University of Glasgow

A Computer Representation of Pitch Based on the Spiral of Fifths

Stuart Pullinger, Nicholas Bailey, Graham Hair

Glasgow University Centre for Music Technology

University of Glasgow

Aim

- To represent music in a computer
  - For storage in a database
  - For music analysis
  - For performance analysis
  - For automatic score generation
  - For playback and interaction

University of Glasgow

Requirements for a pitch representation

- Interval Invariance
  - A major second is always a major second
- Functionally distinct pitches
- Enharmonic equivalence
- Complete and simple
- Microtone capability
  - At least 12, 19 and 24 tones per octave

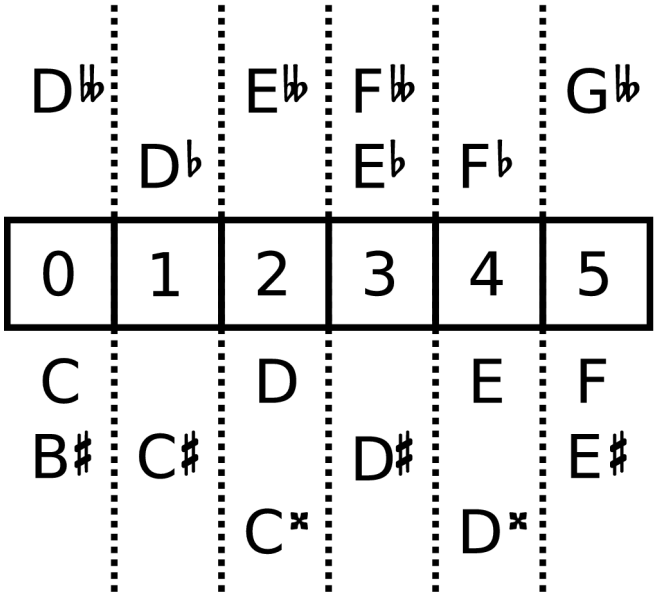
University of Glasgow

MIDI Pitch Representation

- Pitches are positions on a numberline from 0 to 127
- No distinction between enharmonically equivalent notes
- No clear distinction between intervals

