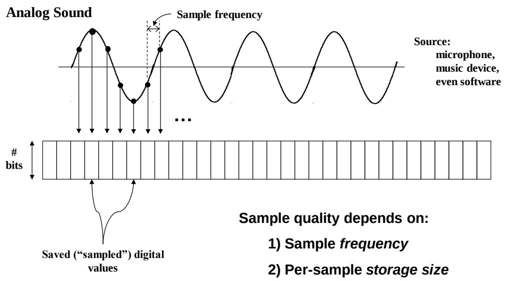
CSc 165
Computer Game Architecture

15 - Sound

Overview

- Sound Characteristics & File Formats (CSc 133)
- Sound APIs
- 3D Sound
- OpenAL and JOAL
- Audio support in RAGE

Sampled Audio (from CSc-133)



Sample quality depends on:

1) Sample *frequency*

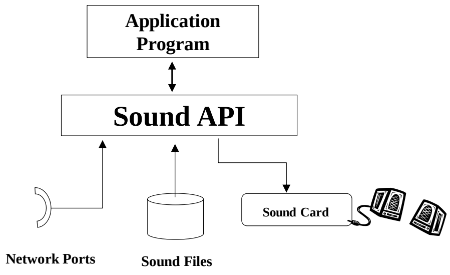
2) Per-sample *storage size (bits per sample)*

Sound File Formats

`.au`	Sun Audio File (Unix/Linux)
`.aiff`	Audio Interchange File Format (Mac)
`.cda`	CD Digital Audio (track information)
`.mpx`	MPEG Audio (mp, mp2, mp3, mp4)
`.mid`	MIDI file (sequenced, not sampled)
`.ogg`	Ogg-Vorbis file (open source)
`.ra`	Real Audio (designed for streaming)
`.wav`	Windows "wave file"

Finding sound files: `www.findsounds.com`

Sound APIs



Popular Sound API's

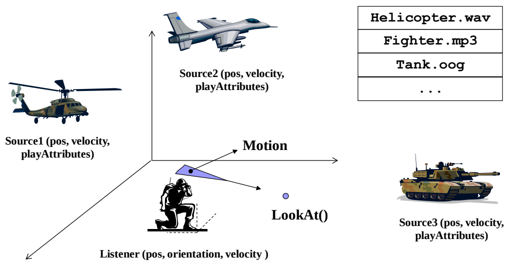
2D Sound

- Java **`AudioClip`**
- JavaSound

3D Sound

- DirectSound / DirectSound3D
- Linux Open Sound System (OSS)
- Advanced Linux Sound Architecture (ALSA)
- OpenAL / JOAL

3D Sound


Helicopter.wav
Fighter.mp3
Tank.oog
. . .
Source2 (pos, velocity, playAttributes)
Source1 (pos, velocity, playAttributes)
Motion
LookAt()
Source3 (pos, velocity, playAttributes)
Listener (pos, orientation, velocity)

directional, distance attenuation, doppler shift, etc….

Doppler Effect

Change in frequency due to relative motion between Source and Listener

- Approaching Source == compressed waves
  == higher frequency
- Receding Source == expanded waves
  == lower frequency

openAL

- "Open Audio Library" 3D Audio API
  `https://openal.org`
- Open-source (although one version is proprietary)
- Cross-platform
- Modeled after OpenGL
- Updated fork: "OpenAL Soft"
  (also open source project)

OpenAL Platform Support

- Macintosh (OS 8/9/X)
- Linux (OSS & ALSA)
- BSD
- Solaris
- IRIX
- Android
- iOS

- Windows
- Sony PlayStation 2, 3, Portable
- Microsoft Xbox & 360
- Nintendo GameCube
- Wii

…and many others!

