



## Music Fundamentals for Sonic Pi

# Today's Outline

- One Goal for CC Researchers
- Getting Started with Sonic Pi
- Sound Properties: Frequency, Amplitude, Timbre, Time
- Example of How to Read Music (Western Notation)
- Intervals and Chords
- Emotion and Playing with Patterns

# One Example Goal for CC Researchers

**Gabriela Montero**: live improvisation (based on audience's prompts)

Can we have a **computer** display this same level of **creativity** (novelty, meaningfulness, surprise...?)



# Let's Learn Some Fundamentals

We'll talk about different approaches and systems later...



...for now, we need to learn a few **core ideas** related to combining **music** with **computers**!

# Sonic Pi

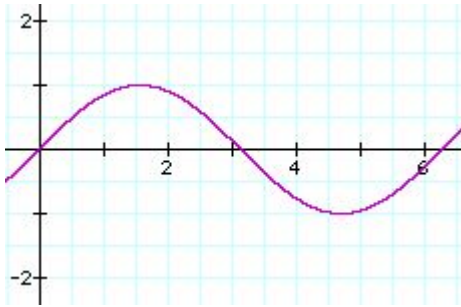
- Create (live) music with Ruby-like code!
- Download at:  
<https://sonic-pi.net/>
- Tutorial at:  
<https://sonic-pi.net/tutorial>

```
with_fx :reverb do
  sample :elec_pop
  sleep 1
  use_synth :saw
  play :Eb2
  sleep 1
end
```

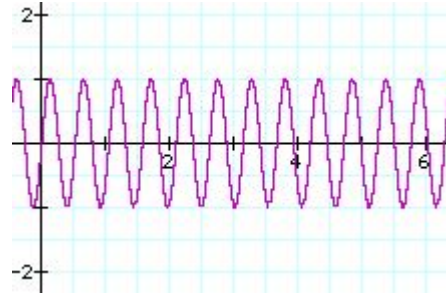
# Frequency (Pitch)

Higher **frequency** of sound wave => higher **pitch** of note

## Low note



## High note



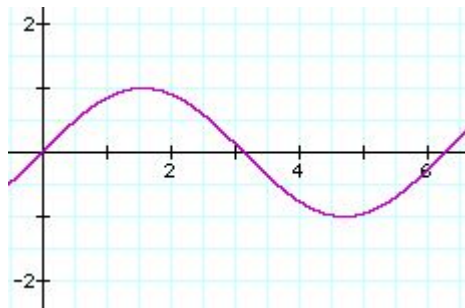
*Sonic Pi:*

- **play 47** means play the 47th note on a piano

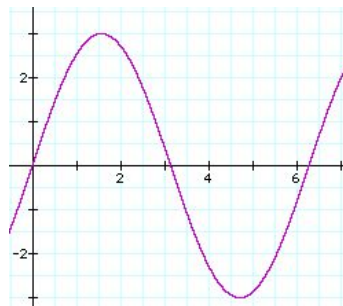
# Amplitude (Loud/Soft)

Higher **amplitude** of sound wave => **louder** note

Soft note



Loud note

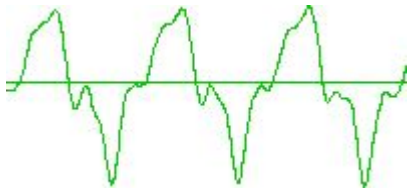


*Sonic Pi: amplitude (how loud/soft) is written as **amp***

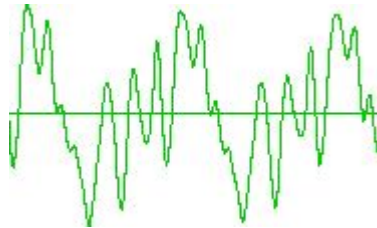
# Timbre (Tone Color)

Different instruments have different sound wave shapes...

Piano



Violin



Electric Guitar



*Sonic Pi examples:*

- **use\_synth :piano** will switch to a piano ([synth list here](#))
- **sample :ambi\_choir** will use a choir sound  
(*you can also use your own samples!*)



# Tempo

Tempo: the speed at which your song plays

- Clock's tick is 60 beats per minute
- Faster tempo => More beats per minute



*Sonic Pi: **use\_bpm 60** means 60 beats per minute*

# Simple Time

Many songs are in **simple time**, which means you can clap your hands or count out loud phrases of four beats each:

[1 2 3 4]

[1 2 3 4]

[1 2 3 4]

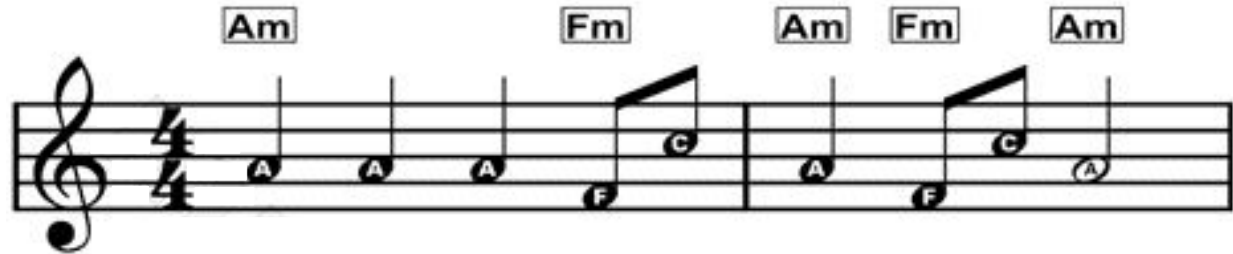
Or...you could count each of these phrases as 1 beat that takes place more slowly:

[1]

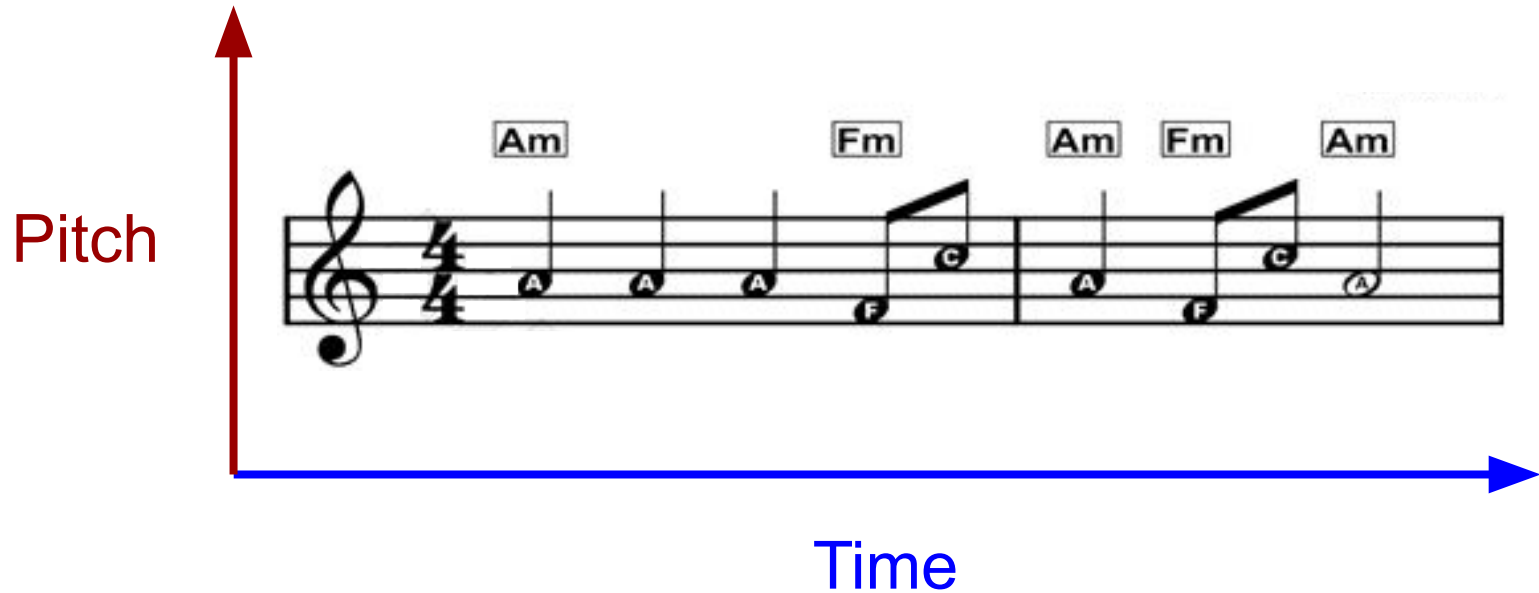
[1]

[1]

# Reading Music Example (Western Notation)



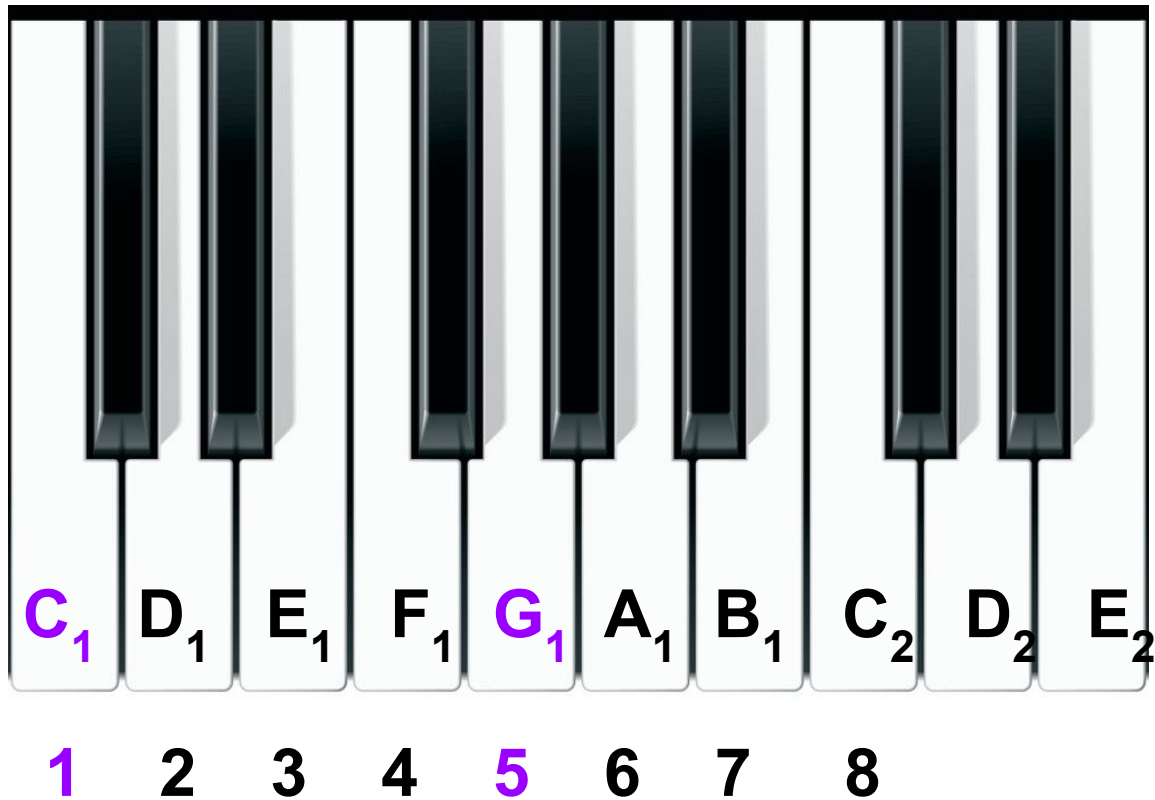
# Reading Music Example (Western Notation)