University of Glasgow

MIDI Pitch Representation



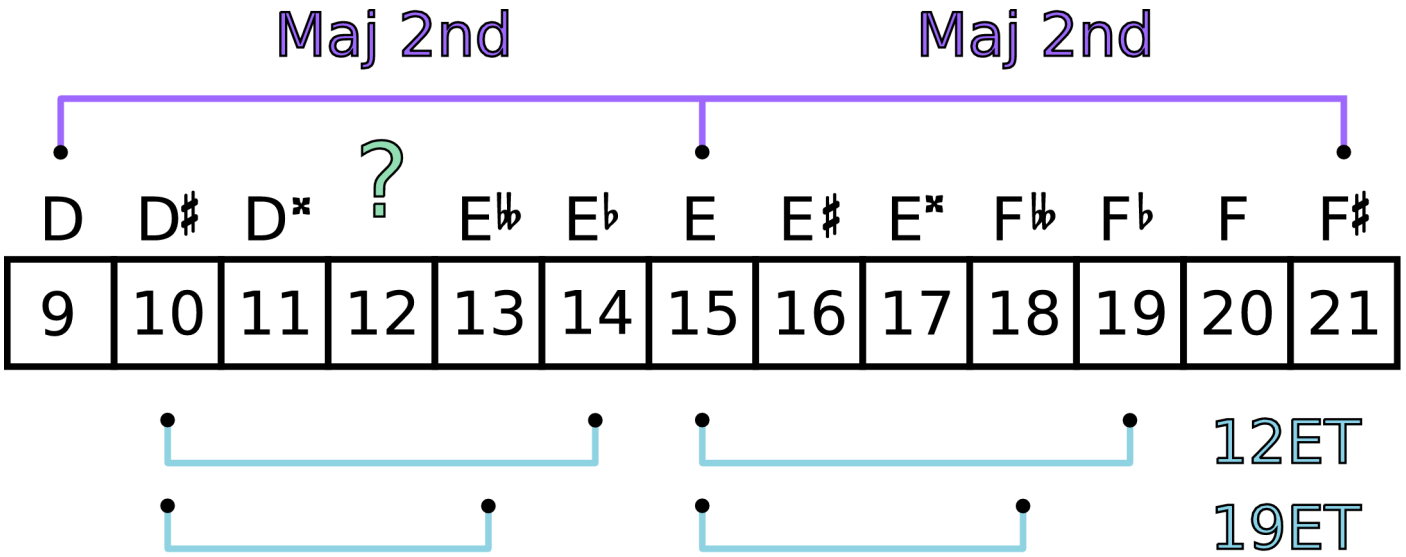
University of Glasgow

Base-40 Pitch Representation

- Pitches are positions on a numberline from 1 to 40
- All 35 common pitch classes are represented
- Intervals do not vary
- Enharmonic equivalents can be calculated
- Not complete – interval invariance is acheived at the expense of including gaps of ambiguous pitch

