIGHER ORDER NETWORK (HON)



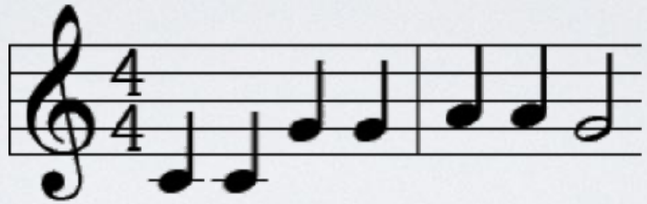
Snippet of *Twinkle, Twinkle Little Star*



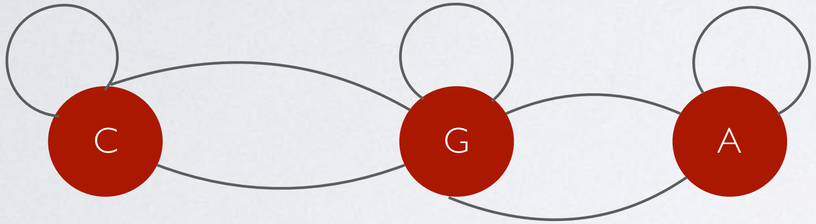
Simple Network

Xu, Jian, Thanuka L. Wickramarathne, and Nitesh V. Chawla. "Representing higher-order dependencies in networks." *Science advances* 2.5 (2016): e1600028.

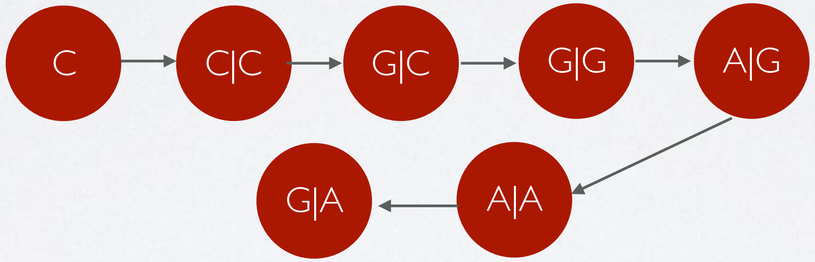
HIGHER ORDER NETWORK (HON)



Snippet of *Twinkle, Twinkle Little Star*



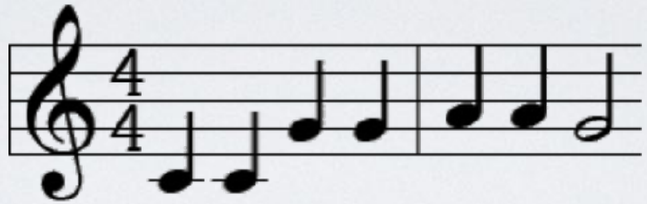
Simple Network



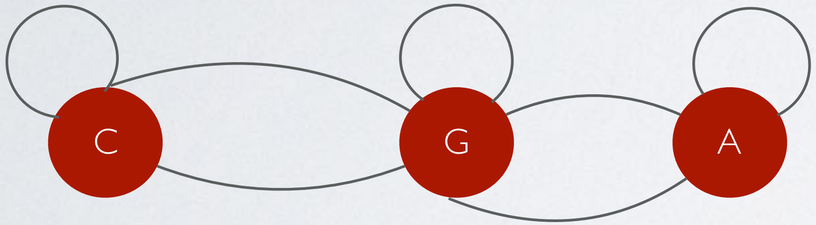
Two-order Network

Xu, Jian, Thanuka L. Wickramarathne, and Nitesh V. Chawla. "Representing higher-order dependencies in networks." *Science advances* 2.5 (2016): e1600028.

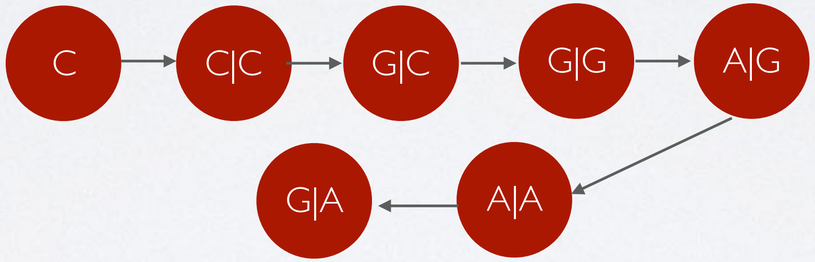
HIGHER ORDER NETWORK (HON)



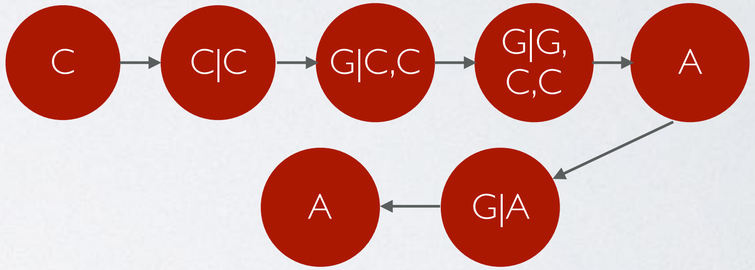
Snippet of *Twinkle, Twinkle Little Star*



Simple Network



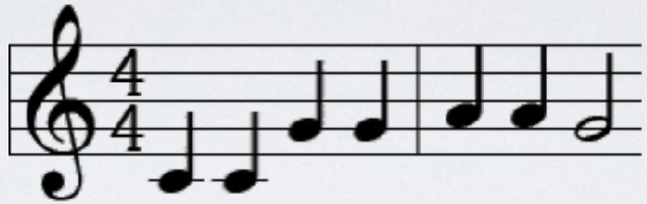
Two-order Network



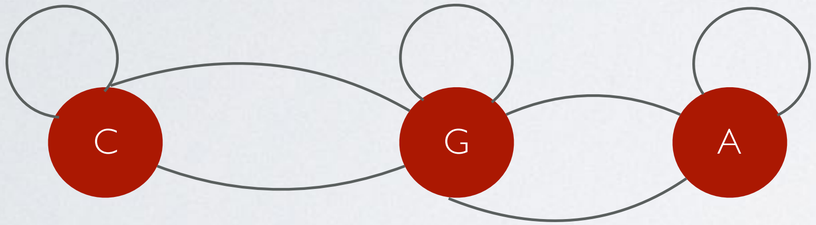
Higher-order Network

Xu, Jian, Thanuka L. Wickramarathne, and Nitesh V. Chawla. "Representing higher-order dependencies in networks." *Science advances* 2.5 (2016): e1600028.

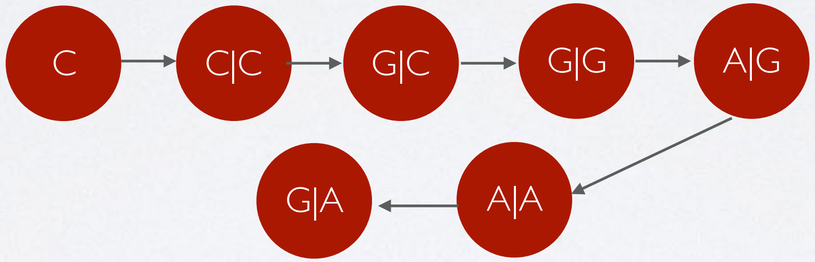
HIGHER ORDER NETWORK (HON)



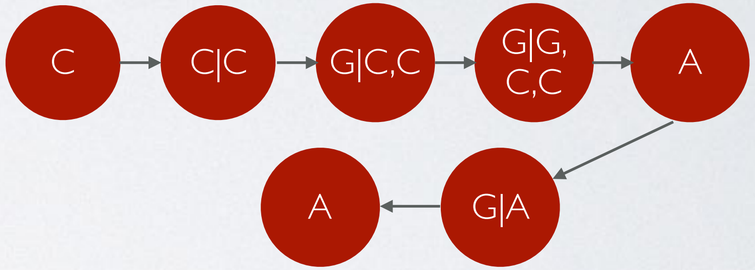
Snippet of *Twinkle, Twinkle Little Star*



Simple Network



Two-order Network



Higher-order Network

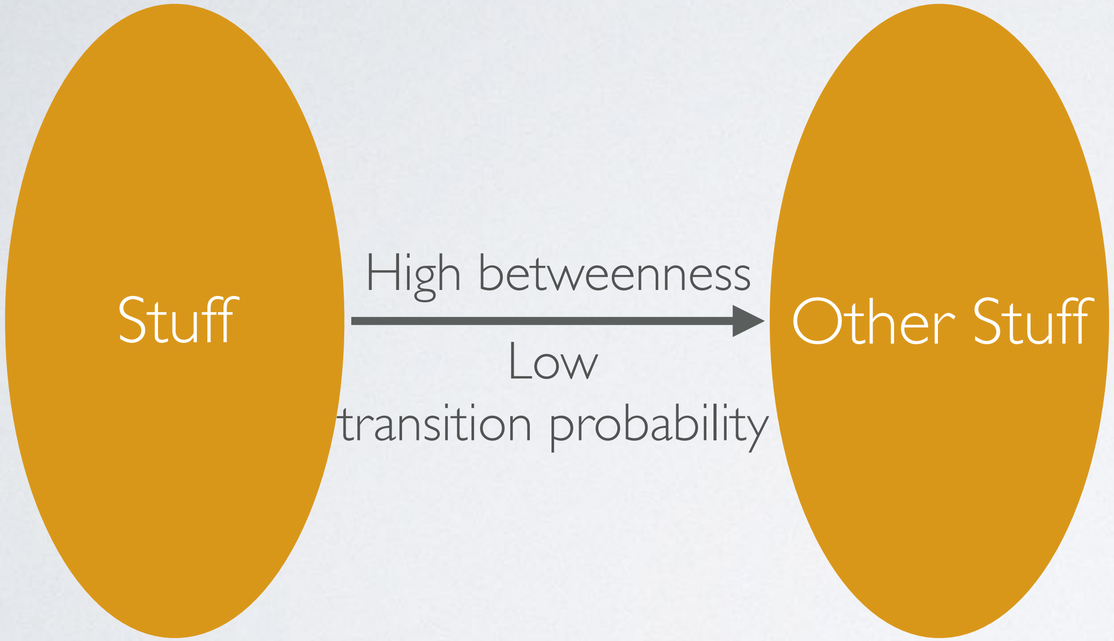
Node: rules
Edges: Transition Probability

Xu, Jian, Thanuka L. Wickramarathne, and Nitesh V. Chawla. "Representing higher-order dependencies in networks." *Science advances* 2.5 (2016): e1600028.