# We Can Use Letters & Numbers to Describe Pitches



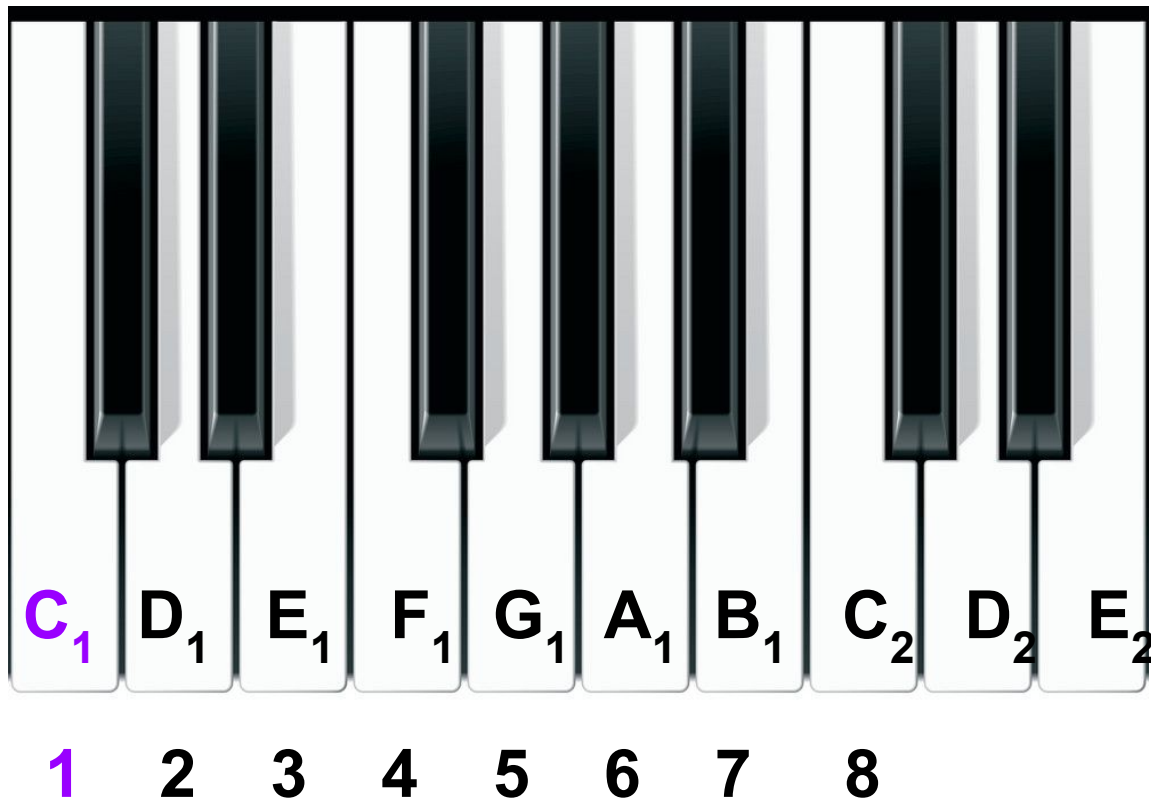
# Intervals: Distance Between Pitches



Each pitch has a different sound wave...

