

Humdrum melodic tools

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Humdrum program documentation

`mint -h`

gives one-page summary of *mint* command (similar for all Humdrum Toolkit programs)

`myank --options`

list options for *serialize* command (same for all Humdrum Extras programs)

Humdrum Toolkit man pages:

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

Humdrum Extras man pages:

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

Chapter 11 in the Humdrum Users' Guide (Melodic Intervals):

<http://www.humdrum.org/Humdrum/guide11.html>

List of various Humdrum resources:

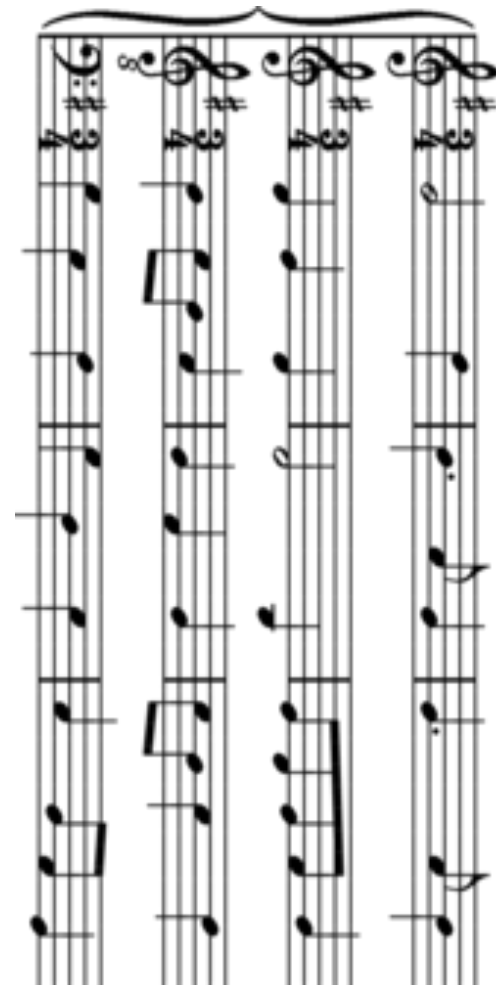
<http://humdrum.ccarh.org>

J.S. Bach



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



J.S. Bach

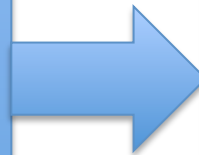
mint

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

- Melodic INTerval

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

**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



mint

mint -s [_[] test.krn

****kern**

2c

2d

2e

[4f

4f]

2g

2a

2b

2cc

*_

****mint**

[c]

+M2

+M2

+m2

P1

+M2

+M2

+M2

+m2

*_

****mint**

[c]

+M2

+M2

.

+m2

+M2

+M2

+M2

+m2

*_

Ignore tied notes:

[_[] → 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 # save a local copy of the data
extractx -g bass chorales.krns | mint -s [_[] | ridx -H | sortcount | less
extract -f 1      chorales.krns | mint -s [_[] | ridx -H | sortcount | less
```

bass	tenor	alto	soprn
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 | sortcount
```

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 | sortcount
```

```
cat chorales.krns | hint -ac | serialize -c | ridx -H | sortcount
```

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	=2	=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, notes, rests, and accidentals. A small, stylized face with a single eye and a smile is overlaid on the bottom staff, partially obscuring the musical notation. The face appears to be a digital or artistic addition to the score.

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

2 3

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

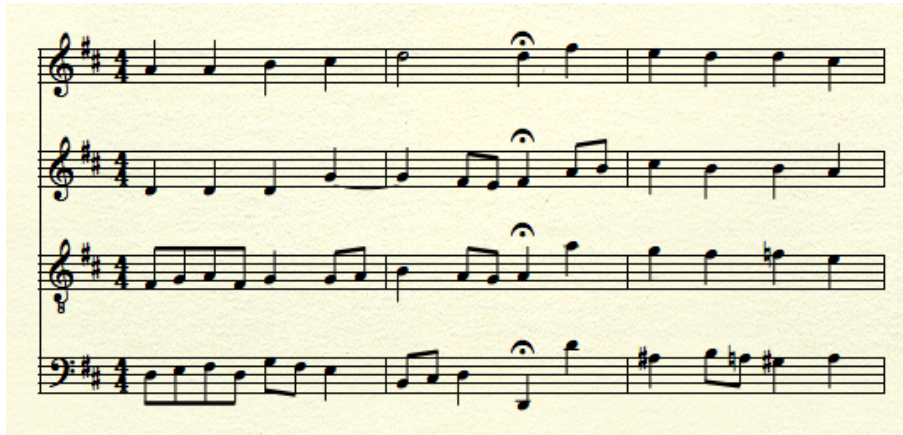
Johann Sebastian Bach

The image displays a musical score for the piece "Valet will ich dir geben" by Johann Sebastian Bach. The score is written for four staves, all in G major (indicated by two sharps) and 4/4 time. The first staff includes two measure numbers in boxes: "2" and "3". The notation includes various note values, rests, and a repeat sign in the first staff. The bottom staff begins with a bass clef and a small number "8" below it. The score is presented in a clean, black-and-white format.

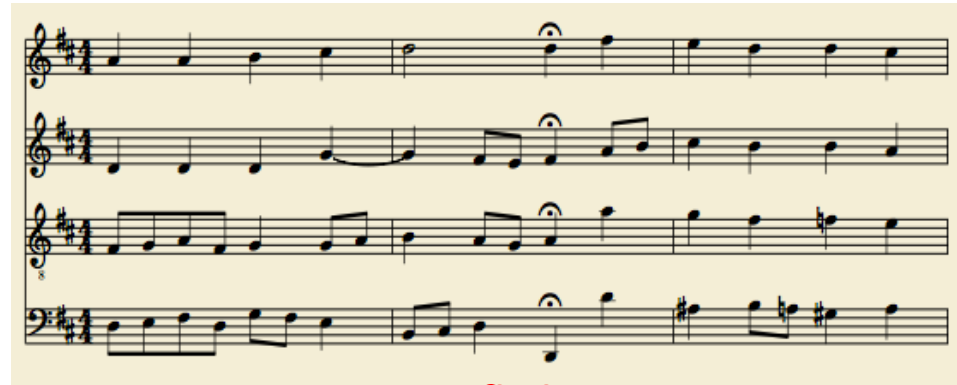
hum2xml / MuseScore | Finale | Sibelius | Noteflight

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

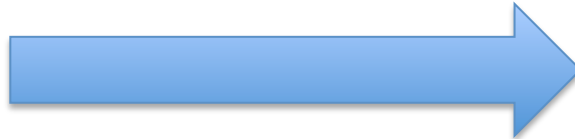
<http://www.humdrum.org/Humdrum/commands/context.html>

- 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

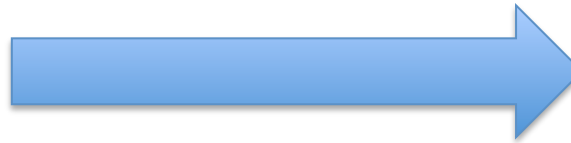
extract

<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.

**a	**b	**c
a1	b1	c1
a2	b2	c2
*	*^	*
a3	b3	B1
a4	b4	B2
a5	b5	B3
*	*v	*v
a6	b6	c6
*_	*_	*_

c3
c4
c5
*

extract -p 2

extract -i **b

