Humdrum Analysis Tools I

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Musical Data Representations

- Performance
- MIDI
- Notation
- SCORE
- Humdrum Analysis
Musical Data Representations

- Performance
- MIDI
- MuseData (stage1)
- MuseData (stage2)
- Humdrum Analysis
- Notation
  - SCORE
  - MuseData (i-files/mpg files)
Unix shell

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

**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](http://www.cygwin.com)
  * or install your favorite Linux OS in VirtualBox ([http://www.virtualbox.org](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://www.ee.surrey.ac.uk/Teaching/Unix)
  -- [http://community.linuxmint.com/tutorial/view/454](http://community.linuxmint.com/tutorial/view/454)
  -- [http://macdevcenter.com/pub/a/mac/2001/12/14/terminal_one.html](http://macdevcenter.com/pub/a/mac/2001/12/14/terminal_one.html)
  -- [http://www.youtube.com/watch?v=PYW7UG5VRgw](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)
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 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).

```plaintext
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
*>A *>A *>A *
*clefF4 *clefGv2 *clefG2 *clefG2
*k[f#] *k[f#] *k[f#] *
*G: *G: *G: *
*MM100 *MM100 *MM100 *
4GG 4B 4d 4g
=1 =1 =1 =1
4G 4B 4d 2g
4E 8cL 4e 
. 8BJ .
4F# 4A 4d 4dd
```
• 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

**thru file.krn**

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

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

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

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

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

```thru -v norep file.krn```
### thru and census

**census with repeated sections**

```bash
thru *.krn | census -k
```

**HUMDRUM DATA**

<table>
<thead>
<tr>
<th>Data Token Summary</th>
<th>168723</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of data tokens:</td>
<td>168723</td>
</tr>
<tr>
<td>Number of null tokens:</td>
<td>39889</td>
</tr>
<tr>
<td>Number of multiple-stops:</td>
<td>0</td>
</tr>
<tr>
<td>Number of data records:</td>
<td>42189</td>
</tr>
<tr>
<td>Number of comments:</td>
<td>5627</td>
</tr>
<tr>
<td>Number of interpretations:</td>
<td>6027</td>
</tr>
<tr>
<td>Number of records:</td>
<td>53843</td>
</tr>
</tbody>
</table>

**KERN DATA**

<table>
<thead>
<tr>
<th>Note Summary</th>
<th>101015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of note-heads:</td>
<td>101015</td>
</tr>
<tr>
<td>Number of notes:</td>
<td>99393</td>
</tr>
<tr>
<td>Longest note:</td>
<td>0</td>
</tr>
<tr>
<td>Shortest note:</td>
<td>32</td>
</tr>
<tr>
<td>Highest note:</td>
<td>aa</td>
</tr>
<tr>
<td>Lowest note:</td>
<td>CC</td>
</tr>
<tr>
<td>Number of rests:</td>
<td>889</td>
</tr>
<tr>
<td>Maximum number of voices:</td>
<td>4</td>
</tr>
<tr>
<td>Number of single barlines:</td>
<td>6365</td>
</tr>
<tr>
<td>Number of double barlines:</td>
<td>372</td>
</tr>
</tbody>
</table>

**census without repeats**

```bash
gthru -v norep *.krn | census -k
```

**HUMDRUM DATA**

<table>
<thead>
<tr>
<th>Data Token Summary</th>
<th>143755</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of data tokens:</td>
<td>143755</td>
</tr>
<tr>
<td>Number of null tokens:</td>
<td>34224</td>
</tr>
<tr>
<td>Number of multiple-stops:</td>
<td>0</td>
</tr>
<tr>
<td>Number of data records:</td>
<td>35944</td>
</tr>
<tr>
<td>Number of comments:</td>
<td>5626</td>
</tr>
<tr>
<td>Number of interpretations:</td>
<td>4784</td>
</tr>
<tr>
<td>Number of records:</td>
<td>46354</td>
</tr>
</tbody>
</table>

**KERN DATA**

<table>
<thead>
<tr>
<th>Note Summary</th>
<th>86104</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of note-heads:</td>
<td>86104</td>
</tr>
<tr>
<td>Number of notes:</td>
<td>84661</td>
</tr>
<tr>
<td>Longest note:</td>
<td>0</td>
</tr>
<tr>
<td>Shortest note:</td>
<td>32</td>
</tr>
<tr>
<td>Highest note:</td>
<td>aa</td>
</tr>
<tr>
<td>Lowest note:</td>
<td>CC</td>
</tr>
<tr>
<td>Number of rests:</td>
<td>783</td>
</tr>
<tr>
<td>Maximum number of voices:</td>
<td>4</td>
</tr>
<tr>
<td>Number of single barlines:</td>
<td>5293</td>
</tr>
<tr>
<td>Number of double barlines:</td>
<td>371</td>
</tr>
</tbody>
</table>
for-loops in bash shell

```bash
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  
chor251.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
**kern**

