第6讲　在 Mathematica 中作图

6－8　播放声音

（本节内容为选修）

Wolfram 系统处理图形和声音的方法是非常类似的．Play创建一个播放声音的对象，函数值给出作为时间函数的声音的振幅，播放指令将数学函数转化为波形的声音，返回一个Sound 对象。Mathematica可以展示任意的函数及数据的波形分析，以及基于音符的音频合成，和艺术级的声音设置。

```
{Plot[Sin[ t], {t, 0, 2}], Play[Sin[2 Pi 440 t], {t, 0, 1}]}
```

```
Speak[Plot让我们看到数学函数的形体美]
```

```
Speak[Play让我们听到函数美妙的歌声]
```

1．Play 以声音的波形形式播放函数

Play[f, {t, tmin, tmax}]	在[tmin, tmax] 秒之间播放振幅函数f
Play[{f1, f2}, {t, tmin, tmax}]	产生立体声音。首先给出左通道
Play[{f1, f2, ..., ...}]	在多通道上产生声音

例1：自定义音符．(试试m = 256 的效果)

```
m = 512;
freq = {1, 2^(2/12), 2^(4/12), 2^(5/12), 2^(7/12), 2^(9/12), 2^(11/12), 2};

f[m_, t_] :=
 Play[{Sin[512 * 2^(m/12) * 2 Pi * x], Sin[509 * 2^(m/12) * 2 Pi * x]}, {x, 0, t}]
Show[{f[0, 0.618], f[2, 0.618], f[4, 0.618], f[5, 0.618], f[7, 0.618], f[9, 0.618]}]
```

例2：中国科学技术大学校歌〝永恒的东风〞（片段）

```
Show[{f[7, 0.309], f[7, 0.618], f[9, 0.309], f[7, 0.4635], f[5, 0.1545],
  f[4, 0.309], f[2, 0.309], f[0, 0.927], f[2, 0.309], f[-5, 0.927],
  f[-5, 0.309], f[-3, 0.618], f[-5, 0.618], f[0, 0.4635],
  f[4, 0.1545], f[7, 0.4635], f[4, 0.1545], f[9, 1.854],
  f[7, 0.927], f[9, 0.309], f[7, 0.618], f[4, 0.309], f[0, 0.309],
  f[2, 0.618], f[4, 0.309], f[7, 0.309], f[2, 0.927],
  f[7, 0.309], f[7, 0.618], f[9, 0.309], f[7, 0.4635], f[5, 0.1545], f[4, 0.309],
  f[2, 0.309], f[0, 0.4635], f[0, 0.1545], f[0, 0.309], f[2, 0.309], f[-5, 1.236]}]
```

2. Sound 播放音符

Sound 播放音符的声音基元和指令，它可以组合不同乐器的音符序列。
像Play一样运行指令后显示包含一个表示该声音的图形和一个按钮。点击按钮播放声音。

Sound[primitives]	表示一个声音
Sound[primitives, t]	指定声音持续 t
Sound[primitives, {tmin, tmax}]	从tmin到tmax 播放声音

3. SoundNote 音符表示

给Sound提供播放的声音的基本音符元素

SoundNote[pitch, t]	音符持续的时间长度为 t
SoundNote[pitch, {tmin, tmax}]	音符持续的时间从tmin到tmax
SoundNote[pitch, tspec, "style", *opts*]	指定乐器播放音符

音符规定

"C", "C♯", "D" 等	中央C八度音阶的的所有音符
"C*m*", "C♯*m*", "D*m*" 等	*m*八度音阶的所有音符 ("C4" 是中央C音)
None	休止 (一次音乐停顿)
"*percussion*"	一次打击

"C+4" 等价于 "C4"；
低音符可以通过 "C-1" 等指定负数用来指定中央 C 音以下的音调.

SoundNote[] 在默认情况下，表示用钢琴风格的中央C音，演奏时间为1秒

例3：产生一个中央 C 音

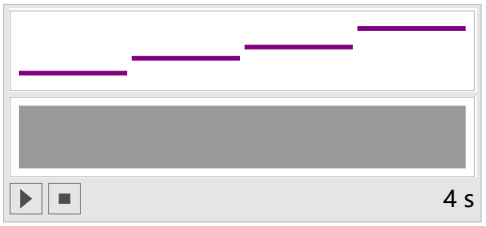
```
Sound[SoundNote[0]]
```

例4：生成一个一秒的小提琴的中央 G 音：

```
Sound[SoundNote["G", 1, "Violin"]]
```

例5：演奏 135 i

```
Sound[{SoundNote["C"], SoundNote["E"], SoundNote["G"], SoundNote["C5"]}]
```




```
Sound[{SoundNote[], SoundNote[4], SoundNote[7], SoundNote[12]}]
```

