the gamedesigninitiative at cornell university

Lecture 11

Data-Focused Design

Take-Away for Today

- What is “data-focused” design?
  - How do the programmers use it?
  - How to the designers/artists/musicians use it?
- What are the benefits of data-focused design?
  - To both the developer and the player
- What is a level editor and how does it work?
  - What can you do graphically?
  - How does scripting work in a level editor?

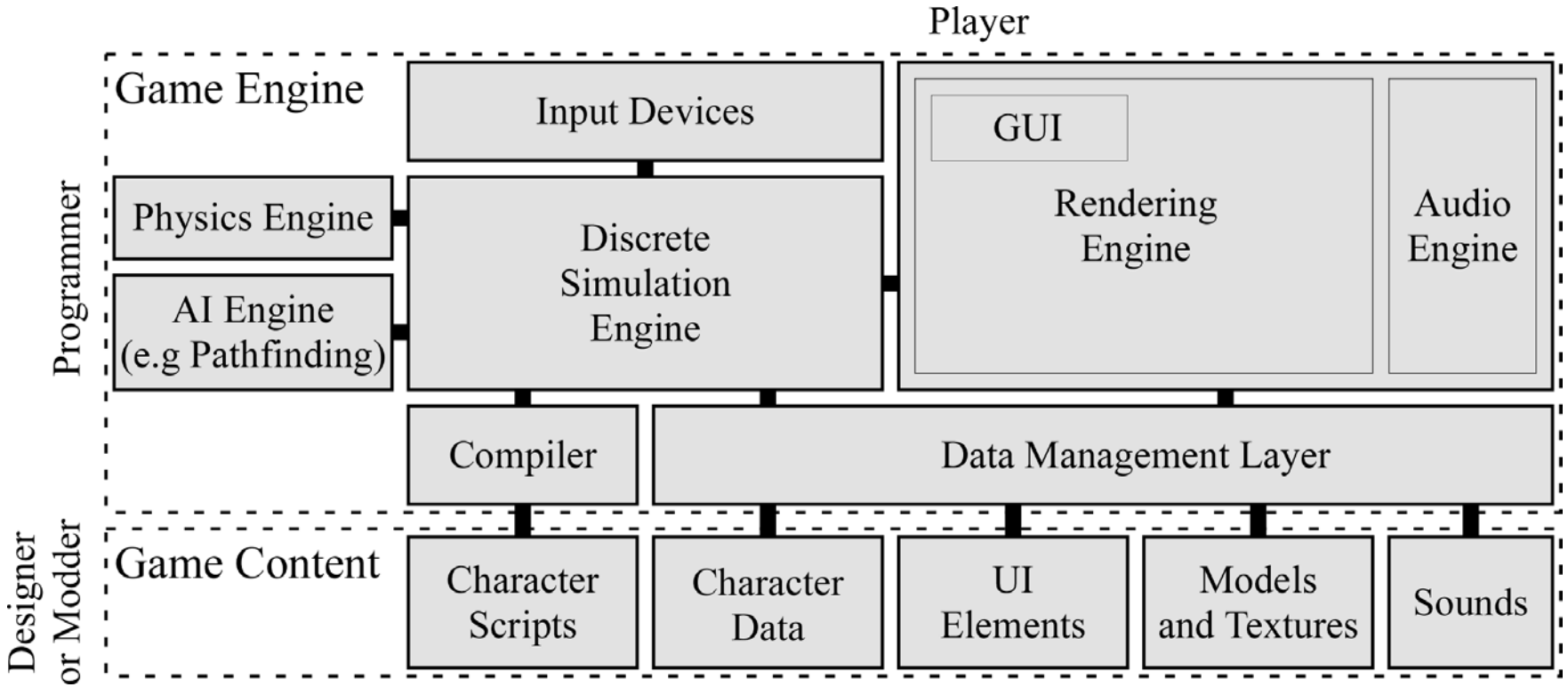
Recall: Game Components

- **Game Engine**
  - Software, created primarily by programmers
- **Rules and Mechanics**
  - Created by the designers, with programmer input
- **User Interface**
  - Coordinated with programmer/artist/HCI specialist
- **Content and Challenges**
  - Created primarily by designers

