

# Humdrum melodic tools

[craigsapp@stanford.edu](mailto:craigsapp@stanford.edu)

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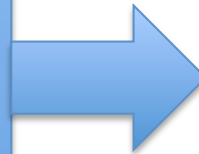
# mint

<http://www.humdrum.org/Humdrum/commands/mint.html>

- Melodic INTerval

`humcat -s h://371chorales/chor001.krn | mint`

| **kern | **kern  | **kern | **kern   |
|--------|---------|--------|----------|
| *Ibass | *Itenor | *Ialto | *Isoprnr |
| 4GG    | 4B      | 4d     | 4g       |
| =1     | =1      | =1     | =1       |
| 4G     | 4B      | 4d     | 2g       |
| 4E     | 8cL     | 4e     | .        |
| .      | 8BJ     | .      | .        |
| 4F#    | 4A      | 4d     | 4dd      |
| =2     | =2      | =2     | =2       |
| 4G     | 4G      | 2d     | 4.b      |
| 4D     | 4F#     | .      | .        |
| .      | .       | .      | 8a       |
| 4E     | 4G      | 4B     | 4g       |
| =3     | =3      | =3     | =3       |
| 4C     | 8cL     | 8eL    | 4.g      |
| .      | 8BJ     | 8d     | .        |
| 8BBL   | 4c      | 8e     | .        |
| 8AAJ   | .       | 8f#J   | 8a       |
| 4GG    | 4d      | 4g     | 4b       |



| **mint | **mint  | **mint | **mint   |
|--------|---------|--------|----------|
| *Ibass | *Itenor | *Ialto | *Isoprnr |
| [GG]   | [B]     | [d]    | [g]      |
| =1     | =1      | =1     | =1       |
| +P8    | P1      | P1     | P1       |
| -m3    | +m2     | +M2    | .        |
| .      | -m2     | .      | .        |
| +M2    | -M2     | -M2    | +P5      |
| =2     | =2      | =2     | =2       |
| +m2    | -M2     | P1     | -m3      |
| -P4    | -m2     | .      | .        |
| .      | .       | .      | -M2      |
| +M2    | +m2     | -m3    | -M2      |
| =3     | =3      | =3     | =3       |
| -M3    | +P4     | +P4    | P1       |
| .      | -m2     | -M2    | .        |
| -m2    | +m2     | +M2    | .        |
| -M2    | .       | +M2    | +M2      |
| -M2    | +M2     | +m2    | +M2      |

# Ignoring tied notes

|                     | <code>mint</code>   | <code>mint -s [_[] test.krn</code> |
|---------------------|---------------------|------------------------------------|
| <code>**kern</code> | <code>**mint</code> | <code>**mint</code>                |
| <code>2c</code>     | <code>[c]</code>    | <code>[c]</code>                   |
| <code>2d</code>     | <code>+M2</code>    | <code>+M2</code>                   |
| <code>2e</code>     | <code>+M2</code>    | <code>+M2</code>                   |
| <code>[4f</code>    | <code>+m2</code>    | <code>.</code>                     |
| <code>4f]</code>    | <code>P1</code>     | <code>+m2</code>                   |
| <code>2g</code>     | <code>+M2</code>    | <code>+M2</code>                   |
| <code>2a</code>     | <code>+M2</code>    | <code>+M2</code>                   |
| <code>2b</code>     | <code>+M2</code>    | <code>+M2</code>                   |
| <code>2cc</code>    | <code>+m2</code>    | <code>+m2</code>                   |
| <code>*_</code>     | <code>*_</code>     | <code>*_</code>                    |

`[_[]` → regular expression: “the character ‘\_’ or ‘[]’.

→ musical meaning: ignore notes which are tied to previous notes.

`[....]` → regular expression operator meaning any one character in list.

`_` → note is tied to notes before and after (tie continue marker)

`]` → note is tied to previous note (tie end marker)

`[` → note is tied to following note (tie start marker)

# Bach chorale intervals by voice

```
humcat -s h://371chorales > chorales.krns
```

```
extractx -g bass chorales.krns | mint -s [_[] | ridx -H | sort | uniq -c | sort -nr | head -n 18
```

```
extract -f 1 chorales.krns | mint -s [_[] | ridx -H | sort | uniq -c | sort -nr | head -n 18
```

| <b>bass</b> | <b>tenor</b> | <b>alto</b> | <b>soprn</b> |
|-------------|--------------|-------------|--------------|
| 4260 +M2    | 4597 -M2     | 4242 P1     | 4723 -M2     |
| 4141 -M2    | 3861 +M2     | 4067 -M2    | 3693 +M2     |
| 2980 +m2    | 3851 P1      | 3501 +M2    | 2724 P1      |
| 2602 -m2    | 2869 -m2     | 3215 -m2    | 2373 -m2     |
| 1827 +P4    | 2227 +m2     | 2444 +m2    | 1939 +m2     |
| 1402 -P5    | 1076 +P4     | 905 +P4     | 601 +P4      |
| 730 -P4     | 543 -m3      | 786 -M3     | 495 -m3      |
| 676 -m3     | 486 -M3      | 378 -m3     | 343 -M3      |
| 615 P1      | 451 -P5      | 299 +m3     | 298 +m3      |
| 561 -M3     | 357 +m3      | 265 -P4     | 258 -P4      |
| 517 +P8     | 356 -P4      | 244 +M3     | 224 +P5      |
| 508 +P5     | 265 +P5      | 197 r       | 187 +M3      |
| 416 -P8     | 234 +M3      | 182 -P5     | 184 r        |
| 254 A1      | 200 r        | 125 +P5     | 119 -P5      |
| 202 r       | 109 -d5      | 59 A1       | 41 +P8       |
| 176 +M3     | 79 +m6       | 53 +M6      | 27 +m6       |
| 150 +m3     | 71 +M6       | 48 d1       | 16 -m6       |
| 138 -d5     | 61 A1        | 41 +m6      | 15 +M6       |