JOAL

The Java OpenAL Binding

- a "sibling" of JOGL
- part of the Sun Java Gaming Initiative

Works much like JOGL

- Java wrappers around OpenAL components
- method calls mimic C calls
- uses OpenAL Soft

`http://jogamp.org`

Main OpenAL Components

Sources

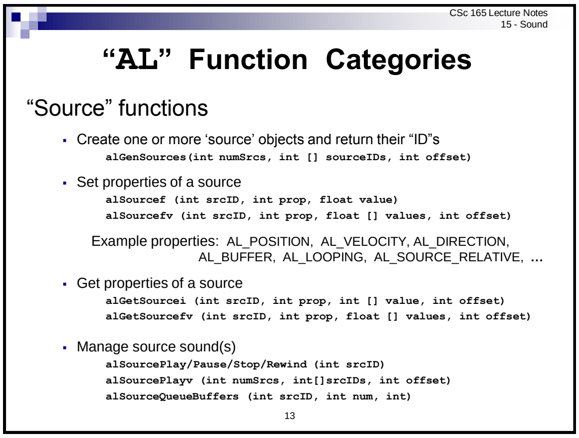
- A source of sound generation in the world
- Attributes include position, orientation, velocity…

Listeners

- An entity that *hears* sound(s)
- One (per context), usually attached to the *Player*
- Also has attributes for location and orientation

Buffers

- Attached to *sources*
- Hold *audio data* (e.g. sound files)
- "Play" their contents



“AL” Function Categories

“Source” functions

- Create one or more ‘source’ objects and return their “ID”s

```
alGenSources(int numSrcs, int [] sourceIDs, int offset)
```

- Set properties of a source

```
alSourcef (int srcID, int prop, float value)
alSourcefv (int srcID, int prop, float [] values, int offset)
```

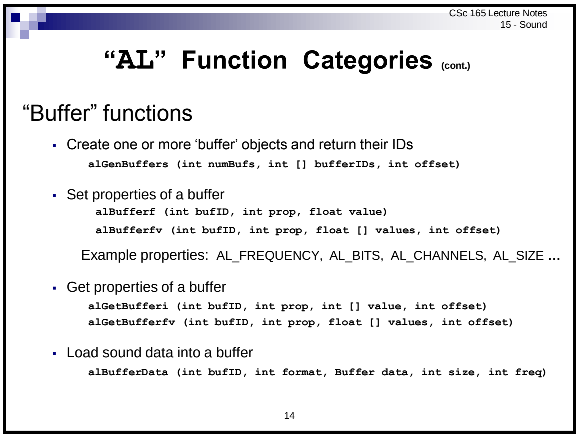
Example properties: AL_POSITION, AL_VELOCITY, AL_DIRECTION, AL_BUFFER, AL_LOOPING, AL_SOURCE_RELATIVE, …

- Get properties of a source

```
alGetSourcei (int srcID, int prop, int [] value, int offset)
alGetSourcefv (int srcID, int prop, float [] values, int offset)
```

- Manage source sound(s)

```
alSourcePlay/Pause/Stop/Rewind (int srcID)
alSourcePlayv (int numSrcs, int[]srcIDs, int offset)
alSourceQueueBuffers (int srcID, int num, int)
```



“AL” Function Categories (cont.)

“Buffer” functions

- Create one or more ‘buffer’ objects and return their IDs

```
alGenBuffers (int numBufs, int [] bufferIDs, int offset)
```

- Set properties of a buffer

```
alBufferf (int bufID, int prop, float value)
alBufferfv (int bufID, int prop, float [] values, int offset)
```

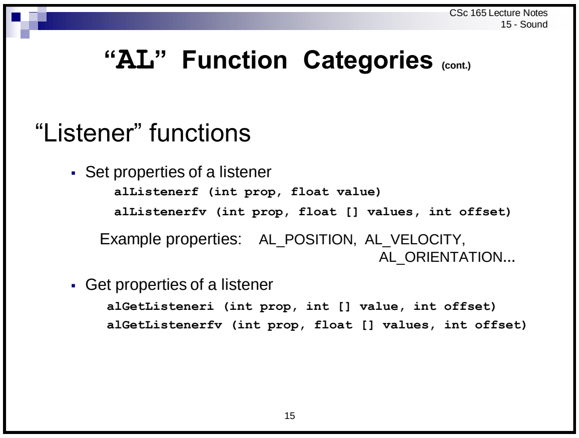
Example properties: AL_FREQUENCY, AL_BITS, AL_CHANNELS, AL_SIZE …

- Get properties of a buffer

```
alGetBufferi (int bufID, int prop, int [] value, int offset)
alGetBufferfv (int bufID, int prop, float [] values, int offset)
```

- Load sound data into a buffer

```
alBufferData (int bufID, int format, Buffer data, int size, int freq)
```



“AL” Function Categories (cont.)