which means when we combine pitches they blend together in interesting ways

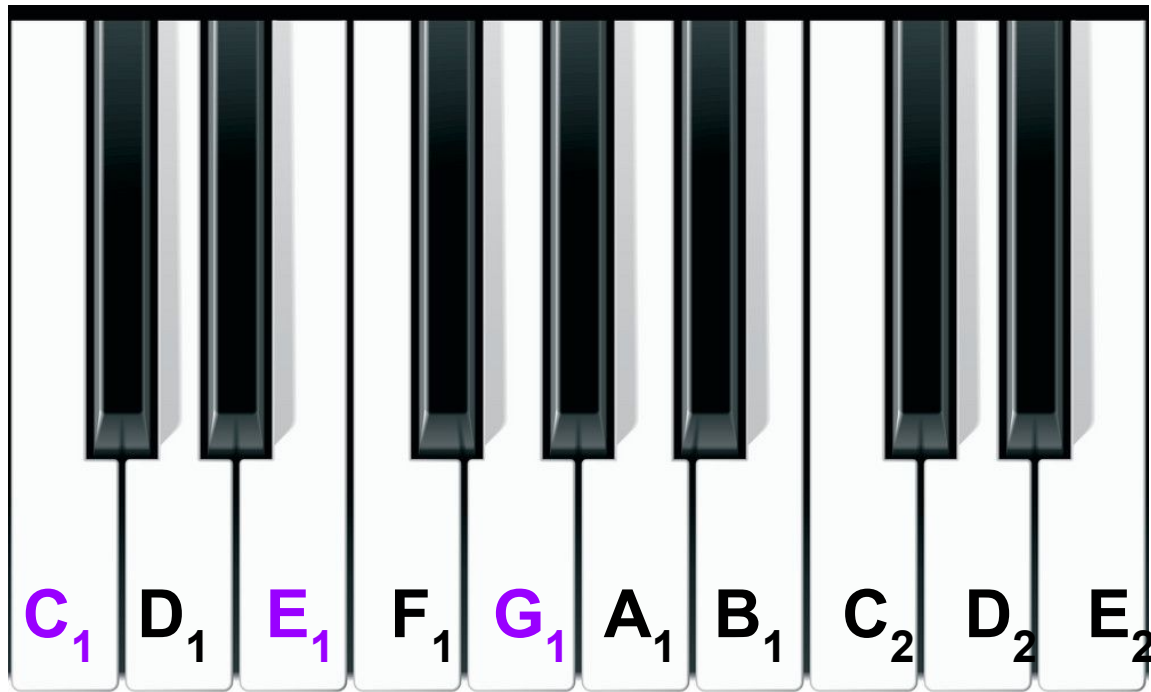
# Chords: Playing Multiple Notes at Once



**Chord:** combo of 3+ notes, built from a single note called the **root**.

Let's try a  
C major chord!

# Chords: Playing Multiple Notes at Once



*Sonic Pi*

***play chord(:c, :major)***

will play the notes

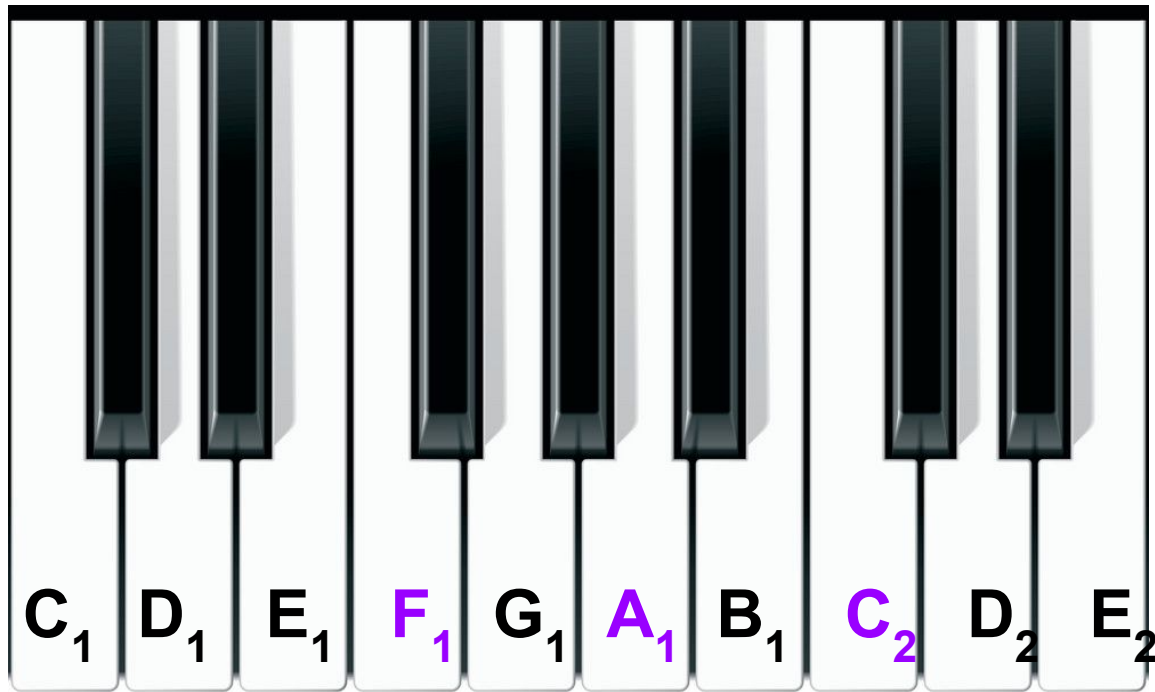
C E G

together

C is the first (1) note in our list of notes (and the **root!**).