# All melodic intervals in chorales

```
humcat -s h://371chorales > chorales.krn
```

```
cat chorales.krns | mint -s [_[] | serialize -c | ridx -H | sort | uniq -c | sort -nr
```

|       |     |    |      |   |      |
|-------|-----|----|------|---|------|
| 17528 | -M2 | 91 | -d4  | 1 | -M10 |
| 15315 | +M2 | 51 | -M6  | 1 | -A8  |
| 11432 | P1  | 38 | +m7  | 1 | -A5  |
| 11059 | -m2 | 35 | +d4  | 1 | -A4  |
| 9590  | +m2 | 21 | +d5  | 1 | +P15 |
| 4409  | +P4 | 19 | -d7  |   |      |
| 2176  | -M3 | 18 | +M7  |   |      |
| 2154  | -P5 | 16 | -m7  |   |      |
| 2092  | -m3 | 16 | +A4  |   |      |
| 1609  | -P4 | 9  | +M9  |   |      |
| 1122  | +P5 | 8  | +A5  |   |      |
| 1104  | +m3 | 7  | -M9  |   |      |
| 841   | +M3 | 6  | +P11 |   |      |
| 783   | r   | 6  | +M10 |   |      |
| 637   | +P8 | 5  | -M7  |   |      |
| 465   | -P8 | 5  | +A8  |   |      |
| 377   | A1  | 4  | +P12 |   |      |
| 271   | -d5 | 2  | -d3  |   |      |
| 201   | +M6 | 2  | +m10 |   |      |
| 190   | +m6 | 2  | +d7  |   |      |
| 124   | d1  | 2  | +d3  |   |      |
| 117   | -m6 | 1  | -m10 |   |      |

# Harmonic v Melodic intervals

```
humcat -s h://371chorales > chorales.krn
```

```
cat chorales.krns | mint -s [_[] | serialize | ridx -H | sort | uniq -c | sort -nr | head -n 18
```

```
cat chorales.krns | hint -ac | serialize -c | ridx -H | sort | uniq -c | sort -nr | head -n 18
```

## melodic intervals

```
17528 -M2
15315 +M2
11432 P1
11059 -m2
9590 +m2
4409 +P4
2176 -M3
2154 -P5
2092 -m3
1609 -P4
1122 +P5
1104 +m3
841 +M3
637 +P8
465 -P8
377 A1
271 -d5
201 +M6
```

## harmonic intervals

```
18053 m3
17545 P5
16147 M3
15263 P1
10812 P4
10035 M6
9935 m6
2537 M2
1542 m7
1534 A4
1103 d5
397 m2
248 M7
175 d7
64 A2
62 d4
43 A5
2 A6
```

# hgrep / myank

- Identify chorale which has +P15:

```
cat chorales.krns | mint -s [_[] | hgrep -Hm P15  
chor024.krn:measure 2:+15 +P8 +m3 +M3
```

- pull out music around two-octave leap in bass part:  
`myank -m 1-3 h://chorales/chor024.krn`

|        |        |        |        |
|--------|--------|--------|--------|
| **kern | **kern | **kern | **kern |
| 8DL    | 8F#L   | 4d     | 4a     |
| 8E     | 8G     | .      | .      |
| 8F#    | 8A     | 4d     | 4a     |
| 8DJ    | 8F#J   | .      | .      |
| 8GL    | 4G     | 4d     | 4b     |
| 8F#J   | .      | .      | .      |
| 4E     | 8GL    | [ 4g   | 4cc#   |
| .      | 8AJ    | .      | .      |
| =2     | 4B     | =2     | =2     |
| 8BBL   | 4B     | 4g ]   | 2dd    |
| 8C#J   | .      | .      | .      |
| 4D     | 8AL    | 8f#L   | .      |
| .      | 8GJ    | 8eJ    | .      |
| 4DD;   | 4A;    | 4f#;   | 4dd;   |
| 4d     | 4a     | 8aL    | 4ff#   |
| .      | .      | 8bJ    | .      |
| =3     | =3     | =3     | =3     |
| 4A#    | 4g     | 4cc#   | 4ee    |
| 8BL    | 4f#    | 4b     | 4dd    |
| 8AJ    | .      | .      | .      |
| 4G#    | 4f     | 4b     | 4dd    |
| 4A     | 4e     | 4a     | 4cc#   |
| =      | =      | =      | =      |
| * _    | * _    | * _    | * _    |

# hum2muse / muse2ps

<http://extras.humdrum.org/man/hum2muse>

<http://muse2ps.ccarh.org>

```
myank -m 1-3 h://chorales/chor024.krn | autostem | hum2muse | muse2ps =z18j \  
| ps2pdf -sPAPERSIZE=letter - - > output.pdf
```

```
myank -m 1-3 h://chorales/chor024.krn | autostem | hum2muse | muse2ps =z18j \  
| pstopnm -dpi=300 | convert - -trim -resize 50% output.png
```

Valet will ich dir geben

J.S. Bach

The image displays a musical score for the piece 'Valet will ich dir geben' by J.S. Bach. The score is written for four staves, all in G major (indicated by two sharps) and common time (C). The notation includes various musical symbols such as treble and bass clefs, time signatures, and note values. A small, stylized face with a single eye and a smile is overlaid on the bottom staff, partially obscuring the musical notation. The face is rendered in a light pinkish-brown color.

# hum2abc / abcm2ps

<http://extras.humdrum.org/man/hum2abc>

<http://moinejf.free.fr>

```
myank -m 1-3 h://chorales/chor024.krn | hum2abc -n1 | abcm2ps --O - \
| ps2pdf -sPAPERSIZE=letter -- > output.pdf
```

```
myank -m 1-3 h://chorales/chor024.krn | hum2abc -n1 | abcm2ps --O - \
| pstopnm -dpi=300 | convert -trim -resize 33% output.png
```

## 24. Valet will ich dir geben

*Johann Sebastian Bach*

8

# ms / mup

<http://www.humdrum.org/Humdrum/commands/ms.html>

<http://www.arkkra.com>

```
myank -m 1-3 h://chorales/chor024.krn | ms | ps2pdf -sPAPERSIZE=letter - - > output.pdf
```

```
myank -m 1-3 h://chorales/chor024.krn | ms -z | mup \  
| ps2pdf -sPAPERSIZE=letter - - > output.pdf
```

