Humdrum Analysis Tools I

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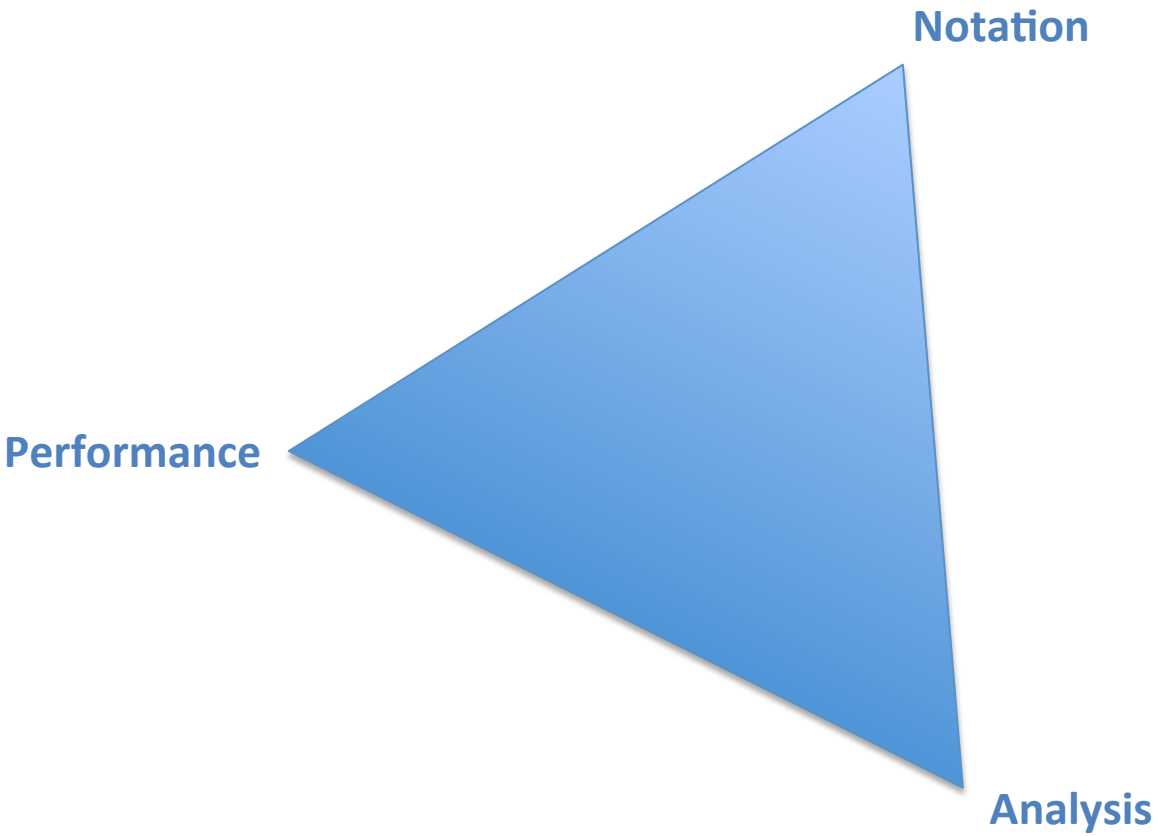