“Listener” functions

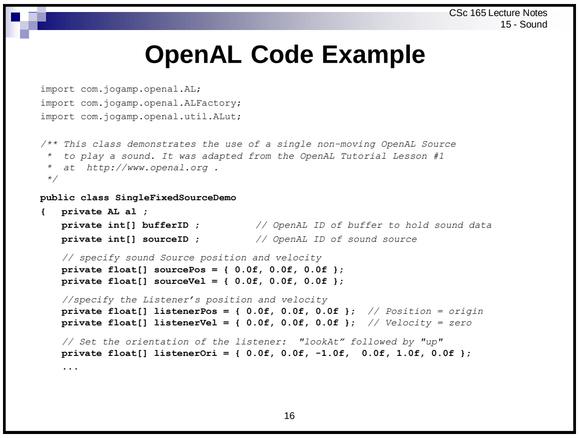
- Set properties of a listener

```
alListenerf (int prop, float value)
alListenerfv (int prop, float [] values, int offset)
```

Example properties: AL_POSITION, AL_VELOCITY, AL_ORIENTATION…

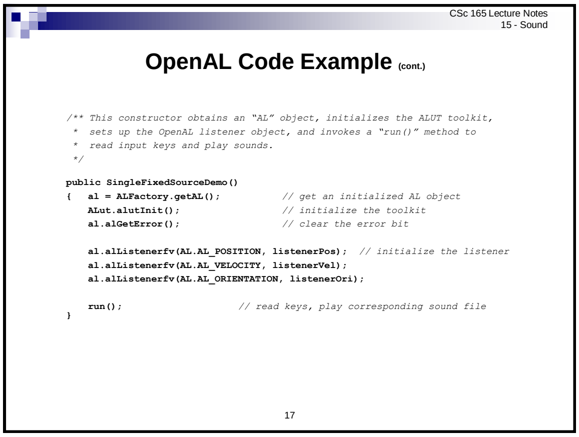
- Get properties of a listener

```
alGetListeneri (int prop, int [] value, int offset)
alGetListenerfv (int prop, float [] values, int offset)
```



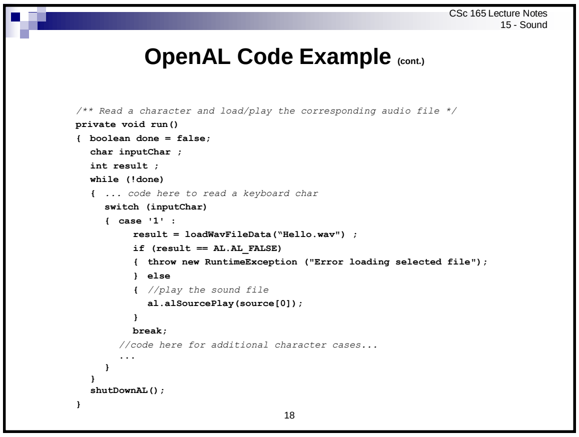
OpenAL Code Example

```
import com.jogamp.openal.AL;
import com.jogamp.openal.ALFactory;
import com.jogamp.openal.util.ALut;

/** This class demonstrates the use of a single non-moving OpenAL Source
 *  to play a sound. It was adapted from the OpenAL Tutorial Lesson #1
 *  at  http://www.openal.org .
 */

public class SingleFixedSourceDemo
{   private AL al ;
    private int[] bufferID ;          // OpenAL ID of buffer to hold sound data
    private int[] sourceID ;          // OpenAL ID of sound source

    // specify sound Source position and velocity
    private float[] sourcePos = { 0.0f, 0.0f, 0.0f };
    private float[] sourceVel = { 0.0f, 0.0f, 0.0f };

    //specify the Listener’s position and velocity
    private float[] listenerPos = { 0.0f, 0.0f, 0.0f };  // Position = origin
    private float[] listenerVel = { 0.0f, 0.0f, 0.0f };  // Velocity = zero

    // Set the orientation of the listener:  "lookAt” followed by "up"
    private float[] listenerOri = { 0.0f, 0.0f, -1.0f,  0.0f, 1.0f, 0.0f };
    ...
```