## **Valet will ich dir geben**

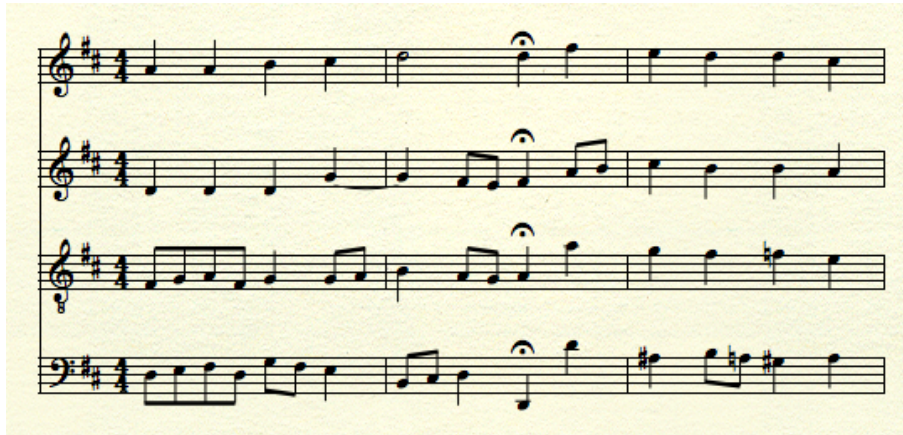
**Johann Sebastian Bach**

The image displays a musical score for the chorale 'Valet will ich dir geben' by Johann Sebastian Bach. The score is written for four staves, all in G major (one sharp) and 4/4 time. The first staff includes two rehearsal marks: a box with the number '2' above the second measure and a box with the number '3' above the eighth measure. The notation includes various note values, rests, and a final double bar line with repeat dots. The bottom staff begins with a small '8' below the first measure.

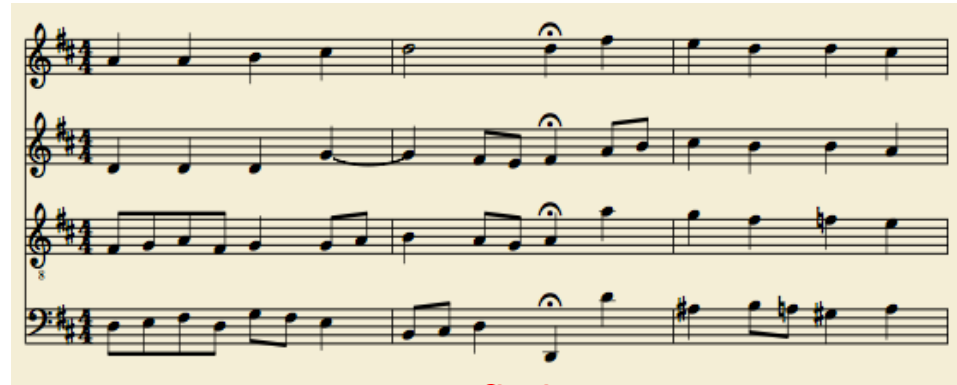
# hum2xml / MuseScore | Finale | Sibelius | Noteflight

myank -m 1-3 h://chorales/chor024.krn | autostem | hum2xml > output.xml

**Finale 2012**



**MuseScore 1.2**



**Sibelius 7**



**Noteflight**



# hum2xml / musicxml2ly / lilypond

myank -m 1-3 h://371chorales/chor024.krn | hum2xml | musicxml2ly -o- \  
| lilypond -f pdf -o output

- *autostem* feature built into lilypond, so does not need to be used before converting



# auto-beaming

```
myank -m 1-3 h://371chorales/chor024.krn | hum2xml | grep -v beam \  
| musicxml2ly -o- - | lilypond -o output -
```



```
myank -m 1-3 h://371chorales/chor024.krn | hum2xml | grep -v beam \  
| musicxml2ly --no-beaming -o- - | lilypond -o output -
```



# Essen Folksongs

<http://kern.ccarh.org/browse?l=/essen>

# scaletype

<http://extras.humdrum.org/man/scaletype>

Simple categorization of scales by pitch classes used in a file:

- 8+ pitch classes: “chromatic”
- 7 pitch classes: “heptatonic”
- 6 pitch classes: “hexatonic”
- 5 pitch classes: “pentatonic”
- <5 pitch classes: “too few”

```
humcat -s h://folk/china > china.krns
```

```
humcat -s h://folk/germany > germany.krns
```

```
scaletype -F china.krns | sort | uniq -c | sort -nr
```

```
scaletype -F germany.krns | sort | uniq -c | sort -nr
```

## Chinese songs

```
1096 pentatonic
 706 hexatonic
 282 heptatonic
 117 toofew
  40 chromatic
```

## Germany songs

```
2558 heptatonic
1415 hexatonic
 842 chromatic
 434 pentatonic
 104 toofew
```

# sortcount script

- PERL script to elaborate the pipeline:

| sort | uniq -c | sort -nr

```
#!/usr/bin/perl
use strict;
use Getopt::Long;

my $alphabeticQ = 0; # -a: sort output lines alphabetically
my $percentQ    = 0; # -p: show counts as percentages
my $fractionQ   = 0; # -f: show counts as fractions
my $totalQ      = 0; # -t: show total count of input lines
my $smallQ      = 0; # -s: sort by smallest numbers first
my $humdrumQ    = 0; # -h: output data in Humdrum file format

Getopt::Long::Configure("bundling");
GetOptions (
    'a|alphabetic'      => \$alphabeticQ,
    'p|percent'         => \$percentQ,
    'f|fraction'        => \$fractionQ,
    't|totalQ'          => \$totalQ,
    's|smallQ'          => \$smallQ,
    'h|humdrum'         => \$humdrumQ,
);

my @contents = <>;

my (%unique, $line, @output, $sum, $key, @output2, $value, @keys);
```