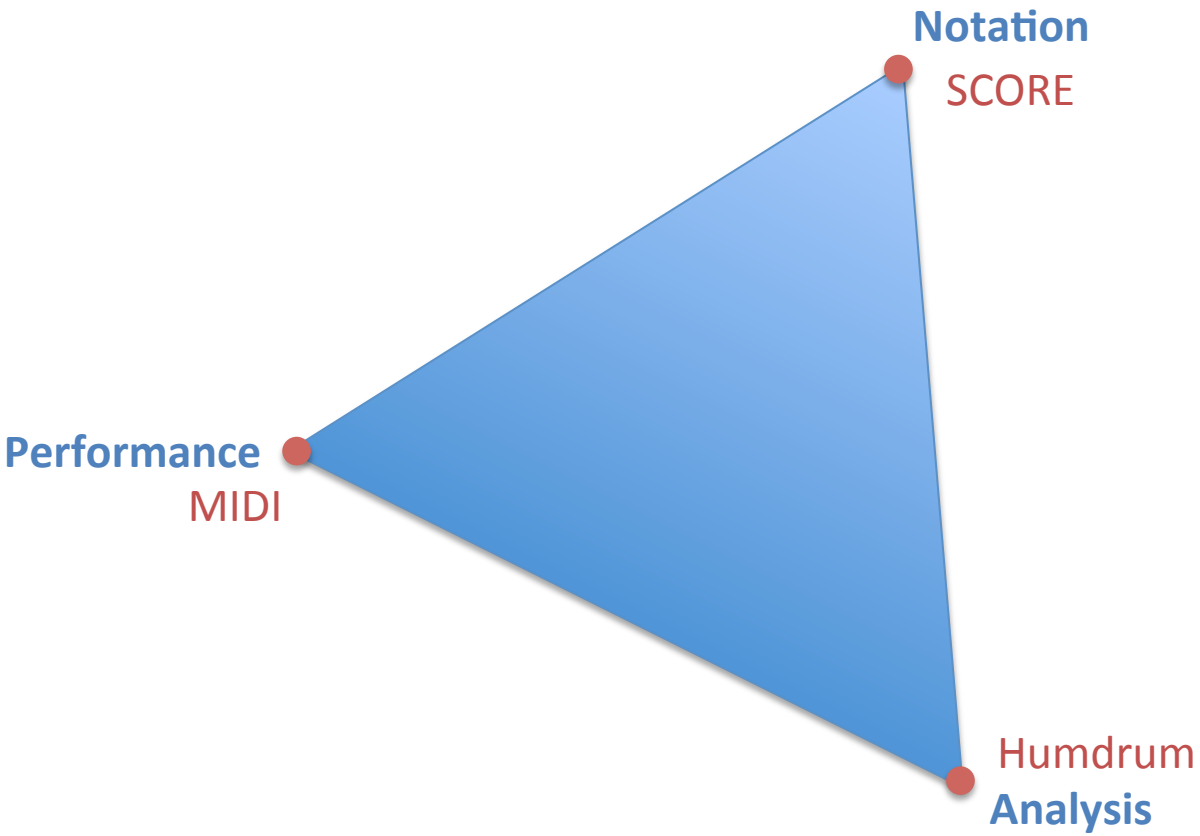
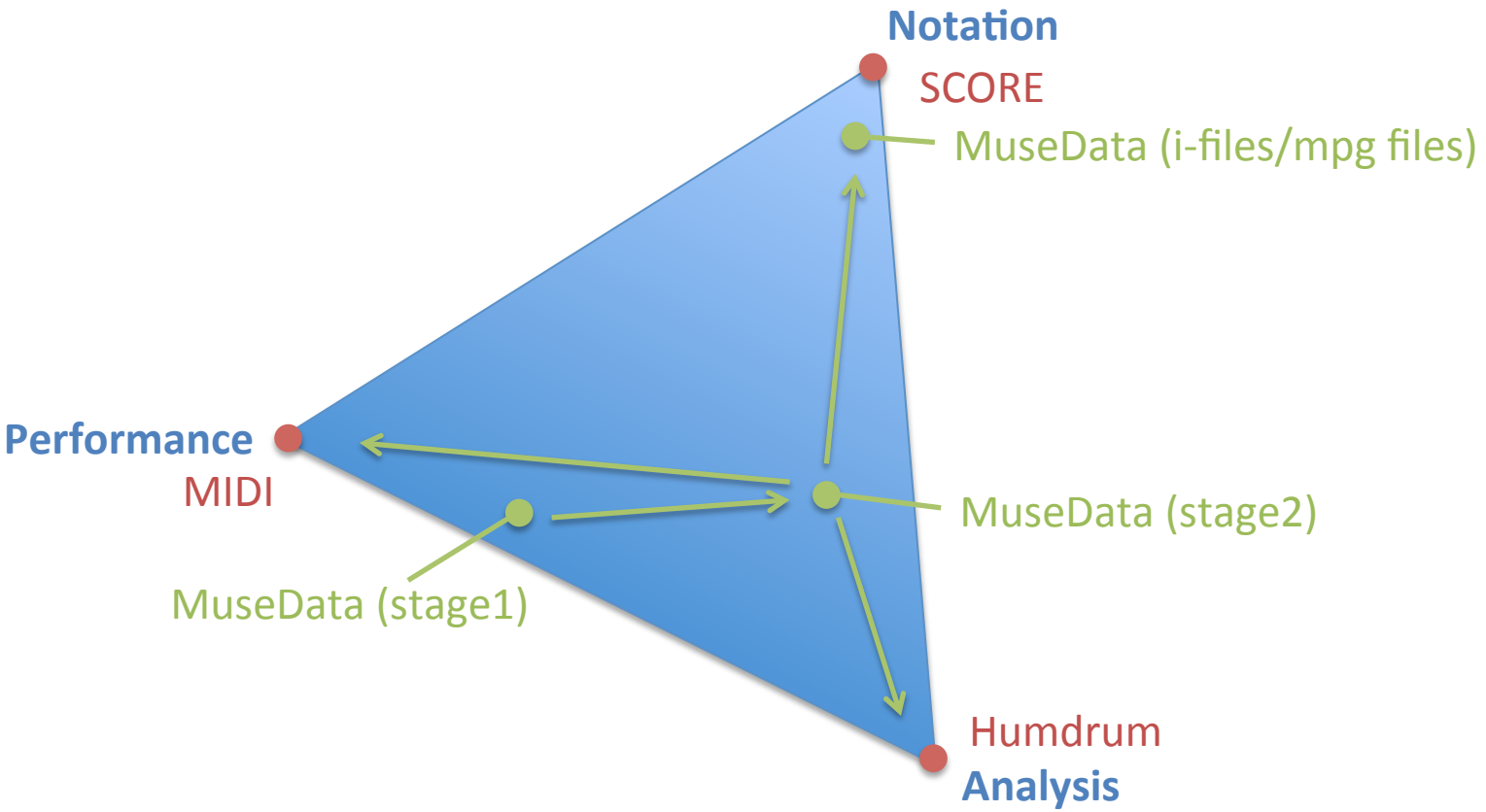
Musical Data Representations