University of Glasgow

Base-40 Pitch Representation



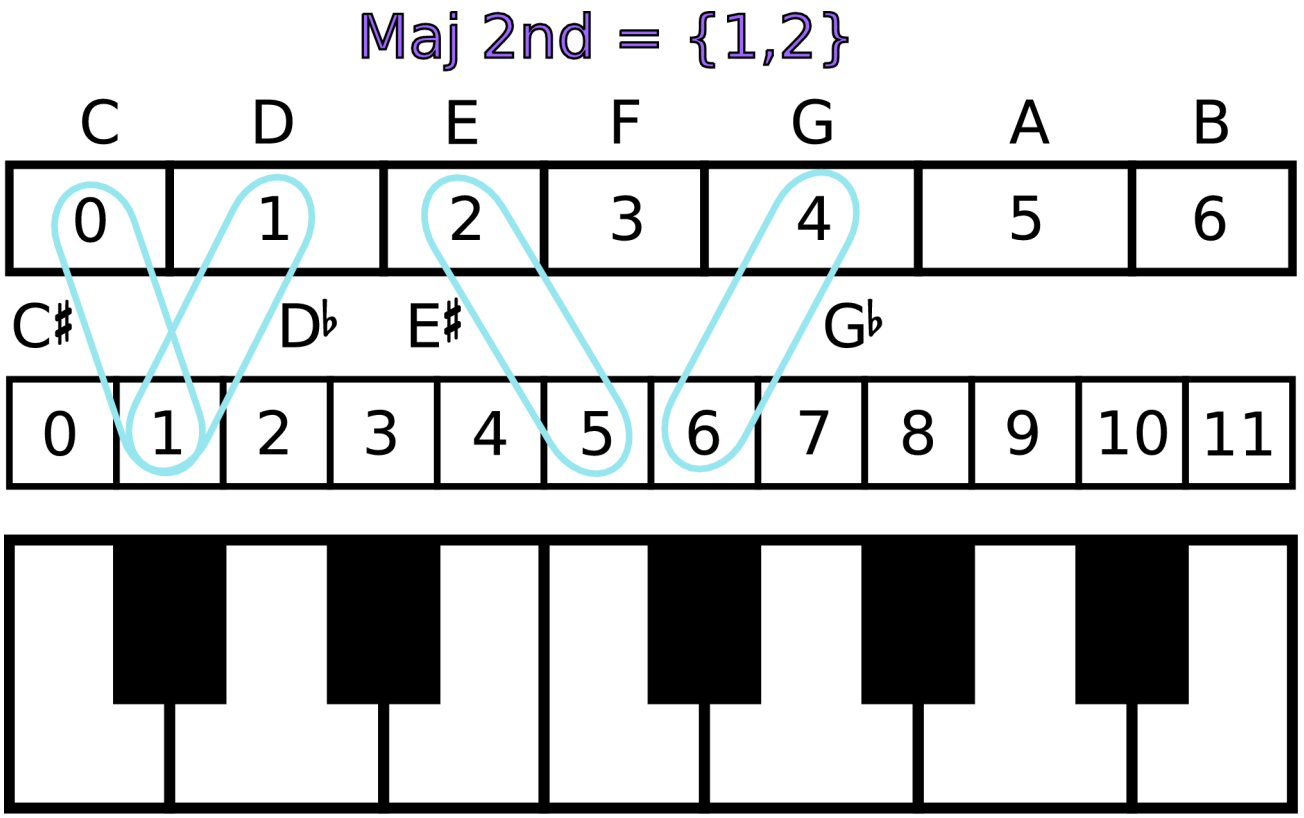
University of Glasgow

Binomial Pitch representation

- Pitch is represented by a pair of integers:
  - One for the name class ie. {C,D,E,F,G,A,B}
  - One for the pitch class
- Enharmonic equivalent notes have the same pitch class but different name classes
- Intervals are represented by a pair of integers ie. Maj 2^{nd} = {1,2}
- Different representations for different divisions of the octave