# sortcount (2)

```
foreach $line (@contents) {
    $unique{$line}++;
}
@keys = keys %unique;
@keys = sort @keys if $alphabeticQ;
foreach $key (@keys) {
    $sum += $unique{$key};
    $output[@output] = $key;
}
if ($humdrumQ && $percentQ) { print "***pcent\t**data\n"; }
elsif ($humdrumQ && $fractionQ) { print "***frac\t**data\n"; }
elsif ($humdrumQ) { print "***count\t**data\n"; }

foreach $key (@keys) {
    if ($percentQ) { $value = int(10000.0*$unique{$key}/$sum + 0.5)/100.0; }
    elsif ($fractionQ) { $value = int(1000.0*$unique{$key}/$sum + 0.5)/1000.0; }
    else { $value = $unique{$key}; }
    $output2[@output2] = "$value\t$key";
}
if ($smallQ && !$alphabeticQ) {
    @output2 = sort { $a <=> $b } @output2;
} elsif (!$alphabeticQ) {
    @output2 = sort { $b <=> $a } @output2;
}
print join("", @output2);

print "*-\t*-\n" if $humdrumQ;
if ($totalQ) {
    print "!!" if $humdrumQ;
    print "TOTAL:\t$sum\n";
}
```

# sortcount (3)

scaletype china.krns -F | sortcount -hpt

| **pcent  | **data     |
|----------|------------|
| 48.9     | pentatonic |
| 31.5     | hexatonic  |
| 12.6     | heptatonic |
| 5.2      | toofew     |
| 1.8      | chromatic  |
| *_       | *_         |
| !!TOTAL: | 2241       |

scaletype germany.krns -F | sortcount -hpt

| **pcent  | **data     |
|----------|------------|
| 47.8     | heptatonic |
| 26.4     | hexatonic  |
| 15.7     | chromatic  |
| 8.1      | pentatonic |
| 1.9      | toofew     |
| *_       | *_         |
| !!TOTAL: | 5353       |

scaletype -F h://pentatonic | sortcount -hpt

| **pcent  | **data     |
|----------|------------|
| 89.6     | pentatonic |
| 10.4     | toofew     |
| *_       | *_         |
| !!TOTAL: | 67         |

# Melodic searching

- search engine behind <http://themefinder.com> and <http://jrp.ccarh.org>
- **tindex**: generate thema search index <http://extras.humdrum.org/man/tindex>
- **themax**: perform search on index <http://extras.humdrum.org/man/themax>
- **theloc**: mark matches in original data <http://extras.humdrum.org/man/theloc>

```
humcat -s h://folk/china > china.krns
```

```
humcat -s h://folk/germany > germany.krns
```

```
tindex china.krns > china.tindex
```

```
tindex germany.krns > germany.tindex
```

# Searching by diatonic pitch name

**themax -p "cdfga" china.tindex --total**

humdrum://folk/china/han0028.krn::118 38  
humdrum://folk/china/han0050.krn::140 67  
humdrum://folk/china/han0124.krn::19 32  
humdrum://folk/china/han0143.krn::125  
humdrum://folk/china/han0200.krn::154  
humdrum://folk/china/han0207.krn::176  
humdrum://folk/china/han0245.krn::150  
humdrum://folk/china/han0246.krn::192  
humdrum://folk/china/han0323.krn::137  
humdrum://folk/china/han0365.krn::143  
humdrum://folk/china/han0386.krn::12  
humdrum://folk/china/han0407.krn::124  
15

**themax -p "cdfga" germany.tindex --total**

humdrum://folk/germany/deut0974.krn::1 49  
humdrum://folk/germany/deut3227.krn::1 27  
2

# Location of matches

```
themax -p "cdefg" china.tindex -total -loc | head -n1 | theloc
```

```
humdrum://folk/china/han0028.krn::1 18=5B1-22=6B1.5 38=11B1-42=12B1.5
```

match from note 18 to 22, measure 5, beat 1 to measure 6 beat 1.5  
and 38 to 42, measure 11 beat 1 to measure 12 beat 1.5

```
themax -p "cdefg" china.tindex -total -loc | head -n1 | theloc -m
```

|      |      |
|------|------|
| =5   | =11  |
| 8cc@ | 8cc@ |
| 8d@  | 8d@  |
| 4f@  | 4f@  |
| =6   | =12  |
| 8g@  | 8g@  |
| 8a@  | 8a@  |
| 8f   | 8f   |
| 8d   | 8d   |
| =7   | =13  |

!!!RDF\*\*kern: @= matched note

# Display matched notes

```
themax -p "cdefg" china.tindex --total --loc | head -n1 | theloc -m \  
| autostem | hum2muse =z21j | muse2ps | pstopnm -dpi=300 \  
| convert - -trim -resize 50% output.png
```

## Zhi shoujin



# Parallel feature searching

- search for the pitch-class sequence “cdefg” where sequence always rises

```
themax -p "cdefg" -C "uuuuu" china.tindex -total -loc | head -n1 | theloc -m \
| autostem | hum2muse =z21j | muse2ps | pstopnm -dpi=300 \
| convert - -trim -resize 50% output.png
```

Zhi shoujin



# Parallel feature searching (2)

- search for the semi-tone interval sequence +2 +3 +2 +2 starting on a “G”

```
themax -p "g" -l "+2 +3 +2 +2" china.tindex -total -loc | head -n1 | theloc -m \
| autostem | hum2muse =z21jc60 | muse2ps | pstopnm -dpi=300 \
| convert - -trim -resize 50% output.png
```

Lan yu lian



# context

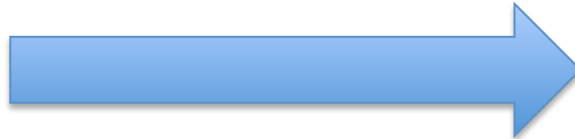
<http://www.humdrum.org/Humdrum/commands/context.html>

- Create lists of successive elements (n-grams)
- Raw data for generating transition probabilities (Markov chains)

```
**data
```

```
A  
B  
C  
D  
E  
F  
G  
H  
I  
J  
*_
```

context -n 3



```
**data
```

```
A B C  
B C D  
C D E  
D E F  
E F G  
F G H  
G H I  
H I J  
.  
.  
*_
```