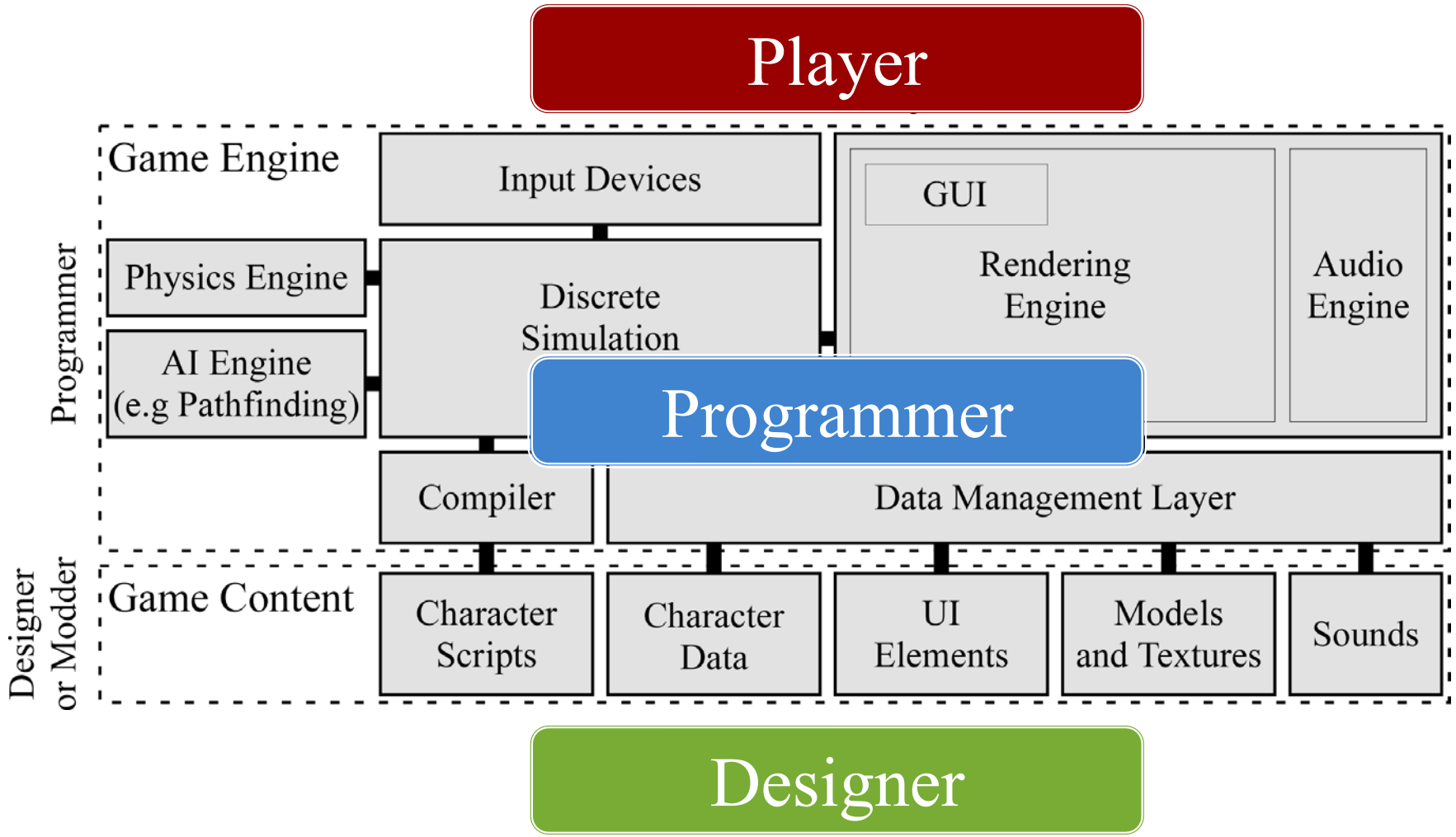
Data-Focused Design

- **No code outside engine**
  - Engine determines space of possibilities
  - Actual possibilities are data/scripts
- **Examples**:
  - Art and music in industry-standard file formats
  - Object data in JSON or other data file formats
  - User interface in JSON or other data files
  - Character behavior specified through scripts

Architecture: The Big Picture



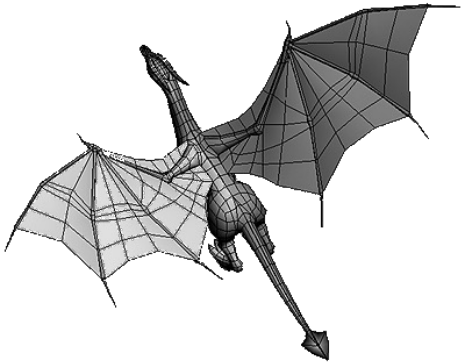
Architecture: The Big Picture

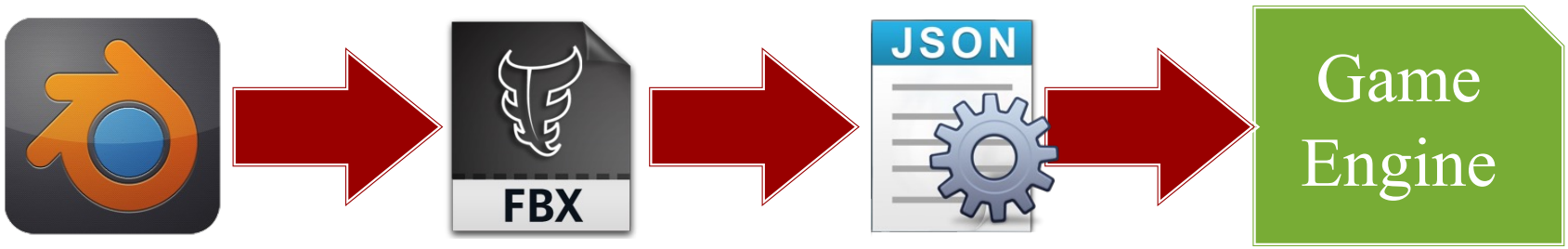


Common Development Cycle

- Start with small number of programmers
- Programmers create a content pipeline
  - Productivity tools for artists and designers
  - Data can be imported, viewed and playtested
- Hire to increase number of artists, designers
  - **Focus**: creating content for the game
- Ship title and repeat (e.g. cut back on artists)

Content Pipeline

Art Tools	Initial File Format	Final File Format	Software
	AUTODESK **FBX**	**G3DJ**	libGDX