# Chords: Multiple Notes at Once



*Sonic Pi*

***play chord(:f, :major)***

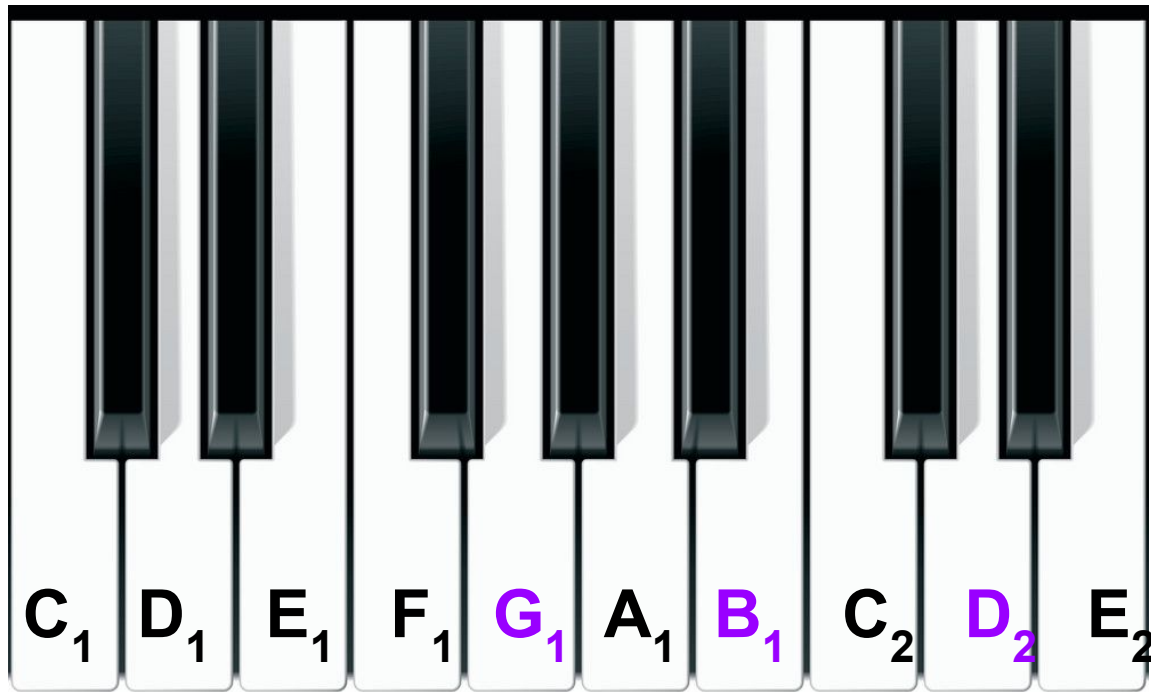
will play the notes

F A C

together

F is the fourth (IV) note in our list of notes.

# Chords: Multiple Notes at Once



*Sonic Pi*

***play chord(:g, :major)***

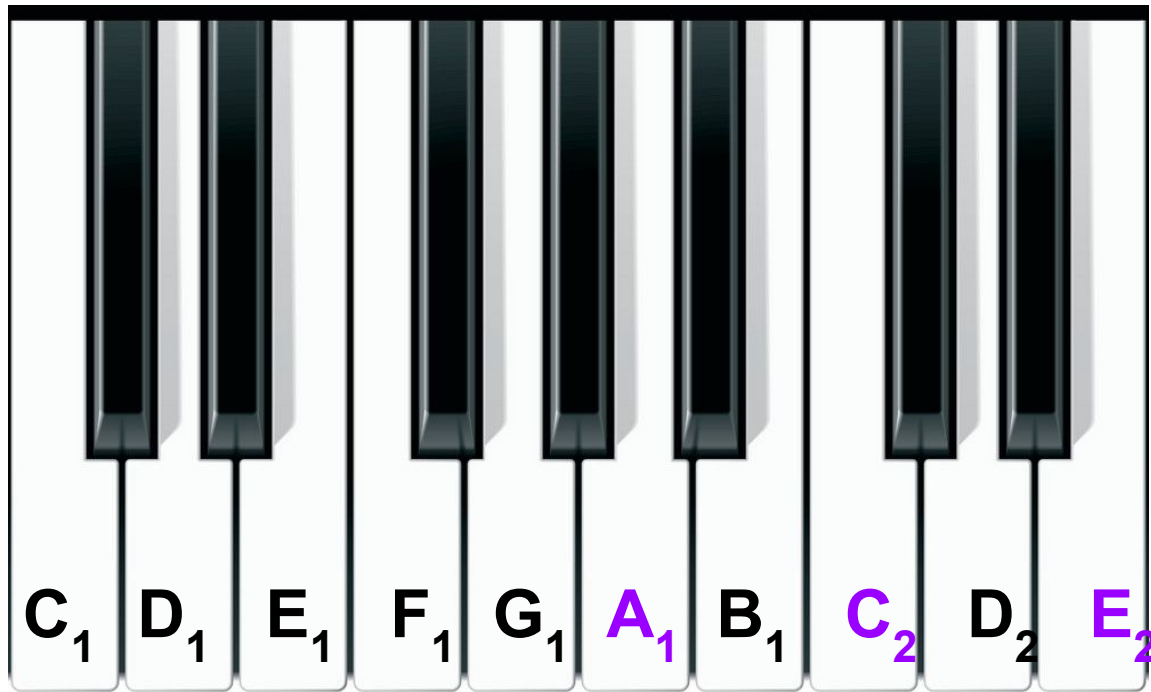
will play the notes

G B D

together

G is the fifth (V) note in our list of notes.