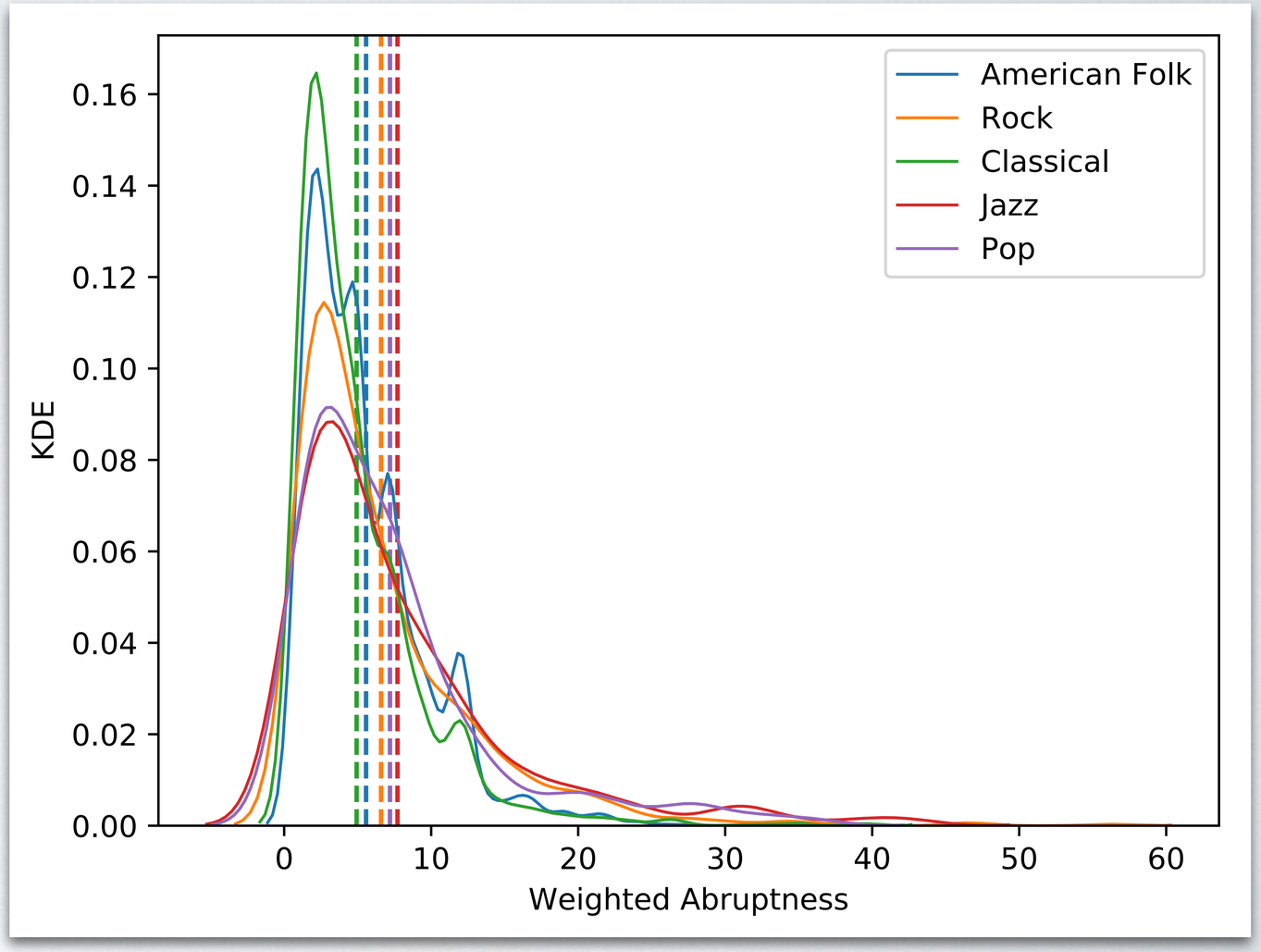
FEATURES FROM HON

- Abruptness
- Branching
- Melodic
- …

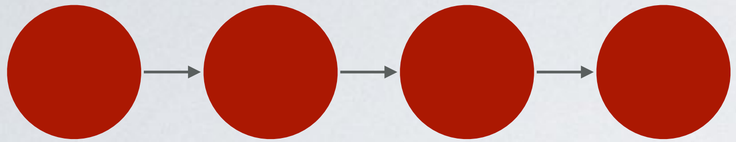
ABRUPTNESS



Abrupt if the note pitch change difference of the two end is large

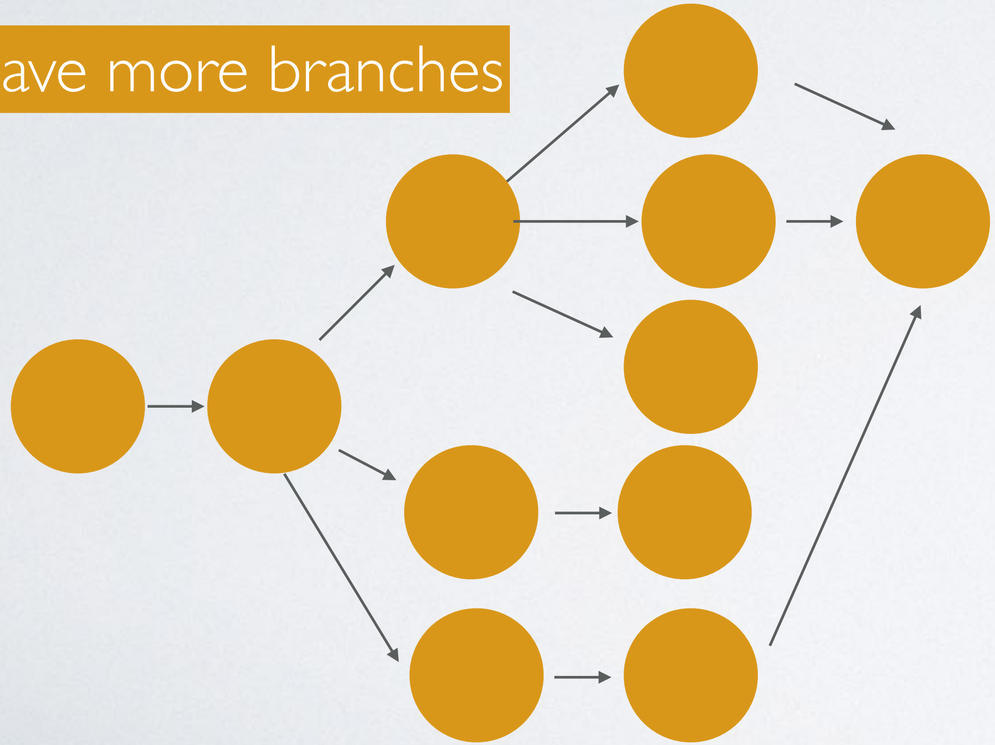


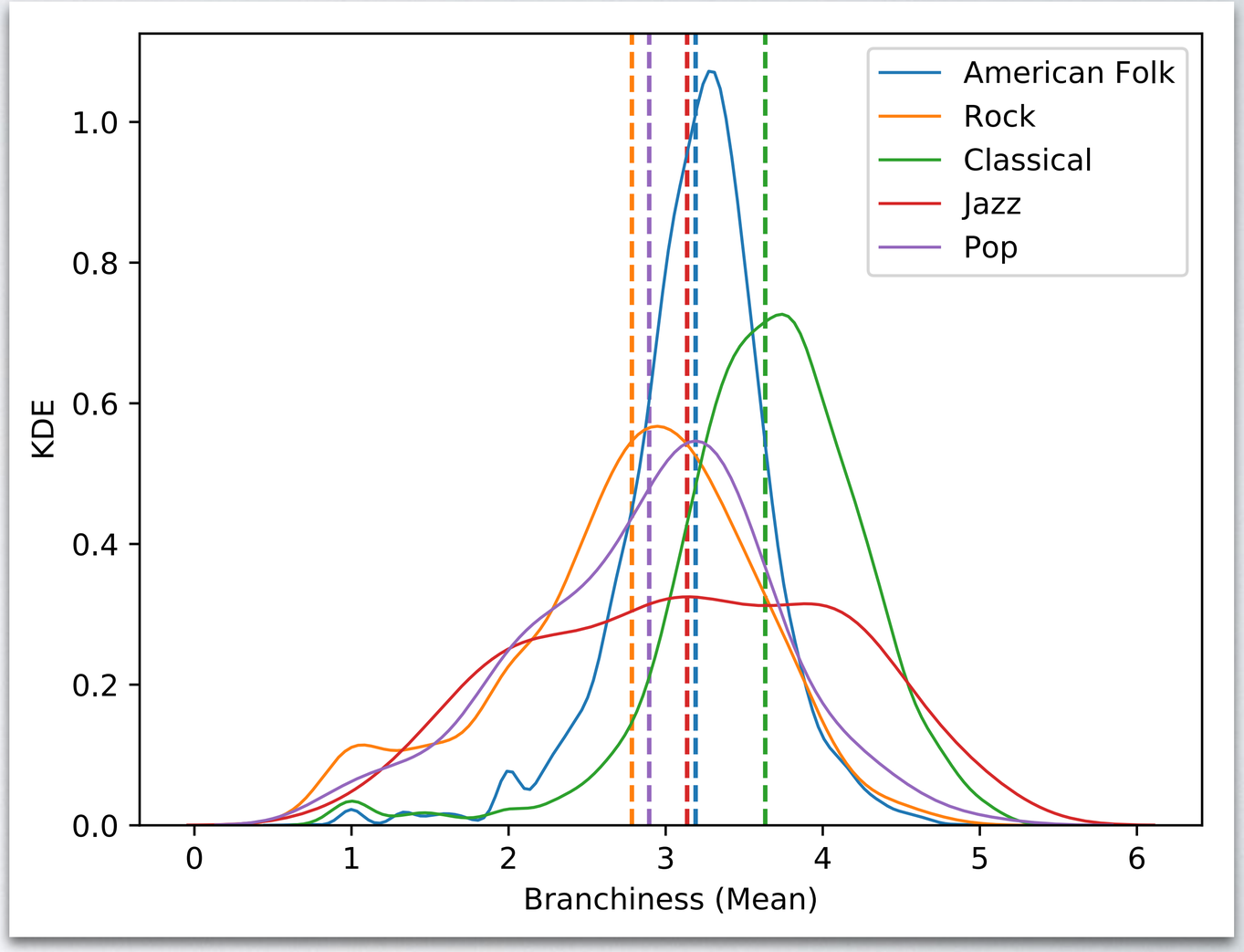
BRANCHING



"Chainly"

