REPRESENTATION

****kern** — core pitch/duration representation for common practice music notation

DESCRIPTION

The ****kern** scheme can be used to represent basic or core information for period-of-common-practice Western music. The ****kern** representation allows pitch and canonical duration information to be encoded. In addition, ****kern** also provides limited capabilities for representing accidentals, articulation, ornamentation, ties, slurs, phrasing, barlines, stem-direction and beaming. In general, ****kern** is intended to represent the underlying semantic information implied by a musical score rather than the visual or orthographic information embodied by a given printed rendition; ****kern** is designed to facilitate analytic applications rather than music printing or sound generation. Other Humdrum representations should be used for these latter purposes.

Three types of data tokens are distinguished in ****kern**: notes, rests, and barlines.

Notes can encode a variety of attributes including absolute pitch, accidental, canonical duration, articulation, ornamentation, ties, slurs, phrasing, stem-direction and beaming.

Pitches in ****kern** are encoded as "nominally" equally-tempered values. Transposing instruments are represented at concert pitch with a tandem interpretation indicating the nature of the transposition. Pitch information is encoded through a scheme of upper- and lower-case letters. Middle C (C4) is represented using the single lower-case letter `c`. Successive octaves are designated by letter repetition, thus C5 is represented by `cc`, C6 by `ccc` and so on. For pitches below C4, upper-case letters are used: `C` for C3, `CC` for C2, and so on. This same scheme is used for other pitch letter-names. Changes of octave are deemed to occur between B and C. Thus the B below middle `c` is represented as `B`; the B below `CC` is represented as `BBB`, and so on.

Accidentals are encoded using the octothorpe (#) for sharps, the minus sign (-) for flats, and the lower-case letter `n` for naturals. Accidentals are encoded immediately following the diatonic pitch information. Double-sharps and double-flats have no special representations in ****kern** and are simply denoted by repetition `(##)` and `(--)`. Triple- and quadruple accidentals are similarly encoded by repetition. Sharps, flats, and naturals are mutually exclusive in ****kern,** so tokens such as `cc#n` and `GG-#` are illegal. In addition, natural signs may not be repeated (i.e. `nn`).

In ****kern,** all pitches are encoded as contextually independent absolute values. Pitches must be encoded with the appropriate accidental, even if the accidental is specified in a key-signature, or is present earlier in the same measure. Transposing instruments must be notated at (sounding) concert pitch (although see the tandem interpretation **transposition (3)**).

Note tokens may be modified by the presence of additional signifiers.

The ****kern** representation provides no generic means for representing "curved lines" found in printed scores. Lines must be explicitly interpreted as ties, slurs or phrases. The open brace { denotes the beginning of a phrase. The closed brace } denotes the end of a phrase. The open parenthesis (and closed parenthesis) signify the beginning and end of a slur respectively. The semicolon ; denotes a pause. The open square bracket [denotes the first note of a tie. The closed square bracket] denotes the last note of a tie. The underscore character _ denotes middle notes of a tie.

Additional signifiers are provided for denoting articulation marks and ornaments. The letters `T` and `t` are used to signify whole-tone and semitone trills, respectively. Whole-tone and semitone mordents are signified by the letters `M` and `m`. Inverted mordents are signified by `W` (whole-tone) and `w` (semitone). (Note that trills, mordents, and inverted mordents wider than two semitones in size are also denoted by the upper-case signifier.) The letter `S` signifies a turn, whereas the dollar sign (`$`) signifies an inverted (or Wagnerian) turn. When a concluding turn is appended to the end of an ornament (such as a trill), the upper-case letter `R` is added to the ornament signifier (as in `tR` and `TR`). In addition to these ornaments, ****kern** provides a signifier for (multi-note) arpeggiation (`:`). The presence of ornaments other than trills, mordents, inverted mordents, and turns types can be indicated by the generic ornament symbol (`O`).

