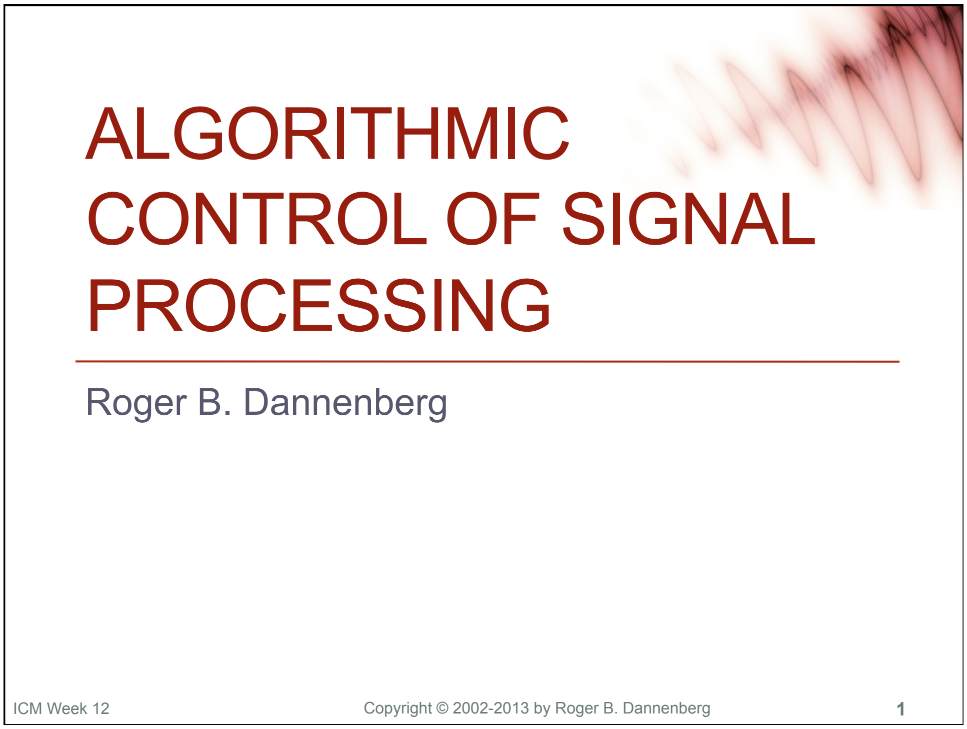
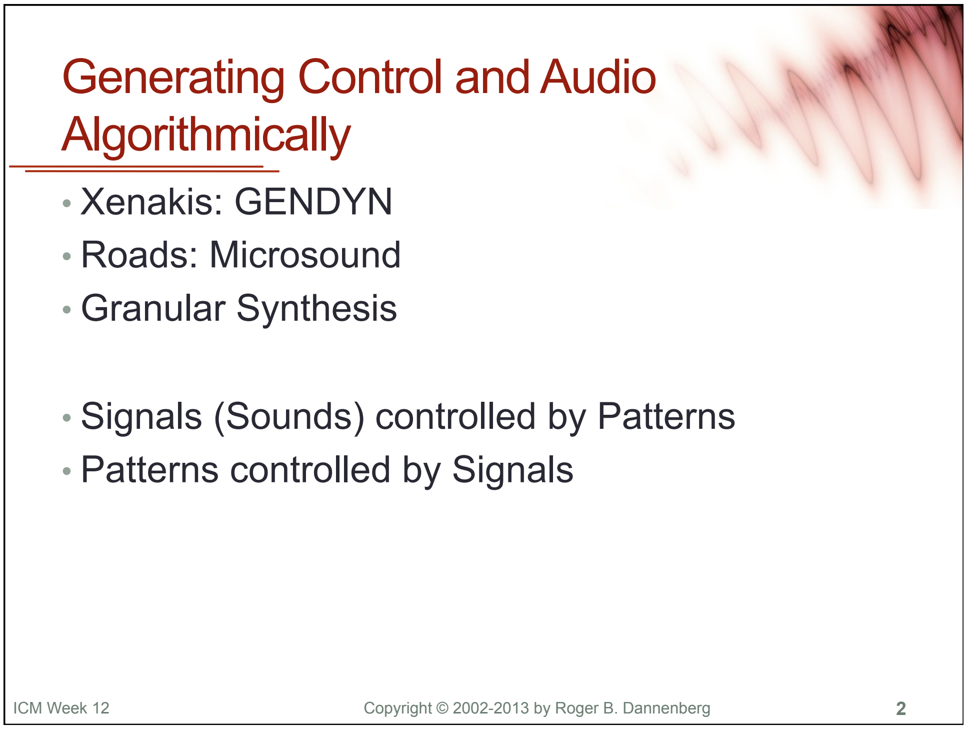