```

**b
b1
b2
*^
b3  B1
b4  B2
b5  B3
*v  *v
b6
*_

```

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 \`
`| convert -density 300 - -trim -resize 50% output.png`

Christ ist erstanden

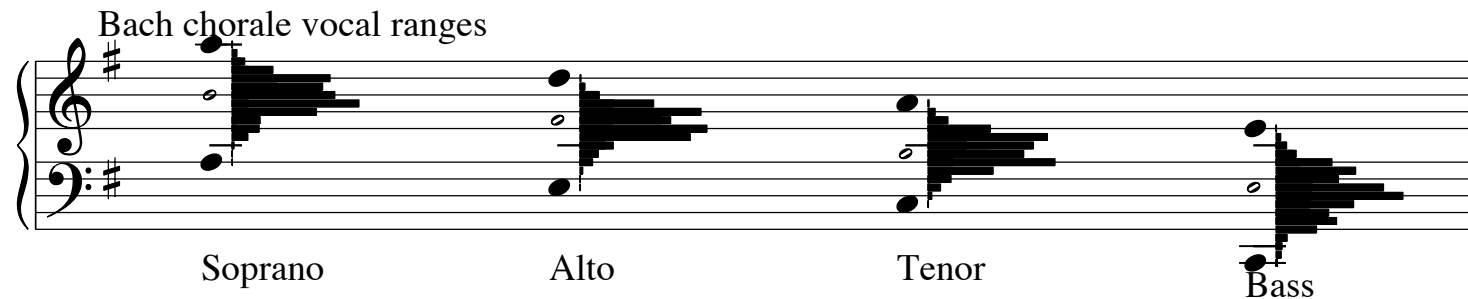
J.S. Bach



Bach chorale vocal ranges

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

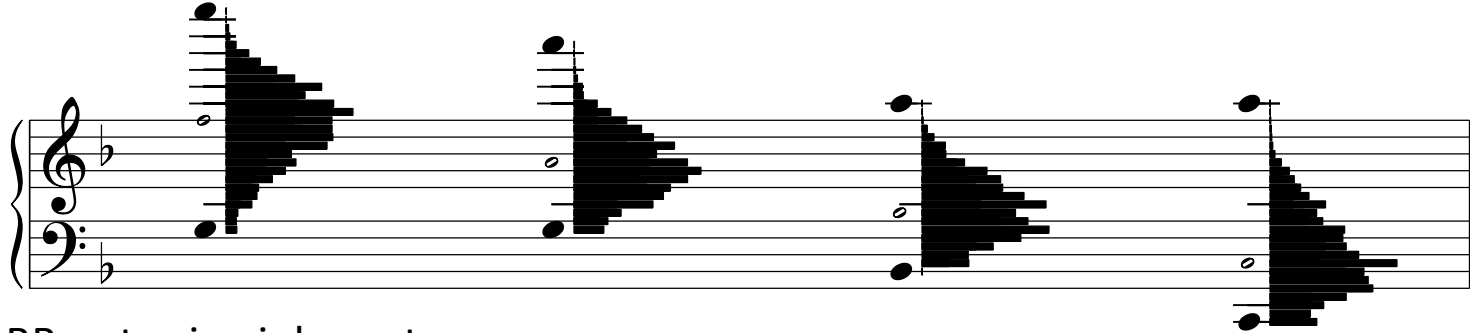
`prange --score h://371chorales | getsvg > output.svg`



```
#!/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; }
```

Beethoven string quartet ranges

`prange --score h://beethoven/quartets | geteps > output.eps`



Locate BB notes in viola part:

`extractx -i **kern h://beethoven/quartets | extractx -p 2 | hgrep -Hdm BB`

`myank -m 243-249 h://beethoven/quartets/quartet14-7.krn | hum2muse --ns | \`
`muse2ps "z16l2250w3150v90,120,90,100C^T^Beethoven Op. 131, mvmt. 7, mm.243-249" | convert -density 300 -quality 100 -trim -resize 50% output.png`

Beethoven Op. 131, mvmt. 7, mm.243-249