* k[

* C:

  c
  d
  e
  f
  g
  a
  b
  cc
  *-

**kern**

* Trd1c2

  k[f#c#]

  D:

    d
    e
    f#
    g
    a
    b
    cc#
    dd
    *-

**kern**

* Trd3c6

  k[f#c#g#d#a#e#]

  F#:

    f#
    g#
    a#
    b
    cc#
    dd#
    ee#
    ff#
    *-

transpose –b 6

transpose –d 1 –c 2

transpose –k f#
key/keycor

**kern

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
• “Measure Yank”: extracts selected measures from full score:

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

```plaintext
**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 particular part from a full score:

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

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

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

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

<table>
<thead>
<tr>
<th>**keyno</th>
<th>**kern</th>
<th>**count</th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>B</td>
<td>3</td>
</tr>
<tr>
<td>61</td>
<td>c#</td>
<td>1</td>
</tr>
<tr>
<td>63</td>
<td>e−</td>
<td>5</td>
</tr>
<tr>
<td>64</td>
<td>e</td>
<td>10</td>
</tr>
<tr>
<td>66</td>
<td>f#</td>
<td>19</td>
</tr>
<tr>
<td>68</td>
<td>g#</td>
<td>13</td>
</tr>
<tr>
<td>69</td>
<td>a</td>
<td>3</td>
</tr>
<tr>
<td>70</td>
<td>b−</td>
<td>1</td>
</tr>
</tbody>
</table>

*-* *-* *-
!!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
```

<table>
<thead>
<tr>
<th><strong>kern</strong></th>
<th><strong>kern</strong></th>
<th><strong>kern</strong></th>
<th><strong>kern</strong></th>
<th><strong>beat</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>=1-</td>
<td>=1-</td>
<td>=1-</td>
<td>=1-</td>
<td>=1-</td>
</tr>
<tr>
<td>4c</td>
<td>4e</td>
<td>4g</td>
<td>4cc</td>
<td>1</td>
</tr>
<tr>
<td>4B</td>
<td>4d</td>
<td>[4g</td>
<td>4g</td>
<td>2</td>
</tr>
<tr>
<td>4A</td>
<td>4c</td>
<td>8gL</td>
<td>4a</td>
<td>3</td>
</tr>
<tr>
<td>.</td>
<td>.</td>
<td>8f#J</td>
<td>.</td>
<td>3.5</td>
</tr>
<tr>
<td>8GL</td>
<td>4d</td>
<td>4g</td>
<td>4b</td>
<td>4</td>
</tr>
<tr>
<td>8FJ</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>4.5</td>
</tr>
<tr>
<td>=2</td>
<td>=2</td>
<td>=2</td>
<td>=2</td>
<td>=2</td>
</tr>
<tr>
<td>4E</td>
<td>8cL</td>
<td>4.g</td>
<td>2cc</td>
<td>1</td>
</tr>
<tr>
<td>.</td>
<td>8B-J</td>
<td>.</td>
<td>.</td>
<td>1.5</td>
</tr>
<tr>
<td>4F</td>
<td>4A</td>
<td>.</td>
<td>.</td>
<td>2</td>
</tr>
<tr>
<td>.</td>
<td>.</td>
<td>[8fNX</td>
<td>.</td>
<td>2.5</td>
</tr>
<tr>
<td>4C;</td>
<td>4G;</td>
<td>8fL</td>
<td>4cc;</td>
<td>3</td>
</tr>
<tr>
<td>.</td>
<td>.</td>
<td>8e;J</td>
<td>.</td>
<td>3.5</td>
</tr>
<tr>
<td>8cL</td>
<td>4c</td>
<td>[4e</td>
<td>4g</td>
<td>4</td>
</tr>
<tr>
<td>8B-J</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>4.5</td>
</tr>
<tr>
<td>=3</td>
<td>=3</td>
<td>=3</td>
<td>=3</td>
<td>=3</td>
</tr>
</tbody>
</table>
• 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

\texttt{beat h://371chorales/chor200.krn | ridx -GLIMd}
uniq -c

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

| 15  | 1   | • 15 times an event on beat 1 (could be tied note or rest) |
| 10  | 1.5 | • 10 times an event on beat 1.5 |
| 1   | 1.75|
| 11  | 2   |
| 9   | 2.5 |
| 15  | 3   |
| 11  | 3.5 |
| 1   | 3.75|
| 13  | 4   | • Type “man uniq” to see the manual page for the uniq command. |
| 12  | 4.5 |
| 2   | 4.75|
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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1</td>
<td>1–1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>2–1</td>
</tr>
<tr>
<td>44</td>
<td>1</td>
<td>2–3</td>
</tr>
<tr>
<td>45</td>
<td>1</td>
<td>2–4</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2–5</td>
</tr>
<tr>
<td>99</td>
<td>1</td>
<td>3–10</td>
</tr>
<tr>
<td>1182</td>
<td>1</td>
<td>3–11A</td>
</tr>
<tr>
<td>2380</td>
<td>1</td>
<td>3–11B</td>
</tr>
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