# Most common interval patterns

```
kern -x china.krns | grep -v ^= | mint -s [_[] | grep -v [[] | context -n 5 | ridx -H \  
| grep -v r | sortcount -hpt | less
```

## china.krns

|      |     |     |     |     |     |
|------|-----|-----|-----|-----|-----|
| 0.32 | -M2 | -m3 | -M2 | +M2 | +m3 |
| 0.23 | +M2 | -M2 | -m3 | -M2 | +M2 |
| 0.22 | -M2 | +M2 | +m3 | -m3 | -M2 |
| 0.22 | +M2 | -M2 | -M2 | -m3 | -M2 |
| 0.22 | -M2 | +M2 | -M2 | -m3 | -M2 |
| 0.22 | +M2 | +m3 | -m3 | -M2 | -M2 |
| 0.22 | -M2 | +M2 | -M2 | -M2 | -m3 |
| 0.21 | +M2 | +M2 | -M2 | -M2 | -m3 |
| 0.21 | +m3 | +M2 | -M2 | -m3 | -M2 |
| 0.2  | -M2 | +M2 | -M2 | +M2 | -M2 |
| 0.19 | -m3 | -M2 | +M2 | -M2 | -M2 |
| 0.19 | -M2 | -M2 | -m3 | +m3 | +M2 |
| 0.19 | -m3 | -M2 | +M2 | +m3 | -m3 |
| 0.19 | +M2 | -M2 | -M2 | -m3 | +m3 |
| 0.18 | -M2 | -m3 | +m3 | -m3 | -M2 |
| 0.17 | +M2 | +m3 | -m3 | -M2 | -m3 |
| 0.17 | +m3 | -m3 | -M2 | -M2 | +M2 |
| 0.17 | +M2 | -M2 | +M2 | -M2 | +M2 |
| 0.16 | -m3 | -M2 | -M2 | +M2 | +M2 |
| 0.16 | -M2 | -M2 | +M2 | +M2 | -M2 |

## germany.krns

|      |     |     |     |     |     |
|------|-----|-----|-----|-----|-----|
| 0.44 | P1  | P1  | P1  | P1  | P1  |
| 0.33 | -M2 | -M2 | -m2 | -M2 | -M2 |
| 0.30 | +M2 | -M2 | -M2 | -m2 | -M2 |
| 0.22 | +M2 | +m2 | -m2 | -M2 | -M2 |
| 0.22 | +m3 | -M2 | -m2 | -M2 | -M2 |
| 0.20 | +M2 | +M2 | -M2 | -M2 | -m2 |
| 0.20 | +m2 | +M2 | +M2 | -M2 | -M2 |
| 0.19 | P1  | +M2 | -M2 | -M2 | -m2 |
| 0.19 | +M2 | +M2 | +m2 | -m2 | -M2 |
| 0.18 | -M2 | -m2 | -M2 | -M2 | +M2 |
| 0.18 | +m2 | +M2 | -M2 | -m2 | -M2 |
| 0.17 | P1  | -M2 | -m2 | -M2 | -M2 |
| 0.16 | +M2 | -M2 | -m2 | -M2 | -M2 |
| 0.16 | -M2 | -M2 | -m2 | +m2 | +M2 |
| 0.16 | -M2 | -m2 | -M2 | -M2 | P1  |
| 0.16 | -M2 | -M2 | -m2 | -M2 | +M2 |
| 0.16 | -m2 | -M2 | -M2 | +M2 | -M2 |
| 0.16 | +M2 | +m2 | +M2 | -M2 | -m2 |
| 0.15 | P1  | P1  | +M2 | +M2 | +m2 |
| 0.15 | +M2 | +m2 | +M2 | +M2 | -M2 |

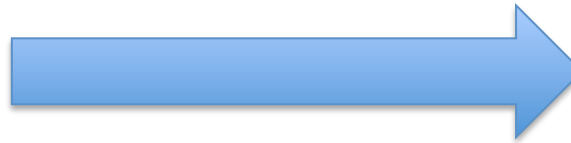
# extract

<http://www.humdrum.org/Humdrum/commands/extract.html>

- extract one or more spines from a Humdrum file
- useful for pulling one or more parts out of a full score

| **a | **b | **c |
|-----|-----|-----|
| a1  | b1  | c1  |
| a2  | b2  | c2  |
| a3  | b3  | c3  |
| a4  | b4  | c4  |
| a5  | b5  | c5  |
| a6  | b6  | c6  |
| *_  | *_  | *_  |