Articulation marks include the apostrophe (') for staccato, the double-quote (") for pizzicato, the greve (`) for attacca, the tilde (~) for tenuto, and the caret (^) for all note-related accents (including < and >). In addition, **\*\*kern** provides signifiers for up-bow (`v`) and down-bow (`u`). The presence of other articulation types can be indicated by the generic articulation symbol (`I`).

As noted, the ****kern** scheme is intended for analytic applications rather than as a means for representing visual renderings of notation. Nevertheless, ****kern** distinguishes up-stems, down-stems, and beamings in order to assist in analytic tasks such as the determination of voicings and in order to facilitate the parsing of note-groupings. Up-stems and down-stems are indicated by the slash (/) and backslash characters (\) respectively. The beginning and ends of beams are signified by the upper-case letters `L` and `J`. Multiple beams are indicated via letter repetition, e.g. `LL` ⇔ `JJ` and `LLL` ⇔ `JJJ` for double- and triple-beams respectively. Partial beams may extend to the right (`K`) or left (`k`). Again, multiple partial beams are indicated via letter repetition. By way of example, a doubly-dotted sixteenth note beamed to a thirty-second note can be represented as:

```
16..LL
32JJkk
```

Slurs and phrase markings can be nested (e.g. slurs within slurs) and may also be elided (e.g. overlapping phrases) to a single depth. Nested markings mean that one slur or phrase is entirely subsumed under another slur or phrase. For example: `( ( ) )` means that a short slur has occurred within a longer slur. Elisions are overlaps, for example, where an existing phrase fails to end while a new phrase begins. In ****kern** the ampersand character is used to mark elided slurs or phrases. For example: `{ &{ } &}` means that two phrases overlap — the initial phrase ending after second phrase has begun.

Durations are encoded in a manner identical to the ****recip** representation. Durations are

encoded as nominal proportions using integer numbers and the period character. With the exception of the value zero, durations are represented by reciprocal numerical values corresponding to the American duration names: `1` for whole note, `8` for eighth, `32` for thirty-second, etc. The number zero (`0`) is reserved for the *breve* duration (i.e. a duration of twice the length of a whole note). Dotted durations are indicated by adding the period character (`.`) immediately following the numerical value — hence `8.` signifies a dotted-eighth note and `2..` signifies a doubly-dotted half note. Any number of augmentation dots may follow the duration integer.

Triplet and other irregular durations are represented using the same reciprocal logic. Three quarter triplets in the time of four quarters (a whole duration) are signified by the value `3` (i.e. "third notes"). Eighth-note quintuplets (5 in the time of 4) are represented by the value `10` (a half duration divided by 5). See ****recip (2)** for further details.

The ****kern** representation also allows for the encoding of acciaccaturas, non-canonical groupettos, and appoggiaturas. Depending on the expected analytic application, one way to handle these notational devices is to encode the notes according to the manner in which they are typically performed. Alternatively, since these notes are viewed as embellishment notes and hold potentially less analytic status, a special designation for these notes can be useful for certain types of studies.

Acciaccaturas (grace notes) are visually represented as minature notes denoted by a slash mark through the stem. In ****kern** these notes are treated as "durationless" notes and are designated by the lower-case letter `q`. Hence, the token `G#q` denotes a G#3 acciaccatura. Non-canonical groupettos are minature (non-cue) notes (typically in groups) whose stems do not contain a slash, and whose notated durations cause the total notated duration for the measure to exceed the prevailing meter. These groupetto notes are encoded as notes having their notated durations, but are also designated by the upper-case letter `Q`. Hence, a minature sixteenth-note middle C would be encoded as `16cQ`. Depending on the analytic task, these notes may be treated as equivalent to their notated durations, or they may be discarded. For example, the **timebase** command eliminates these notes. Note that data records containing acciaccaturas or groupettos notes must not include normal notes.

