

J.S. Bach: Aria from Goldberg Variations BWV 988
played by Glenn Gould
recording CBS Masterworks, New York **1955**

The following pages demonstrate the automated quantisation and transcription of the Bach Aria based only on the onsets as played by Gould. We list the original onset data gathered from this recording together with the recognised rhythmical grouping and followed by the successful quantisation with our program. The results are also rendered into Lilypond scores.

This Logbook is the second part covering bars 17 – 32. For the first part please look for Logbook_3.pdf under <http://dream.cs.bath.ac.uk/transcriptions/>

For more information read my paper:

Boenn, G "Automated Transcription of Ornaments from Audio Recordings",
Proceedings of the International Computer Music Conference (ICMC),
Copenhagen, 2007

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bar 17

In this bar the simultaneous ornaments in LH and RH are challenging to quantise. Moreover, the last beat has a more ternary feel than it is written in the score. Here is a good approximation of the underlying hierarchy:



bar 17, beat 1

4 durations:

0.0831025

0.0618652

0.372576

0.482456

data gathered in groups...

+++++

0:

0.0831025019

0.0618651994

+++++

+++++

1:

0.372575998

+++++

+++++

2:

0.482455999

+++++

quantisation result:

0:

index: 0: 0.0625

index: 1: 0.0625

1:

index: 2: 0.375

2:

index: 3: 0.5



bar 17, beat 2

11 durations:

0.0697786
0.0615977
0.0697786
0.1564
0.128489
0.134264
0.0948027
0.0837344
0.072666
0.0587103
0.0697786

this is challenging because lh and rh have ornaments at the same time!

data gathered in groups...

+++++

0:

0.156399995
0.128489003
0.134264007
0.0948027

+++++

+++++

1:

0.0697785988
0.0615977012
0.0697785988
0.128489003
0.0948027
0.0837344006
0.0726659968
0.0587102994
0.0697785988

+++++

quantisation result:

0:

index: 3: 0.125

index: 4: 0.125

index: 5: 0.125

index: 6: 0.125

1:

index: 0: 0.0833333358

index: 1: 0.0833333358

index: 2: 0.0833333358

index: 4: 0.0833333358

index: 6: 0.0833333358

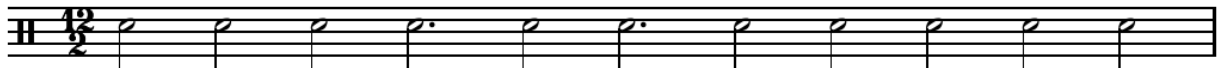
index: 7: 0.0833333358

index: 8: 0.0833333358

index: 9: 0.0833333358

index: 10: 0.0833333358

gould55_17_2b_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=1.000000_s=1.250000_3.pdf



bar 17, beat 3

6 durations:

0.3161
0.0893424
0.0875283
0.0834467
0.115646
0.307937

data gathered in groups...

+++++

0:
0.316100001
0.307936996

+++++

+++++

1:
0.0893424004
0.0875283033
0.0834466964
0.115645997

+++++

quantisation result:

0:
index: 0: 0.25
index: 5: 0.25
1:
index: 1: 0.125
index: 2: 0.125
index: 3: 0.125
index: 4: 0.125

gould55_17_3_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=0.000000_s=1.000000_0.pdf



bar 18

8 durations:

0.0844057
0.0827453
0.0690466
0.0810848
0.159817
0.167013
0.19358
0.162308

data gathered in groups...

+++++

0:

0.0844056979
0.0827452987
0.0690466017
0.0810848027

+++++

+++++

1:

0.159816995
0.167013004
0.193580002
0.162307993

+++++

quantisation result:

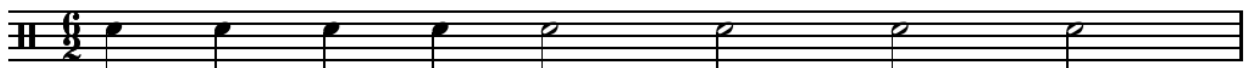
0:

index: 0: 0.0833333358
index: 1: 0.0833333358
index: 2: 0.0833333358
index: 3: 0.0833333358

1:

index: 4: 0.166666672
index: 5: 0.166666672
index: 6: 0.166666672
index: 7: 0.166666672

gould55_18_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=1.000000_s=1.000000_0.pdf



bar 19

12 durations:

0.0870076
0.0793651
0.0767196
0.0412992
0.0448266
0.159612
0.189447
0.168136
0.0383598
0.0349794
0.0324809
0.047766

this bar has a problem with the trill in the LH. When omitted, results are:

data gathered in groups...