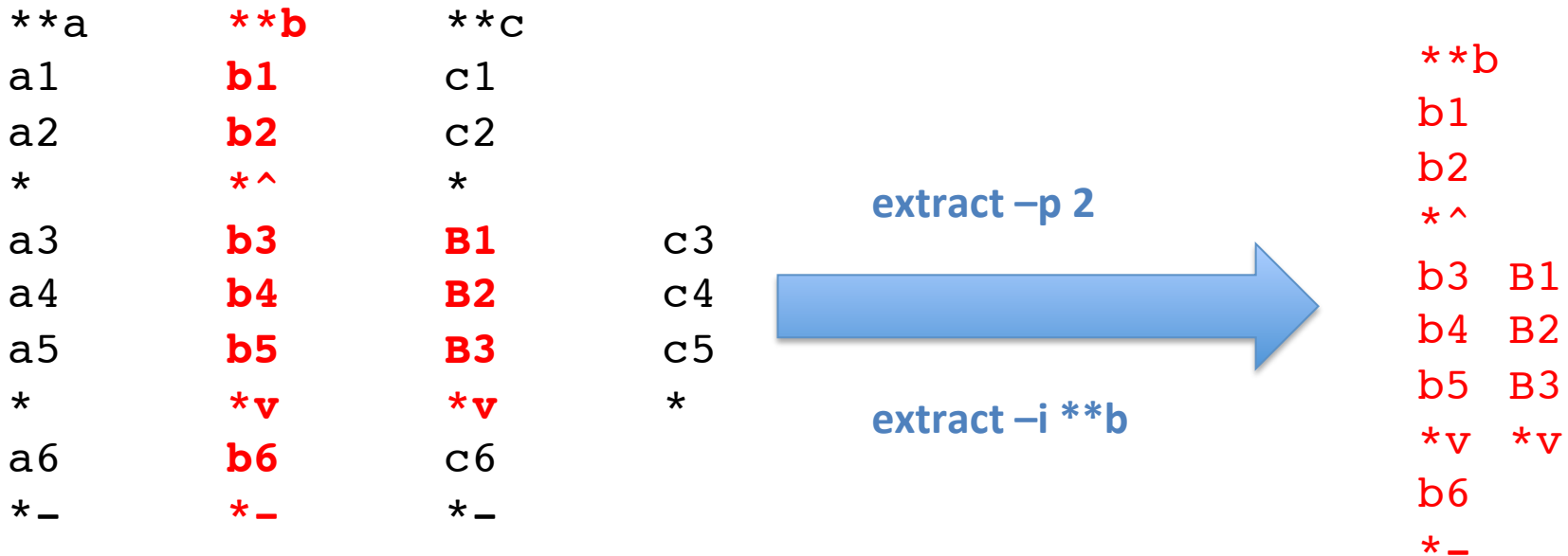
**extract -f 2**



| **b |
|-----|
| b1  |
| b2  |
| b3  |
| b4  |
| b5  |
| b6  |
| *_  |

# extract (2)

- -f # → extract by field (column)
- -p # → extract by spine (variable field count per line)
- -i \*\*b → extract all \*\*b spines.



# Bach chorale melodic patterns

rest/fermata boundaries excluded:

```
extractx -g bass chorales.krns | sed 's/;/ r/g' | serialize -c | mint -s [_[] | egrep -v [=[] \
| context -n 5 | grep -v r | ridx -H | sortcount -pht
```

## most common bass melodic patterns

|              |     |     |     |     |     |
|--------------|-----|-----|-----|-----|-----|
| 0.89%        | -M2 | -M2 | -m2 | -M2 | -M2 |
| 0.70         | -M2 | -M2 | -m2 | -M2 | +M2 |
| 0.62         | -M2 | -m2 | -M2 | -M2 | -m2 |
| 0.61         | -m2 | -M2 | -M2 | -M2 | -m2 |
| 0.57         | -m2 | -M2 | -M2 | -m2 | -M2 |
| 0.53         | +M2 | +m2 | -m2 | -M2 | -M2 |
| 0.48         | -M2 | -m2 | -M2 | +M2 | +m2 |
| 0.46         | -m2 | -M2 | -M2 | +M2 | +M2 |
| 0.43         | -m2 | -M2 | +M2 | +m2 | +M2 |
| 0.42         | -M2 | -m2 | -M2 | -m2 | +m2 |
| 0.41         | +M2 | +M2 | +m2 | +M2 | +M2 |
| 0.40         | -m2 | -M2 | -M2 | -m2 | +m2 |
| 0.40         | +M2 | +M2 | +m2 | -m2 | -M2 |
| 0.37         | -M2 | -M2 | +M2 | +M2 | +m2 |
| 0.37         | +M2 | +m2 | +M2 | +M2 | +m2 |
| 0.37         | +M2 | +m2 | -P5 | +M2 | -P5 |
| 0.34         | -M2 | -m2 | +m2 | -m2 | -M2 |
| TOTAL: 13337 |     |     |     |     |     |

## tenor

|              |     |     |     |     |     |
|--------------|-----|-----|-----|-----|-----|
| 0.55%        | +M2 | +M2 | -M2 | -M2 | -m2 |
| 0.39         | -M2 | -m2 | -M2 | +M2 | +m2 |
| 0.36         | -M2 | -M2 | -m2 | -M2 | +M2 |
| 0.36         | -m2 | -M2 | +M2 | +m2 | +M2 |
| 0.35         | +M2 | +m2 | -m2 | -M2 | -M2 |
| 0.30         | P1  | +M2 | -M2 | -M2 | -m2 |
| 0.30         | +M2 | +M2 | +m2 | -m2 | -M2 |
| 0.30         | +m2 | +M2 | +M2 | -M2 | -M2 |
| 0.28         | -M2 | -M2 | +M2 | +M2 | +m2 |
| 0.28         | -M2 | +M2 | +M2 | -M2 | -M2 |
| 0.28         | +m2 | +M2 | +M2 | +m2 | -m2 |
| 0.26         | +M2 | -M2 | -M2 | -m2 | -M2 |
| 0.24         | -M2 | +M2 | +m2 | -m2 | -M2 |
| 0.24         | -M2 | +M2 | +m2 | +M2 | +M2 |
| 0.24         | +M2 | +M2 | +m2 | +M2 | +M2 |
| 0.24         | +m2 | +M2 | -M2 | -m2 | -M2 |
| 0.24         | P1  | -M2 | -M2 | +M2 | +M2 |
| TOTAL: 12662 |     |     |     |     |     |

# Josquin bass melodic patterns

```
humcat -s h://jrp/Jos > josquin.krns
```

```
extractx -g Bassus josquin.krns | serialize -S | kern -x | mint -s [_[] | grep -v = \  
| context -n 5 | ridx -H | grep -v r | sortcount -pht
```

## most common Bassus melodic patterns

|       |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|
| 0.52% | -m2 | -M2 | -M2 | -m2 | -M2 |
| 0.47  | -M2 | -M2 | -m2 | -M2 | -M2 |
| 0.39  | +M2 | +m2 | -m2 | -M2 | -M2 |
| 0.37  | -m2 | -M2 | -M2 | +M2 | -M2 |
| 0.35  | +M2 | +M2 | +m2 | +M2 | +M2 |
| 0.33  | +M2 | +M2 | +m2 | -m2 | -M2 |
| 0.33  | +m2 | -m2 | -M2 | -M2 | +M2 |
| 0.32  | +M2 | -M2 | -M2 | -m2 | -M2 |
| 0.31  | -M2 | -m2 | -M2 | -M2 | +M2 |
| 0.31  | -m2 | -M2 | -M2 | -M2 | -m2 |
| 0.28  | P1  | P1  | P1  | P1  | P1  |
| 0.28  | -M2 | -m2 | -M2 | +M2 | -M2 |
| 0.26  | +m2 | +M2 | -M2 | -m2 | -M2 |
| 0.25  | +M2 | -M2 | -m2 | -M2 | -M2 |
| 0.25  | +M2 | +M2 | -M2 | -M2 | -m2 |
| 0.25  | -m2 | -M2 | -M2 | +M2 | +M2 |
| 0.23  | +M2 | +m2 | +M2 | +M2 | -P5 |
| 0.22  | -M2 | +M2 | +M2 | +m2 | +M2 |
| 0.22  | -M2 | -M2 | -m2 | -M2 | +M2 |
| 0.21  | +M2 | +M2 | +m2 | +M2 | -M2 |

...

