

PERFORMATICS

Teaching Computing and Music *Together*


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[Play audio](#) [Stop audio](#)



Scratch Time

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Notes and Broadcasts


Can you see patterns in the notes?

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Notes and Broadcasts

Using loops to repeat patterns

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Lists and Variables

Stepping through two lists synchronously

StoLat4 Notes	
1	67
2	64
3	67
4	64
5	67
6	69
7	67
8	65
9	64
10	65
11	65
12	62
13	65
14	62
15	65

StoLat4 Rhythms	
1	1
2	1
3	1
4	1
5	1
6	0.5
7	0.5
8	0.5
9	0.5
10	2
11	1
12	1
13	1
14	1
15	1

length: 36 length: 36



Transposing

Choosing the key

The Scratch code for 'Transposing' starts with a 'when 4 key pressed' event. It asks the user 'What key should I play in, A, B, or C?' and waits for an answer. It uses three nested 'if' blocks to check for 'a', 'b', or 'c'. If 'a' is chosen, 'KeyDelta' is set to -3; if 'b', it's -1; if 'c', it's 0. A second 'ask' block prompts the user to 'Please enter only A, B, or C'. Below this, variables are set: tempo to 90 bpm, instrument to 54, Index-Notes to 1, and Index-Rhythms to 1. A 'repeat' block loops through the 'Notes' list. Inside the loop, a 'play note' block uses 'item Index-Notes of Notes + KeyDelta' and 'item Index-Rhythms of Rhythms' to play a note. 'Index-Notes' and 'Index-Rhythms' are then incremented by 1.