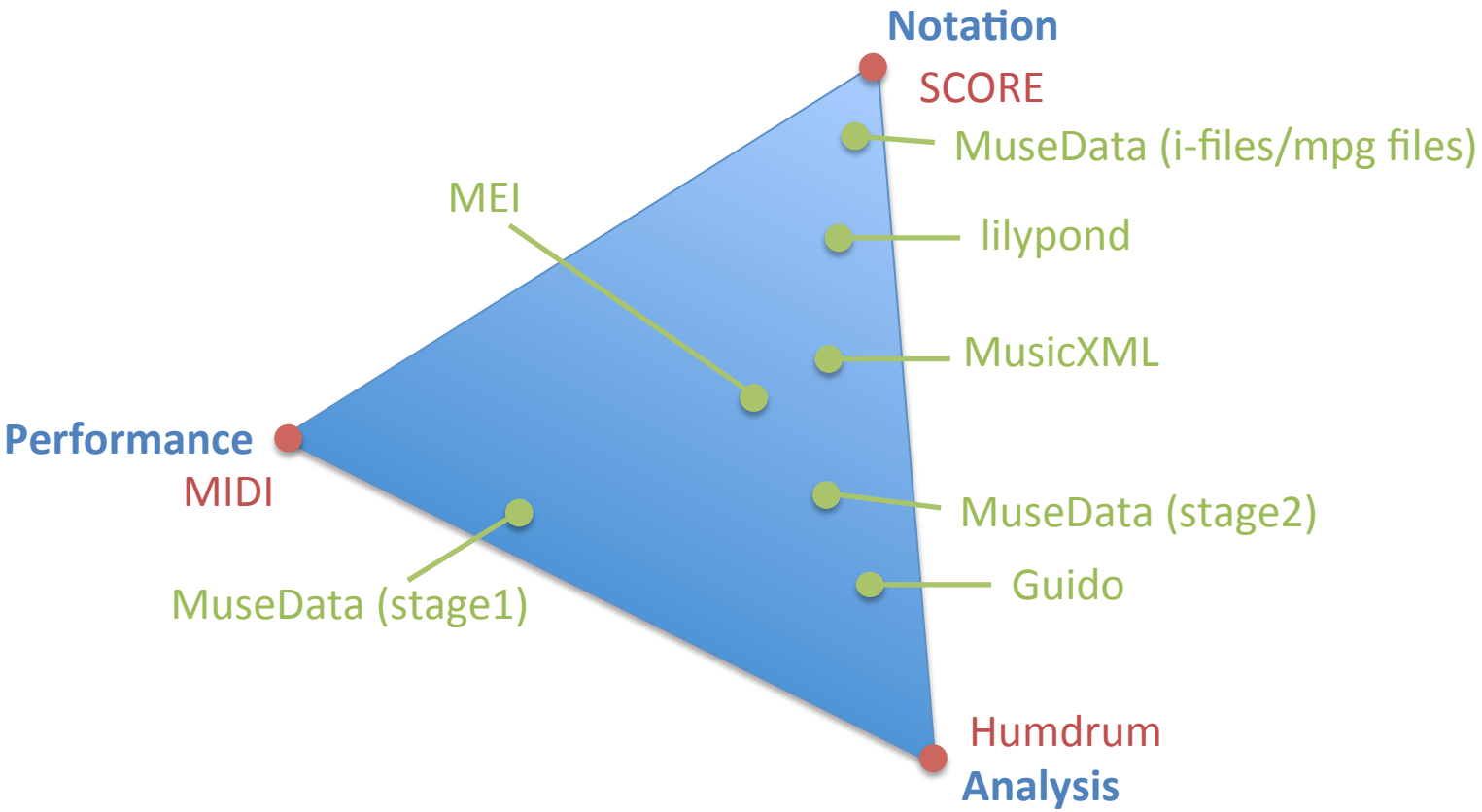
Musical Data Representations



Musical Data Representations



Musical Data Representations



Unix shell

- Humdrum Toolkit designed for use in a unix shell (terminal)

http://en.wikipedia.org/wiki/Unix_shell

linux: should be easy to find a terminal

OS X: /Applications/Utility/Terminal.app

Windows: not a unix system, so install unix emulator:
  * http://www.cygwin.com
  * or install your favorite Linux OS in VirtualBox (http://www.virtualbox.org)