+++++

0:

0.0870075971

0.079365097

0.076719597

+++++

+++++

1:

0.0412992015

0.0448266007

0.0383597985

0.0349793993

0.047766

0.0324808992

+++++

+++++

2:

0.159612

0.189447001

0.168136001

+++++

quantisation result:

0:

index: 0: 0.0833333358

index: 1: 0.0833333358

index: 2: 0.0833333358

1:

index: 3: 0.0416666679

index: 4: 0.0416666679

index: 8: 0.0416666679

index: 9: 0.0416666679

index: 11: 0.0416666679

index: 10: 0.0416666679

2:

index: 5: 0.1666666672

index: 6: 0.1666666672

index: 7: 0.1666666672

gould55_19f_mark.txt.msiof_0_quant.txt_notat_.txt_d=3.000000_s=1.000000_0.
pdf



bar 19, beat 1

5 durations:

0.264286
0.241071
0.233036
0.116518
0.145089

data gathered in groups...

+++++

0:

0.264286011
0.241071001
0.233035997

+++++

+++++

1:

0.116517998
0.145089

+++++

quantisation result:

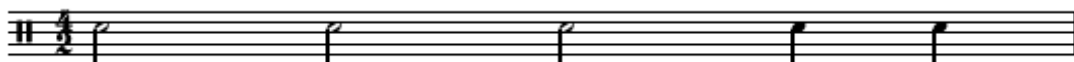
0:

index: 0: 0.25
index: 1: 0.25
index: 2: 0.25

1:

index: 3: 0.125
index: 4: 0.125

gould55_19_1_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=0.000000_s=1.000000_0.pdf



bar 19, beat 2

2 durations:

0.457263

0.542737

data gathered in groups...

+++++

0:

0.457262993

0.542737007

+++++

quantisation result:

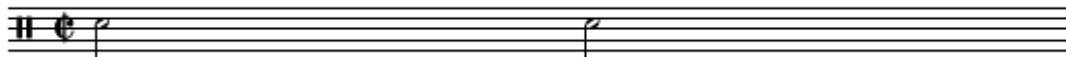
0:

index: 0: 0.5

index: 1: 0.5

gould55_19_2_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=-

1.000000_s=1.000000_0.pdf



bar 19, beat 3

8 durations:

- 0.106033
- 0.0530165
- 0.0530165
- 0.310329
- 0.119287
- 0.108775
- 0.101005
- 0.148537

data gathered in groups...

+++++

0:

0.0530164987

0.0530164987

+++++

+++++

1:

0.31032899

+++++

+++++

2:

0.106032997

0.119286999

0.108774997

0.101005003

0.148536995

+++++

quantisation result:

gould55_19_3_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=3.000000_s=1.000000_0.pdf



bar 20

8 durations:

0.173808
0.0675369
0.0939274
0.0807321
0.090664
0.164728
0.160613
0.167991

data gathered in groups...

+++++

0:

0.173807994
0.164728001
0.160613
0.167990997

+++++

+++++

1:

0.067536898
0.0939273983
0.0807320997
0.0906639993

+++++

quantisation result:

0:

index: 0: 0.166666672
index: 5: 0.166666672
index: 6: 0.166666672
index: 7: 0.166666672

1:

index: 1: 0.0833333358
index: 2: 0.0833333358
index: 3: 0.0833333358
index: 4: 0.0833333358

gould55_20_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=0.000000_s=1.000000_0.pdf



bar 21, beat 1

5 durations:

0.110132

0.120264

0.231718

0.238767

0.299119

data gathered in groups...

+++++

0:

0.110132001

0.120264001

+++++

+++++

1:

0.231718004

0.238766998

+++++

+++++

2:

0.299118996

+++++

quantisation result:

0:

index: 0: 0.125

index: 1: 0.125

1:

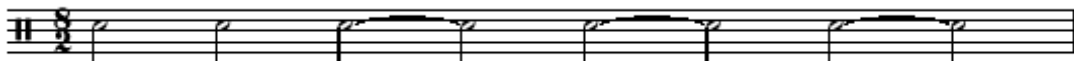
index: 2: 0.25

index: 3: 0.25

2:

index: 4: 0.25

gould55_21_1_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=2.000000_s=1.000000_0.pdf



bar 21, beat 2

6 durations:

0.0745342

0.0865424

0.0741201

0.0819876

0.233126

0.449689

data gathered in groups...