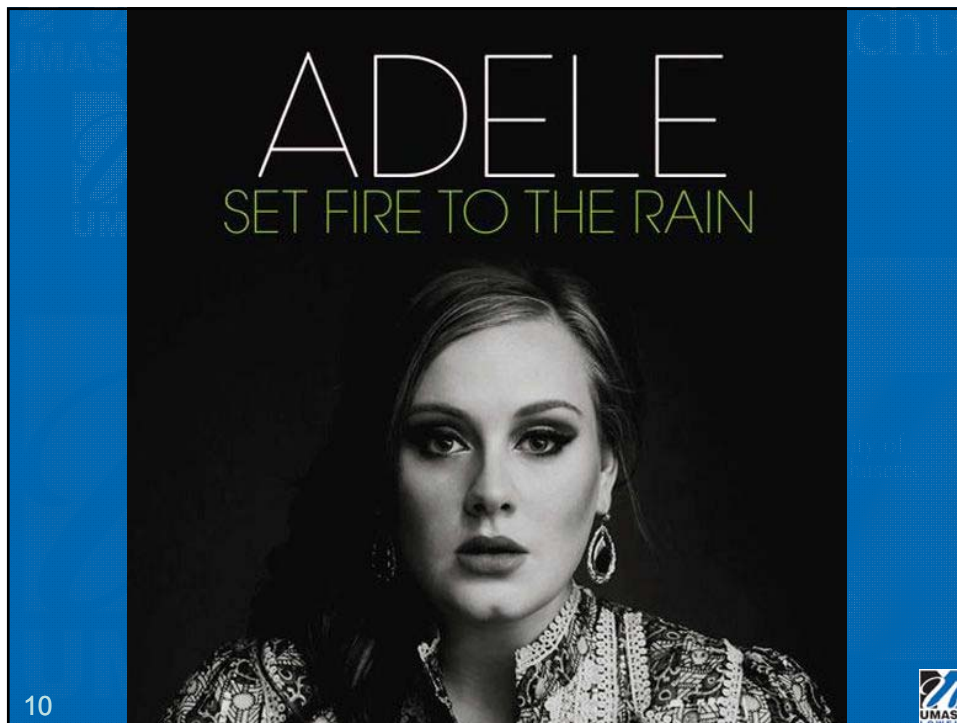
Playing Multiple Parts

Student Chris Adoretti

The Scratch code for 'Playing Multiple Parts' starts with a 'when b key pressed' event. It sets tempo to 120 bpm, Tonic Note to 64, and initializes 'Current Note', 'Current H Note', 'Current T Note', 'Lead Part Index', 'Lead Rhythm Index', and 'instrument' to 26. A 'repeat' block loops through 'Lead Part' (1 to 16). Inside, it broadcasts 'Play One Lead Note', 'Play One Harmony Note', and 'Play One Tenor Note', then increments 'Lead Part Index' and 'Lead Rhythm Index'. Three 'when I receive' blocks handle the broadcasts: 'Play One Tenor Note' sets 'Current T Note' to 'Current T Note + item Lead Part Index of Tenor Part' and plays notes for 'item Lead Rhythm Index of Lead Part Durations'; 'Play One Harmony Note' sets 'Current H Note' to 'Current H Note + item Lead Part Index of Harmonic Part' and plays notes for 'item Lead Rhythm Index of Lead Part Durations'; 'Play One Lead Note' says 'Lead Part Index', sets 'Current Note' to 'Current Note + item Lead Part Index of Lead Part', and plays notes for 'item Lead Rhythm Index of Lead Part Durations'. A 'when space key pressed' block stops all.

Controlling Multiple Parts

The screenshot displays a Scratch project titled "HappyBirthday-v7". The main script area contains several "when I receive" and "when clicked" blocks. Key blocks include "broadcast Initialize OMP", "set volume to 100%", "set Starting Note to 53", "set Rhythm Timer Multiplier to 0.5", "set No. of Phrases to 4", and "set all parts to play (value 1)". A "when I receive Initialize All 4 Parts" block sets lead notes and indices for Lead, Tenor, Bass, and Piano parts. A "when clicked" block triggers a "reset timer" and broadcasts "Play All 4 Parts". A control panel on the right shows a timer at 25.8, a rhythm multiplier at 0.5, and buttons for "Slower", "Reset", and "Faster". Below these are buttons for "Lead", "Tenor", "Bass", and "Piano".



Computational Thinking Jeannette Wing, 2006

- CT is a fundamental skill for everyone ...
- CT involves solving problems, designing systems ... by drawing on the concepts fundamental to computer science
- CT includes a range of mental tools ...
 - using abstraction and decomposition when attacking a large complex task
 - judging a program not just for correctness and efficiency but for aesthetics, and a system's design for simplicity and elegance

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PERFORMATICS

- Connecting Computer Science to Music and Art through interdisciplinary courses
 - synchronized vs. hybrid courses
- Originally conceived to attract and retain CS majors by connecting theory to practice
 - evolved into exposing non-CS majors to higher levels of computing than typically seen in “GenEd” courses
- Supported by NSF CISE CPATH (2007) and NSF DUES TUES (2011)


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PERFORMAMATICS

- **Mark Guzdial, Georgia Tech:**
“Where could Performamatics have its greatest impact?”
 - the use of Scratch in introductory CS courses is not what’s most exciting
 - the potential of this work to attract more CS majors is low
- **Greatest potential impact “is on the non-majors and their attitudes about computing”**
 - computinged.wordpress.com/2011/12/13/

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Sound Thinking: Course Goals

- **Teach CT by dealing approximately equally with both computing and music**
 - GenEd Committee was adamant that Science majors must learn about music while Arts majors must learn about computing
- **Not just sound ... music**
 - aesthetics as well as mechanics
 - encouraging creativity
 - providing context: allowing students to work with — and create — their own music

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Sound Thinking: Where Work Like This Fits





15 [Audio 1](#) [Audio 2](#) [Stop Sound](#) 

Sound Thinking: What Do Students Do?