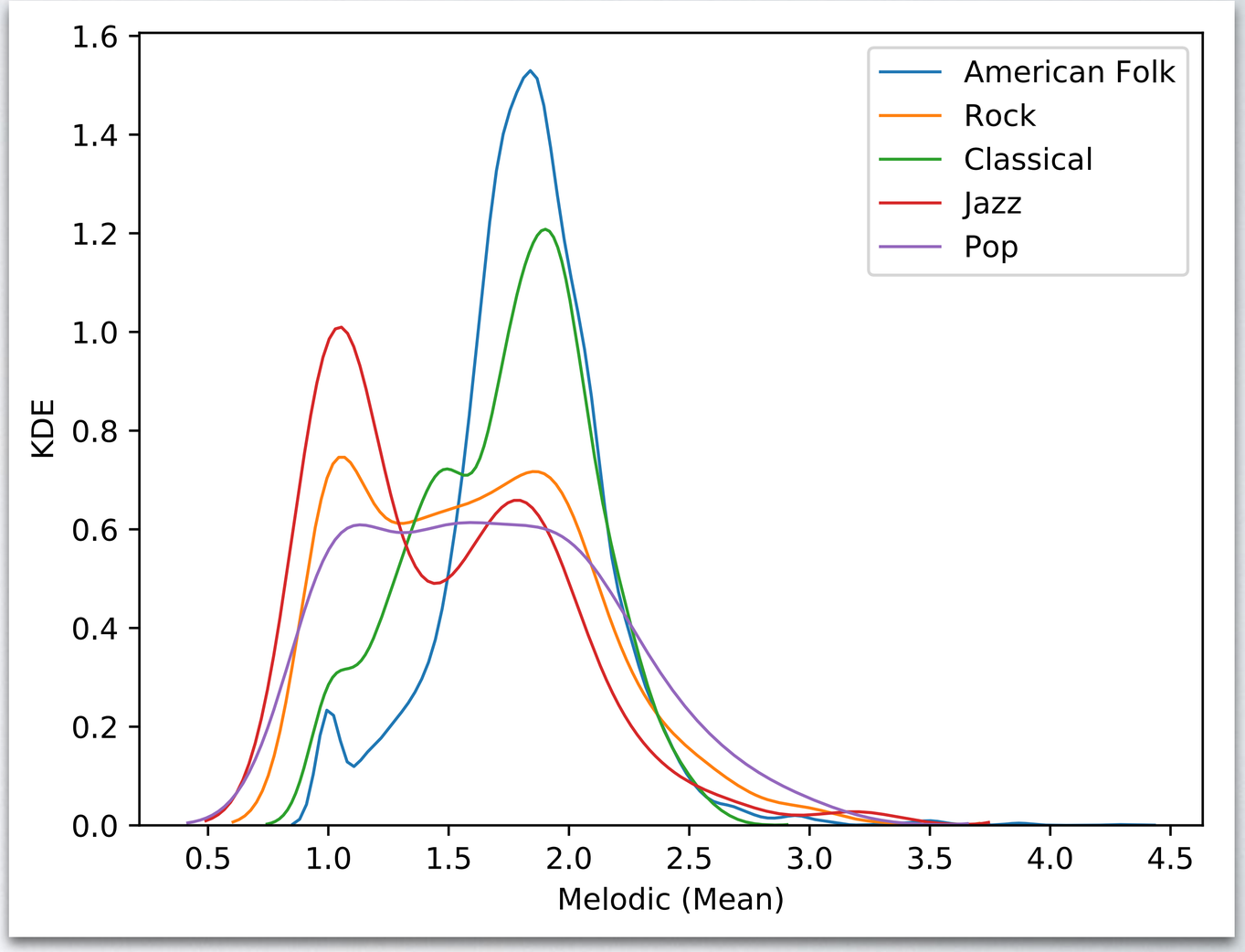
Have more branches



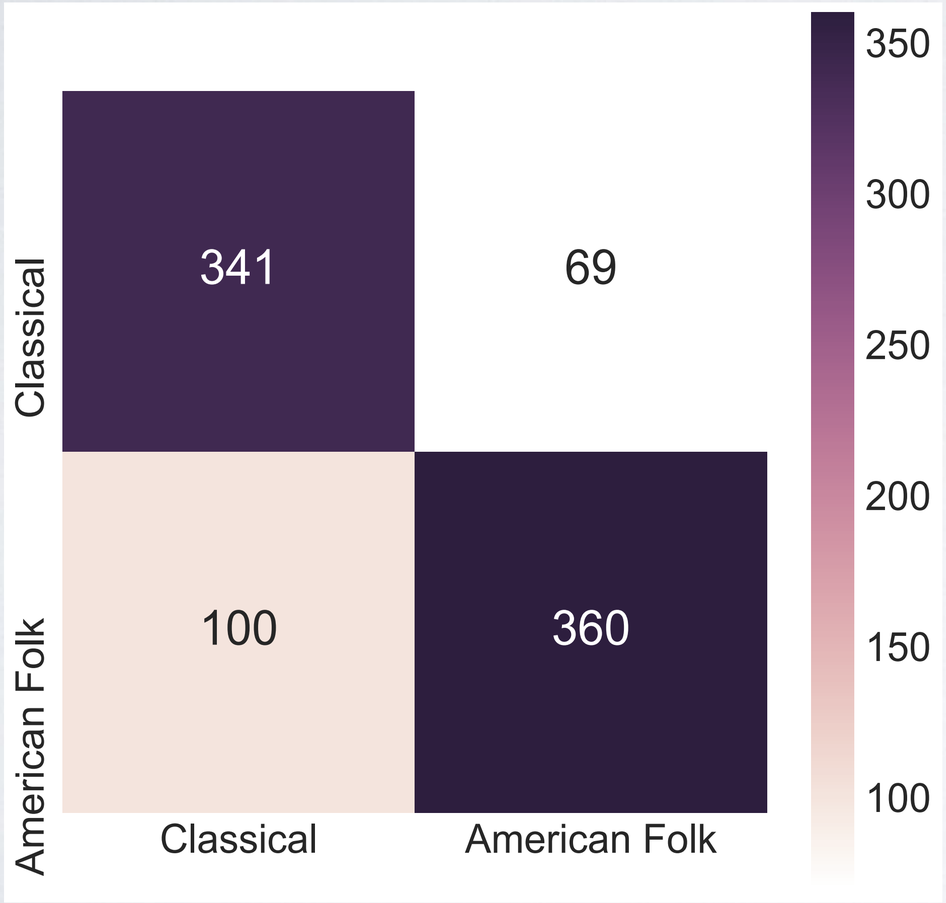


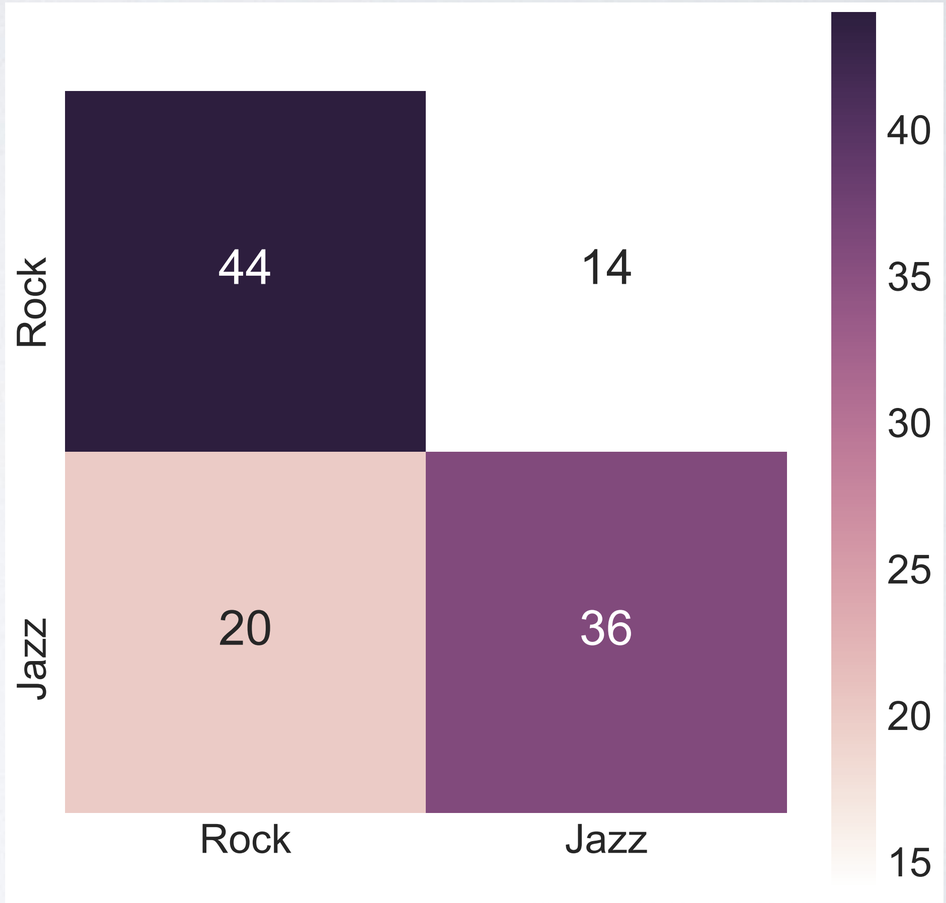
MELODIC

The length of extracted rules



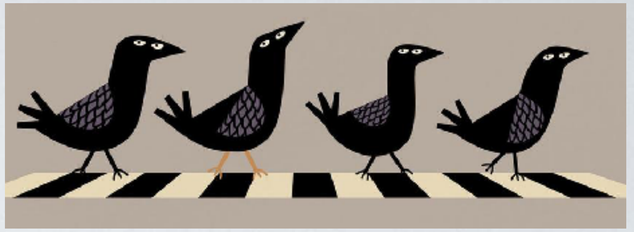
REVERSE ENGINEERING IDENTIFY GENRES USING FEATURES

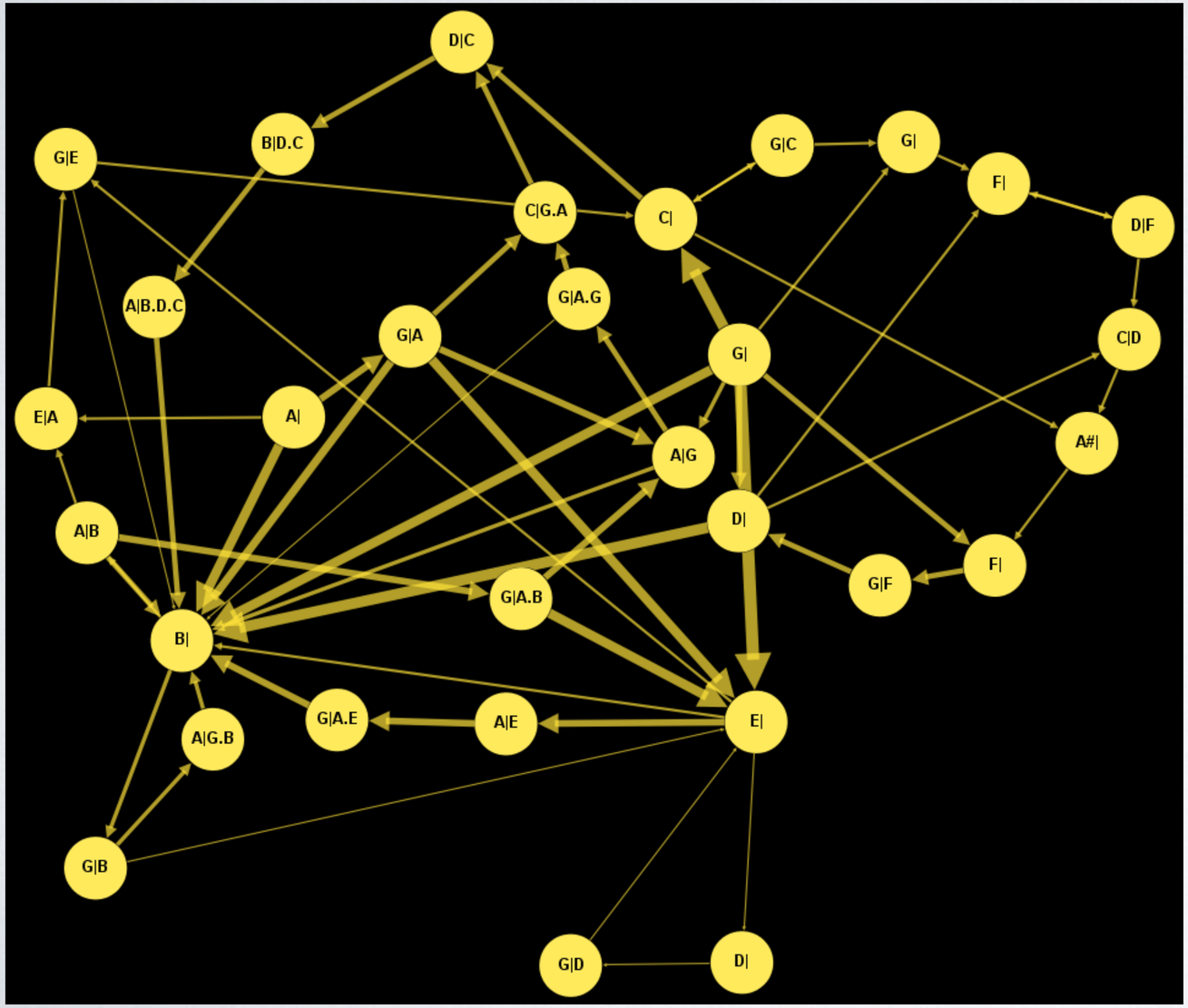


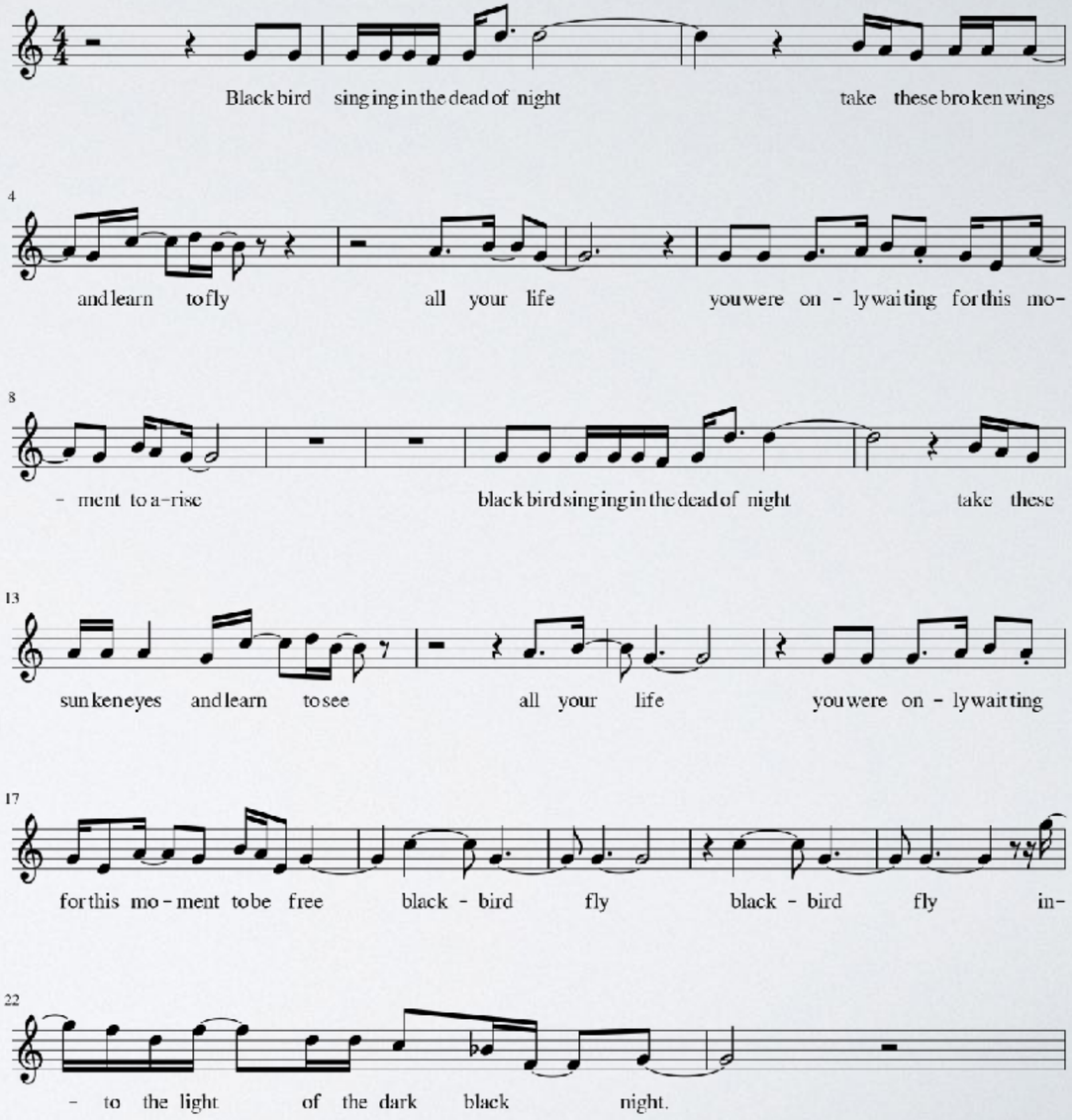