ALGORITHMIC CONTROL OF SIGNAL PROCESSING

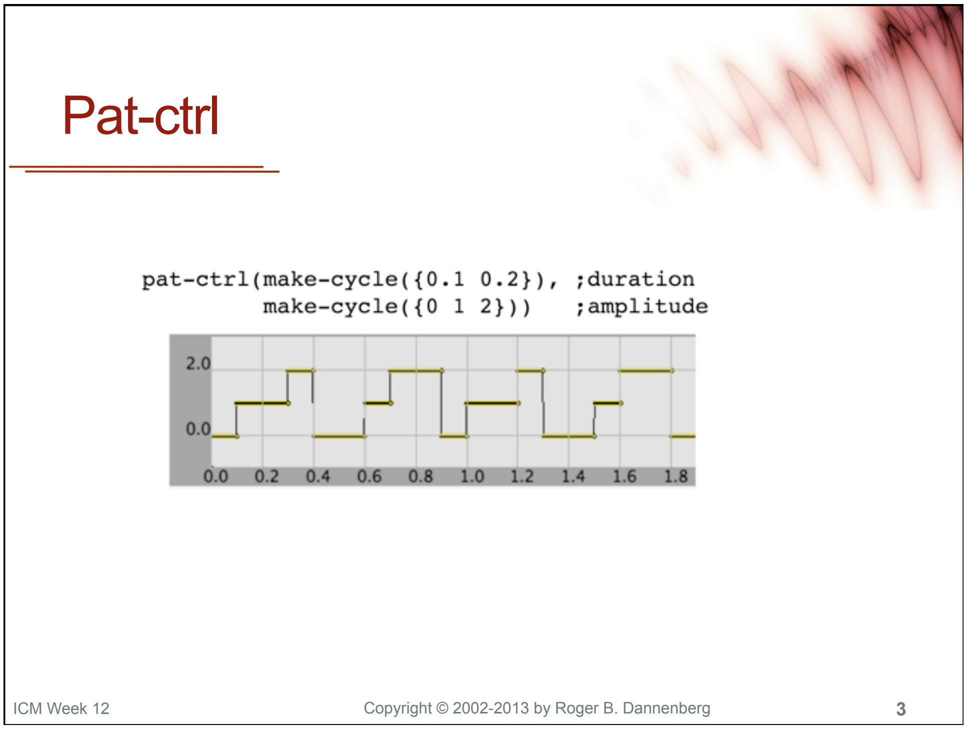
Roger B. Dannenberg



Generating Control and Audio Algorithmically

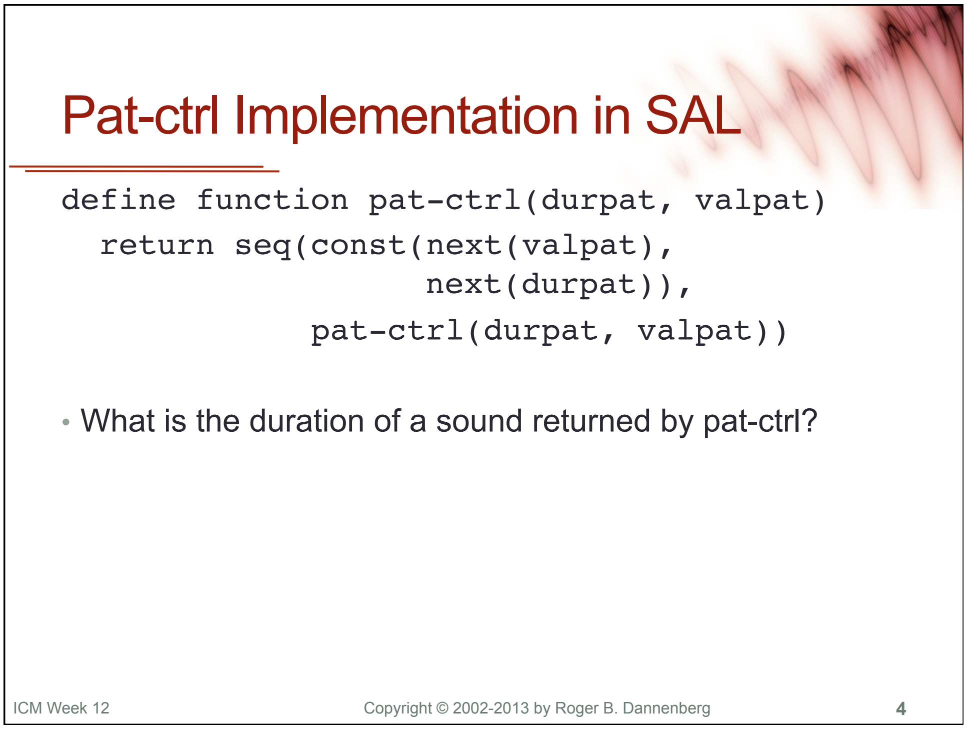
- Xenakis: GENDYN
- Roads: Microsound