# Chords: Multiple Notes at Once



*Sonic Pi*

***play chord(:a, :minor)***

will play the notes

A C E

together

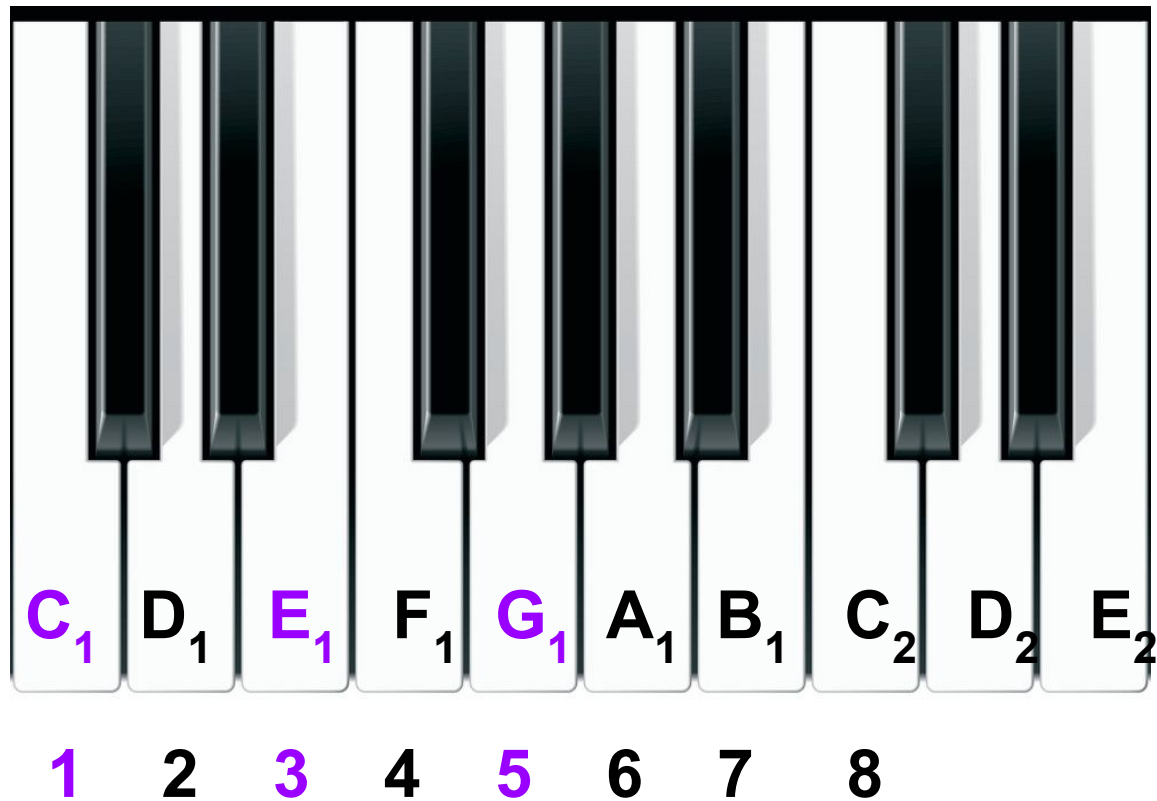
A is the sixth (VI) note in our list of notes.