Classifier: Multilayer Perceptron

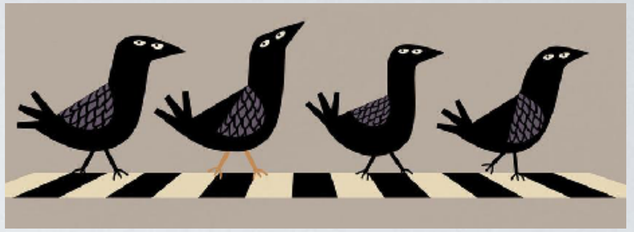
CASE STUDY

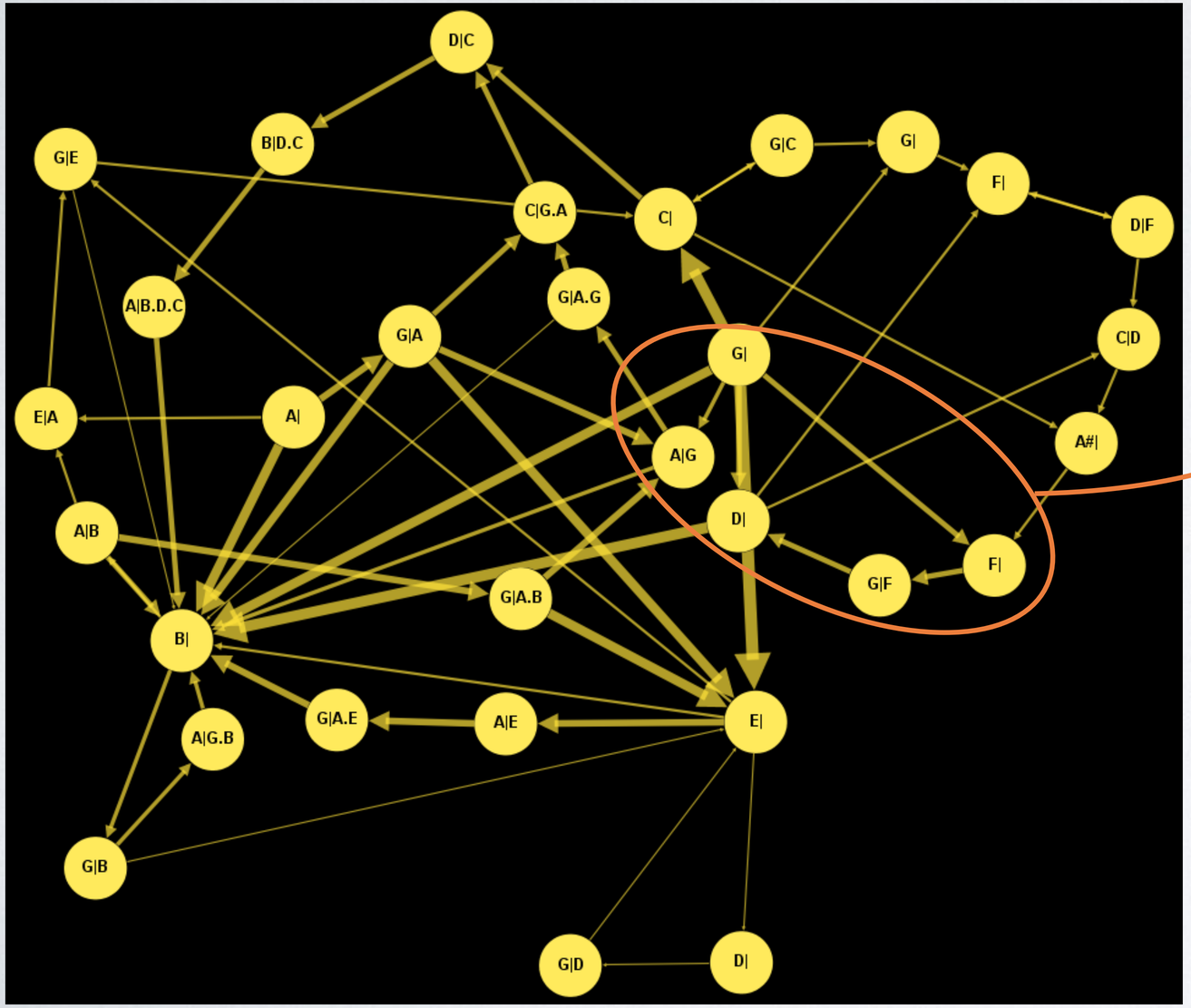


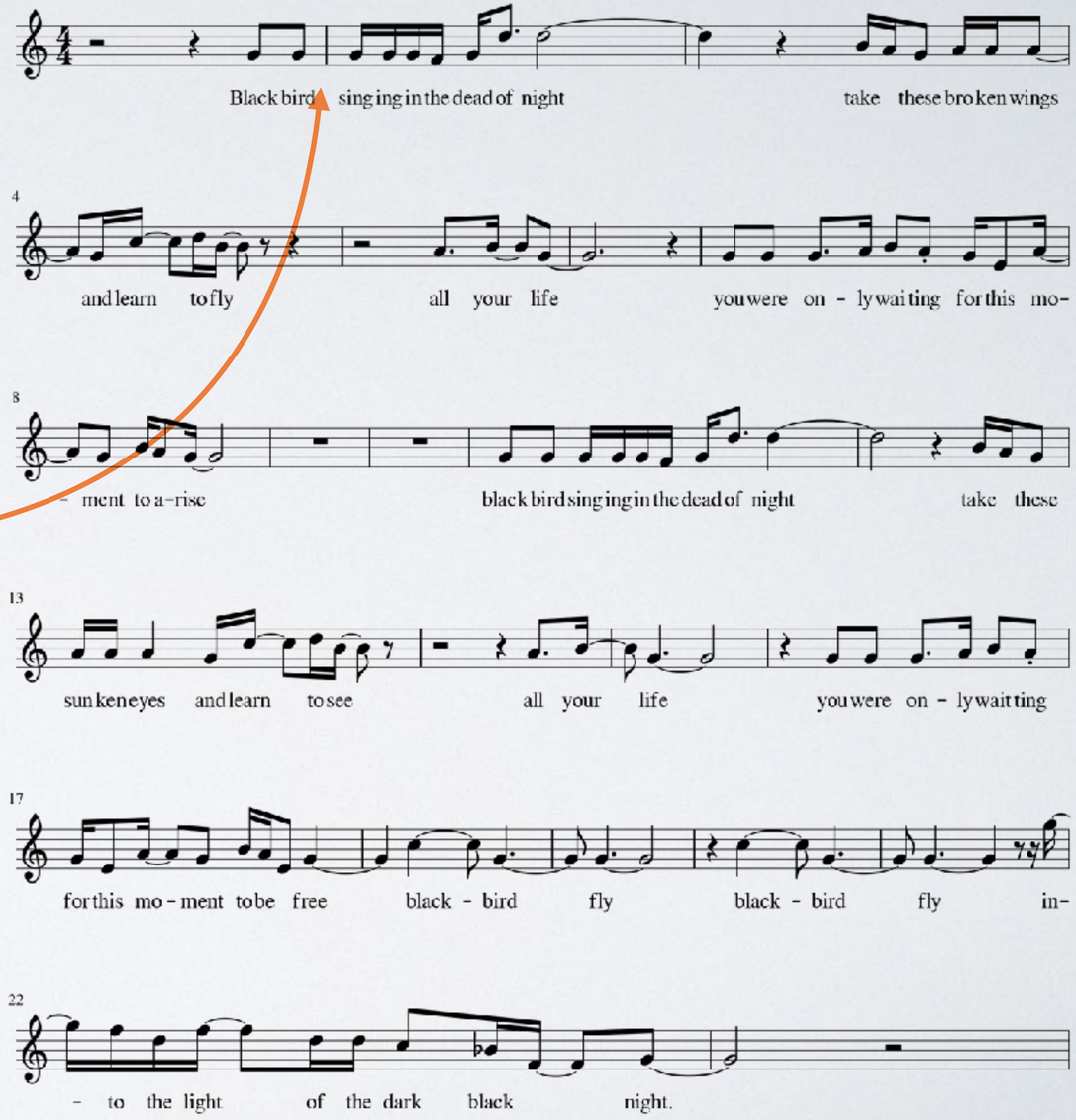

D|C
B|D.C
G|E
G|C
G|
F|
C|G.A
C|
D|F
A|B.D.C
G|A.G
G|A
G|
C|D
E|A
A|
A|G
A#|
A|B
D|
F|
G|F
G|A.B
B|
G|A.E
A|E
E|
A|G.B
G|B
G|D
D|


Black bird singing in the dead of night take these broken wings
4
and learn to fly all your life you were on - ly wai ting for this mo-
8
- ment to a-rise black bird singing in the dead of night take these
13
sun ken eyes and learn to see all your life you were on - ly wait ting
17
for this mo - ment to be free black - bird fly black - bird fly in-
22
- to the light of the dark black night.