+++++

0:

0.0745342001

0.0865423977

0.0741200969

0.081987597

+++++

+++++

1:

0.233126

+++++

+++++

2:

0.449689001

+++++

quantisation result:

0:

index: 0: 0.0625

index: 1: 0.0625

index: 2: 0.0625

index: 3: 0.0625

1:

index: 4: 0.25

2:

index: 5: 0.5

gould55_21_2_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=6.000000_s=1.000000_5.pdf



bar 21, beat 3

6 durations:

0.229251

0.310004

0.117093

0.104083

0.106774

0.132795

data gathered in groups...

+++++

0:

0.229250997

+++++

+++++

1:

0.310003996

+++++

+++++

2:

0.117092997

0.104083002

0.106774002

0.132795006

+++++

quantisation result:

0:

index: 0: 0.25

1:

index: 1: 0.25

2:

index: 2: 0.125

index: 3: 0.125

index: 4: 0.125

index: 5: 0.125

gould55_21_3_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=0.000000_s=1.000000_0.pdf



bar 22, beat 1

4 durations:

0.125165

0.368444

0.130454

0.375937

data gathered in groups...

+++++

0:

0.125165001

0.130454004

+++++

+++++

1:

0.368443996

0.375937015

+++++

quantisation result:

0:

index: 0: 0.125

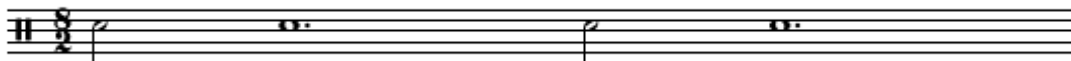
index: 2: 0.125

1:

index: 1: 0.375

index: 3: 0.375

gould55_22_1_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=2.666667_s=1.000000_3.pdf



bar 22, beat 2

6 durations:

- 0.104788
- 0.0820251
- 0.0702512
- 0.0663265
- 0.225667
- 0.450942

data gathered in groups...

+++++

0:

- 0.104787998
- 0.0820251033
- 0.0702511966
- 0.066326499

+++++

+++++

1:

- 0.225667

+++++

+++++

2:

- 0.45094201

+++++

quantisation result:

0:

- index: 0: 0.0625
- index: 1: 0.0625
- index: 2: 0.0625
- index: 3: 0.0625

1:

- index: 4: 0.25

2:

- index: 5: 0.5

gould55_22_2b_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=6.000000_s=1.000000_5.pdf



bar 22, beat 3

4 durations:

0.22606

0.246174

0.243551

0.284215

data gathered in groups...

+++++

0:

0.104787998

0.0820251033

0.0702511966

0.066326499

+++++

+++++

1:

0.225667

+++++

+++++

2:

0.45094201

+++++

quantisation result:

0:

index: 0: 0.25

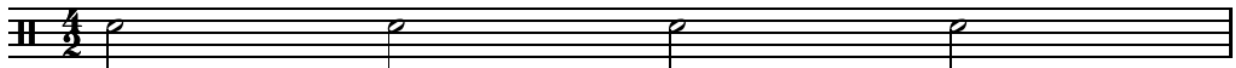
index: 1: 0.25

index: 2: 0.25

index: 3: 0.25

gould55_22_3_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=-

1.000000_s=1.000000_0.pdf



bar 23

10 durations:

0.154063
0.072161
0.098949
0.0856191
0.090746
0.034222
0.033453
0.087798
0.15919
0.183799

data gathered in groups...

+++++

0:

0.154063001
0.159189999
0.183798999

+++++

+++++

1:

0.0721609965
0.0989490002
0.0856190994
0.0907460004
0.0877979994

+++++

+++++

2:

0.0342219993
0.0334529988

+++++

quantisation result:

0:

index: 0: 0.166666672

index: 8: 0.166666672

index: 9: 0.166666672

1:

index: 1: 0.0833333358

index: 2: 0.0833333358

index: 3: 0.0833333358

index: 4: 0.0833333358

index: 7: 0.0833333358

2:

index: 5: 0.0416666679

index: 6: 0.0416666679

gould55_23_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=0.000000_s=1.000000_0.
pdf



bar 24

10 durations:

0.0956009
0.0693045
0.0840501
0.0356353
0.0470632
0.0884738
0.0798722
0.168346
0.161219
0.170435

data gathered in groups...