TOTAL: 67535

## Bach chorale bass part

|        |       |     |     |     |     |
|--------|-------|-----|-----|-----|-----|
| 0.89%  | -M2   | -M2 | -m2 | -M2 | -M2 |
| 0.70   | -M2   | -M2 | -m2 | -M2 | +M2 |
| 0.62   | -M2   | -m2 | -M2 | -M2 | -m2 |
| 0.61   | -m2   | -M2 | -M2 | -M2 | -m2 |
| 0.57   | -m2   | -M2 | -M2 | -m2 | -M2 |
| 0.53   | +M2   | +m2 | -m2 | -M2 | -M2 |
| 0.48   | -M2   | -m2 | -M2 | +M2 | +m2 |
| 0.46   | -m2   | -M2 | -M2 | +M2 | +M2 |
| 0.43   | -m2   | -M2 | +M2 | +m2 | +M2 |
| 0.42   | -M2   | -m2 | -M2 | -m2 | +m2 |
| 0.41   | +M2   | +M2 | +m2 | +M2 | +M2 |
| 0.40   | -m2   | -M2 | -M2 | -m2 | +m2 |
| 0.40   | +M2   | +M2 | +m2 | -m2 | -M2 |
| 0.37   | -M2   | -M2 | +M2 | +M2 | +m2 |
| 0.37   | +M2   | +m2 | +M2 | +M2 | +m2 |
| 0.37   | +M2   | +m2 | -P5 | +M2 | -P5 |
| 0.34   | -M2   | -m2 | +m2 | -m2 | -M2 |
| TOTAL: | 13337 |     |     |     |     |

# Melodic intervals across fermata

```
extractx -g bass chorales.krns | sed 's/;/ r/' \
| kern -x | grep -v ^[0-9.]*r | serialize -c \
| grep -v = | context -n 3 | ridx -H | grep r \
| egrep -v '^r|r$' | sed 's/ r /\t/' > fermata.krn
```

- Edit fermata.krn to add “\*\*kern \*\*kern” at top of file and “\*- \*-” at bottom of file (or write a script to do that).

```
hint -v fermata.krn | ridx -H | sortcount -pht
```

|        |     |      |      |
|--------|-----|------|------|
| 18.43% | P1  |      |      |
| 15.75  | +P8 |      |      |
| 12.39  | +P4 |      |      |
| 6.82   | +P5 |      |      |
| 6.77   | -m3 |      |      |
| 4.46   | +M2 |      |      |
| 3.62   | -P4 |      |      |
| 3.04   | -m2 | 0.68 | -d5  |
| 3.04   | +M3 | 0.58 | -m6  |
| 2.73   | +A1 | 0.47 | +A4  |
| 2.62   | +M6 | 0.42 | +M9  |
| 2.57   | -M3 | 0.37 | +A5  |
| 2.47   | -M2 | 0.31 | +M10 |
| 2.41   | -P5 | 0.26 | -m7  |
| 1.78   | +m2 | 0.26 | +A8  |
| 1.52   | +m3 | 0.21 | +P11 |
| 1.47   | -P8 | 0.21 | +P12 |
| 1.21   | +m6 | 0.16 | -M7  |
| 0.94   | +m7 | 0.10 | -M6  |
| 0.79   | -d4 | 0.10 | +m10 |
| 0.73   | +M7 | 0.05 | -M10 |
|        |     | 0.05 | -M9  |
|        |     | 0.05 | -m10 |
|        |     | 0.05 | +P15 |
|        |     | 0.05 | -d8  |

TOTAL: 1912

# prange

prange h://371chorales

| **keyno | **kern | **count |
|---------|--------|---------|
| 36      | CC     | 28      |
| 37      | CC#    | 2       |
| 38      | DD     | 120     |
| 39      | EE-    | 32      |
| 40      | EE     | 140     |
| 41      | FF     | 263     |
| 42      | FF#    | 127     |
| 43      | GG     | 976     |
| 44      | GG#    | 163     |
| 45      | AA     | 1459    |
| 46      | BB-    | 796     |
| 47      | BB     | 1268    |
| 48      | C      | 1878    |
| 49      | C#     | 833     |
| 50      | D      | 3165    |
| 51      | E-     | 905     |
| 52      | E      | 2931    |
| 53      | F      | 1966    |
| 54      | F#     | 2089    |
| 55      | G      | 3747    |
| 56      | G#     | 1244    |
| 57      | A      | 5112    |
| 58      | B-     | 2188    |
| 59      | B      | 3546    |

|    |     |      |
|----|-----|------|
| 60 | c   | 4014 |
| 61 | c#  | 1790 |
| 62 | d   | 6601 |
| 63 | e-  | 1466 |
| 64 | e   | 5656 |
| 65 | f   | 3323 |
| 66 | f#  | 3404 |
| 67 | g   | 5332 |
| 68 | g#  | 1268 |
| 69 | a   | 4905 |
| 70 | b-  | 1488 |
| 71 | b   | 2890 |
| 72 | cc  | 2230 |
| 73 | cc# | 1106 |
| 74 | dd  | 2299 |
| 75 | ee- | 376  |
| 76 | ee  | 948  |
| 77 | ff  | 289  |
| 78 | ff# | 187  |
| 79 | gg  | 109  |
| 80 | gg# | 1    |
| 81 | aa  | 6    |
| *- | *-  | *-   |