73.212 / 91.212 Sound Thinking
Course Home Page
Spring 2011, Section 201

Assignments

No.	Due Date	Assignment Title
1	Thu Feb 3	Creating a Composition for a Found Objects Instrument 
2	Thu Feb 17	Creating a Composition from Digitized Found Sounds
3	Thu Feb 24	Creating a Song Flowchart
4	Tue Mar 8	Sequencing Sounds with Scratch
5	Tue Mar 29	Creating a Composition Based on Major Seconds and Perfect Fifths
6	Tue Apr 12	Transposing with Scratch
7	Thu Apr 21	Using IchiBoards and Sensors
8	Tue May 3	Final Sound Thinking Project and Performance

16 <http://soundthinking.uml.edu> 

Mike's Notation for His "Eine Kleine Jacket Musik"

Eine Kleine Jacket Musik Michael McKendry 2-12-08

R	↓ ↑	↓	↑ ↓ ↑	↓
L	Hand	Hand	Hand	Hand
	↑ ↓	↑ ↓	↑ ↓ ↑ ↓	↑ ↓ ↑ ↓
	Hand	Hand		
				↑ ↓
	Hand ←	Hand ←	Hand ←	Hand ←

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Mike's Found Instrument: His Jacket

Eine Kleine Jacket Musik Michael McKendry 2-12-08

R	↓ ↑	↓	↑ ↓ ↑	↓
L	Hand	Hand	Hand	Hand
	↑ ↓	↑ ↓	↑ ↓ ↑ ↓	↑ ↓ ↑ ↓
	Hand	Hand		
				↑ ↓
	Hand ←	Hand ←	Hand ←	Hand ←

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Click picture
to play video



Eric's Found Instrument: Lever Drumitar



Eric's Notation for His Lever Drumitar

SPL: $\frac{1}{3}$

1	✓	
2		
3	✓	
4		
5	✓	
6		
7	✓	
8		
9	✓	
10		
11	✓	
12		
13	✓	

40	✓	
41	✓	
42	✓	
43	✓	
44	✓	
45	✓	
46	✓	
47	✓	
48	✓	
49	✓	
50	✓	
51	✓	
52	✓	

Click to play original audio

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Stop Sound







23 <http://www.jackquartet.com> 

Sound Thinking: What Do Students Do?

73.212 / 91.212 Sound Thinking
Course Home Page
Spring 2011, Section 201

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Eric's Audacity Mashup #1 Lever Drumitar

Click to play
Audacity composition

25 Stop Sound

Eric's Audacity Mashup #2 Lever Drumitar

"A spectrogram of my remix. I thought it was rather interesting to look at. See if you can figure out what bits are where."