- Some learning resources for terminal:
  -- Humdrum User's Guide (see Documentation slide)
  -- http://www.ee.surrey.ac.uk/Teaching/Unix
  -- http://community.linuxmint.com/tutorial/view/454
  -- http://macdevcenter.com/pub/a/mac/2001/12/14/terminal_one.html
  -- http://www.youtube.com/watch?v=PYW7UG5VRgw (starting at 3:20)

Humdrum Processing Software

- Humdrum Toolkit:
  http://wiki.humdrum.org/wiki/downloads
  https://github.com/kroger/humdrum

- Humdrum Extras:
  https://github.com/craigsapp/humextra

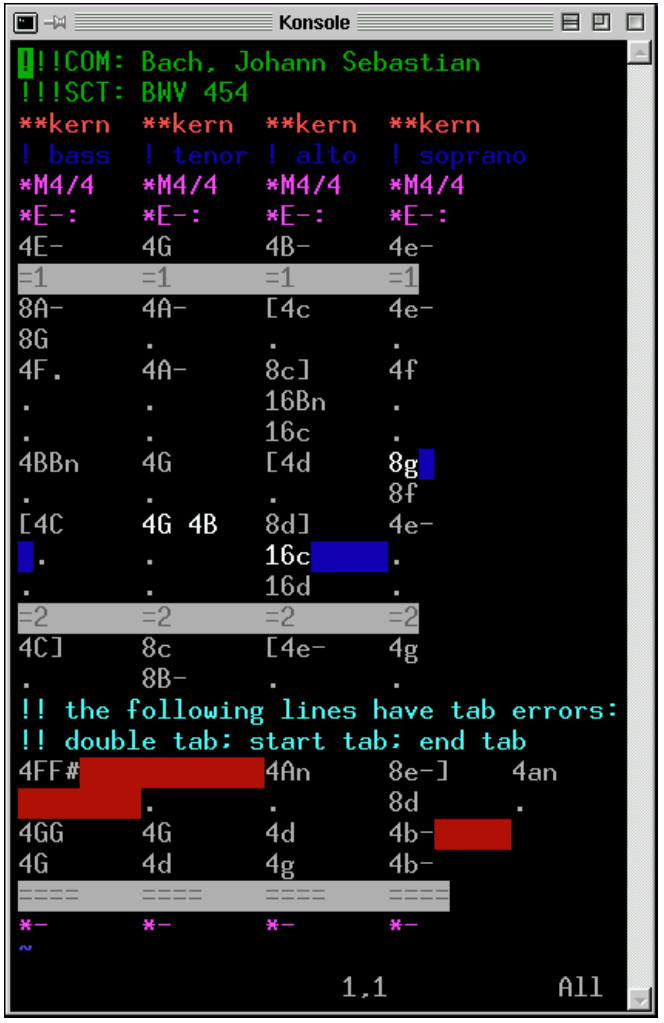
- Humextra online (no software installation required):
  https://extras.humdrum.org/online

- Music21 (Humdrum data import only into Python):
  https://github.com/cuthbertLab/music21

Humdrum File Syntax Coloring

https://github.com/kroger/humdrum/tree/master/editors (emacs, vi)
http://www.ccarh.org/software/humdrum/vi/syntax (vi)

```
!!!COM: Bach, Johann Sebastian
!!!SCT: BWV 454
**kern  **kern  **kern  **kern
! bass  ! tenor ! alto  ! soprano
*M4/4   *M4/4   *M4/4   *M4/4
*E-:    *E-:    *E-:    *E-:
4E-     4G      4B-     4e-
=1      =1      =1      =1
8A-     4A-     [4c     4e-
8G      .       .       .
4F      4A-     8c]     4f
.       .       16Bn    .
.       .       16c     .
4BBn    4G      [4d     8g
.       .       .       8f
[4C     4G 4B   8d]     4e-
.       .       16c     .
.       .       16d     .
=2      =2      =2      =2
4C]     8c      [4e-    4g
.       8B-     .       .
!! the following lines have tab errors:
!! double tab; start tab; end tab
4FF#            4An     8e-]    4an
                .       8d      .
4GG     4G      4d      4b-
4G      4d      4g      4b-
====    ====    ====    ====
*-      *-      *-      *-
```



Humdrum documentation

- Links to scans and HTML files for the User and Reference Guides are listed on
  http://humdrum.ccarh.org