!!tessitura: 45 semitones  
!!mean: 60.8378 (c#)  
!!median: 62 (d)

# prange (2)

extractx -g bass h://371chorales | prange

| **keyno | **ker n | **count |
|---------|---------|---------|
| 36      | CC      | 28      |
| 37      | CC#     | 2       |
| 38      | DD      | 120     |
| 39      | EE-     | 32      |
| 40      | EE      | 140     |
| 41      | FF      | 263     |
| 42      | FF#     | 127     |
| 43      | GG      | 976     |
| 44      | GG#     | 163     |
| 45      | AA      | 1459    |
| 46      | BB-     | 796     |
| 47      | BB      | 1268    |
| 48      | C       | 1873    |
| 49      | C#      | 831     |
| 50      | D       | 3068    |
| 51      | E-      | 870     |
| 52      | E       | 2597    |
| 53      | F       | 1506    |
| 54      | F#      | 1468    |
| 55      | G       | 1922    |
| 56      | G#      | 573     |
| 57      | A       | 1349    |
| 58      | B-      | 410     |
| 59      | B       | 482     |
| 60      | c       | 250     |
| 61      | c#      | 90      |
| 62      | d       | 107     |
| 63      | e-      | 5       |
| 64      | e       | 3       |
| *_      | *_      | *_      |

!!tessitura: 28 semitones  
!!mean: 50.7806 (E-)  
!!median: 51 (E-)

## tenor

|    |      |
|----|------|
| C  | 5    |
| C# | 2    |
| D  | 97   |
| E- | 35   |
| E  | 333  |
| F  | 458  |
| F# | 618  |
| G  | 1760 |
| G# | 663  |
| A  | 3437 |
| B- | 1627 |
| B  | 2589 |
| c  | 2852 |
| c# | 1034 |
| d  | 3230 |
| e- | 520  |
| e  | 1685 |
| f  | 535  |
| f# | 385  |
| g  | 187  |
| g# | 17   |
| a  | 18   |

!!tessitura: 21 semitones  
!!mean: 59.2681 (B)  
!!median: 59 (B)

## alto

|     |      |
|-----|------|
| E   | 1    |
| F   | 2    |
| F#  | 3    |
| G   | 65   |
| G#  | 8    |
| A   | 325  |
| B-  | 150  |
| B   | 475  |
| c   | 870  |
| c#  | 654  |
| d   | 2900 |
| e-  | 850  |
| e   | 3341 |
| f   | 2137 |
| f#  | 2384 |
| g   | 3184 |
| g#  | 878  |
| a   | 1934 |
| b-  | 453  |
| b   | 500  |
| cc  | 124  |
| cc# | 71   |
| dd  | 20   |

!!tessitura: 22 semitones  
!!mean: 64.9064 (f)  
!!median: 65 (f)

## soprano

|     |      |
|-----|------|
| A   | 1    |
| B-  | 1    |
| c   | 42   |
| c#  | 12   |
| d   | 364  |
| e-  | 91   |
| e   | 627  |
| f   | 651  |
| f#  | 635  |
| g   | 1961 |
| g#  | 373  |
| a   | 2953 |
| b-  | 1035 |
| b   | 2390 |
| cc  | 2106 |
| cc# | 1035 |
| dd  | 2279 |
| ee- | 376  |
| ee  | 948  |
| ff  | 289  |
| ff# | 187  |
| gg  | 109  |
| gg# | 1    |
| aa  | 6    |

!!tessitura: 24 semitones  
!!mean: 70.4183 (b-)  
!!median: 71 (b)

# Which chorale has the lowest soprano note?

```
extractx -g soprn /tmp/chorales.krn | hgrep -dmH A
```

```
chor194.krn:measure 8:1.A#;
```

```
chor197.krn:measure 20:1A;
```

```
myank -m 1-3 h://chorales/chor197.krn | autostem | hum2muse | muse2ps =z18j \  
| pstopnm -dpi=300 | convert - -trim -resize 50% output.png
```

Christ ist erstanden

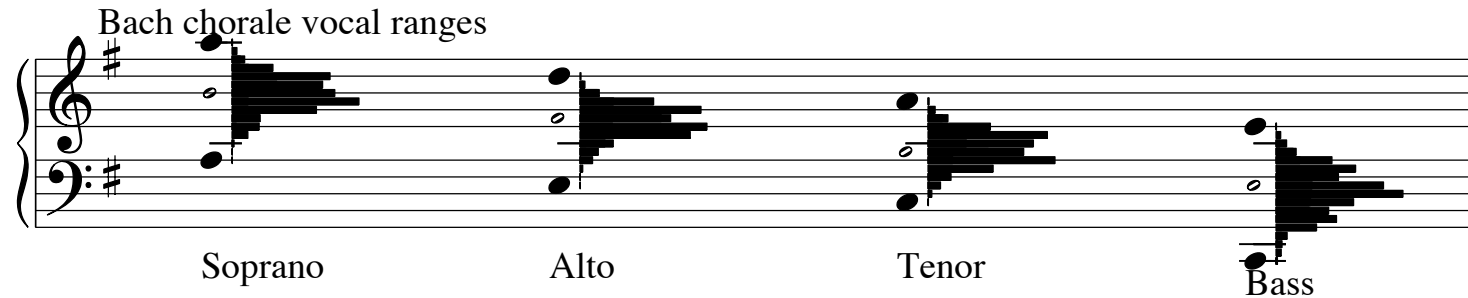
J.S. Bach



# prange

`prange --score h://371chorales | geteps > output.eps`

`prange --score h://371chorales | getsvg > output.svg`



```
#!/usr/bin/perl
use HTTP::Request::Common;
use LWP::UserAgent;
while ($line = <>) { $data .= "$line"; }
$ua = LWP::UserAgent->new;
my $response = $ua->request(
    POST 'http://score.sapp.org/cgi-bin/score',
    [ outputformat => 'eps',
      embedpmx     => 'yes',
      inputdata    => [$data],]);
if ($response->is_success) {
    print $response->decoded_content;
} else { die $response->status_line; }
```