Click to play
Audacity remix

26 Stop Sound

Nicole's Audacity Mashup: Satan Lives Inside Your Radio

Click picture to play audio

Stop Sound

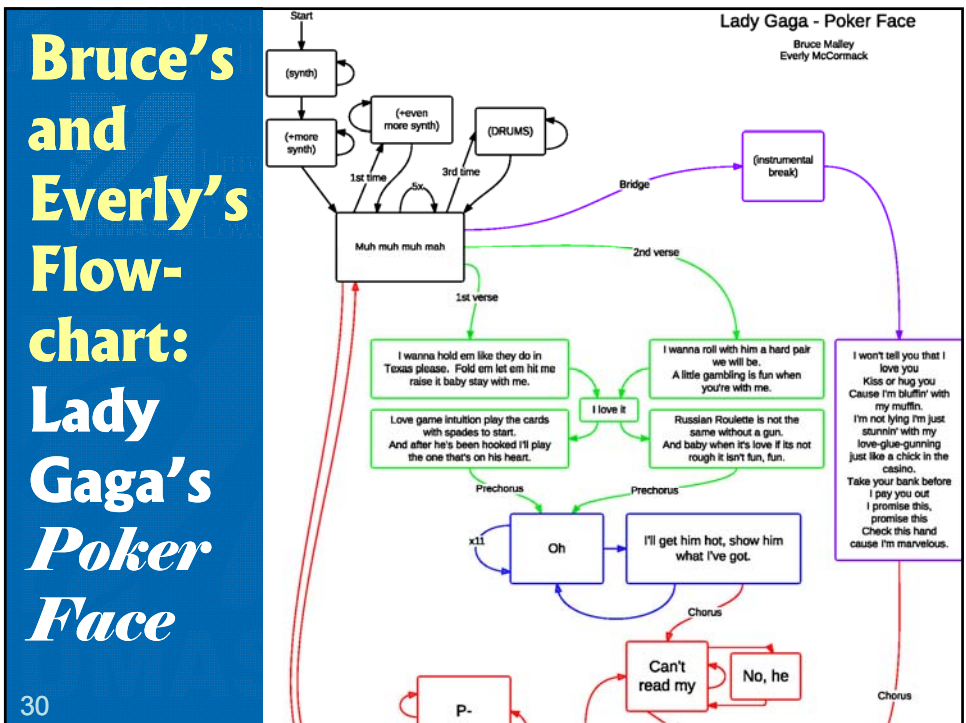
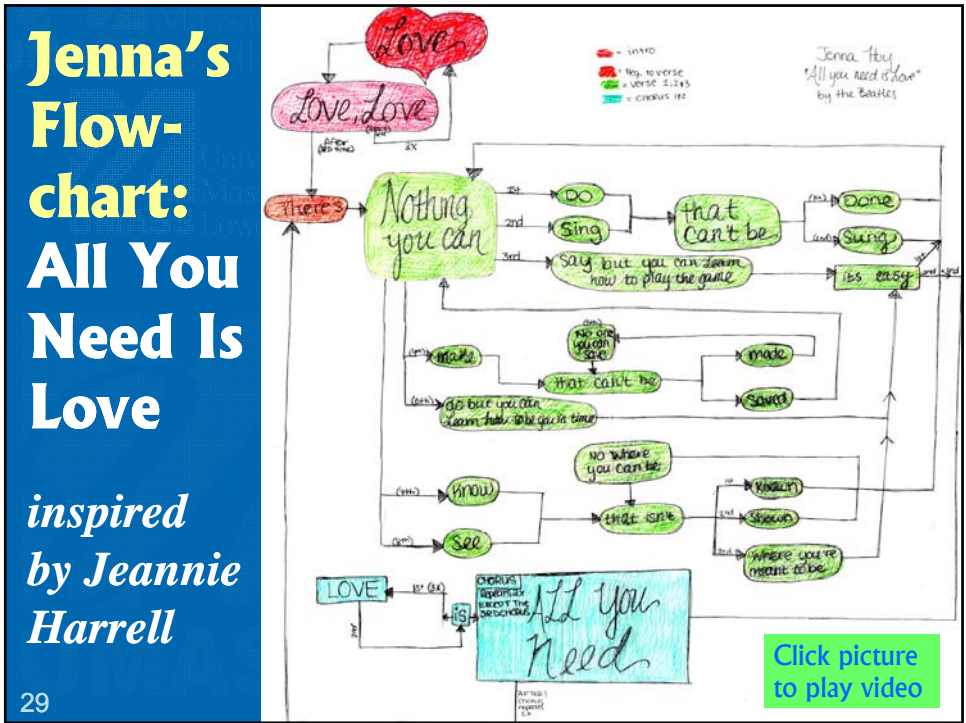
Sound Thinking: What Do Students Do?

73.212 / 91.212 Sound Thinking
Course Home Page
Spring 2011, Section 201

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Sound Thinking: From Editing to Coding

73.212 / 91.212 Sound Thinking
Course Home Page
Spring 2011, Section 201

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<http://soundthinking.uml.edu>



Choosing Appropriate Language

```
(
  SynthDef( "kashmir", {
    arg sound, freq ;
    var sin, env_gen, env, freq_env ;
    env = Env.triangle( 0.2, 0.2 ) ;
    env_gen = EnvGen.kr( env, doneAction: 2 ) ;
    sound = SinOsc.ar( freq, 0, env_gen ) + Saw.ar( freq, env_gen ) ;
    Out.ar( [0,1], sound )
  } ).load(s);
)
(
  var x = 45, a = 6 ;
  p = Pseq([ 45, 46, 47, 48 ], inf).asStream ;
  q = Pseq([ 0.2, 0.2, 0.8 ], inf).asStream ;
  t = Task( {
    loop( {
      if( a < 6, { a = a + 1 }, { a = 1 ; x = p.value } ) ;
      y = Synth( "kashmir", [ freq: x.midicps ] ) ;
      q.value.wait ;
    } ) ;
  } ) ;
  t.start ;
)
t.stop ;
```



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SuperCollider?