- Granular Synthesis

- Signals (Sounds) controlled by Patterns
- Patterns controlled by Signals



Pat-ctrl

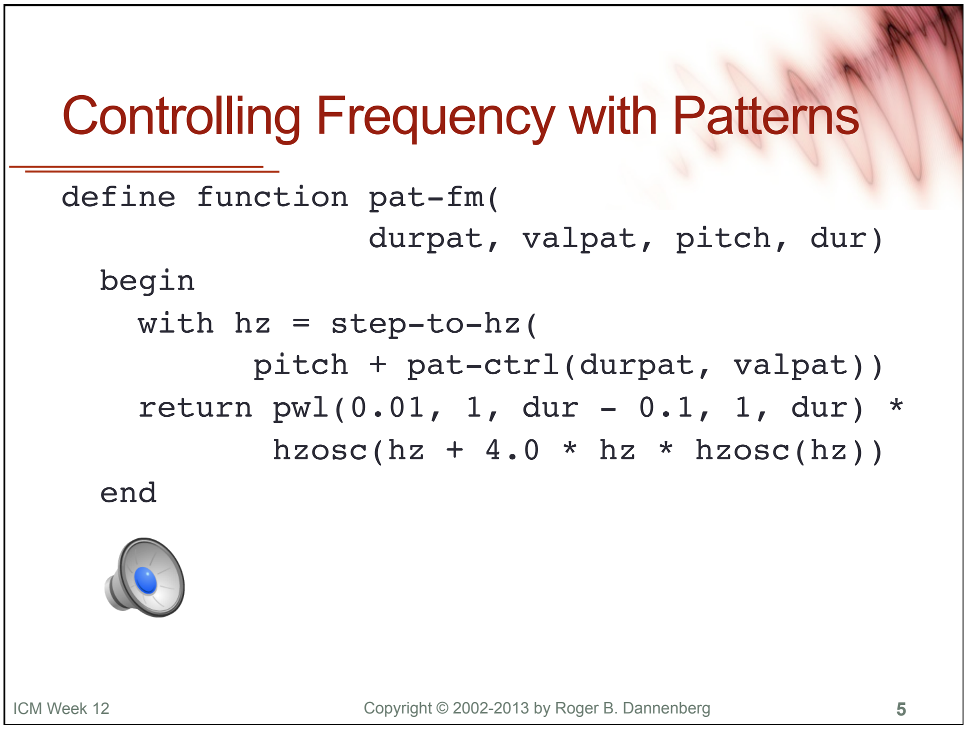
```
pat-ctrl(make-cycle({0.1 0.2}), ;duration
         make-cycle({0 1 2}))   ;amplitude
```