+++++

0:

0.0693045035
0.0798721984

+++++

+++++

1:

0.095600903
0.0693045035
0.0840500966
0.0884737968
0.0798721984

+++++

+++++

2:

0.0356353

+++++

+++++

3:

0.0470632017

+++++

+++++

4:

0.168346003
0.161219001
0.170434996

+++++

quantisation result:

0:

index: 1: 0.0833333358

index: 6: 0.0833333358

1:

index: 0: 0.0833333358

index: 1: 0.0833333358

index: 2: 0.0833333358

index: 5: 0.0833333358

index: 6: 0.0833333358

2:

index: 3: 0.0416666679

3:

index: 4: 0.0416666679

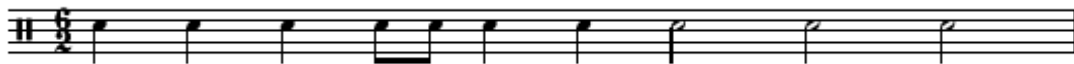
4:

index: 7: 0.1666666672

index: 8: 0.1666666672

index: 9: 0.1666666672

gould55_24_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=6.000000_s=1.166667_1.
pdf



bar 25

8 durations:

0.172983
0.0778646
0.0847958
0.167822
0.17549
0.155877
0.0744728
0.0906946

data gathered in groups...

+++++

0:

0.172983006
0.167822003
0.175490007
0.155876994

+++++

+++++

1:

0.0778646022
0.0847958028
0.0744727999
0.0906945989

+++++

quantisation result:

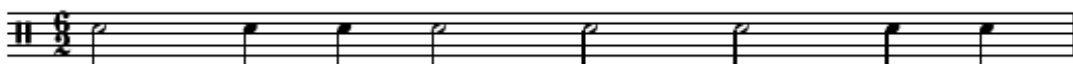
0:

index: 0: 0.166666672
index: 3: 0.166666672
index: 4: 0.166666672
index: 5: 0.166666672

1:

index: 1: 0.0833333358
index: 2: 0.0833333358
index: 6: 0.0833333358
index: 7: 0.0833333358

gould55_25_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=0.000000_s=1.000000_0.pdf



bar 26

14 durations:

0.0392532
0.0341076
0.0861511
0.0298442
0.0392532
0.093943
0.0989415
0.0810056
0.0596883
0.0982064
0.0887974
0.0810056
0.084534
0.085269

data gathered in groups...

+++++

0:

0.0392532013
0.0341075994
0.0298442002
0.0392532013

+++++

+++++

1:

0.0861511007
0.0939429998
0.0989414975
0.0810056031
0.0982064009
0.0887973979
0.0810056031
0.0845339969
0.0852689967

+++++

+++++

2:

0.0596882999

+++++

quantisation result:

0:

index: 0: 0.03125

index: 1: 0.03125

index: 3: 0.03125

index: 4: 0.03125

1:

index: 2: 0.0625

index: 5: 0.0625

index: 6: 0.0625

index: 7: 0.0625

index: 9: 0.0625

index: 10: 0.0625

index: 11: 0.0625

index: 12: 0.0625

index: 13: 0.0625

bar 27

12 durations:

0.0809024
0.079178
0.0767352
0.0826268
0.0784595
0.0817646
0.075873
0.0883748
0.0906739
0.0786032
0.0859319
0.100877

data gathered in groups...

+++++

0:

0.0809023976
0.079177998
0.0767351985
0.0826267973
0.0784595013
0.0817646012
0.0758730024
0.088374801
0.0906739011
0.0786032006
0.0859318972
0.100877002

+++++

quantisation result:

0:

index: 0: 0.0833333358
index: 1: 0.0833333358
index: 2: 0.0833333358
index: 3: 0.0833333358
index: 4: 0.0833333358
index: 5: 0.0833333358
index: 6: 0.0833333358
index: 7: 0.0833333358
index: 8: 0.0833333358
index: 9: 0.0833333358
index: 10: 0.0833333358
index: 11: 0.0833333358

gould55_27_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=-1.000000_s=1.000000_0.pdf



bar 28

12 durations:

0.0720811
0.0803597
0.0770768
0.0786469
0.0812161
0.0862118
0.0795033
0.0886383
0.0825007
0.0890665
0.084499
0.1002

data gathered in groups...

+++++

0:

0.0720810965
0.0803596973
0.0770768002
0.0786468983
0.0812160969
0.0862118006
0.0795032978
0.0886382982
0.0825007036
0.089066498
0.0844990015
0.100199997

+++++

quantisation result:

index: 0: 0.0833333358
index: 1: 0.0833333358
index: 2: 0.0833333358
index: 3: 0.0833333358
index: 4: 0.0833333358
index: 5: 0.0833333358
index: 6: 0.0833333358
index: 7: 0.0833333358
index: 8: 0.0833333358
index: 9: 0.0833333358
index: 10: 0.0833333358
index: 11: 0.0833333358

gould55_28_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=-1.000000_s=1.000000_0.pdf



bar 29

12 durations:

0.109668
0.077048
0.082214
0.0830996
0.0805904
0.0779336
0.0797048
0.0839852
0.0797048
0.0805904
0.0805904
0.0848708

data gathered in groups...