# Chord Progressions Aren't Always Creative

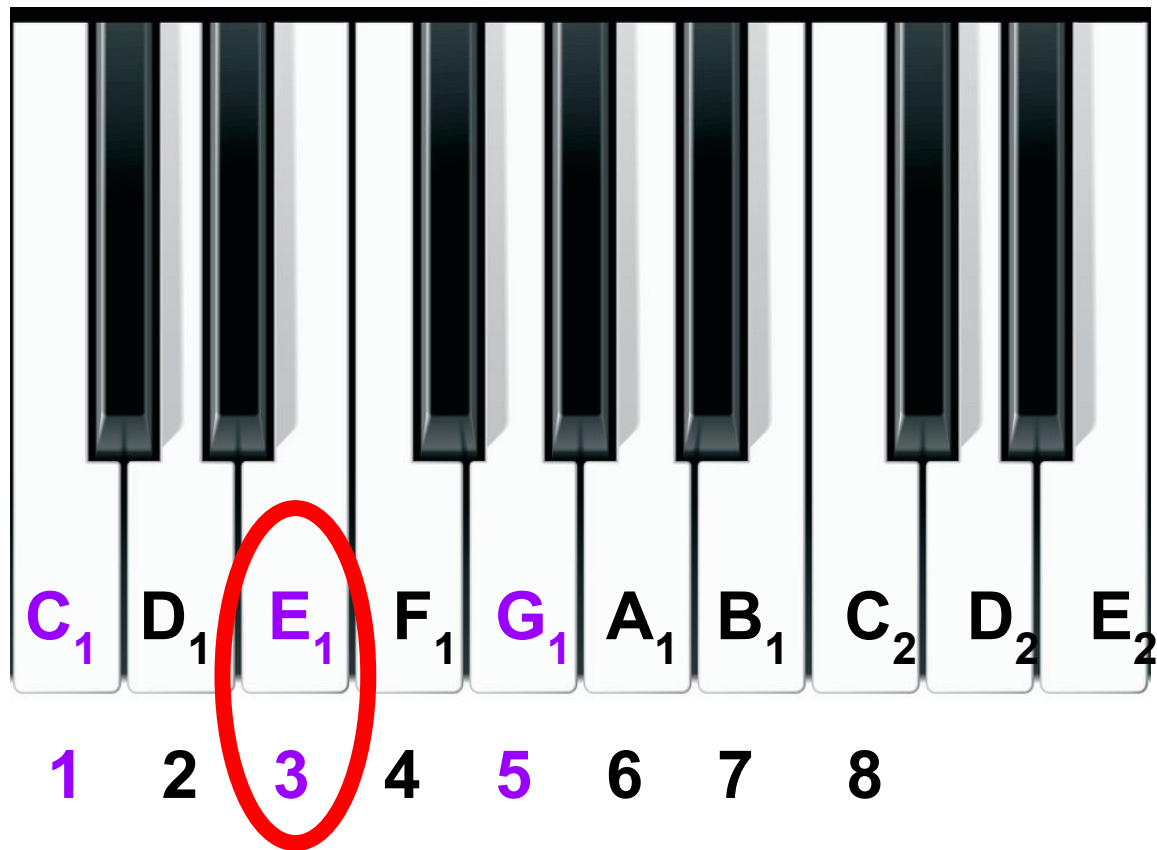


Many popular songs (“Four Chord Songs”) rely on the chord progressions we just saw (often **I - V - VI - IV**)

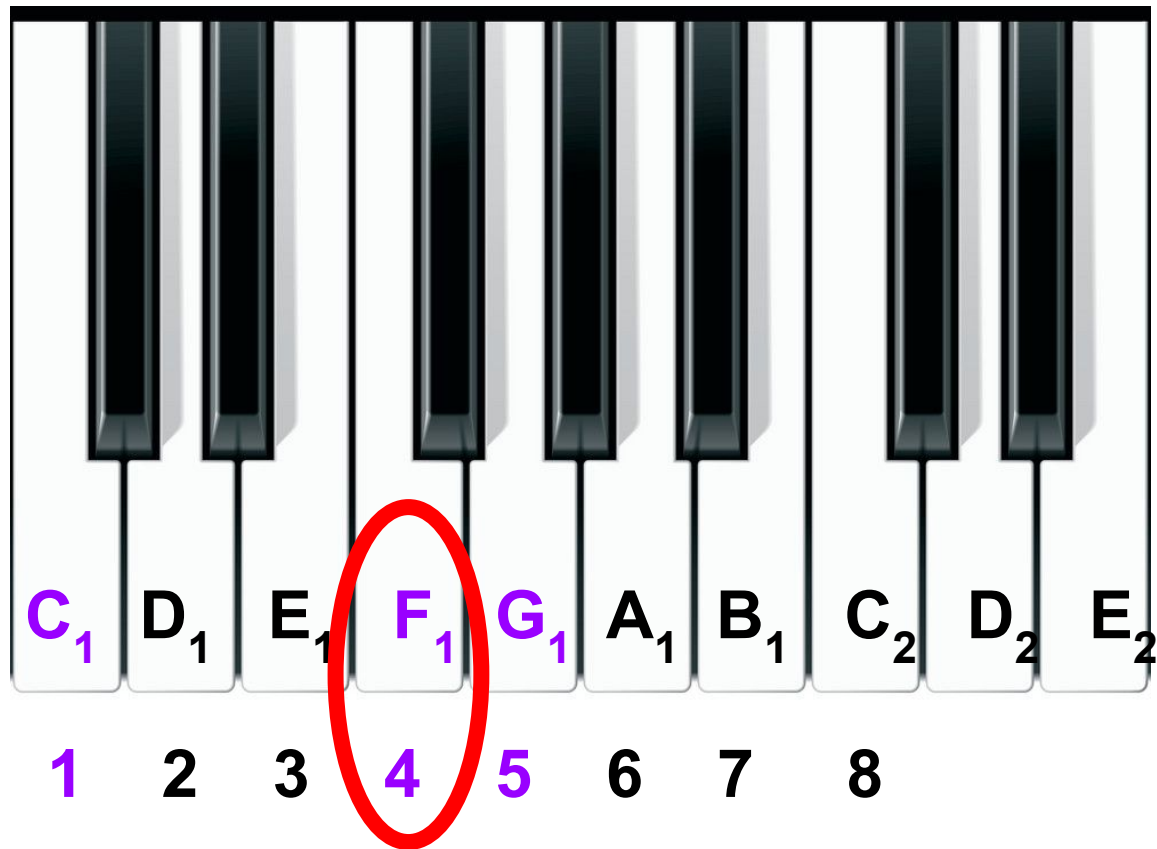
# Establishing a Key vs. Establishing Emotion



# Establishing a Key vs. Establishing Emotion



# Establishing a Key vs. Establishing Emotion



The C chord is  
*suspended* (Csus4).

**play chord(:c, :sus4)**



# Just Like Metaphor: Familiar + Surprise

C...E...C...E...C...E...



# Just Like Metaphor: Familiar + Surprise

C...E...C...E...C...E...

*F*??

# Just Like Metaphor: Familiar + Surprise

C...E...C...E...C...E...

*F??*    *B???*

# Just Like Metaphor: Familiar + Surprise

C...E...C...E...C...E...