- Main webpage for the Humdrum Toolkit:
  http://www.humdrum.org/Humdrum

- Humdrum Wiki:
  http://wiki.humdrum.org

- Humdrum Extras documentation:
  http://extras.humdrum.org/man

- Humdrum Users' Group (**HUG):
  https://groups.google.com/forum/?fromgroups#!forum/starstarhug

humdrum

- humdrum is a command which validates the Humdrum file format structure of a file.

```
humdrum file.krn
```

```
*kern
1c
*-
```

humdrum: ERROR 17: First exclusive interpretation record contains a non-exclusive interpretation in line 1, file file.krn.

```
*kern
1c
==
```

humdrum: ERROR 14: All spines have not been properly terminated in line 4, file file.krn.

```
! comment
**kern
1c
*-
```

humdrum: ERROR 9: Local comment precedes first exclusive interpretation record in line 1, file file.krn.

proof

- proof is a command which validates the content of **kern data (more specific than humdrum command which validates structure)

```
**kern
*clefG2
*k[f#]
*M4/4
*MM120
=1-
1g
=2
2f#
=3
[1a
==
*-
```

```
proof file.krn
```

```
proof: Warning: Possible change of meter in measure 2, line 10
proof: Warning: Possible change of meter in measure 3, line 12
proof: Error: Incorrect tie specification in spine 1, line 11 "1a"
```

- -w option suppresses warnings and only lists errors.

```
proof –w file.krn
```

```
proof: Error: Incorrect tie specification in spine 1, line 11 "1a"
```

http://humdrum.org/Humdrum/commands/proof.html

census

- census is a command which gives basic counting statistics on a Humdrum file
- -k option can be added to include **kern data counting.

```
**kern
*M3/4
=1-
2c
[4d
=2
4d]
4e
4r
==
*-
```

```
census file.krn
```

```
HUMDRUM DATA

Number of data tokens:      8
Number of null tokens:      0
Number of multiple-stops:   0
Number of data records:     8
Number of comments:         0
Number of interpretations:  3
Number of records:          11

KERN DATA

Number of note-heads:       4
Number of notes:            3
Longest note:               2
Shortest note:              4
Highest note:               e
Lowest note:                c
Number of rests:            1
Maximum number of voices:   1
Number of single barlines:  2
Number of double barlines:  1
```

humcat

- The humcat command can be used to download data from KernScores.

- All Humdrum Extras have built-in downloading capability (except when compiled natively for Windows) from the web, KernScores (http://kern.humdrum.org), and the Josquin Research Project (http://josquin.stanford.edu).

```
humcat h://371chorales/chor001.krn | less
```

```
!!!COM: Bach, Johann Sebastian
!!!CDT: 1685/02/21/-1750/07/28/
!!!OTL@@DE:     Aus meines Herzens Grunde
!!!OTL@EN:      From the Depths of My Heart
!!!SCT: BWV 269
!!!PC#: 1
!!!AGN: chorale
**kern          **kern          **kern          **kern
*ICvox          *ICvox          *ICvox          *ICvox
*Ibass          *Itenor         *Ialto          *Isoprn
*I"Bass         *I"Tenor        *I"Alto         *I"Soprano
*>[A,A,B]       *>[A,A,B]       *>[A,A,B]       *>[A,A,B]
*>norep[A,B]    *>norep[A,B]    *>norep[A,B]    *>norep[A,B]
*>A             *>A             *>A             *>A
*clefF4         *clefGv2        *clefG2         *clefG2
*k[f#]          *k[f#]          *k[f#]          *k[f#]
*G:             *G:             *G:             *G:
*M3/4           *M3/4           *M3/4           *M3/4
*MM100          *MM100          *MM100          *MM100
4GG             4B              4d              4g
=1              =1              =1              =1
4G              4B              4d              2g
4E              8cL             4e              .
.               8BJ             .               .
4F#             4A              4d              4dd
```

humcat (2)

- The humcat command can be used to download and pipe data to standard Humdrum Toolkit commands:

```
humcat h://371chorales/chor001.krn | census -k
```

```
HUMDRUM DATA

Number of data tokens:      412
Number of null tokens:      91
Number of multiple-stops:   0
Number of data records:     103
Number of comments:         16
Number of interpretations:  14
Number of records:          133

KERN DATA

Number of note-heads:       229
Number of notes:            223
Longest note:               2.
Shortest note:              8
Highest note:               dd
Lowest note:                FF#
Number of rests:            0
Maximum number of voices:   4
Number of single barlines:  22
Number of double barlines:  1
```

humcat (3)

- humcat can also be used to stream multiple files from KernScores:

```
humcat -s h://371chorales | census -k
```

```
HUMDRUM DATA

Number of data tokens:      143760
Number of null tokens:      34224
Number of multiple-stops:   0
Number of data records:     35940
Number of comments:         5996
Number of interpretations:  4770
Number of records:          46706

KERN DATA

Number of note-heads:       86109
Number of notes:            84666
Longest note:               0
Shortest note:              32
Highest note:               aa
Lowest note:                CC
Number of rests:            783
Maximum number of voices:   4
Number of single barlines:  5291
Number of double barlines:  370
```