Content Creation Tools

- **Level Editor**
  - Create challenges and obstacles
  - Layout the user interface
  - Tune parameters (physics, difficulty, etc.)
- **Scripting Tools**
  - Layout the user interface
  - Define character behavior
  - Script triggers and events

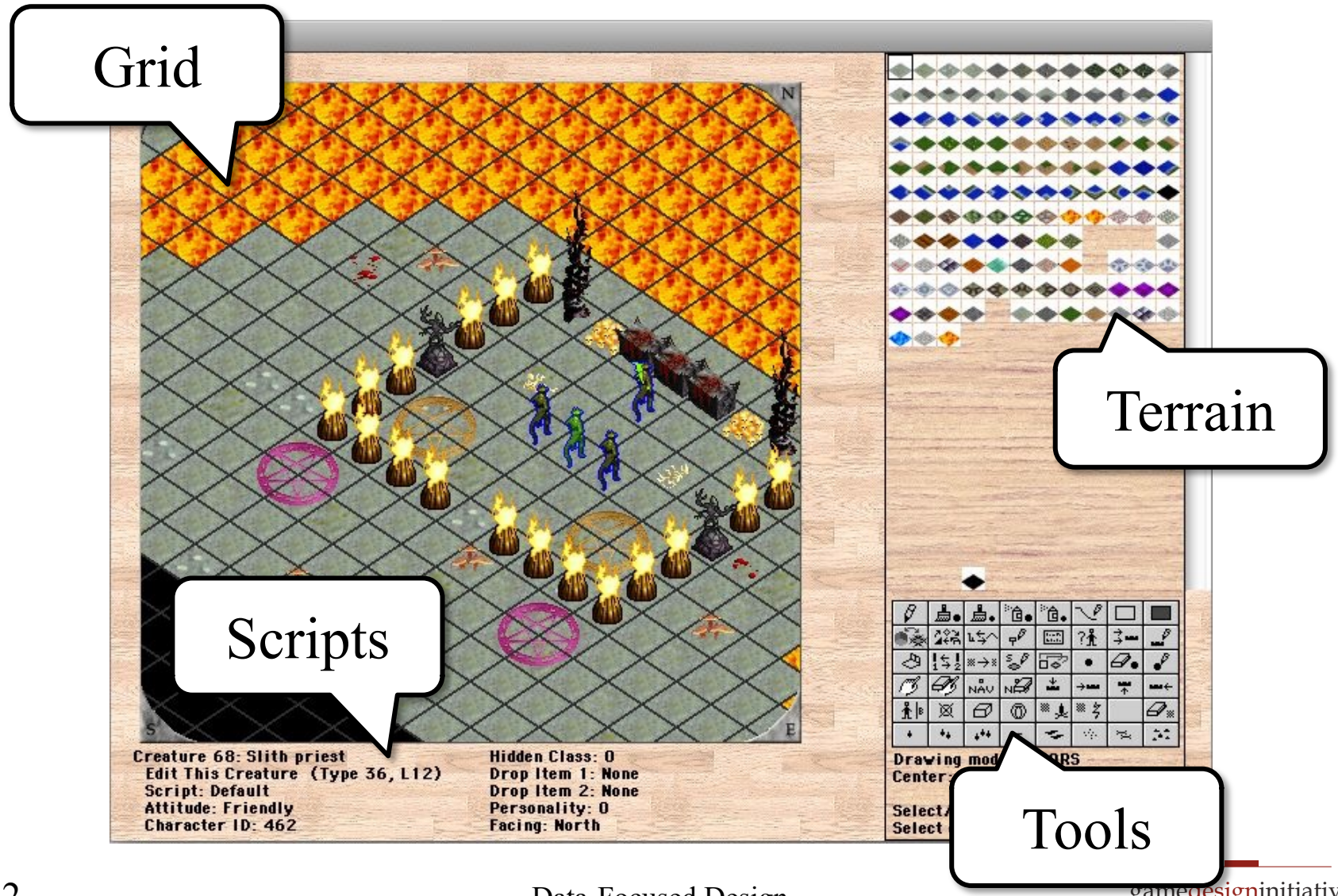
Level Editor Features

- **Create Terrain**
  - Defines game geometry as 2D or 3D space
  - Terrain can be **free-form** or as **grid tiles**
- **Place Objects**
  - Includes NPCs, hazards, power-ups, etc.
  - Again can be free-form or aligned to a grid
- **Annotate Objects/Terrain**
  - Attach scripts to interactive objects
  - Define boundaries for event triggers

Example: *Blades of Avernum*

Bahssikava
by Tom Watts

Example: *Blades of Avernum*



Level Editor: **Code Sharing**

- **Option**: level editor in **same project**
  - Single IntelliJ project for both
  - **Pro**: Easy to integrate into the game itself
  - **Con**: Harder to separate modules/subsystems
- **Option**: develop **core technology**
  - Identify source code used by each
  - JAR for both level editor and game
  - **Pro**: Cleaner separation of subsystems
  - **Con**: Harder to iterate the design

Level Editor: **Serialization**

Stores:
Game Model

Level
File

Level Editor: **Serialization**

- Do not **duplicate** data
  - Art and music are separate files
  - Just reference by the file name

- Must **version** your file
  - As game changes, format may change
  - Version identifies the current file format
  - Want a conversion utility between versions
  - Version should be part of **file header**