Pat-ctrl Implementation in SAL

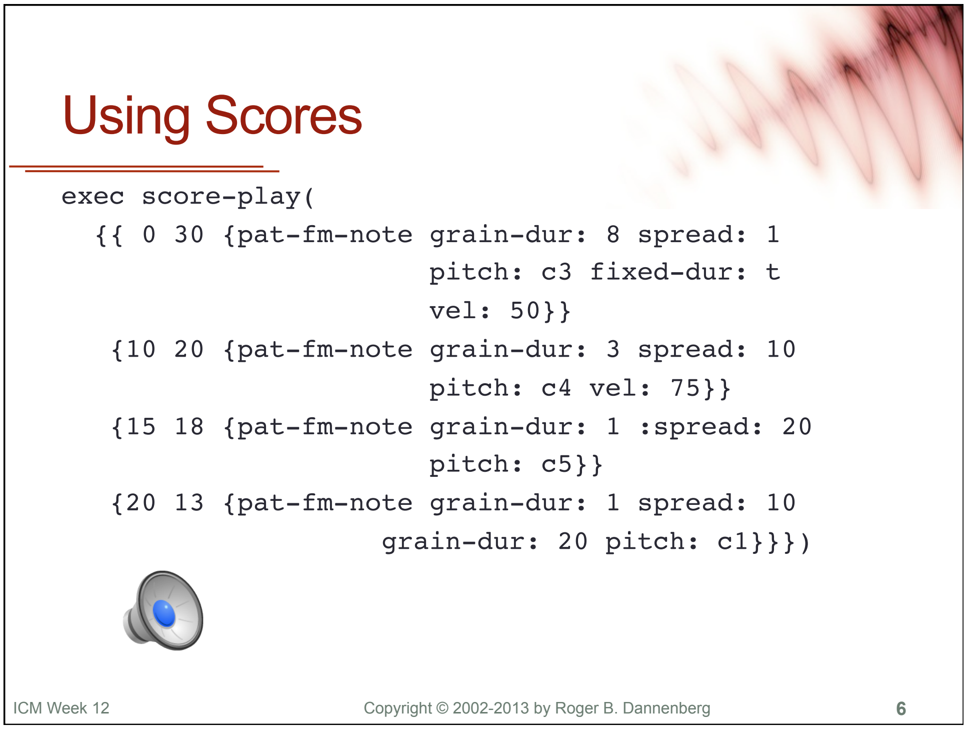
```
define function pat-ctrl(durpat, valpat)
  return seq(const(next(valpat),
                   next(durpat)),
             pat-ctrl(durpat, valpat))
```

- What is the duration of a sound returned by pat-ctrl?