In the case of appoggiaturas, ****kern** requires that they be encoded as performed. An appropriate duration is assigned to the appoggiatura according to common performance practice. The duration of the subsequent note is reduced by a corresponding amount. The status of the two notes forming the appoggiatura is nevertheless marked. The appoggiatura itself is designated by the upper-case letter `P`, whereas the subsequent note (whose notated duration has been shorted) is designated by the lower-case letter `p`.

Rests tokens are denoted by the single lower-case letter `r` along with a numerical duration signifier. Rests may also have the attributes of stem-direction, beaming, slur, and phrase, but rests cannot be assigned articulation or ornamentation attributes.

Barlines are represented using the "common system" for barlines — see **barlines (2)**. A barline is denoted by the occurrence of an equals sign (=) at the beginning of the token — followed by an optional measure number (integer) followed by an optional letter (single lower-case alphabetic character), followed by an optional pause marking (`;`). Double-

barlines are represented by the occurrence of two or more equals signs (==) at the beginning of the token — followed by an optional pause marking (;).

In representing any work, editorial interpretations are inevitable. It may be necessary to make explicit certain implicit information in a score (such as expanding abbreviations), or it may be necessary to estimate missing or unreadable information. Interpreting the voicings (that is, making explicit the degree of connectedness between successive pitches) is an important editorial function in ****kern** representations. The ****kern** representation provides several special-purpose signifiers to help make explicit various classes of editorial amendments, interpretations, or commentaries. Five types of editorial signifiers are made available: (1) *sic* (information is encoded literally, but is questionable) signified by `Y`; (2) *invisible symbol* (unprinted note, rest or barline, but logically implied) signified by `y`; (3) *editorial interpretation,* (a "modest" editorial act of interpretation — such as the interpretation of accidentals in *musica ficta*) signified by `x`; (4) *editorial intervention* (a "significant" editorial intervention) signified by `X`; (5) *footnote* (accompanying local or global comment provides a text commentary pertaining to a specified data token) signified by `?`.

FILE TYPE

It is recommended that files containing predominantly `**kern` data should be given names with the distinguishing '.krn' extension.

SIGNIFIERS

The following table summarizes the ****kern** mappings of signifiers and signifieds.

0	breve duration
1	whole duration
2	half duration
3	half-note triplet duration
4	quarter duration
6	quarter-note triplet duration
8	eighth duration
12	eighth-note triplet duration
16	sixteenth duration
24	sixteenth-note triplet duration
32	thirty-second duration
64	sixty-fourth duration
128	one-hundred and twenty-eighth duration
.	duration augmentation dot (must follow a number)
–	flat sign (minus character)
– –	double-flat (two successive minus characters)

a-g	absolute pitches above middle C
A-G	absolute pitches below middle C
#	sharp
##	double sharp
h	end glissando
j	harmonic
k	partial beam extending leftward
kk	two partial beams extending leftward
m	mordent (semitone)
n	natural sign
p	designator of a note subsequent to an appoggiatura
q	acciaccatura (grace note signifier; in lieu of duration)
r	rest
t	trill (semitone)
u	down-bow
v	up-bow
w	inverted mordent (semitone)
y	editorial mark: invisible symbol; unprinted note, rest or barline, but logically implied
H	begin glissando
I	generic articulation (unspecified articulation)
J	end beam
JJ	end two beams
K	partial beam extending rightward
KK	two partial beams extending rightward
L	start beam
LL	start two beams
M	mordent (whole tone)
O	generic ornament (unspecified ornament)
P	appoggiatura note designator
Q	groupetto note designator
R	signified ornament ends with a turn
S	turn
$	Wagnerian turn
T	trill (whole tone)
W	inverted mordent (whole tone)
x	editorial interpretation; immediately preceding signifier is interpreted
xx	editorial interpretation; entire data token is interpreted
X	editorial intervention; immediately preceding signifier is an editorial addition
XX	editorial intervention; entire data token is an editorial addition
Y	editorial mark: *sic* marking; information is encoded literally, but is questionable
z	sforzando