GA Tech Laptop Orchestra



```
jason: jc1 : cat(svar5, yyp4, js3, yyp1)
yoyo: loop amplify(yyp3, 3) @m
snag: loop svar5 @m
sid<3: loop merge(eye1,partay[u,u,u,u,u,u,u,u])@m
great scott!/: loop yyp4 @m
jason: 80 more mm. let's make them count!
```

Ken's Mashup



```
when clicked
repeat 4
  broadcast Beatbox
  play sound HumanBeatbox2
  wait 2.7 secs
repeat 4
  broadcast whoop
  play sound HumanBeatbox2
  wait 2.7 secs
repeat 4
  broadcast space ripple
  play sound HumanBeatbox2
  wait 2.7 secs
repeat 4
  broadcast balloon
  change volume by 20
  play sound HumanBeatbox2
  change volume by -20
  wait 2.7 secs
play sound HumanBeatbox2 until done
play sound Ya

when I receive Beatbox
play sound Ya
wait 2.7 secs

when I receive whoop
play sound Whoop
play sound Ya
wait 2.7 secs

when I receive space ripple
play sound Whoop
play sound Ya
play sound SpaceRipple
wait 2.7 secs

when I receive balloon
play sound Whoop
play sound Ya
play sound SpaceRipple
play sound BalloonScratch
wait 2.7 secs
```

Click picture to play audio

Stop Sound

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In-Class Scratch Development

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Click picture to play audio

Stop Sound

Sound Thinking: From Editing to Coding

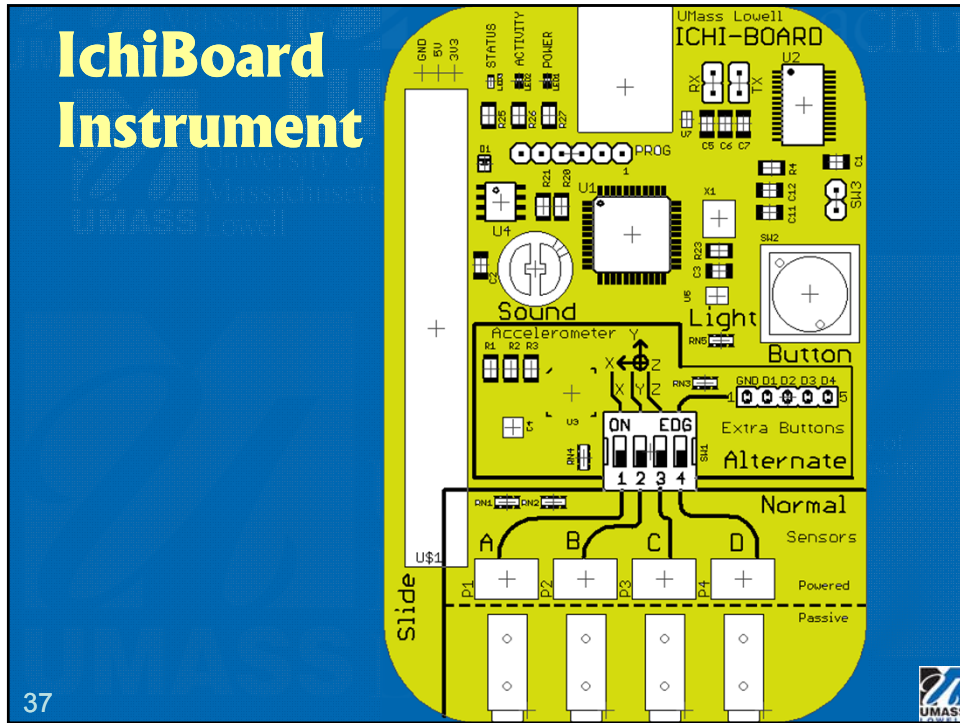
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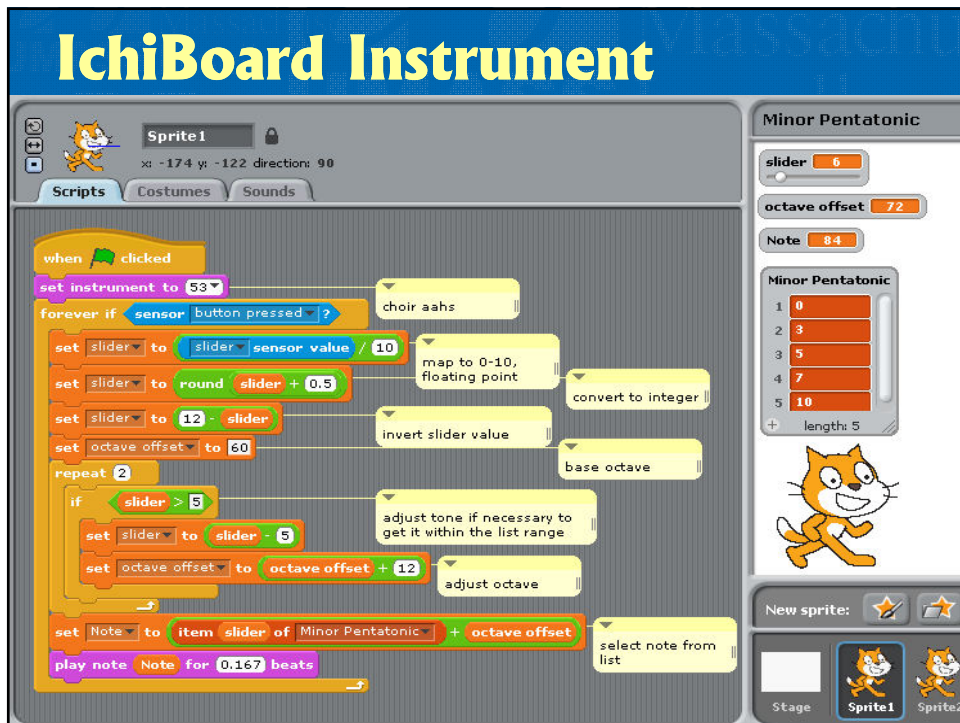
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Live Coding with Scratch