Controlling Frequency with Patterns

```
define function pat-fm(
                durpat, valpat, pitch, dur)
  begin
    with hz = step-to-hz(
          pitch + pat-ctrl(durpat, valpat))
    return pwl(0.01, 1, dur - 0.1, 1, dur) *
           hzosc(hz + 4.0 * hz * hzosc(hz))
  end
```



Using Scores

```
exec score-play(
  {{ 0 30 {pat-fm-note grain-dur: 8 spread: 1
                       pitch: c3 fixed-dur: t
                       vel: 50}}
   {10 20 {pat-fm-note grain-dur: 3 spread: 10
                       pitch: c4 vel: 75}}
   {15 18 {pat-fm-note grain-dur: 1 :spread: 20
                       pitch: c5}}
   {20 13 {pat-fm-note grain-dur: 1 spread: 10
                    grain-dur: 20 pitch: c1}}})
```

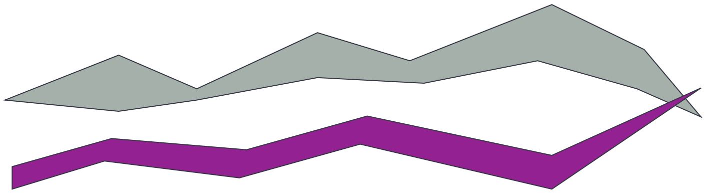
Using Scores (2)

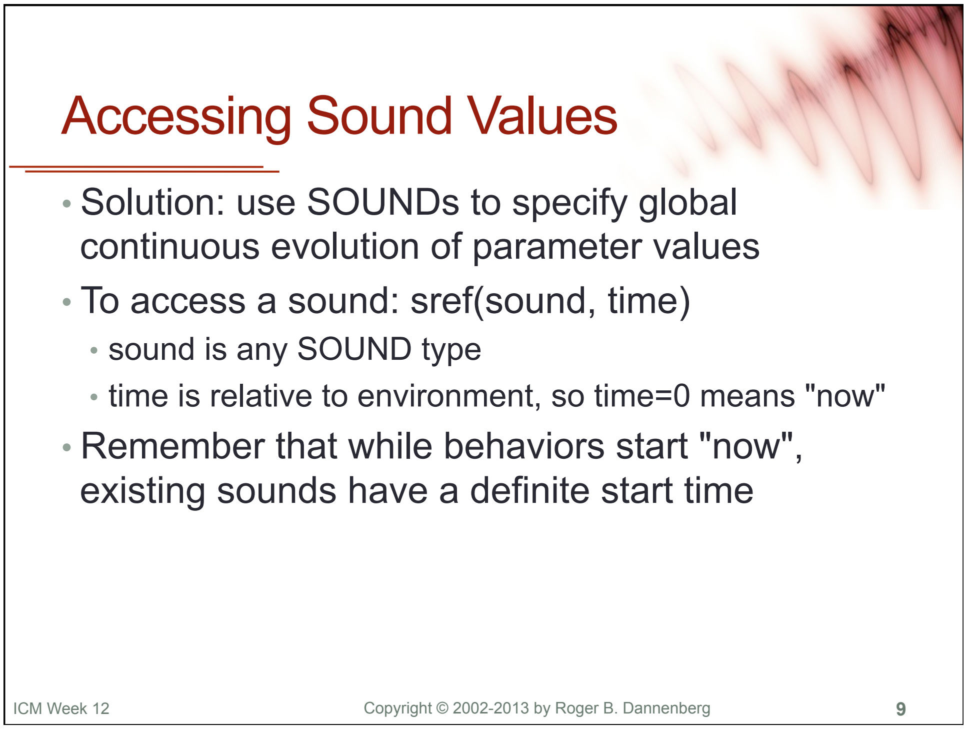
```
exec score-play(
  {{ 0 30 {pat-fm-note grain-dur: 8 spread: 1
                       pitch: c3 fixed-dur: t
                       vel: 50}}
   {10 20 {pat-fm-note grain-dur: 3 spread: 10
                       pitch: c4 vel: 75}}
   {15 18 {pat-fm-note grain-dur: 1 :spread: 20
                       pitch: c5}}
   {20 13 {pat-fm-note grain-dur: 1 spread: 10
                    grain-dur: 20 pitch: c1}}})
```