Standard Serialization Formats

XML

```
<NPC>
   <type>Orc</type>
   <health>200</health>
   <position>
      <x>50</x>
      <y>25</y>
    </position>
</NPC>
```

JSON

```
{
   "NPC" : {
      "type" : "Orc",
      "health" : 200,
      "position" : {
         "x" : 50,
         "y" : 25
}}}
```

Standard Serialization Formats

XML

```
<NPC>
   <type>Orc</type>
   <health>200</health>
   <po
      <x
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</NPC>
```

XmlReader

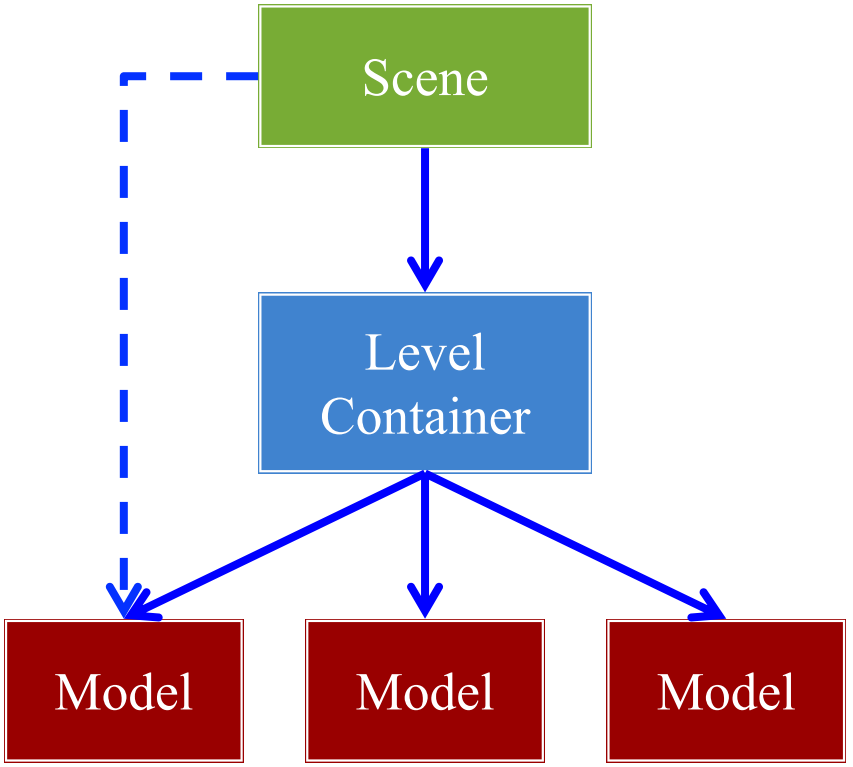
JSON

```
{
   "NPC" : {
      "type" : "Orc",
      "
      "po
         "x" : 50,
         "y" : 25
}}}
```

JsonReader

Levels and Game Architecture

- Level container (**model**)
  - Collection of model objects
  - Interface to the controllers
  - Similar to a collection type
  - May have other methods
- Level parser (**controller**)
  - Performs (de)serialization
  - Collabs with *all* models
  - Typically a factory pattern
  - Can embed *some* in model



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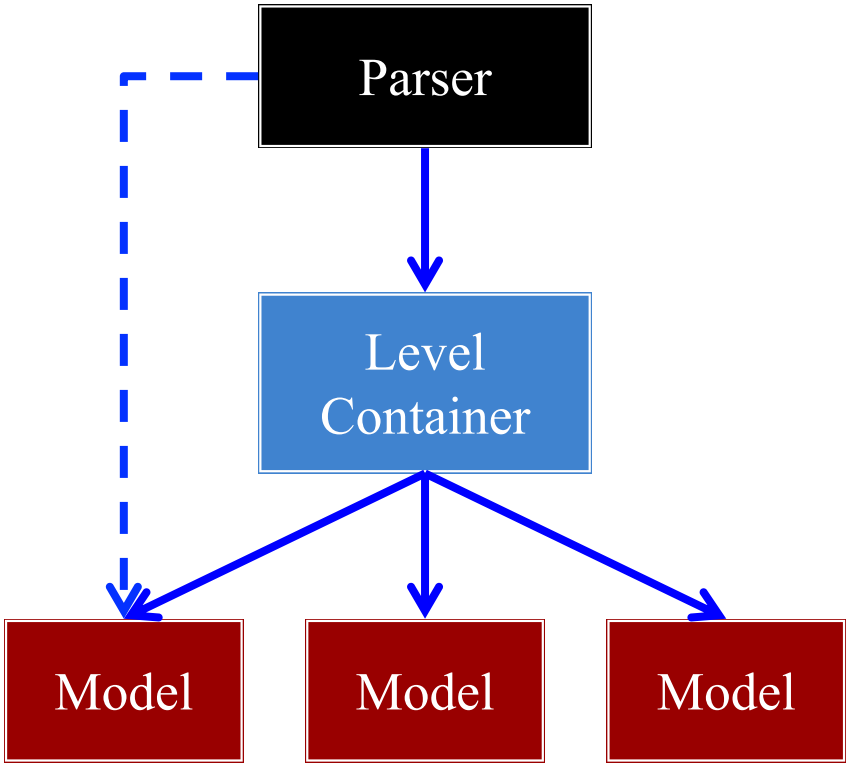