The screenshot shows a Scratch project titled "Arvo Pärtish Aeolian". The main workspace contains two key scripts:

- Script 1:** Triggered by "when key 1 pressed", it enters a "forever" loop. It sets a "Counter" to 0, then repeats for the length of the "AeolianPitchSet". In each iteration, it plays a note (pitch: item Counter of AeolianPitchSet + 72, for item any of RhythmSet), increments the counter by 1, and changes the volume by 5.
- Script 2:** Triggered by "when key 2 pressed", it enters a "forever" loop. It sets "Counter2" to 1, then repeats for the length of the "AeolianPitchSet". In each iteration, it plays a note (pitch: item Counter2 of AeolianPitchSet + 60, for item any of RhythmSet) and increments Counter2 by 1.

Additional elements include:

- When clicked:** A script that sets tempo to 30 bpm, instrument to 43, volume to 100, and then enters a "forever" loop with an "if volume < 10" condition to stop all sounds.
- Properties Panel:** Shows "Arvo Pärt" as the sprite, "Arvo Pärt volume" at 100, and two lists: "AeolianPitchSet" (values: 12, 10, 8, 7, 5, 3, 2, 0) and "RhythmSet" (values: .5, 1, 1).
- Stage:** Displays a small image of Arvo Pärt.

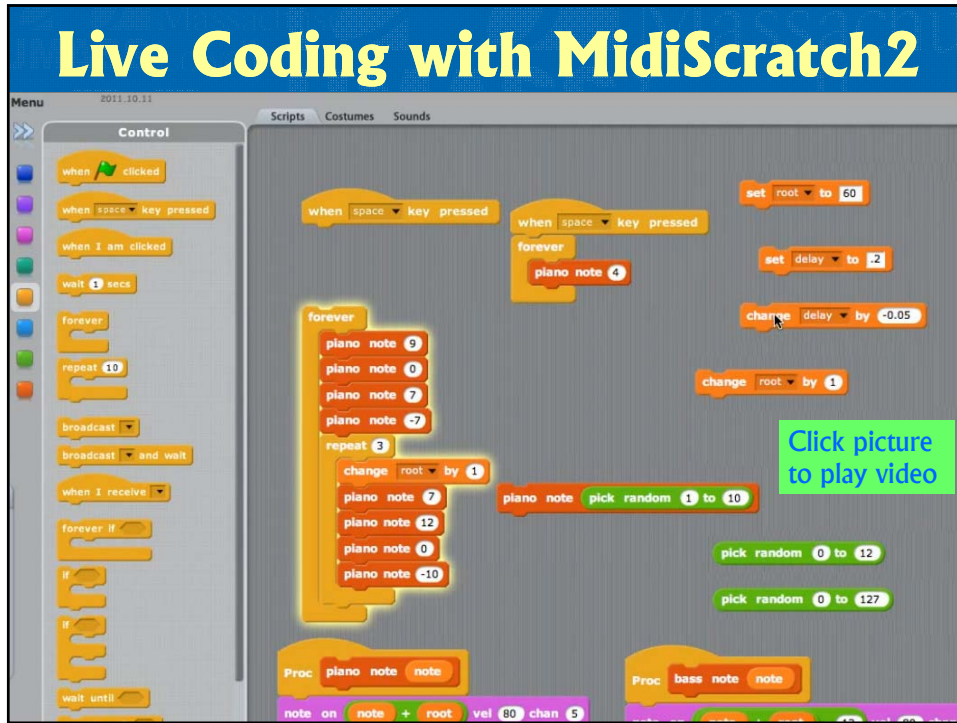
[Click picture to play video](#)

Jeremy & Nicole IchiBoard Duet

The photograph shows a man with glasses and a dark jacket kneeling on a wooden floor, playing a circular electronic instrument mounted on a stand. He is using a mallet to strike the instrument's surface. The instrument has various sensors and cables attached to it.

[Click picture to play video](#)

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University of Massachusetts Lowell
Depts. of Music and Computer Science

PERFORMAMATICS

Computational Thinking through Computing and Music
an interdisciplinary NSF TUES project

[Home](#) [Workshop](#) [About Our Project](#) [About Us](#) [Resources](#) [Publications](#)

Our first NSF-sponsored [interdisciplinary workshop](#) will take place on:
Thursday and Friday, June 21-22, 2012, at UMass Lowell