- For lots of data, better to download files for local use:

```
humcat -s h://371chorales | humsplit
census –k chor*.krn
```

thru/thrux

- thru can be used to generate performance sequence from score sequence

```
**kern
*>[A,A,B]
*clefG2
*M2/4
*k[]
=1-
*>A
2c
=2:|!
*>B
2d
==
*-
```

```
thru file.krn
```

```
**kern
*thru
*clefG2
*M2/4
*k[]
=1-
*>A
2c
=2:|!
*>A
2c
=2:|!
*>B
2d
==
*-
```

thru/thrux (2)

- alternate thru sequences
- “norep” is a convention for the score without repeating sections

```
**kern
*>[A,A1,A,A2,B]
*>norep[A,A2,B]
*k[]
=1-
*>A
2c
=2
*>A1
2d
=3:|!
*>A2
2e
=4
*>B
2d
==
*-
```

```
thru –v norep file.krn
```

```
**kern
*thru
*k[]
=1-
*>A
2c
=2
*>A2
2e
=4
*>B
2d
==
*-
```

thru and census

census with repeated sections

thru *.krn | census -k

```
HUMDRUM DATA

Number of data tokens:      168723
Number of null tokens:      39889
Number of multiple-stops:   0
Number of data records:     42189
Number of comments:         5627
Number of interpretations:  6027
Number of records:          53843

KERN DATA

Number of note-heads:       101015
Number of notes:            99393
Longest note:               0
Shortest note:              32
Highest note:               aa
Lowest note:                CC
Number of rests:            889
Maximum number of voices:   4
Number of single barlines:  6365
Number of double barlines:  372
```

census without repeats

thru -v norep *.krn | census -k

```
HUMDRUM DATA

Number of data tokens:
143755
Number of null tokens:      34224
Number of multiple-stops:   0
Number of data records:     35944
Number of comments:         5626
Number of interpretations:  4784
Number of records:          46354

KERN DATA

Number of note-heads:       86104
Number of notes:            84661
Longest note:               0
Shortest note:              32
Highest note:               aa
Lowest note:                CC
Number of rests:            783
Maximum number of voices:   4
Number of single barlines:  5293
Number of double barlines:  371
```

for-loops in bash shell

```
for i in *.krn
do
  echo $i `census –k $i | grep “Number of notes”`
done
```

```
chor001.krn Number of notes: 223
chor002.krn Number of notes: 229
chor003.krn Number of notes: 196
chor004.krn Number of notes: 185
chor005.krn Number of notes: 330
chor006.krn Number of notes: 120
chor007.krn Number of notes: 346
chor008.krn Number of notes: 358
chor009.krn Number of notes: 238
…
```

sort

Identify the chorales with the most notes (excluding repeats)

```
for i in *.krn
do
  echo $i `census –k $i | grep “Number of notes”`
done | sort –nrk5 | less
```

```
chor205.krn Number of notes: 957
chor132.krn Number of notes: 790
chor133.krn Number of notes: 600
chor197.krn Number of notes: 554
chor241.krn Number of notes: 517
chor215.krn Number of notes: 475
chor259.krn Number of notes: 471
chor091.krn Number of notes: 467
chor252.krn Number of notes: 458
chor214.krn Number of notes: 443
chor116.krn Number of notes: 429
chor069.krn Number of notes: 429
chor011.krn Number of notes: 414
chor277.krn Number of notes: 405
chor220.krn Number of notes: 380
…
```

sort options being used:

-n == sort numerically

-r == reverse order (largest first)

-k 5 == sort by 5th field on line

transpose

```
**kern
*k[]
*C:
c
d
e
f
g
a
b
cc
*-
```

transpose –b 6
transpose –d 1 –c 2

```
**kern
*Trd1c2
*k[f#c#]
*D:
d
e
f#
g
a
b
cc#
dd
*-
```

transpose –k f#

```
**kern
*Trd3c6
*k[f#c#g#d#a#e#]
*F#:
f#
g#
a#
b
cc#
dd#
ee#
ff#
*-
```

key/keycor

```
**kern
c
d
e
f
g
a
b
cc
*-
```

key file.krn
keycor file.krn

transpose –b 23 file.krn | key

transpose –b 18 file.krn | key

keycor h://wtc/wtc1p01.krn
keycor h://wtc/wtc1p02.krn
keycor h://wtc/wtc1p03.krn
keycor h://wtc/wtc1p04.krn

hum2mid

- Convert Humdrum file into a MIDI file.

```
hum2mid h://essen/asia/china/shanxi/shanx276.krn -o shanx276.mid
```