- Key ideas:
  - Scores do not have to consist of "notes"
  - Packaging a complex behavior as a Nyquist instrument (a behavior with keyword parameters) supports hierarchical composition
  - Via scores, programs, even score-gen

Using Nyquist SOUNDs for Global Control

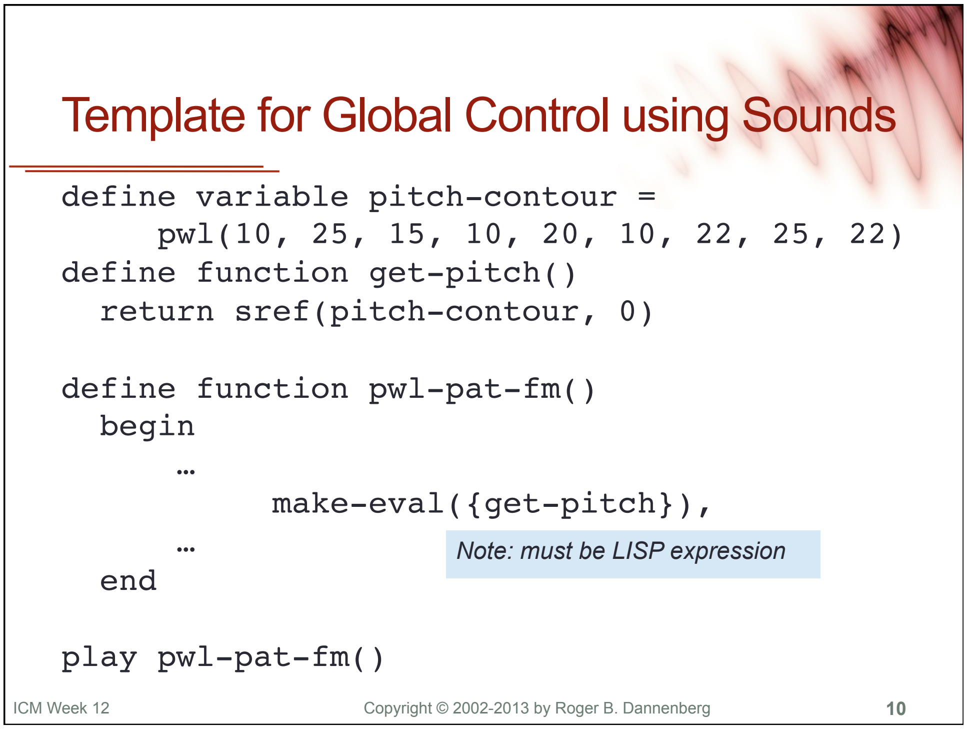
- Scores are fine for *events*
- What about continuous change?
- Example from before: Tendency Masks:





Accessing Sound Values

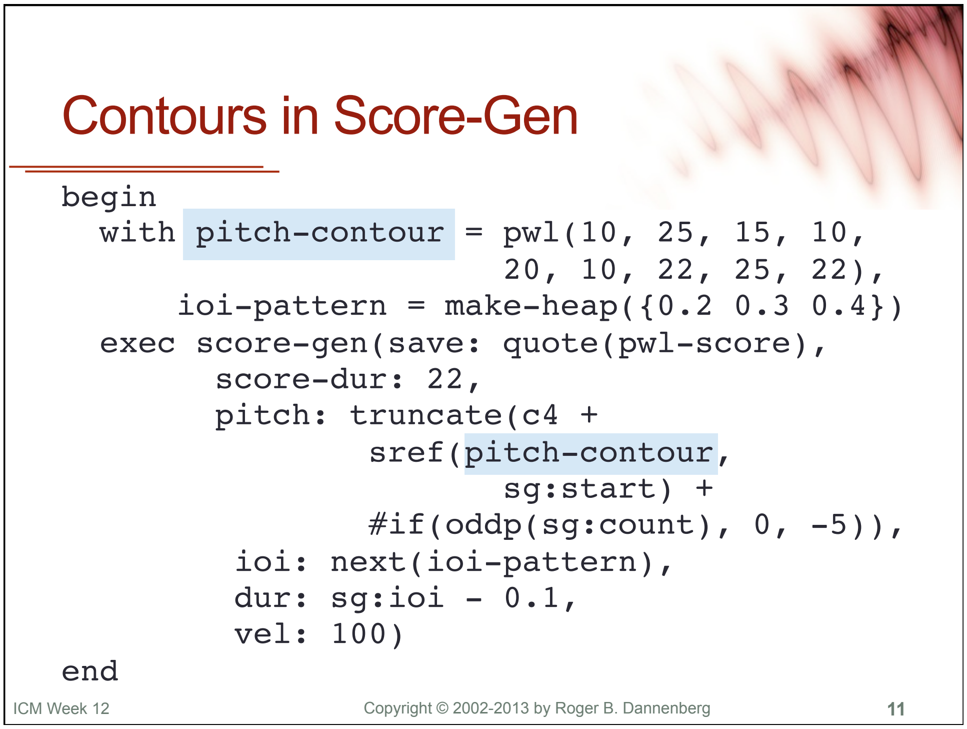
- Solution: use SOUNDs to specify global continuous evolution of parameter values
- To access a sound: sref(sound, time)
  - sound is any SOUND type
  - time is relative to environment, so time=0 means "now"
- Remember that while behaviors start "now", existing sounds have a definite start time



Template for Global Control using Sounds

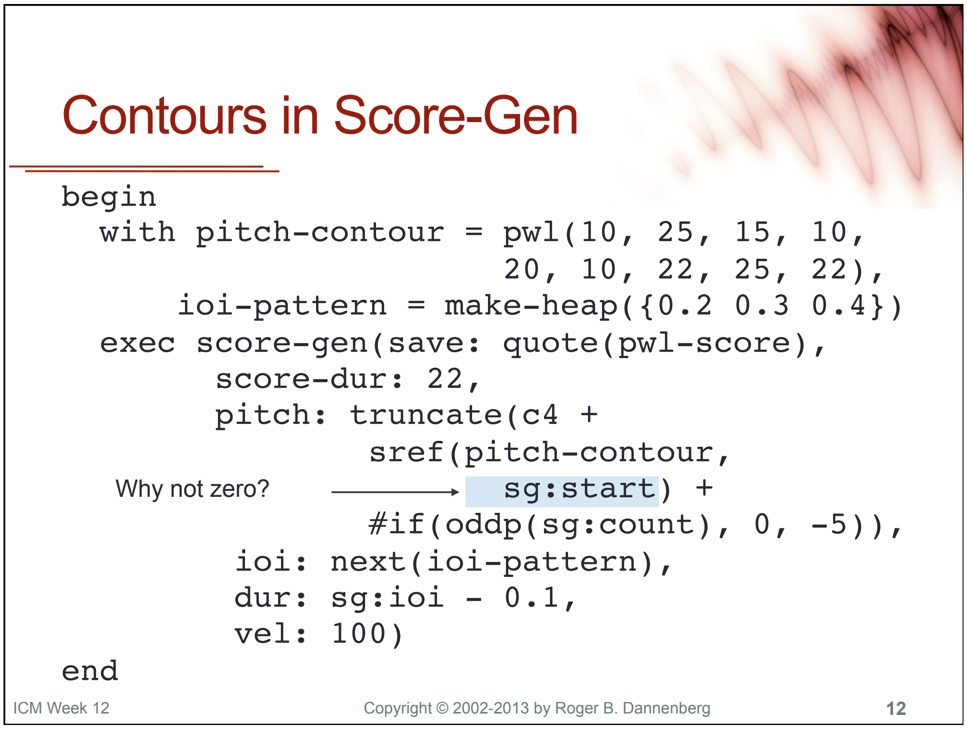
```
define variable pitch-contour =
     pwl(10, 25, 15, 10, 20, 10, 22, 25, 22)
define function get-pitch()
  return sref(pitch-contour, 0)

define function pwl-pat-fm()
  begin
      …
           make-eval({get-pitch}),
      …
  end

play pwl-pat-fm()
```