例6：演奏 《来生缘》 (片段)

```
Sound[{SoundNote[-3, 0.2], SoundNote[4, 0.2], SoundNote[2, 0.2],
  SoundNote[4, 0.2], SoundNote[0, 0.2], SoundNote[-1, 0.2],
```

```
SoundNote[-1, 0.2], SoundNote[-3, 0.2], SoundNote[-3, 0.2],
SoundNote[4, 0.2], SoundNote[2, 0.2], SoundNote[4, 0.2], SoundNote[0, 0.2],
SoundNote[-1, 0.2], SoundNote[-1, 0.2], SoundNote[-3, 0.2],

SoundNote[-3, 0.2], SoundNote[4, 0.2], SoundNote[2, 0.2], SoundNote[4, 0.2],
SoundNote[0, 0.2], SoundNote[-1, 0.2], SoundNote[-1, 0.2], SoundNote[-3, 0.2],
SoundNote[9, 0.2], SoundNote[4, 0.2], SoundNote[2, 0.2], SoundNote[4, 0.2],
SoundNote[0, 0.2], SoundNote[-1, 0.2], SoundNote[4, 0.2], SoundNote[2, 0.2],

SoundNote[4, 2.4], SoundNote[2, 0.2],
SoundNote[0, 0.2], SoundNote[-3, 0.2], SoundNote[-5, 0.2],

SoundNote[-3, 2.75],

SoundNote[-3, 0.8], SoundNote[-3, 0.4],
SoundNote[-1, 0.2], SoundNote[0, 1], (*寻寻觅觅*)

SoundNote[None, 0.25], SoundNote[-3, 0.4], SoundNote[4, 0.2],
SoundNote[2, 0.2], SoundNote[2, 0.2], SoundNote[0, 0.2], SoundNote[2, 0.4],
SoundNote[-3, 0.2], SoundNote[2, 1], (*在无声无息中消失*)

SoundNote[-1, 0.2], SoundNote[-1, 0.2], SoundNote[-1, 0.2],
SoundNote[-1, 0.2], SoundNote[-1, 0.4], SoundNote[-3, 0.4],
SoundNote[-5, 0.0], SoundNote[-5, 0.6], (*总是找不到回忆*)

SoundNote[-5, 0.2], SoundNote[-5, 0.4], SoundNote[-3, 0], SoundNote[-1, 0.4],
SoundNote[0, 0.2], SoundNote[-3, 0.2], SoundNote[-3, 0.2],
SoundNote[-3, 0.2], SoundNote[-3, 0.4], SoundNote[-5, 0.2],
SoundNote[-3, 1], SoundNote[None, 0.3], (*找不到曾被遗忘的真实*)

SoundNote[-3, 0.2], SoundNote[-3, 0.2], SoundNote[-3, 0.2],
SoundNote[-3, 0.2], SoundNote[-3, 0.4], SoundNote[-1, 0.2],
SoundNote[0, 1], SoundNote[None, 0.25], (*一段一段的回忆*)

SoundNote[-3, 0.4], SoundNote[4, 0.2], SoundNote[2, 0.2],
SoundNote[2, 0.2], SoundNote[0, 0.2], SoundNote[2, 0.4],
SoundNote[-3, 0.2], SoundNote[2, 1], (*回忆已经没有意义*)

SoundNote[7, 0.2], SoundNote[7, 0.2], SoundNote[7, 0.2],
SoundNote[7, 0.2], SoundNote[7, 0.4], SoundNote[2, 0.4],
SoundNote[7, 0.2], SoundNote[9, 0.4], SoundNote[7, 0.2], SoundNote[9, 0.4],
SoundNote[7, 0.4], SoundNote[4, 1], SoundNote[None, 0.4],

SoundNote[9, 0.2], SoundNote[9, 0.2], SoundNote[9, 0.2], SoundNote[9, 0.2],
SoundNote[9, 0.4], SoundNote[4, 0.2], SoundNote[9, 1], (*也许分开不容易*)
```

```
SoundNote[None, 0.2], SoundNote[7, 0.4], SoundNote[4, 0.2],
SoundNote[2, 0.2], SoundNote[2, 0.2], SoundNote[2, 0.2],
SoundNote[2, 0.2], SoundNote[2, 0.4], SoundNote[-3, 0.2],
SoundNote[2, 1], SoundNote[None, 0.6], (*也许相亲相爱不可以*)

SoundNote[7, 0.2], SoundNote[7, 0.2], SoundNote[7, 0.2],
SoundNote[7, 0.2], SoundNote[7, 0.4], SoundNote[2, 0.4],
SoundNote[7, 0.2], SoundNote[9, 0.4], SoundNote[7, 0.2], SoundNote[9, 0.4],
SoundNote[7, 0.4], SoundNote[4, 1], SoundNote[None, 0.4],

SoundNote[4, 0.2], SoundNote[4, 0.2], SoundNote[4, 0.2],
SoundNote[4, 0.2], SoundNote[4, 0.4], SoundNote[2, 0.4], SoundNote[4, 0.2],
SoundNote[2, 0.2], SoundNote[0, 0.8], (*情深缘浅不得已*)

SoundNote[None, 0.2], SoundNote[-3, 0.4], SoundNote[4, 0.2],
SoundNote[2, 0.2], SoundNote[2, 0.2], SoundNote[2, 0.2], SoundNote[2, 0.4],
SoundNote[-3, 0.2], SoundNote[2, 1](*你我也知道去珍惜*)}]
```

4 . Speak 语音

Speak["string"] 播放 "string" 中的文本的语音表示

Button["按钮名", Speak["string"]] 设置播放按钮，单击按钮播放string

SpokenString[expr] 给出表达式expr 语音表示的文本字符串

例7：朗读中英文.

```
Speak[InterpolatingPolynomial]
```

Speak[SpokenString给出表达式语音表示的文本字符串]

例8：朗读数学表达式.

```
Speak[1 + x^3 + Cos[x]]
```

```
SpokenString[1 + x^3 + Cos[x]]
```

```
1 plus x cubed plus cosine of x
```

例9：制作语音按钮.

```
Button["press", Speak["Good morning"]]
```

```
BarChart3D[{1, Button[2, Speak[2]], 3}]
```