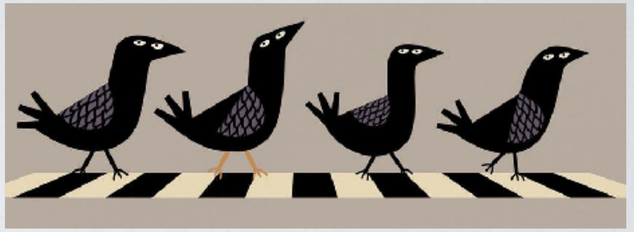
CASE STUDY

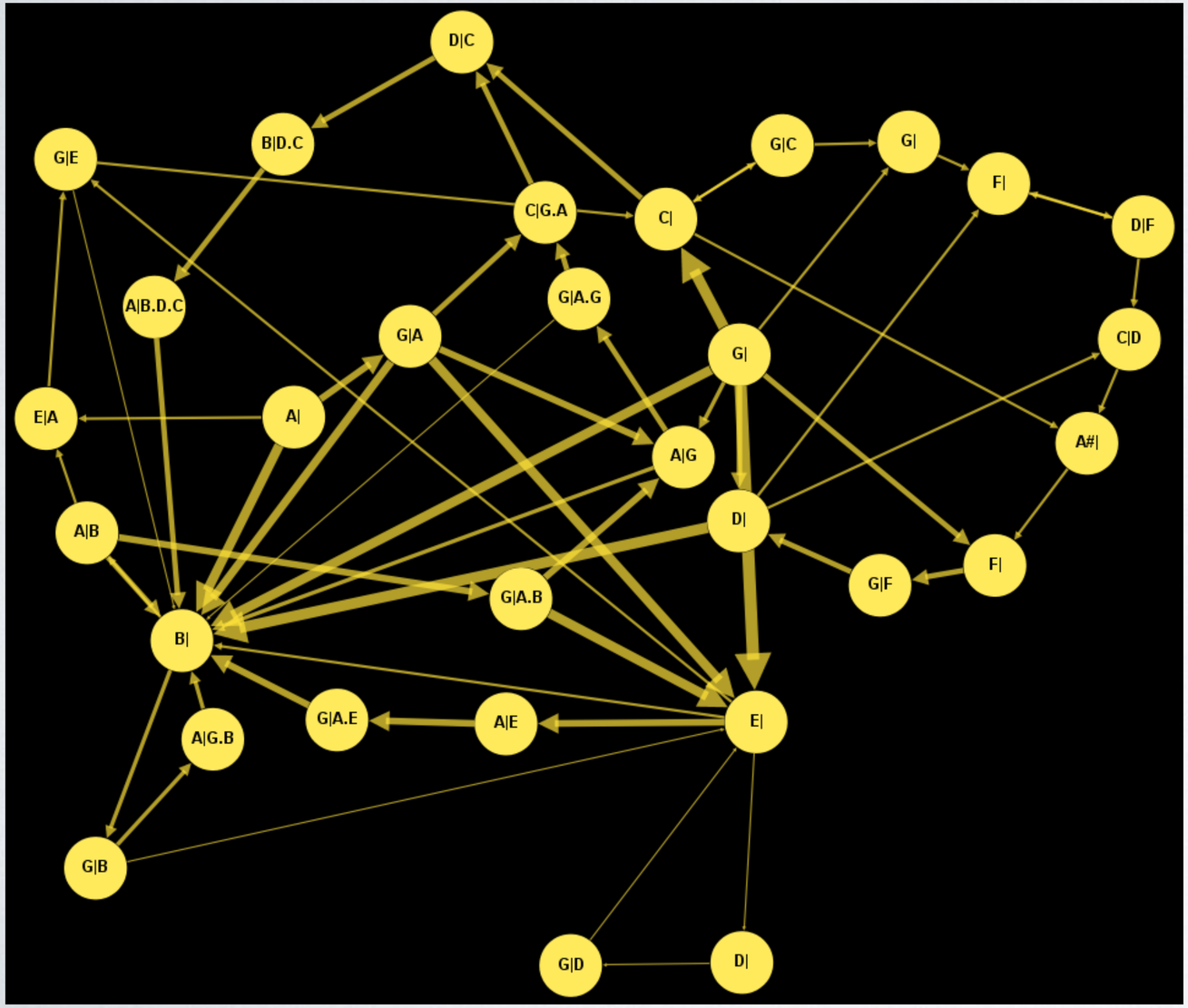


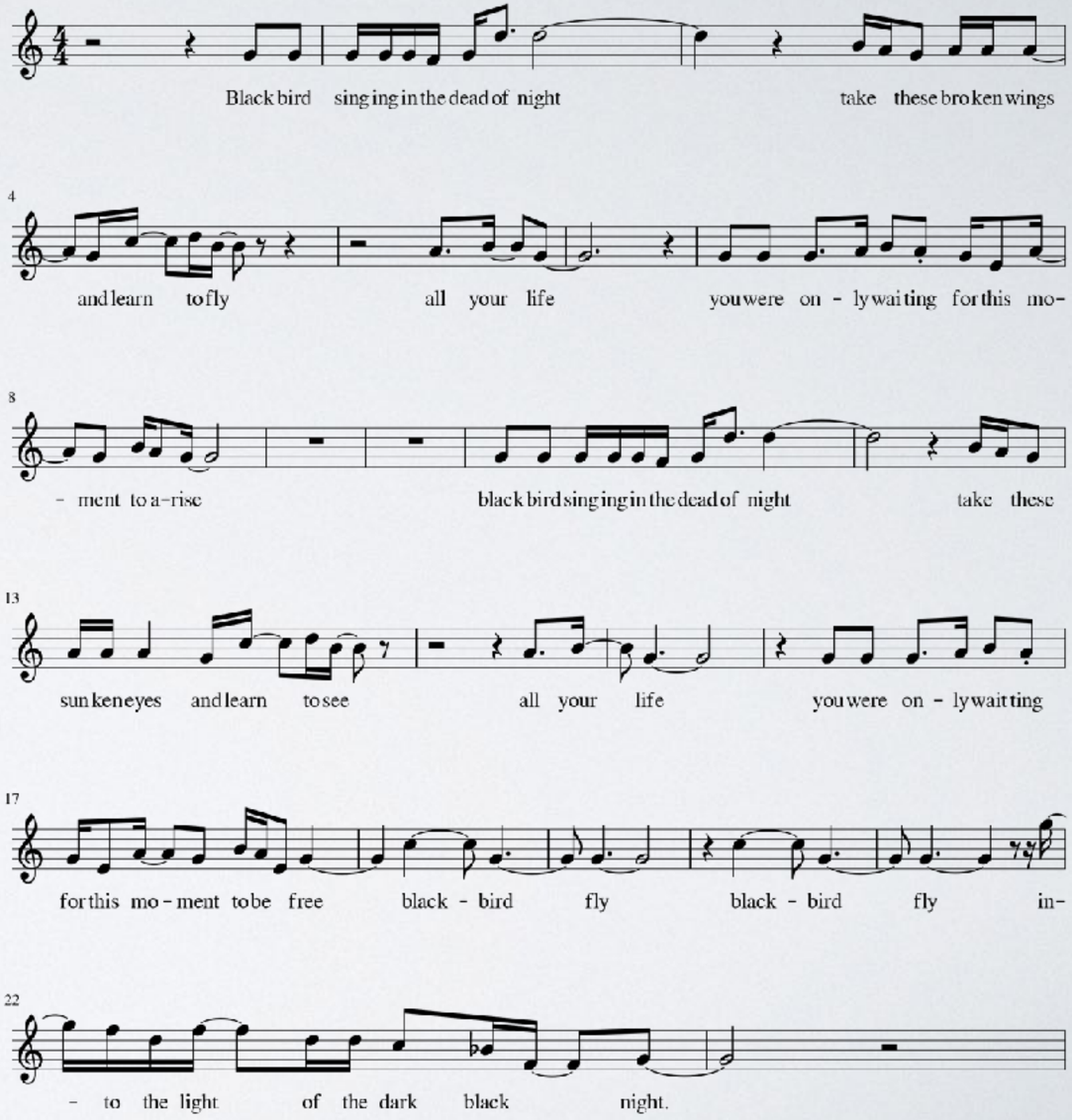

D|C
B|D.C
G|E
G|C
G|
F|
C|G.A
C|
D|F
A|B.D.C
G|A.G
G|A
G|
C|D
E|A
A|
A|G
A#|
D|
A|B
F|
G|F
G|A.B
B|
G|A.E
A|E
E|
A|G.B
G|B
G|D
D|


Black bird sing ing in the dead of night take these broken wings
4
and learn to fly all your life you were on - ly wai ting for this mo-
8
- ment to a-rise black bird sing ing in the dead of night take these
13
sun ken eyes and learn to see all your life you were on - ly wait ting
17
for this mo - ment to be free black - bird fly black - bird fly in-
22
- to the light of the dark black night.