Some options:

-O == create a Type-0 MIDI file
--autopan == array parts in stereo field
--plus == store pitch spellings using MIDI+ method

--temperament == see http://kern.ccarh.org/browse?l=temperament

http://extras.humdrum.org/man/hum2mid

myank

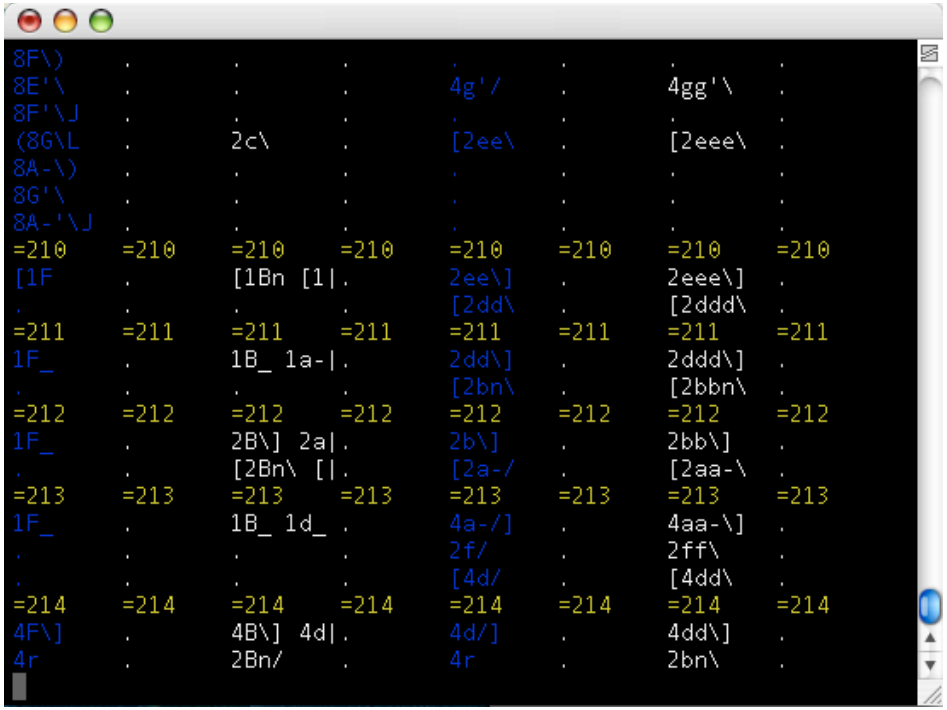
- "Measure Yank": extracts selected measures from full score:

```
myank -m1-2 h://371chorales/chor032.krn
```

```
**kern      **kern      **kern      **kern
*clefF4     *clefGv2    *clefG2     *clefG2
*k[f#c#g#]  *k[f#c#g#]  *k[f#c#g#]  *k[f#c#g#]
*A:         *A:         *A:         *A:
*M4/4       *M4/4       *M4/4       *M4/4
*met(c)     *met(c)     *met(c)     *met(c)
*MM100      *MM100      *MM100      *MM100
=1-         =1-         =1-         =1-
8AL         4c#         4a          4ee
8BJ         .           .           .
8c#L        4c#         4a          4ee
8AJ         .           .           .
8DL         4d          4a          4ff#
8EJ         .           .           .
8F#L        4d          4a          4ff#
8DJ         .           .           .
=2          =2          =2          =2
2A;         2c#;        2a;         2ee;
4r          4ry         4ry         4r
4A          4f#         4a          4cc#
=3          =3          =3          =3
4G#         4e          4b          4dd
4A          4e          4a          4cc#
8EL         4e          4g#         4b
8DJ         .           .           .
8C#L        4e          4a          8cc#L
8AAJ        .           .           8ddJ
=           =           =           =
*-          *-          *-          *-
```

humplay

- Humplay will perform Humdrum files in real-time as it displays the file on screen.
- See http://extra.humdrum.org/man/humplay for real-time commands.



Try:

humplay h://beethoven/sonatas/sonata08-2.krn
humplay h://musedata/haydn/sym/sym101-1.krn
humplay h://wtc/wtc2/p18.krn
humplay h://371chorales/chor268.krn

extract/extractx

- Use the extract program to pull out a partiular part from a full score:

  humcat h://371chorales/chor043.krn | extract –f2
  extractx –s2 h://371chorales/chor043.krn
  extractx –g alto h://371chorales/chor043.krn

