GP Assignment - Markov Analysis and Algorithmic Composition

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Abstract: This assignment contains Fugue tokens of Beethoven's "Ode to Joy" and Turk's "March" in which variants are produced of them. It also contains a short essay explaining the process.

Beethoven Task

State Transition **Count** Matrix:

from/ to	E	F	G	D	C	EQ	DI	DH	CI	DQ	CH
E	2	2	0	2	0	1	0	0	0	1	0
F	2	0	2	0	0	0	0	0	0	0	0
G	0	2	2	0	0	0	0	0	0	0	0
D	2	0	0	0	2	0	0	0	0	0	0
C	0	0	0	2	2	0	0	0	0	0	0
EQ	0	0	0	0	0	0	1	0	0	0	0
DI	0	0	0	0	0	0	0	1	0	0	0
DH	1	0	0	0	0	0	0	0	0	0	0
CI	0	0	0	0	0	0	0	0	0	0	1
DQ	0	0	0	0	0	0	0	0	1	0	0
CH	1	0	0	0	0	0	0	0	0	0	0

State Transition **Probability** Matrix:

from/ to	E	F	G	D	C	EQ	DI	DH	CI	DQ	CH
E	.25	.25	0	.25	0	.125	0	0	0	.125	0
F	.5	0	.5	0	0	0	0	0	0	0	0
G	0	.5	.5	0	0	0	0	0	0	0	0
D	.5	0	0	0	.5	0	0	0	0	0	0
C	0	0	0	.5	.5	0	0	0	0	0	0
EQ	0	0	0	0	0	0	1	0	0	0	0
DI	0	0	0	0	0	0	0	1	0	0	0
DH	1	0	0	0	0	0	0	0	0	0	0
CI	0	0	0	0	0	0	0	0	0	0	1
DQ	0	0	0	0	0	0	0	0	1	0	0
CH	1	0	0	0	0	0	0	0	0	0	0

State Transition Probability **Distribution** Matrix:

from/ to	E	F	G	D	C	EQ	DI	DH	CI	DQ	CH
E	.25%	.50%	.50%	.75%	.75%	.875%	.875%	.875%	.875%	1.00	1.00
F	.5%	.5%	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
G	0	.5%	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
D	.5%	.5%	.5%	.5%	1.00	1.00	1.00	1.00	1.00	1.00	1.00
C	0	0	0	.5%	1.00	1.00	1.00	1.00	1.00	1.00	1.00

EQ	0	0	0	0	0	0	1.00	1.00	1.00	1.00	1.00
DI	0	0	0	0	0	0	0	1.00	1.00	1.00	1.00
DH	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
CI	0	0	0	0	0	0	0	0	0	0	1.00
DQ	0	0	0	0	0	0	0	0	1.00	1.00	1.00
CH	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

4. 0.571 0.790 0.693 0.359 0.009 0.252 0.134 0.839 0.846 0.863 0.396 0.213 0.540 0.976 0.351 0.619 0.227 0.798 0.595 0.438 0.278 0.235 0.138 0.212 0.202 0.309 0.689 0.829 0.060 0.725

1. S → *S*
2. R → .571
3. S → D
4. D
5. R → .790
6. S → G
7. G
8. R → .693
9. S → G
10. G
11. R → .359
12. S → E
13. E
14. R →.009
15. S → D
16. D
17. R → .252
18. S → DI
19. DI
20. R → .134
21. S → DH
22. DH
23. R → .839
24. S → E
25. E
26. R → .846
27. S → CH
28. CH
29. R → .863

30. S → CI
31. CI
32. R → .396
33. S → E
34. E
35. R → .213
36. S → E
37. E
38. R → .540
39. S → G
40. G
41. R →.976
42. S → G
43. G
44. R → .351
45. S → E
46. E
47. R → .619
48. S → C
49. C
50. R →.227
51. S → DI
52. DI
53. R → .798
54. S → DH
55. DH
56. R → .595
57. S → E
58. E
59. R → .438
60. S → CH
61. CH
62. R → .278
63. S → CI
64. CI
65. R → .235
66. S → E
67. E
68. R → .138
69. S → E
70. E
71. R → .212
72. S → E
73. E
74. R → .202
75. S → F

76. F
77. R → .309
78. S → E
79. E
80. R → .689
81. S → C
82. C
83. R → .829
84. S → DI
85. DI
86. R → .060
87. S → DH
88. DH
89. R → .725
90. S → E
91. E

Variant: D, G, G, E, D, DI, DH, E, CH, CI, E, E, G, G, E, C, DI, DH, E, CH, CI, E, E, E, F, E, C, DI, DH, E

Turks Task

State Transition **Count** Matrix:

from/ to	C	G	EH	CH	D	FH	DH	E
C	2	1	0	0	1	0	0	0
G	0	0	1	0	0	1	0	1
EH	0	0	0	1	0	0	0	0
CH	0	0	0	1	1	0	0	0
D	0	2	0	1	5	0	0	0
FH	0	0	0	0	0	0	1	0
DH	0	0	0	0	0	0	0	1
E	1	0	0	0	1	0	0	3