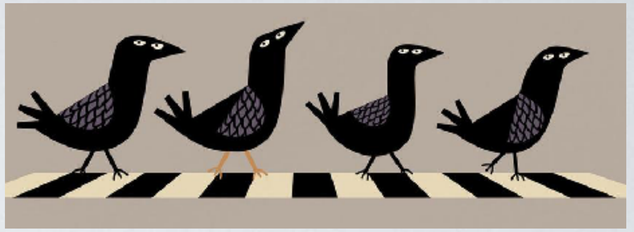
CASE STUDY

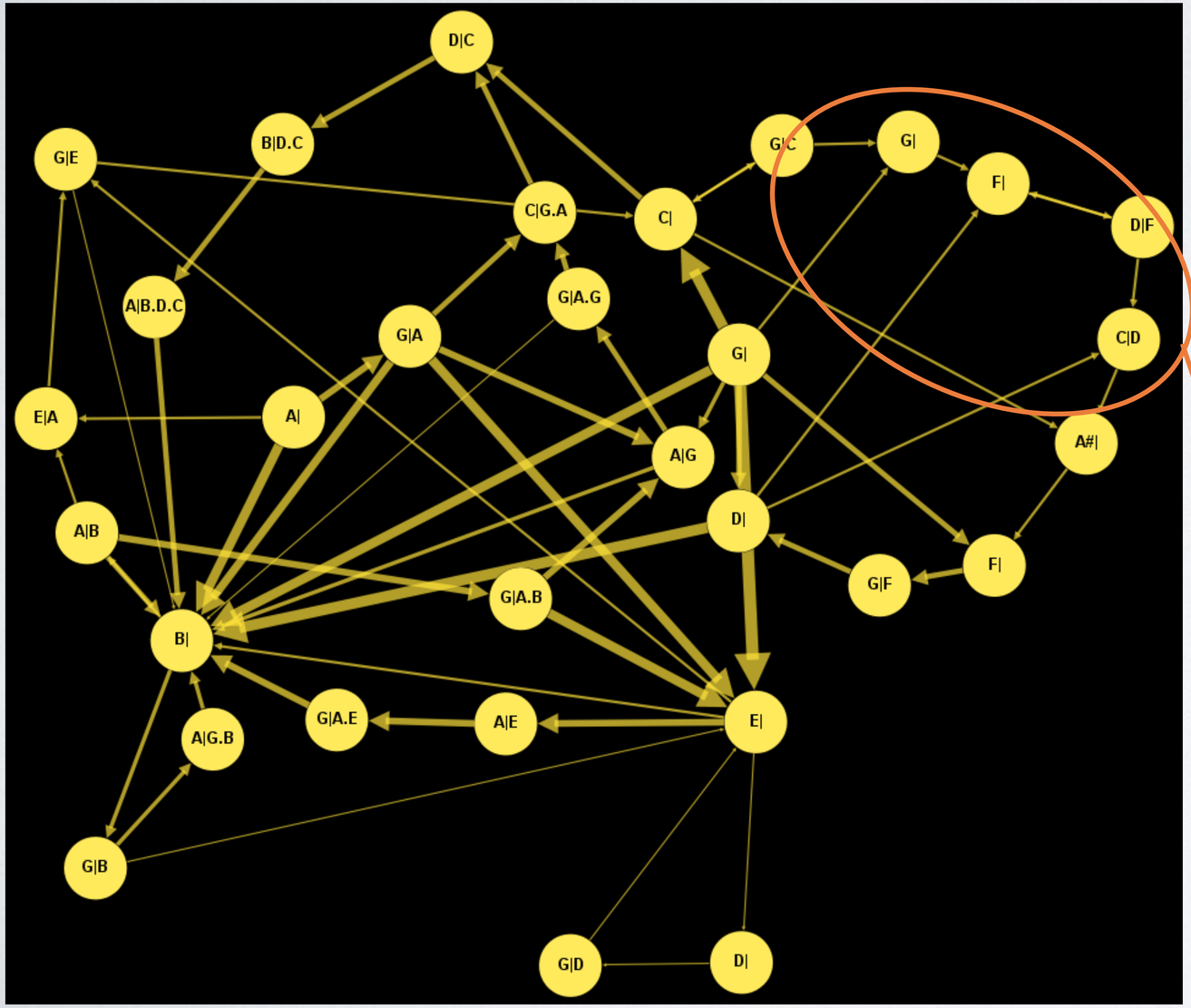


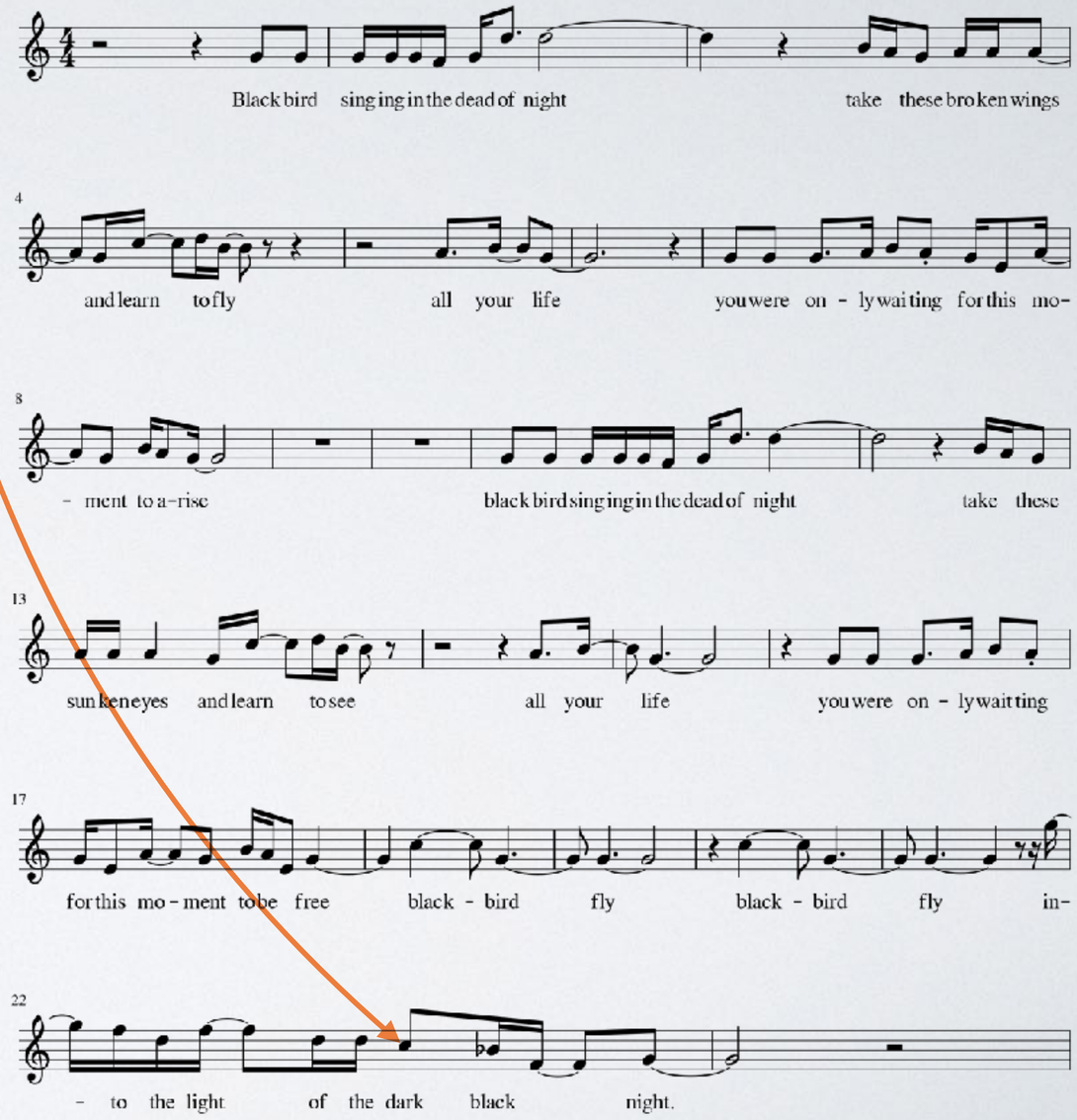

D|C
B|D.C
G|E
G|C
G|
F|
C|G.A
C|
D|F
A|B.D.C
G|A.G
G|A
G|
C|D
E|A
A|
A|G
A#|
A|B
D|
F|
G|F
G|A.B
B|
G|A.E
A|E
E|
A|G.B
G|B
G|D
D|


Black bird singing in the dead of night take these broken wings
4
and learn to fly all your life you were on - ly wai ting for this mo-
8
- ment to a-rise black bird singing in the dead of night take these
13
sun ken eyes and learn to see all your life you were on - ly wait ting
17
for this mo - ment to be free black - bird fly black - bird fly in-
22
- to the light of the dark black night.