In-Model Deserialization

Unacceptable

```
class Model {

  ...

  void loadFile(String name) {...}

  ...

  void loadFile(File file) {...}

  ...

}
```

Acceptable

```
class Model {

  ...

  void loadData(JSON data) {...}

  ...

  void loadData(XML data) {...}

  ...

}
```

In-Model Deserialization

Unacceptable

```
class Model {
   ...
   void loadFile(String name) {...}
   ...
   void loadFile(File file) {...}
   ...
}
```

I/O handled in model

Acceptable

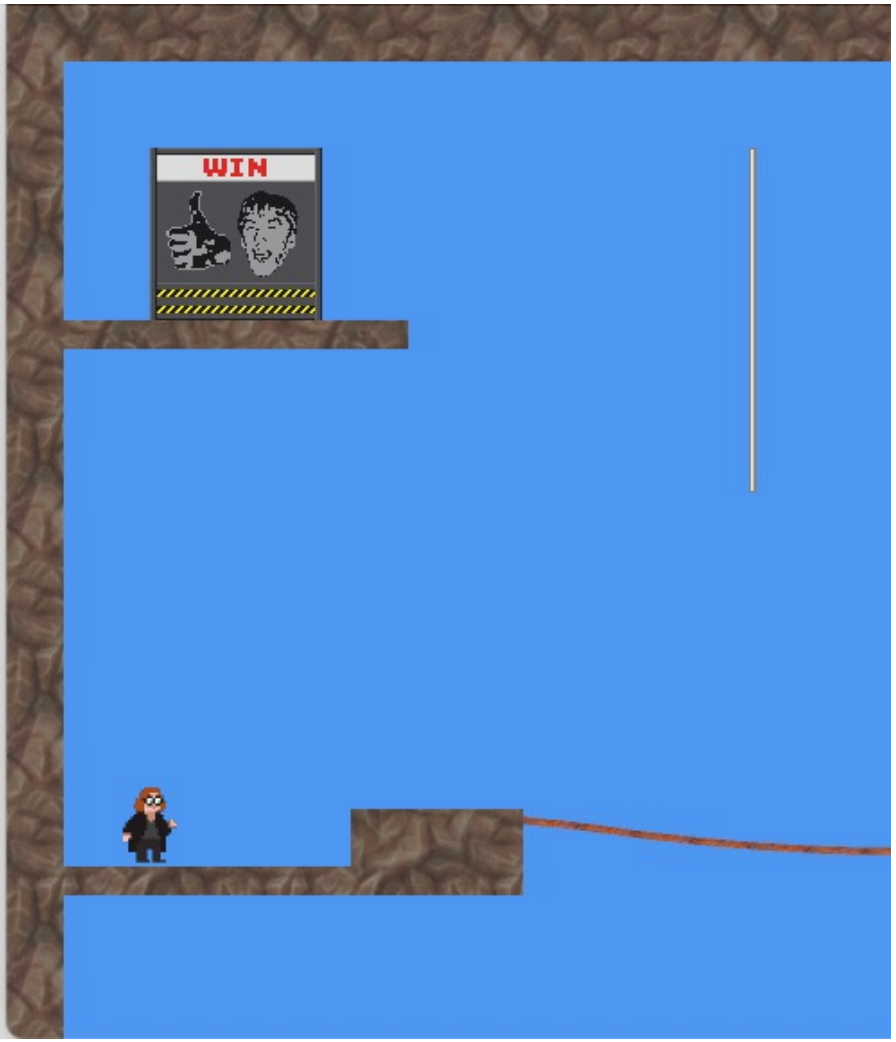
```
class Model {
   ...
   void loadData(JSON data) {...}
   ...
   void loadData(XML data) {...}
```

I/O handled previously

I/O Code is **brittle** and **platform-specific**

Example: Programming Lab 4

```
7     "goal" : {
8         "pos"        : [4.0, 14.0],
9         "size"       : 3.0,
10        "density"    : 0.0,
11        "friction"   : 0.0,
12        "restitution": 0.0
13    },
14    "traci" : {
15        "pos"        : [2.5, 5.0],
16        "inner"      : [0.7, 0.95],
17        "size"       : 1.5,
18        "force"      : 20.0,
19        "damping"    : 10.0,
20        "density"    : 0.5,
21        "friction"   : 0.0,
22        "maxspeed"   : 5.0,
23        "jump_force": 5.5,
24        "jump_cool" : 30,
25        "shot_cool" : 40,
26        "sensor": {
27            "shrink" : 0.6,
28            "height" : 0.05
29        },
30        "debug" : {
31            "avatar" : "#ffff00ff",
32            "sensor" : "#ff0000ff",
```



I/O is Brittle and Platform Specific

- Not all platforms **specify files** in the same way
  - Windows uses \ for directories, not /
  - Only Windows maps drives to letters
  - macOS is not *case sensitive* but .jar files are
- Not all platforms allow you to **read/write files**
  - macOS restricts access to Desktop/Documents
  - Application must get *permission* first
- Some platforms have **no file system** at all!
  - iOS and Android only have *application data*
  - But no concept of folders or directories

LibGDX Has Three File Types

- **Internal**: Read-Only
  - Location where the assets are stored
  - Could be inside of a .jar file!
- **Local**: Read-Write
  - Folder where application/.jar is located
  - Often do not have write permission
- **External**: Read-Write
  - Often the user's home directory
  - Usually have write permission

LibGDX Has Three File Types

- **Internal**: Read-Only
  - Assets
  - ssets are stored
  - .jar file!
- **Local**: Read-Write
  - Do Not Use
  - tion/.jar is located
  - ite permission
- **External**: Read-Write
  - Saved Games
  - e directory
  - ermission

LibGDX Has Three File Types

- **Internal**: Read-Only
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  - Often the user's home directory
  - Usually have write permission

Use GDIAC class SandboxFileHandler for yor save directory

Levels and Error Detection

- Game data is **not compiled** into software
  - Files go into a well-define folder
  - Game loads everything in folder at start-up
  - Adding new files to folder adds levels
- But this requires **robustness**
  - What if the levels are missing?
  - What if the levels are corrupted?
  - What if you are using wrong file version?