To apply for attendance, please fill out the [workshop application](#) form.

Our goal is to develop and disseminate ways to enhance students' grasp of computational thinking by engaging them in fundamental concepts that unite computing and music. Our approach leverages students' near universal interest in music as a context and springboard for engaging in rich computational thinking experiences. Prior work in an NSF CPATH project showed this approach to be effective at creating value in both discipline-specific courses for Computer Science and Music majors, as well as General Education courses for all majors. This project will develop additional activities to deepen students' experiences in both computing and music and techniques for evaluating learning through those activities. The project will also disseminate our work through workshops for pairs of interdisciplinary faculty at 4- and 2-year colleges.

www.performamatics.org

NSF-Sponsored Workshops on Interdisciplinary Teaching
2 days at UMass Lowell, 1 day at conferences

Performamatics: Acknowledgments



- **Additional Senior Personnel**

Sarah Kuhn – UMass Lowell Dept. of Psychology

Scott Lipscomb – Univ. of Minnesota Dept. of Music

Fred Martin – UMass Lowell Dept. of Computer Science

- **MIT Media Lab Lifelong Kindergarten Group**

John Maloney – Staff Researcher, Scratch Lead Developer

Mitchel Resnick – LEGO Papert Prof. of Learning Research

Eric Rosenbaum – Doctoral Student

- **NSF Awards CNS-0722161
and DUE-1118435**



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Thank You to My UAM Hosts

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– Faculty of Mathematics
and Computer Science

- **dr. Jacek Marciniak**

– Faculty of Mathematics
and Computer Science

- **Prof. dr. habil. Jacek Witkoś**

– Deputy President for Research
and International Cooperation



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PERFORMAMATICS
thank you

Jesse M. Heines
S. Alex Ruthmann
Gena R. Greher



<http://www.performamatics.org>

Adam Mickiewicz University
Poznań, Poland

May 17, 2012