State Transition **Probability** Matrix:

from/ to	C	G	EH	CH	D	FH	DH	E
C	.5%	.25%	0	0	.25%	0	0	0
G	0	0	.333%	0	0	.333%	0	.333%
EH	0	0	0	1	0	0	0	0
CH	0	0	0	.5%	.5%	0	0	0
D	0	.25%	0	.125%	.625%	0	0	0
FH	0	0	0	0	0	0	1	0
DH	0	0	0	0	0	0	0	1
E	.2%	0	0	0	.2%	0	0	.6%

State Transition Probability **Distribution** Matrix:

from/ to	C	G	EH	CH	D	FH	DH	E
C	.5%	.75%	.75%	.75%	1.00	1.00	1.00	1.00
G	0	.25%	.25%	.375%	1.00	1.00	1.00	1.00
EH	0	0	0	1.00	1.00	1.00	1.00	1.00
CH	0	0	0	.5%	1.00	1.00	1.00	1.00
D	0	.25%	.25%	.375%	1.00	1.00	1.00	1.00
FH	0	0	0	0	0	0	1.00	1.00
DH	0	0	0	0	0	0	0	1.00
E	.2%	.2%	.2%	.2%	.4%	.4%	.4%	1.00

4. 0.033 0.932 0.257 0.925 0.796 0.267 0.401 0.721 0.604 0.430 0.587 0.334 0.418 0.229 0.286

0.438 0.569 0.606 0.721 0.528 0.763 0.853 0.383 0.708 0.081 0.565

1. S → *S*
2. R → .033
3. S → C
4. C
5. R → .932
6. S → D
5. D
6. R →.257
7. S → CH
8. CH
9. R → .925
10. S → D
11. D
12. R → .796
13. S → D
14. D
15. R → .267
16. S → DH
17. DH
18. R →.401
19. S → E
20. E
21. R →.721
22. S → E
23. E
24. R → .604
25. S → G
26. G
27. R →.430
28. S → D
29. D
30. R →.587
31. S → CH
32. CH
33. R → .334
34. S → D
35. D
36. R →.418
37. S → D
38. D

39. R→. 229
40. S → DH
41. DH
42. R → .286
43. S → E
44. E
45. R →.438
46. S → E
47. E
48. R → .569
49. S → G
50. G
51. R → .606
52. S → D
53. D
54. R →.721
55. S → CH
56. CH
57. R → .528
58. S → D
59. D
60. R → .763
61. S → D
60. D
61. R → .853
62. S → DH
63. DH
64. R → .383
65. S → E
66. E
67. R →.708
68. S → E
69. E
70. R → .081
71. S → C
72. C
73. R→ .565
74. S → D
75. D

Variant: C, D, CH, D, D, DH, E, E, G, D, CH, D, D, DH, E, E, G, D, CH, D, D, DH, E, E, C, D

Short Essay

The two melodies that were focused on this assignment was, Ode to Joy by Beethoven and March by Turk. Both these melodies are written by well-known classical composers, but they differ in certain ways. For instance, in Ode to Joy by Beethoven, the tone of this song takes more of a rising tone where the notes sort of build off another sequentially. Whereas March has a steady tone where the notes are almost representing repeating elements. In terms of a state transition probability matrix, I think the one for Ode to Joy captures the spirit of the song for a few reasons. First, throughout the song there is not only a rising feel to it, but the duration of the notes played stand out as well. To add on, in the state distribution matrix, the values from a key to a key is typically closer to one (the full probability) then it is to zero. That is for the slots that aren't zero. This is the complete opposite from March because the keys played for this song don't seem to be played for as long as a duration. Furthermore, this can be seen in its state transition probability matrix because the values that contain a percentage is likely to be closer to zero then one.

A Markov process is a representation of states that can also work as models which determines the transition probabilities amongst those states. It works by interpreting the full scope of the present to determine the possible future actions. Markov processes are useful for predicting a possible future transition amongst those states. Overall Markov processes aid future hypotheses made about a model where there can be states and transition probabilities. For example, the two variants produced from the two melodies Ode to Joy and March were come to by first, creating a count, probability, and distribution matrix. Then, ran through an algorithm that produced a similar yet not the same variant.

The variant's just like the original contains a sample of JFugue keys. The keys can be a knowledge representation because each key is different and could be played uniquely duration wise as well. Therefore, these keys can serve as different states in a Markov process. Furthermore, since they vary, the transition probabilities amongst these keys can be calculated and even predicted with some accuracy. JFugue serves as executable music knowledge representation because the differences in states or keys can be heard when executed. For example, the variants created from the original's Ode to Joy and March are like their predecessors but in an executable program the differences amongst the representations can still be heard.

All in all, for the variants to come to life, the JFugue notes had to be put into a simple player, which converted the text file containing the notes to midi. The midi file was then converted to a mp3 file which is executable. The creation of the variants was structured through the different matrixes so in some sense the variants are not a result of improvisation. Yet on the other hand, music is a free-flowing art and the variants that where created did have at least some sense to creativity to it. So, it is fair to say that the variants that were produced could be viewed as an improvisational process.