Levels and Error Detection

- **Corruption** a major problem in this design
  - Player might trash a level file (or directory)
  - Modder might alter level improperly
  - Content patch might have failed
- Process all errors **gracefully**
  - Check everything at load time
  - If level corrupt, allow play in others
  - Give helpful error messages

Content Creation Tools

- **Level Editor**
  - Create challenges and obstacles
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- **Scripting Tools**
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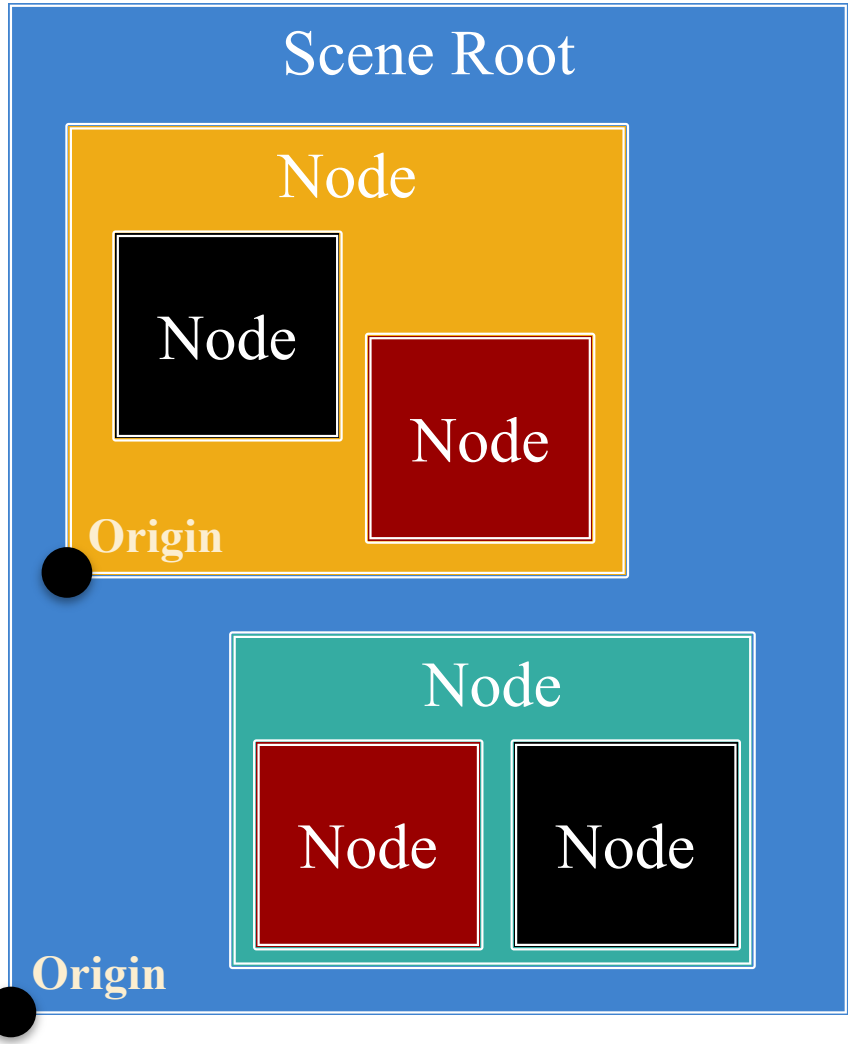
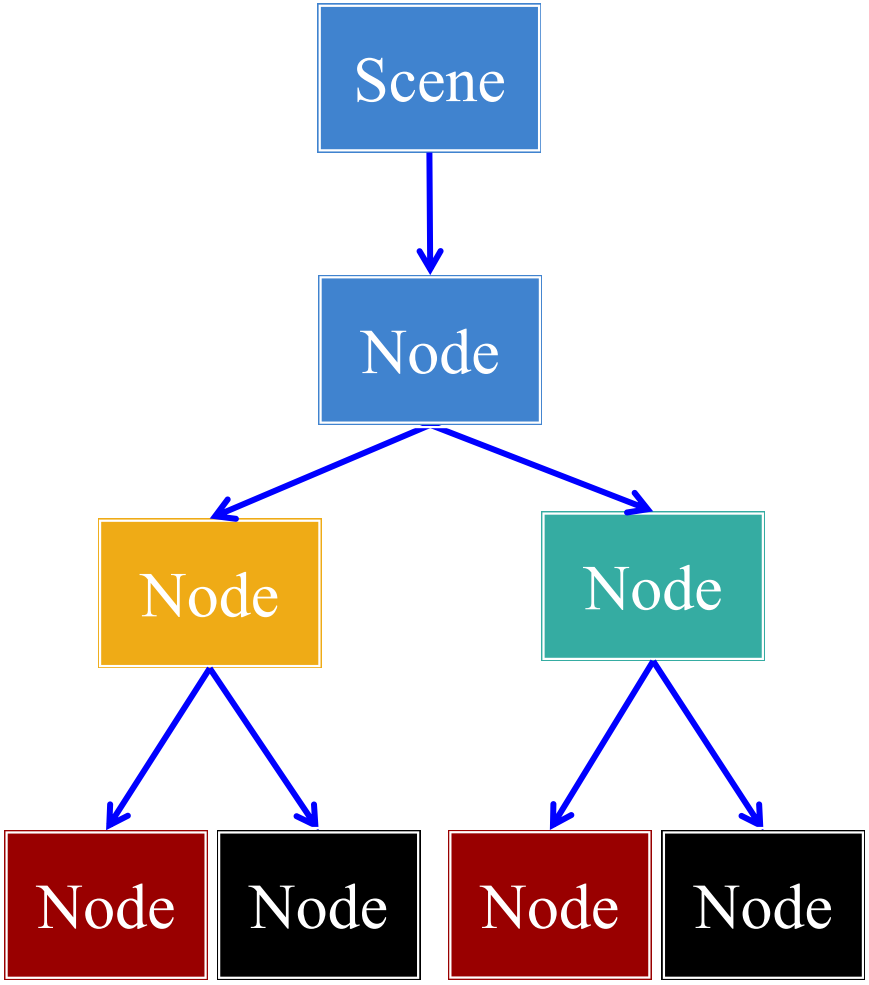
UI Design: Scene Graphs





