

Computer Science Principles

- *Big Idea 1: Creativity*
- *Big Idea 2: Abstraction*
- *Big Idea 3: Data and Information*
- *Big Idea 4: Algorithms*
- *Big Idea 5: Programming*
- *Big Idea 6: The Internet*
- *Big Idea 7: Global Impact*

Creativity

- Computing fosters the creation of artifacts and creative expression. Programming is a creative process.
- Use the tools and techniques of computer science to create interesting artifacts that are enhanced by computation.
- Examples:
 - How to get out of the level 10 of Blockly Maze?
 - Create an app that tracks the number of steps walked in a day
 - Create a visualization of a song
 - Write a program that composes original music or art or poetry!

Abstraction

- *Abstraction* reduces information and detail to facilitate focus on relevant concepts.
 - Multiple levels of abstraction are used in computation.
 - A combination of abstractions built upon binary sequences can be used to represent all digital data.
 - Models and simulations use abstraction to raise and answer questions.
- Examples:
 - A map, a model airplane, a floor plan, a song
 - A button, a label, an image, a color
 - Binary numbers, integers, characters using Unicode

Abstraction

- Code blocks are an example of abstraction



- *AppInventor* abstractions
 - *AccelerometerSensor* and *TextToSpeech* are abstract blocks



- *EarSketch* code to play a music sample on track 1 starting at measure 1 and stopping before start of measure 2

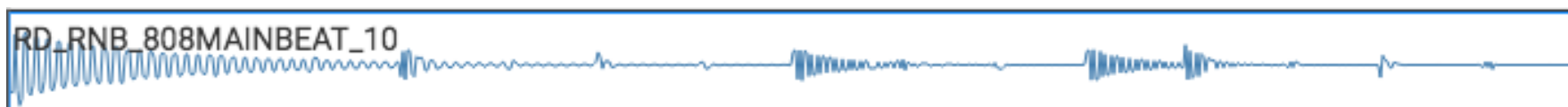
```
fitMedia(RD_RNB_808MAINBEAT_10, 1, 1, 2)
```

Abstraction

- Which of the following is the most abstract?
 - The picture of a chair
 - The dictionary definition of a chair
 - The word “chair”
 - A physical chair

Abstraction

- Which of the following is the most abstract?
 - The dictionary definition of a measure
 - The word “measure”
 - The image of a measure as a sound wave



- The sound file that plays one measure



- The code that generated the music

```
init()
setTempo(99)

fitMedia(RD_RNB_808MAINBEAT_10, 1, 1, 2)

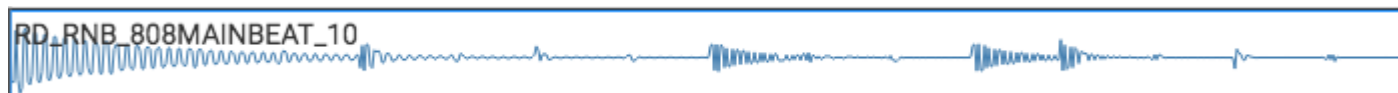
finish()
```

Data and Information

- Data and information facilitate the creation of knowledge. People use computer programs to process information to gain insight and knowledge. Computing facilitates exploration and the discovery of connections in information.
- Computational manipulation of information requires consideration of representation, storage, security and transmission.

- Examples:

- Analog sound:



- Digital sound: 110111001010011101000010...

Data and Information

- Examples:

- *Lossless data compression*. How to represent the following data?

b b b b b b c c c c a a a a a a a a

- **ALAC** (Apple Lossless Audio Codec), **FLAC** (Free Lossless Audio Codec)
- *Lossy compression*: **MP3 music** drops or reduces parts of the music that are less audible to human ears

Algorithms

- Algorithms are used to develop and express solutions to computational problems.
- An algorithm is a precise sequence of instructions for a process that can be executed by a computer.
- They are expressed using programming languages, and can solve many, but not all, problems.
- They are evaluated both analytically and empirically.

Recommended Reading: *Automate This: How Algorithms Came to Rule Our World*. Chris Steiner.

Algorithms

```
repeat until [location pin icon]
do
  if path to the right
  do
    turn right
  if path ahead
  do
    move forward
  else
    turn left
```

```
repeat until [location pin icon]
do
  if path to the left
  do
    turn left
  if path ahead
  do
    move forward
  else
    turn right
```

```
repeat until [location pin icon]
do
  if path ahead
  do
    if path to the left
    do
      if path to the right
      do
        turn right
      else
        turn left
    else
      if path ahead
      do
        turn left
      else
        turn right
  move forward
```

Three algorithms for level 10 of Blockly Maze.

Programming

- Programming is a creative process that enables problem solving, human expression and creation of knowledge.
- It uses logical and mathematical concepts and is facilitated by appropriate abstractions.
- Programs are developed and used by people, and they are written to execute algorithms.

```
from earsketch import *
init()
setTempo(120)

drum1 = ELECTRO_DRUM_MAIN_BEAT_008
drum2 = ELECTRO_DRUM_MAIN_BEAT_007

for measure in range (1, 9):
    fitMedia(drum1, 1, measure, measure + 0.5)
    fitMedia(drum2, 1, measure + 0.5 , measure + 1)

finish()
```



Internet

- The Internet pervades modern computing. It is a network of autonomous systems.
- Characteristics of the internet and the systems built on it influence their use.
- Cloud computing is an important application of the internet.



- Cybersecurity is an important concern for the Internet and those systems that are part of it.

Global Impact

- Computing affects communication, interaction and cognition. It enables innovation in nearly every field and has both beneficial and harmful effects.
- Computing is situated within economic, social and cultural contexts.
- Examples:
 - Protecting the privacy of sensitive data
 - Intellectual Property rights
- Recommended reading: *Blown to Bits* by Hal Abelson, Ken Ledeen, Harry Lewis (available in PDF, Kindle format as well as hardcopy)

Computational Thinking Practices

- P1: Connecting Computing
- P2: Creating Computational Artifacts
- P3: Abstracting
- P4: Analyzing problems and Artifacts
- P5: Communicating
- P6: Collaborating