<space>	(space character) multiple-stop conjunction — indicates joint note-tokens
=	barline; == double barline
[	first note of a tie
]	last note of a tie
_	middle note(s) of a tie (underscore)
(	slur start
)	slur end
{	phrase mark (start)
}	phrase mark (end)
;	pause sign
'	staccato mark
s	spiccato
"	pizzicato mark
`	attacca mark
~	tenuto mark
^	accent mark
:	arpeggiation (of multi-note chord)
,	breath mark
/	up-stem
\\	down-stem
&	elision marker (for slurs or phrases)
?	editorial mark: immediately preceding signifier has accompanying editorial footnote
??	editorial mark: entire preceding data token has accompanying editorial footnote

Summary of ****kern** *Signifiers*

CONTEXT DEPENDENCIES

In general, signifiers in the ****kern** representation are intended to be context independent. This means, for example, that the data tokens `{(16ff#/'` and `/ff#16'({` are equivalent. A few exceptions to this principle are necessary in order to maintain the meaning of multiple-character signifiers.

Numbers encoding a duration must be contiguous. That is, a sixteenth note may be encoded as `16ff#` or `ff#16` but not as `1ff#6`. Augmentation dots (signified by the period) must follow immediately after the associated duration numerals. Thus `16.ff#` is acceptable, but not `16ff#.` or `.16ff#`. Sharps, flats, and naturals must follow immediately after the corresponding alphabetic pitch signifiers (`16ff#` but not `16#ff`). Signifiers that can be repeated must be contiguous. This include pp, PP, LL, JJ, XX, xx, ??, ##, --, and ..

The elision marker (`&`) must immediately precede the associated slur (`&{ ... &}`) or slur (`&( ... &)`).

Barlines follow a strict contextual syntax. Barlines must begin with one or more equals-signs, followed by an optional measure number, followed by an optional lower-case letter, followed by an optional pause signifier.

In certain applications, it may be necessary to have a canonical ordering of the signifiers within **kern data tokens. For example, when comparing two ostensibly identical **kern files, trivial differences of signifier orderings will cause UNIX commands such as **cmp** and **diff** to declare the files to be "different." In this case, it is useful to adopt a standard order of signifiers so that direct file comparisons may be made. Similarly, differences in signifier orderings can cause problems for pattern matching tasks. For example, in searching for a sixteenth-note F-sharp, it is convenient to define a simple regular expression — such as `16f#` rather than having to define a regular expression that handles all possible contextual orderings — such as `(16.*f#)|(f#.*16)`. For this reason, a canonical ordering of the **kern signifiers is given in the following table.

signified	signifier(s)	comments
1. open phrase elision indicator	**&**	must precede {
2. open phrase mark	{	
3. open slur elision indicator	**&**	must precede (
4. open slur	(	
5. open tie	[	
6. duration	**0123456789**	any combination; signifiers may be repeated
7. augmentation dot(s)	.	signifier may be repeated
8. pitch	**abcdefgABCDEFG**	only one of; signifier may be repeated
9. accidental	- or # or **n**	- and # may be repeated
10. pause	;	
11. ornament	**MmS$TtWwR** or **O**	**O** precludes others; no repetition of a given signifier; must appear in order given
12. appoggiatura designator	**p** or **P**	
13. acciaccatura designator	**q**	
14. groupetto designator	**Q**	
15. articulation	**z ' " ` ~ ^ :** or **I**	**I** precludes others; no repetition of a given signifier; must appear in order given
16. bowing	**u** or **v**	only one of
17. stem-direction	/ or \	only one of
18. beaming	**L** or **J**	signifiers may be repeated
19. partial beaming	**k** or **K**	signifiers may be repeated
20. user-defined marks	**il**	one or more of;
	NUVZ	may be repeated but
	@ % + | < >	must be in order given
21. closed or continuing tie	] or _	
22. closed slur elision indicator	**&**	must precede)
23. closed slur	)	
24. closed phrase elision indicator	**&**	must precede }
25. closed phrase mark	}	
26. breath mark	,	
27. editorial marks	**xx** or **XX**	

Canonical Ordering of Signifiers in ****kern** *Note Tokens*

Note that the editorial signifiers `?`, `y`, and `Y`, as well as the single editorial signifiers `x` and `X` (as opposed to `xx` and `XX`) can appear anywhere in a data token, except as the first character.