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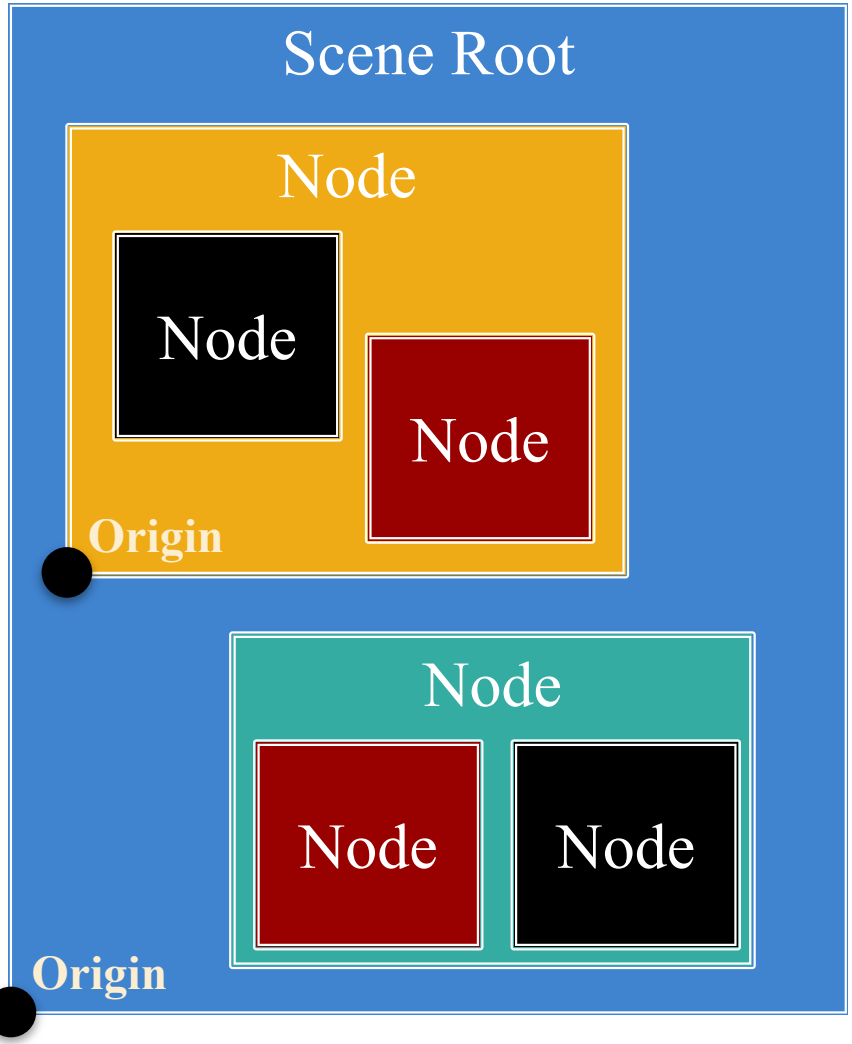
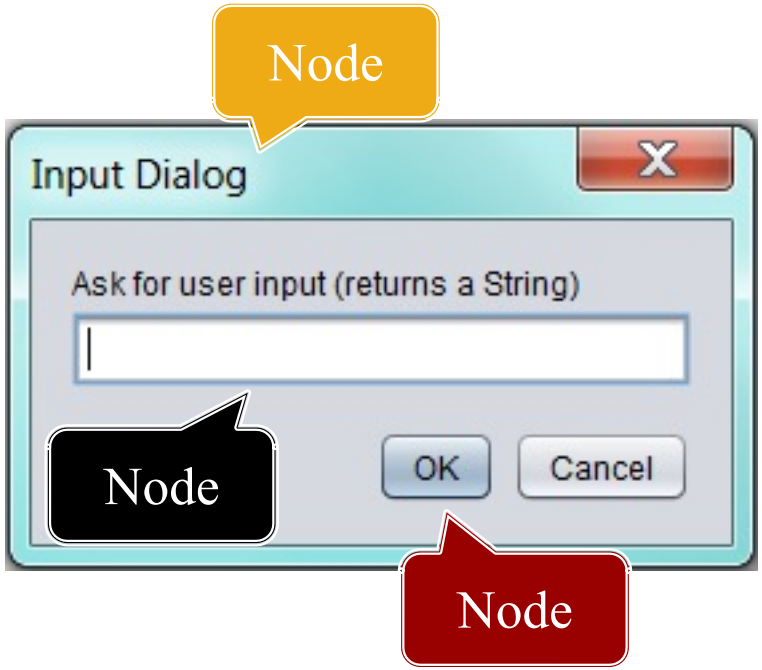
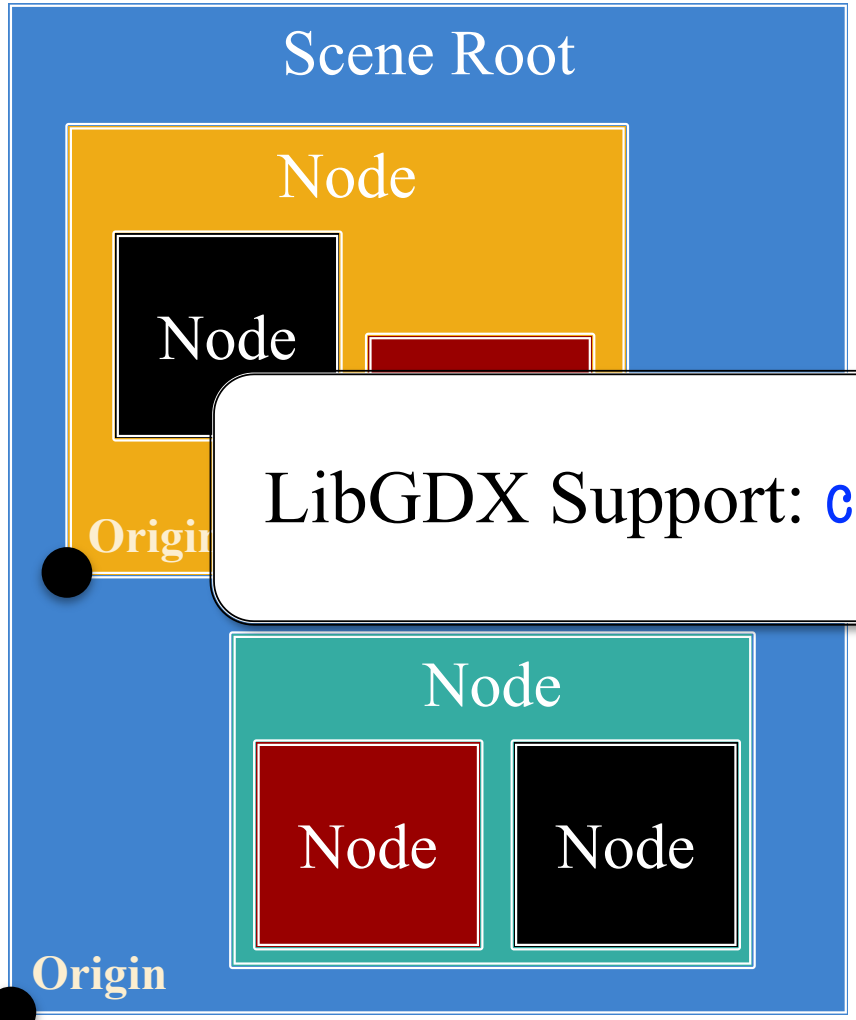