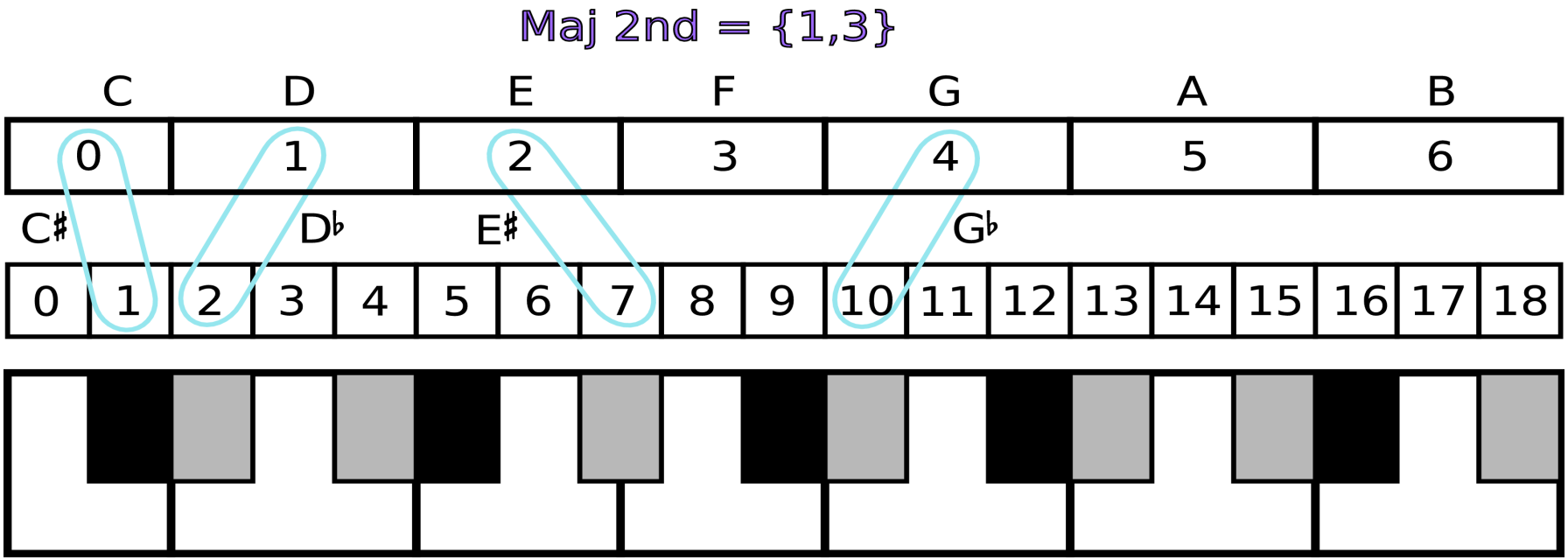
University of Glasgow

Binomial Pitch Represntation - 12ET



University of Glasgow

Binomial Pitch Representation - 19ET



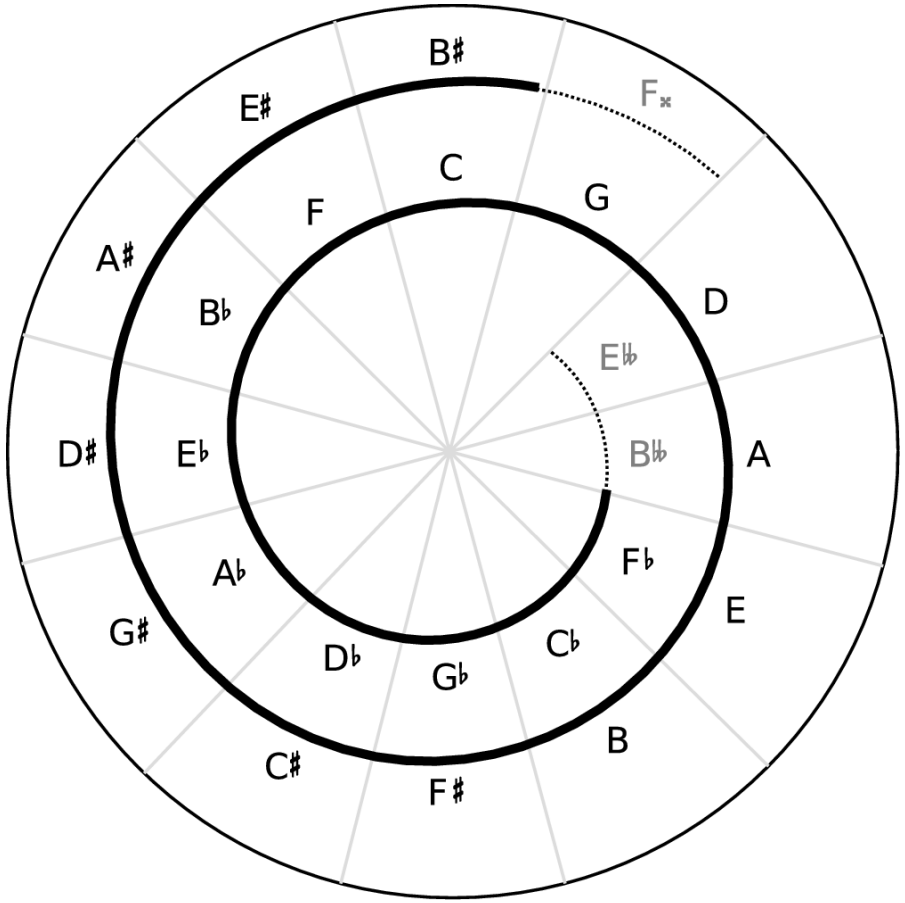
University of Glasgow

Spiral Of Fifths Pitch Representation

- Pitches are positions on a numberline which follows the spiral of fifths
- Intervals do not vary
- Enharmonic equivalent notes are:
  - 12 steps apart for 12ET
  - 19 steps apart for 19ET
- All diatonic scales can be represented with the same system
- Complete – no gaps

University of Glasgow

The Spiral of Fifths – for 12ET



University of Glasgow

Spiral of Fifths Pitch Representation

n	𝄫	♭	♮	♯	𝄪
F	-14	-7	0	7	14
C	-13	-6	1	8	15
G	-12	-5	2	9	16
D	-11	-4	3	10	17
A	-10	-3	4	11	18
E	-9	-2	5	12	19
B	-8	-1	6	13	20

University of Glasgow

Spiral of Fifths Representation - extended

- The representation can be extended to scales with quarter tones and more
- Enharmonic equivalent notes can be found in all diatonic scales
  - Most common scales (12ET, 19ET & 24ET) are simple
  - Simple for all scales constructed from a single size of fifth
  - Slightly more complicated for other diatonic scales

University of Glasgow

Conclusions

- Distiguishes between enharmonic equivalent pitches – unlike MIDI
- Interval invariant
- Complete – no gaps/ambiguous pitches – unlike Base-40
- One representation for all scales – unlike Binomial
- Capable of representing diatonic microtonal scales