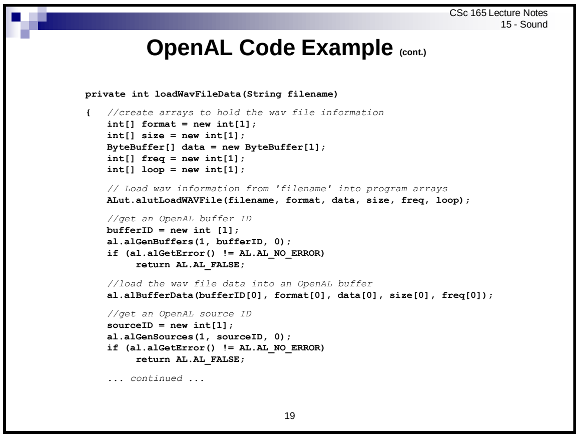
OpenAL Code Example (cont.)

```
/** This constructor obtains an “AL” object, initializes the ALUT toolkit,
 *  sets up the OpenAL listener object, and invokes a “run()” method to
 *  read input keys and play sounds.
 */

public SingleFixedSourceDemo()
{   al = ALFactory.getAL();           // get an initialized AL object
    ALut.alutInit();                  // initialize the toolkit
    al.alGetError();                  // clear the error bit

    al.alListenerfv(AL.AL_POSITION, listenerPos);  // initialize the listener
    al.alListenerfv(AL.AL_VELOCITY, listenerVel);
    al.alListenerfv(AL.AL_ORIENTATION, listenerOri);

    run();                      // read keys, play corresponding sound file
}
```



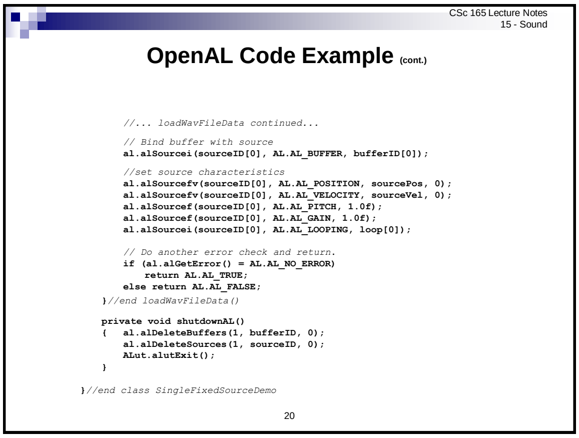
OpenAL Code Example (cont.)

```
/** Read a character and load/play the corresponding audio file */
private void run()
{  boolean done = false;
   char inputChar ;
   int result ;
   while (!done)
   {  ... code here to read a keyboard char
      switch (inputChar)
      {  case '1' :
            result = loadWavFileData(“Hello.wav") ;
            if (result == AL.AL_FALSE)
            {  throw new RuntimeException ("Error loading selected file");
            }  else
            {  //play the sound file
               al.alSourcePlay(source[0]);
            }
            break;
         //code here for additional character cases...
         ...
      }
   }
   shutDownAL();
}
```



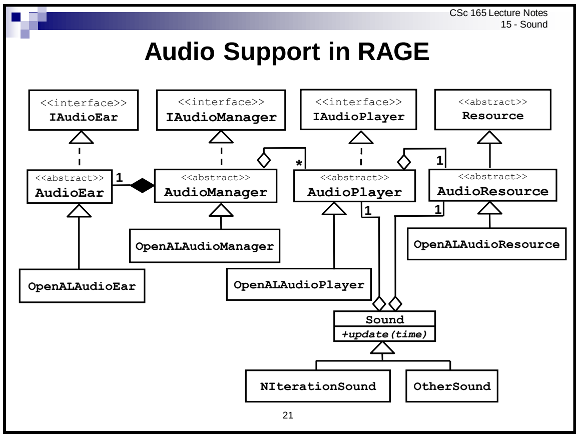
OpenAL Code Example (cont.)

```
private int loadWavFileData(String filename)
{   //create arrays to hold the wav file information
    int[] format = new int[1];
    int[] size = new int[1];
    ByteBuffer[] data = new ByteBuffer[1];
    int[] freq = new int[1];
    int[] loop = new int[1];

    // Load wav information from 'filename' into program arrays
    ALut.alutLoadWAVFile(filename, format, data, size, freq, loop);

    //get an OpenAL buffer ID
    bufferID = new int [1];
    al.alGenBuffers(1, bufferID, 0);
    if (al.alGetError() != AL.AL_NO_ERROR)
         return AL.AL_FALSE;

    //load the wav file data into an OpenAL buffer
    al.alBufferData(bufferID[0], format[0], data[0], size[0], freq[0]);

    //get an OpenAL source ID
    sourceID = new int[1];
    al.alGenSources(1, sourceID, 0);
    if (al.alGetError() != AL.AL_NO_ERROR)
         return AL.AL_FALSE;

    ... continued ...
```

