



Music and Computer Science: Motivation, Analogies, and Experience

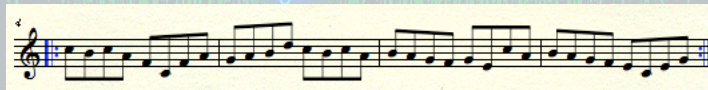
Roger B. Dannenberg
Schools of Computer Science and Art
Carnegie Mellon University

Music and Time

- Music has no material or dimension other than time
- The first concept of time as a unit of measure comes from Ars Nova (12th C)
- Music notation preceded graphs and calculus by centuries,
- Time intervals in music preceded time intervals in Kepler (1600) by centuries

Structure in Music

- Hierarchy: notes, motives, phrases
- Sections: verse, chorus, theme, coda
- Repetition



- Choice

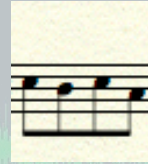


Analogies to Programming

- Procedural Abstraction
- Sequential Execution
- Iteration
- Conditional Execution
- Beyond Music Notation

Procedural Abstraction

```
def part1()  
    note("c5", 0.5)  
    note("b4", 0.5)  
    note("c5", 0.5)  
    note("a4", 0.5)
```



Sequential Execution

```
def my_music()  
    part1()  
    part2()  
    part3()
```

Iteration

```
def twice()
    for i in [1, 2]
        part1()
        part2()
```

Conditional Execution

```
def my_music()
    for i in [1, 2]
        part1()
        if i == 1
            first_ending()
        else
            second_ending()
```

Beyond Music Notation

- Random choice
- Recursion — Fractal Music
- Graph Models
- Parameterized Music
- Algorithmic Composition
- Interactive Music

Experience

- Computer Music Camp
 - American Center, 1983
 - Handful of students, age 8 to 14
 - Simple music compositions
 - Procedures, Loops, Conditionals
- Computer Music for Music Majors
 - CMU, 1984-87
 - Programming in C with music I/O library
 - Concurrent, interactive music systems

Experience (cont'd)

- Highly motivating
- *Debugging and program understanding aided by listening to output while reading the code*
- Avoid traditional data structures, data types, program syntax
 - Use a domain (music) that is “real” and familiar

Other Domains

- Java-based music programming in UG CS courses
- Computational, generative algorithms for sculpture

Other Domains

- ALICE

(Randy Pausch and Caitlin Kelleher, CMU)

Be your own animated movie director.

- Partnering with EA (providing Sims characters and artwork)
- Widely used now in schools
- Positive outcomes: better grades in CS



Conclusions

- Arts & Sciences connections can be:
 - Natural
 - Useful
 - Mutually reinforcing
- Prior domains (music, drama, sculpture, ...) can be highly motivating