+++++

0:

0.109668002

+++++

+++++

1:

0.0770480037

0.0822139978

0.0830996037

0.0805903971

0.077933602

0.0797047988

0.083985202

0.0797047988

0.0805903971

0.0805903971

0.0848708004

+++++

quantisation result:

index: 0: 0.09375

1:

index: 1: 0.09375

index: 2: 0.09375

index: 3: 0.09375

index: 4: 0.09375

index: 5: 0.09375

index: 6: 0.09375

index: 7: 0.09375

index: 8: 0.09375

index: 9: 0.09375

index: 10: 0.09375

index: 11: 0.09375

gould55_29_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=0.000000_s=1.125000_1.
pdf



bar 30

12 durations:

0.0774749
0.0799139
0.0757532
0.0807747
0.0840746
0.0766141
0.0832138
0.0799139
0.0832138
0.07934
0.0922525
0.107461

data gathered in groups...

+++++

0:

0.0774748996
0.0799138993
0.0757531971
0.0807747021
0.0840746015
0.0766140968
0.0832137987
0.0799138993
0.0832137987
0.0793400034
0.0922525004
0.107460998

+++++

quantisation result:

0:

index: 0: 0.0833333358
index: 1: 0.0833333358
index: 2: 0.0833333358
index: 3: 0.0833333358
index: 4: 0.0833333358
index: 5: 0.0833333358
index: 6: 0.0833333358
index: 7: 0.0833333358
index: 8: 0.0833333358
index: 9: 0.0833333358
index: 10: 0.0833333358
index: 11: 0.0833333358

gould55_30_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=-1.000000_s=1.000000_0.pdf



bar 31

12 durations:

0.09309
0.0795306
0.0711864
0.0749674
0.0779661
0.0817471
0.0809648
0.0938722
0.100652
0.0795306
0.0817471
0.0847458

data gathered in groups...

+++++

0:

0.0930899978
0.0795305967
0.0711864009
0.0749673992
0.0779661015
0.0817470998
0.0809648037
0.093872197
0.100652002
0.0795305967
0.0817470998
0.084745802

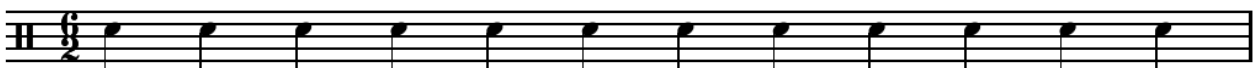
+++++

quantisation result:

0:

index: 0: 0.0833333358
index: 1: 0.0833333358
index: 2: 0.0833333358
index: 3: 0.0833333358
index: 4: 0.0833333358
index: 5: 0.0833333358
index: 6: 0.0833333358
index: 7: 0.0833333358
index: 8: 0.0833333358
index: 9: 0.0833333358
index: 10: 0.0833333358
index: 11: 0.0833333358

gould55_31_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=-1.000000_s=1.000000_0.pdf



bar 32, beat 1 and 2

8 durations:

- 0.103387
- 0.0960026
- 0.110933
- 0.100658
- 0.1249
- 0.144485
- 0.141596
- 0.178038

data gathered in groups...

+++++

0:

- 0.103386998
- 0.0960026011
- 0.110932998
- 0.100658
- 0.124899998
- 0.144484997
- 0.141596004
- 0.178038001

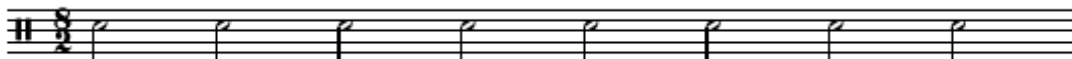
+++++

quantisation result:

0:

- index: 0: 0.125
- index: 1: 0.125
- index: 2: 0.125
- index: 3: 0.125
- index: 4: 0.125
- index: 5: 0.125
- index: 6: 0.125
- index: 7: 0.125

gould55_32_1_2_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=-1.000000_s=1.000000_0.pdf



bar 32, beat 3

2 durations:

0.381716

0.618284

data gathered in groups...

+++++

0:

0.381716013

+++++

+++++

1:

0.618283987

+++++

quantisation result:

0:

index: 0: 0.5

1:

index: 1: 0.5

gould55_32_3_mark.txt.ms.iot_0_quant.txt_notat_.txt_d=0.000000_s=1.000000_0.pdf