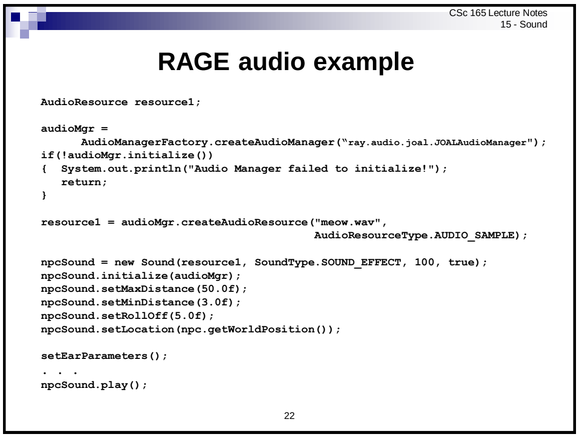


OpenAL Code Example (cont.)

```
        //... loadWavFileData continued...

        // Bind buffer with source
        al.alSourcei(sourceID[0], AL.AL_BUFFER, bufferID[0]);

        //set source characteristics
        al.alSourcefv(sourceID[0], AL.AL_POSITION, sourcePos, 0);
        al.alSourcefv(sourceID[0], AL.AL_VELOCITY, sourceVel, 0);
        al.alSourcef(sourceID[0], AL.AL_PITCH, 1.0f);
        al.alSourcef(sourceID[0], AL.AL_GAIN, 1.0f);
        al.alSourcei(sourceID[0], AL.AL_LOOPING, loop[0]);

        // Do another error check and return.
        if (al.alGetError() = AL.AL_NO_ERROR)
           return AL.AL_TRUE;
        else return AL.AL_FALSE;
    }//end loadWavFileData()

    private void shutdownAL()
    {   al.alDeleteBuffers(1, bufferID, 0);
        al.alDeleteSources(1, sourceID, 0);
        ALut.alutExit();
    }

}//end class SingleFixedSourceDemo
```

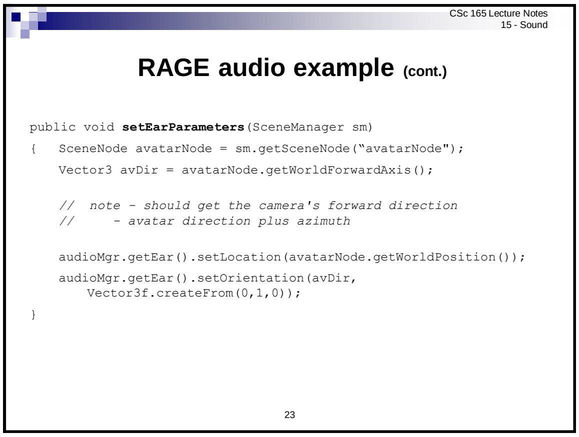


Audio Support in RAGE



RAGE audio example

```
AudioResource resource1;

audioMgr =
      AudioManagerFactory.createAudioManager(“ray.audio.joal.JOALAudioManager");
if(!audioMgr.initialize())
{   System.out.println("Audio Manager failed to initialize!");
    return;
}

resource1 = audioMgr.createAudioResource("meow.wav",
                                         AudioResourceType.AUDIO_SAMPLE);

npcSound = new Sound(resource1, SoundType.SOUND_EFFECT, 100, true);
npcSound.initialize(audioMgr);
npcSound.setMaxDistance(50.0f);
npcSound.setMinDistance(3.0f);
npcSound.setRollOff(5.0f);
npcSound.setLocation(npc.getWorldPosition());

setEarParameters();
.  .  .
npcSound.play();
```



RAGE audio example (cont.)

```
public void setEarParameters(SceneManager sm)
{   SceneNode avatarNode = sm.getSceneNode(“avatarNode");
    Vector3 avDir = avatarNode.getWorldForwardAxis();

    //  note - should get the camera's forward direction
    //     - avatar direction plus azimuth

    audioMgr.getEar().setLocation(avatarNode.getWorldPosition());
    audioMgr.getEar().setOrientation(avDir,
        Vector3f.createFrom(0,1,0));
}
```