Note: must be LISP expression



Contours in Score-Gen

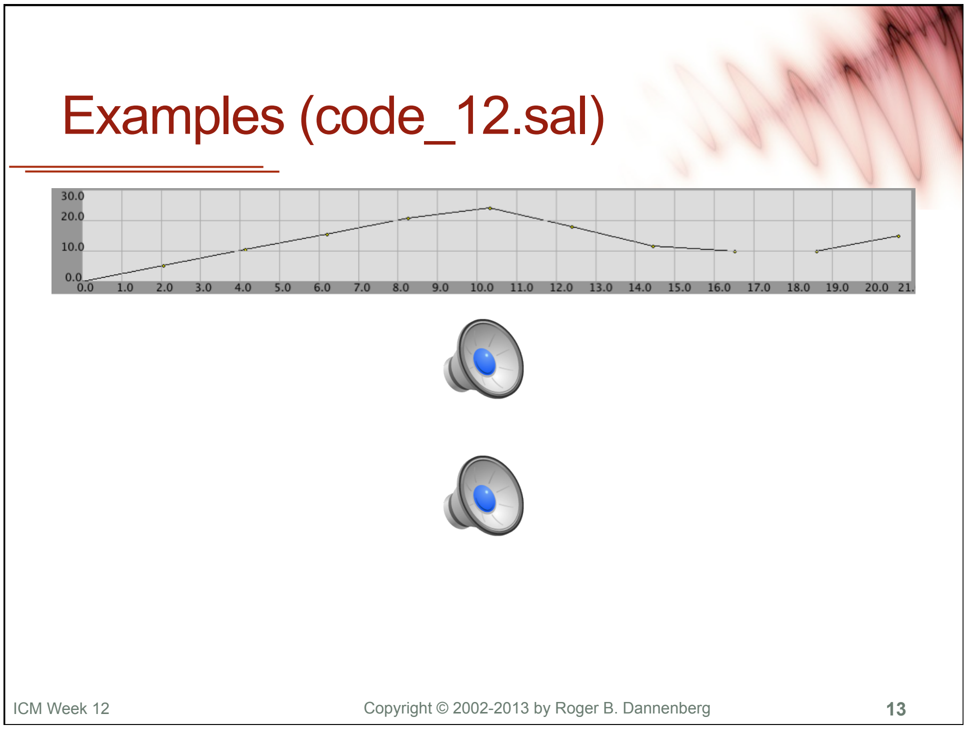
```
begin
  with pitch-contour = pwl(10, 25, 15, 10,
                           20, 10, 22, 25, 22),
      ioi-pattern = make-heap({0.2 0.3 0.4})
  exec score-gen(save: quote(pwl-score),
        score-dur: 22,
        pitch: truncate(c4 +
                sref(pitch-contour,
                       sg:start) +
                #if(oddp(sg:count), 0, -5)),
         ioi: next(ioi-pattern),
         dur: sg:ioi - 0.1,
         vel: 100)
end
```



Contours in Score-Gen

```
begin
  with pitch-contour = pwl(10, 25, 15, 10,
                           20, 10, 22, 25, 22),
      ioi-pattern = make-heap({0.2 0.3 0.4})
  exec score-gen(save: quote(pwl-score),
        score-dur: 22,
        pitch: truncate(c4 +
                sref(pitch-contour,
                       sg:start) +
                #if(oddp(sg:count), 0, -5)),
         ioi: next(ioi-pattern),
         dur: sg:ioi - 0.1,
         vel: 100)
end
```

Why not zero? → sg:start



Examples (code_12.sal)