*F?? B???? C...*

# Surprise and Tension: Also Important in Rhythm!

## Example

- **Kick** 2 3 4 (Rest) 2 3 4      **Kick** 2 3 4 (Rest) 2 3 4

...has the listener waiting for that next kick more than:

- **Kick** 2 3 4      **Kick** 2 3 4      **Kick** 2 3 4      **Kick** 2 3 4

# Surprise and Tension: Also Important in Rhythm!

**Syncopation:** emphasis on unexpected beats

Everyone imitated **Scott Joplin's** music so much (etc.) that we've had to find **new ways** to include surprising rhythms in this way!



# Symmetry Provides a Connection to the Familiar

## Example

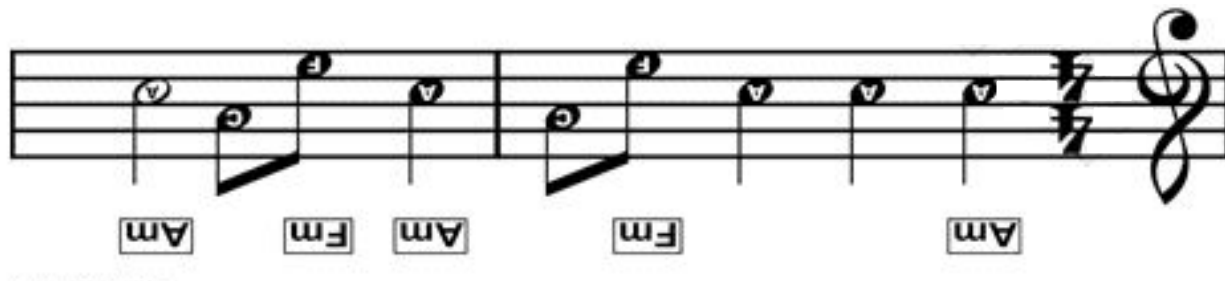
- **Sequence:** repeat the same melody, except up/down in pitch

A musical score in 3/4 time, key of D major (one sharp). The melody is written in the treble clef, and the bass line is in the bass clef. The lyrics are: "Send her vic - tor - ri - ous, Hap - py and glo - ri - ous,". The melody consists of a sequence of notes: D4 (quarter), E4 (quarter), F#4 (quarter), G4 (half), A4 (quarter), B4 (quarter), C5 (quarter), D5 (half). The bass line consists of a sequence of notes: D3 (quarter), E3 (quarter), F#3 (quarter), G3 (half), A3 (quarter), B3 (quarter), C4 (quarter), D4 (half). The melody and bass line are in perfect octave relationship.

# Symmetry Provides a Connection to the Familiar

## Example

- Ludwig van Beethoven playing his rival's music **upside-down** (*possibly didn't happen, but still an example for our purposes*)

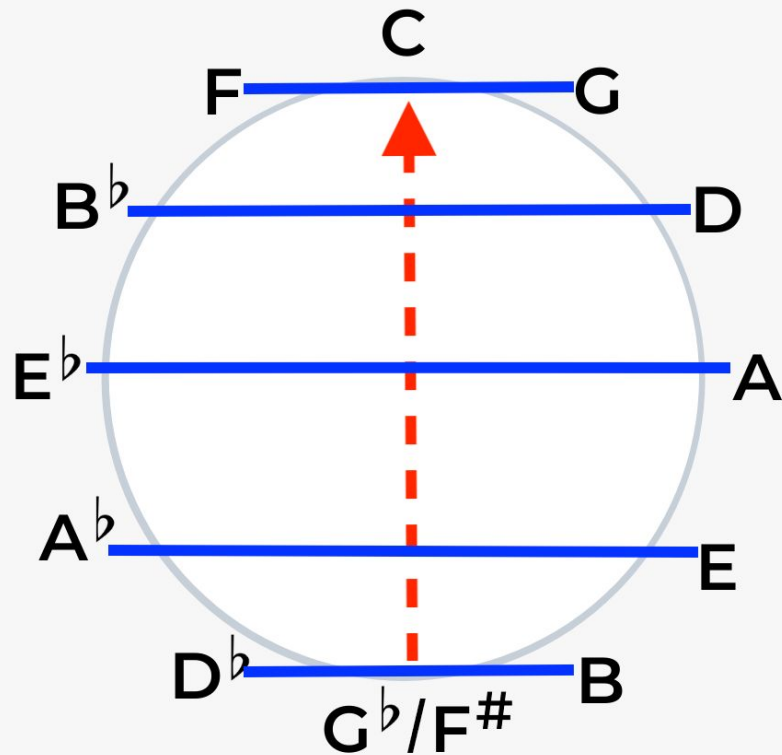


# Symmetry Provides a Connection to the Familiar

## Example

- “Negative Harmony”  
(popularized in 2017)

invert notes and/or  
chords around an axis  
(different definitions)





# Example Song Analysis: Classic Mario Theme



# Example Song Analysis: Classic Mario Theme

- **Beginning riff:** establish the (happy major) key
- **Drums:** establish a familiar beat
- **Hint at Melody:** gives us an idea of the melody using a rhythmic sequence. Plays it again to become familiar, until...
- **Melody:** breaks the familiarity!
  - “Biggest” notes are easy for people to sing along.
  - **Surprise/tension** comes from **rhythm** (would be WAY less exciting if all the rhythms were the same!)

# Next Steps

- **PQ4** Checkpoint!
  - How are **you** doing?
  - How are **your team members** doing?
- We'll return to **Sonic Pi** later this week (a chance to play around with coding and music!)