- Use extractx if input data contains spine splits/joines (*^, *v).

```
**kern
*ICvox
*Ialto
*I"Alto
*>[A,A,B]
*>norep[A,B]
*>A
*clefG2
*k[f#c#g#d#]
*E:
*M4/4
*met(c)
*MM100
=1-
2r
.
.
4r
8g#L
8g#J
=2
4a
8aL
8g#J
8g#L
16f#L
16eJJ
8f#L
8f#J
.
=3
```

prange

- Generate pitch histograms of input data (like census –k but more detail)

```
extractx -g alto h://371chorales/chor043.krn | prange
```

```
**keyno    **kern     **count
59         B          3
61         c#         1
63         e-         5
64         e          10
66         f#         19
68         g#         13
69         a          3
70         b-         1
*-  *-  *-
!!tessitura:  11 semitones
!!mean:    65.6 (f#)
!!median: 66 (f#)
```

Metric Position

- The beat command can be used to identify the beat number in measure for each data line.
- -a option used to append analysis data to input score.

```
beat -a h://371chorales/chor200.krn
```

```
**kern      **kern      **kern      **kern      **beat
=1-         =1-         =1-         =1-         =1-
4c          4e          4g          4cc         1
4B          4d          [4g         4g          2
4A          4c          8gL]        4a          3
.           .           8f#J        .           3.5
8GL         4d          4g          4b          4
8FJ         .           .           .           4.5
=2          =2          =2          =2          =2
4E          8cL         4.g         2cc         1
.           8B-J        .           .           1.5
4F          4A          .           .           2
.           .           [8fnX       .           2.5
4C;         4G;         8fL]        4cc;        3
.           .           8e;J        .           3.5
8cL         4c          [4e         4g          4
8B-J        .           .           .           4.5
=3          =3          =3          =3          =3
```

rid/ridx

- Rid program removed various categories of Humdrum file structure:
  - -G == remove global comments (and reference records)
  - -L == remove local comments
  - -I == remove interpretations (and spine manipulators)
  - -M = remove measure lines (ridx only)
  - -d == remove null token data lines

```
beat h://371chorales/chor200.krn | ridx -GLIMd
```

1
2
3
3.5
4
4.5
1
1.5
2
2.5
3
3.5
4
…

uniq -c

```
beat h://371chorales/chor200.krn | ridx –GLIMd | sort –nr | uniq -c
```

```
15      1
 10     1.5
  1     1.75
 11     2
  9     2.5
 15     3
 11     3.5
  1     3.75
 13     4
 12     4.5
  2     4.75
```

- 15 times an event on beat 1 (could be tied note or rest)
- 10 times an event on beat 1.5

- Type “man uniq” to see the manual page for the uniq command.

Sonority analysis

```
humcat –s h://371chorales | humsplit
for i in chor*.krn
do
   beat -a $i | tntype -a | extract -f 4,5
done | rid –GLId | grep –v = | sort -n | uniq –c | less
```

```
   6 1   1-1
   1 1   2-1
  44 1   2-3
  45 1   2-4
   3 1   2-5
  99 1   3-10
1182 1   3-11A
2380 1   3-11B
  16 1   3-12
   1 1   3-2A
   3 1   3-2B
  27 1   3-4A
   4 1   3-6
  82 1   3-7A
   1 1   3-7B
  16 1   3-8A
 239 1   3-9
   7 1   4-11A
   1 1   4-11B
   1 1   4-13A
 103 1   4-14A
   1 1   4-19A
   2 1   4-19B
  45 1   4-20
  79 1   4-22A
  13 1   4-23
 242 1   4-26
 136 1   4-27A
 198 1   4-27B
  32 1   4-28
   1 1   4-29A
```

```
  2 1.5  2-2
 24 1.5  2-3
 41 1.5  2-4
 49 1.5  2-5
185 1.5  3-10
288 1.5  3-11A
350 1.5  3-11B
 14 1.5  3-12
  3 1.5  3-2B
 26 1.5  3-4A
 19 1.5  3-4B
  4 1.5  3-5A
  1 1.5  3-5B
  3 1.5  3-6
130 1.5  3-7A
 85 1.5  3-7B
 28 1.5  3-8A
 19 1.5  3-8B
146 1.5  3-9
 17 1.5  4-10
 18 1.5  4-11A
 22 1.5  4-11B
  1 1.5  4-12A
  3 1.5  4-12B
  7 1.5  4-13A
  5 1.5  4-13B
 91 1.5  4-14A
 85 1.5  4-14B
  5 1.5  4-16A
  8 1.5  4-16B
  1 1.5  4-17
```

```
  5 1.5  4-18A
  5 1.5  4-18B
 15 1.5  4-19A
 10 1.5  4-19B
195 1.5  4-20
  8 1.5  4-21
148 1.5  4-22A
 72 1.5  4-22B
142 1.5  4-23
  7 1.5  4-24
203 1.5  4-26
 86 1.5  4-27A
245 1.5  4-27B
 28 1.5  4-28
  6 1.5  4-29A
 20 1.5  4-29B
  1 1.5  4-7
  1 1.5  4-8
```