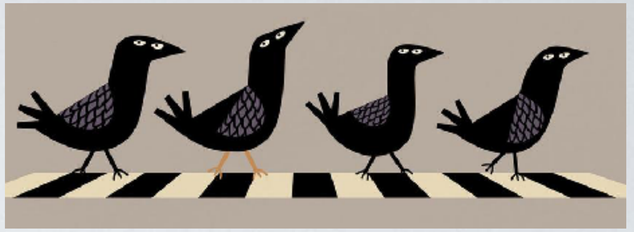
CASE STUDY

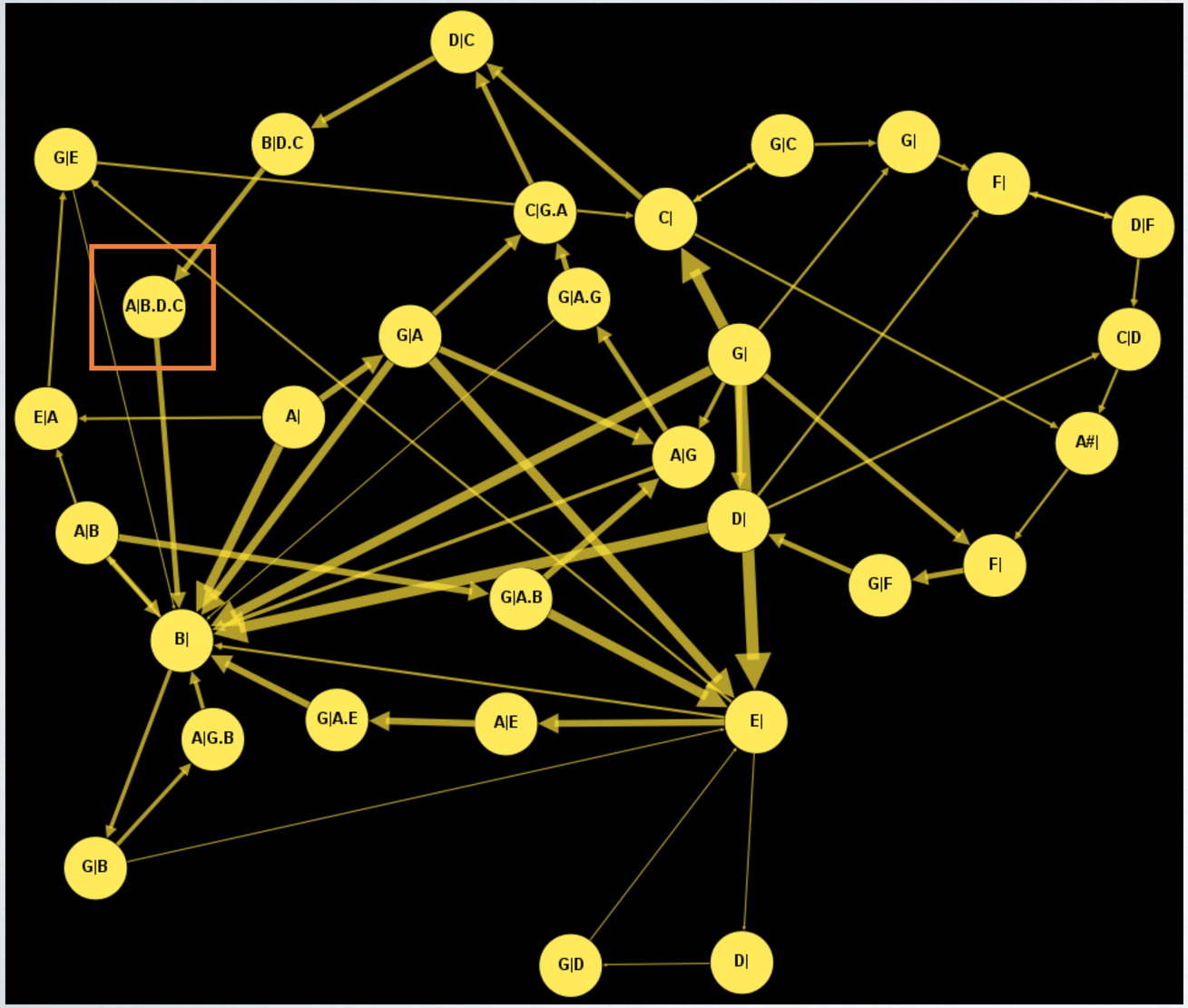


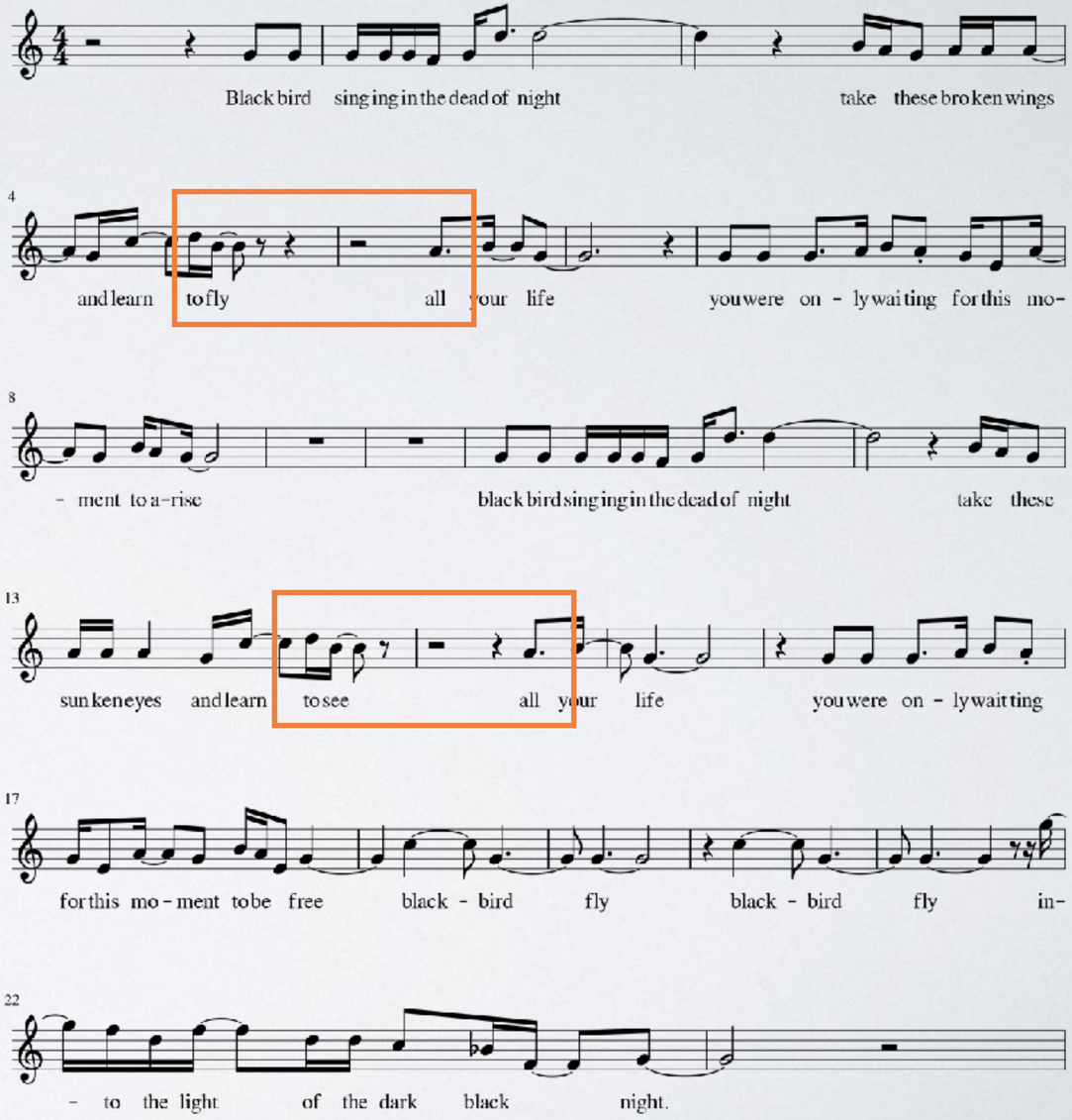

D|C
B|D.C
G|E
G|C
G|
F|
C|G.A
C|
D|F
A|B.D.C
G|A.G
G|A
G|
C|D
E|A
A|
A|G
A#|
A|B
D|
F|
G|F
G|A.B
B|
G|A.E
A|E
E|
A|G.B
G|B
G|D
D|


Black bird singing in the dead of night take these broken wings
4
and learn to fly all your life you were on - ly wai ting for this mo-
8
- ment to a-rise black bird singing in the dead of night take these
13
sun ken eyes and learn to see all your life you were on - ly wait ting
17
for this mo - ment to be free black - bird fly black - bird fly in-
22
- to the light of the dark black night.

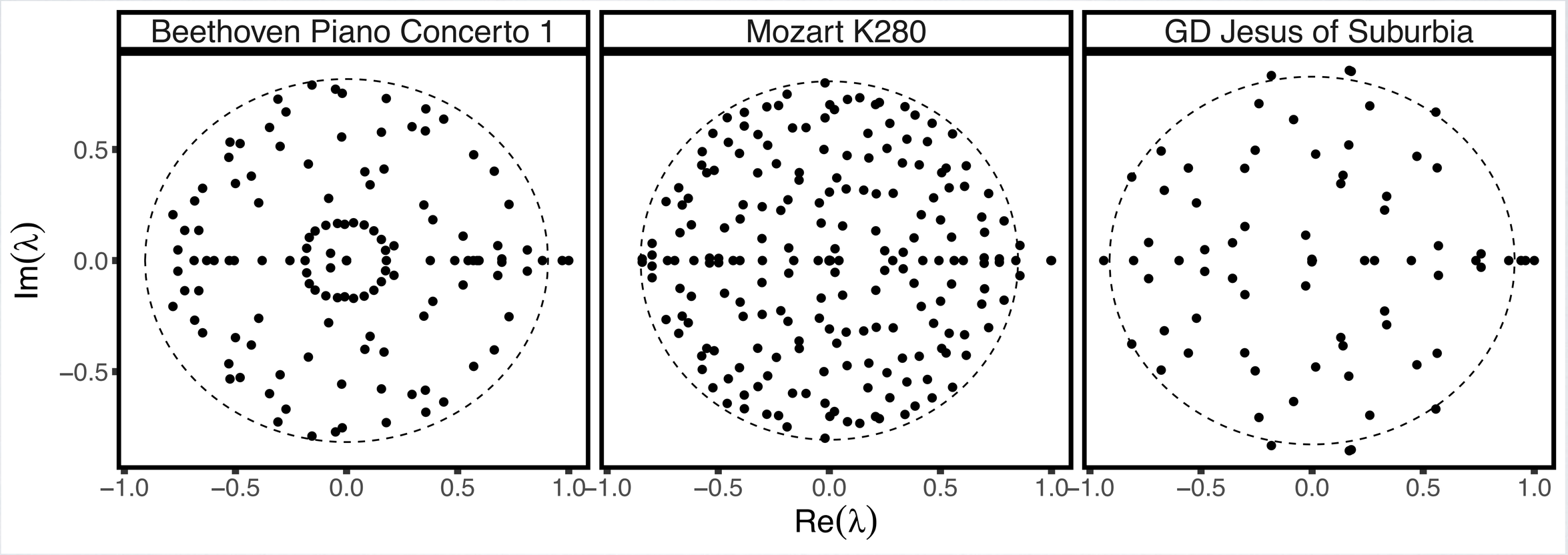
CASE STUDY




D|C
B|D.C
G|E
G|C
G|
F|
C|G.A
C|
D|F
A|B.D.C
G|A.G
G|A
C|D
G|
E|A
A|
A|G
A#|
A|B
D|
F|
G|F
G|A.B
B|
G|A.E
A|E
E|
A|G.B
G|B
G|D
D|


Black bird singing in the dead of night take these broken wings
4
and learn to fly all your life you were on - ly wai ting for this mo-
8
- ment to a-rise black bird singing in the dead of night take these
13
sun ken eyes and learn to see all your life you were on - ly wait ting
17
for this mo - ment to be free black - bird fly black - bird fly in-
22
- to the light of the dark black night.

EIGENVALUES OF HON



CONCLUSIONS

- Features from higher order network can capture characteristics across different music genres
- Eigenvalues of higher order network need further inspection

FUTURE PLAN

- Better understanding of higher order networks and its eigenvalues
- Multilayer network to incorporate different instruments
- Add temporal information to capture rhythm
- and so much more! 😉


Questions?

MIDI CODE TABLE

Note	Octave										
	-1	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
C	0	12	24	36	48	**60**	72	84	96	108	120
C#	1	13	25	37	49	**61**	73	85	97	109	121
D	2	14	26	38	50	**62**	74	86	98	110	122
D#	3	15	27	39	51	**63**	75	87	99	111	123
E	4	16	28	40	52	**64**	76	88	100	112	124
F	5	17	29	41	53	**65**	77	89	101	113	125
F#	6	18	30	42	54	**66**	78	90	102	114	126
G	7	19	31	43	55	**67**	79	91	103	115	127
G#	8	20	32	44	56	**68**	80	92	104	116	
A	9	21	33	45	57	**69**	81	93	105	117	
A#	10	22	34	46	58	**70**	82	94	106	118	
B	11	23	35	47	59	**71**	83	95	107	119	

OTHER FEATURES FROM HON

- Repeatedness
- Pitch range
  - Pitch range within the piece
  - Pitch range between rules
  - Pitch range between adjacent rules