EXAMPLES

A sample document is given below:

```
!! J.S. Bach, Fugue 2 WTC Book I
!! (3 parts), in c minor; BWV 847b
**kern          **kern          **kern
*M4/4           *M4/4           *M4/4
*MM72           *MM72           *MM72
*k[b-e-a-]      *k[b-e-a-]      *k[b-e-a-]
*c:             *c:             *c:
=1              =1              =1
1r              8r              1r
.               16cc            .
.               16bn            .
.               8cc             .
.               8g              .
.               8a-             .
.               16cc            .
.               16b             .
.               8cc             .
.               8dd             .
=2              =2              =2
1r              8g              1r
.               16cc            .
.               16bn            .
.               8cc             .
.               8dd             .
.               16f             .
.               16g             .
.               4a-             .
.               16g             .
.               16f             .
=3              =3              =3
1r              16e-            8r
.               16cc            .
.               16bn            16gg
.               16an            16ff#
.               16g             8gg
.               16fn            .
.               16e-            8cc
.               16d             .
.               8c              8ee-
.               8ee-            16gg
.               .               16ff#
.               8dd             8gg
.               8cc             8aan
=4              =4              =4
*-              *-              *-
```

PERTINENT COMMANDS

The following Humdrum commands accept ****kern** encoded data as inputs:

census -k	determine general characteristics of a ****kern** file
cents	translates ****kern** to ****cents**
deg	translates ****kern** to ****deg**
degree	translates ****kern** to ****degree**
freq	translates ****kern** to ****freq**
hint	calculate harmonic intervals from ****kern** input
key	estimate the key of a ****kern** input
mint	calculate melodic intervals from ****kern** input
pc	translates ****kern** to ****pc**
pitch	translates ****kern** to ****pitch**
proof	check for errors in ****kern** encoded file
semits	translate ****kern** to numerical ****semits**
solfa	translate ****kern** to numerical ****solfa**
solfg	translate ****kern** to numerical ****solfg**
synco	measure degree of metric syncopation
timebase	reformat ****kern** score with constant timebase
tonh	translate ****kern** to numerical ****Tonh**
trans	transpose ****kern** score
urrhythm	characterize the rhythmic prototypes in a passage
vox	determine active and inactive voices in a Humdrum file

The following Humdrum commands produce ****kern** data as outputs:

kern	translates ****cents**, ****degree**, ****freq**, ****fret**, ****MIDI**, ****pitch**, ****semits**, ****solfg**, ****specC**, and ****Tonh** to ****kern**
timebase	reformat ****kern** score with constant timebase
trans	transpose ****kern** score

TANDEM INTERPRETATIONS

The following tandem interpretations can be used in conjunction with ****kern**:

clef	`*clefG2`
instrument	`*I`
instrument class	`*IC`
key signatures	`*k[f#c#]`
key	`*c#:`
meter signatures	`*M6/8`
tempo	`*MM96.3`
timebase	`*tb32`
transposing instrument	`*ITr`

Tandem interpretations for **kern

SEE ALSO

barlines (2), ****cents** (2), ****degree** (2), ****freq** (2), ****fret** (2), ****MIDI** (2), ****mint** (2), ****pc** (2), ****pitch** (2), ****recip** (2), ****semits** (2), ****solfg** (2), ****specC** (2), ****Tonh** (2)