- Node is a coordinate system
  - Logically a "window"
  - Children move with parent
- Hierarchically build widgets



UI Design: Scene Graphs



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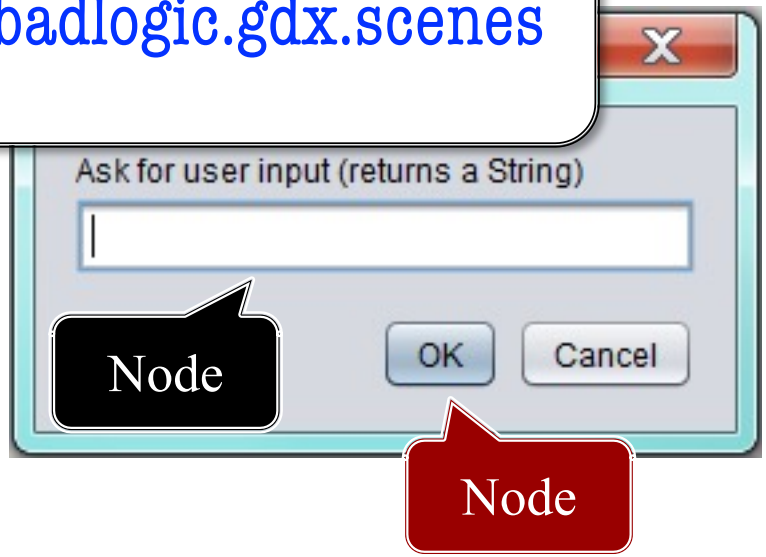
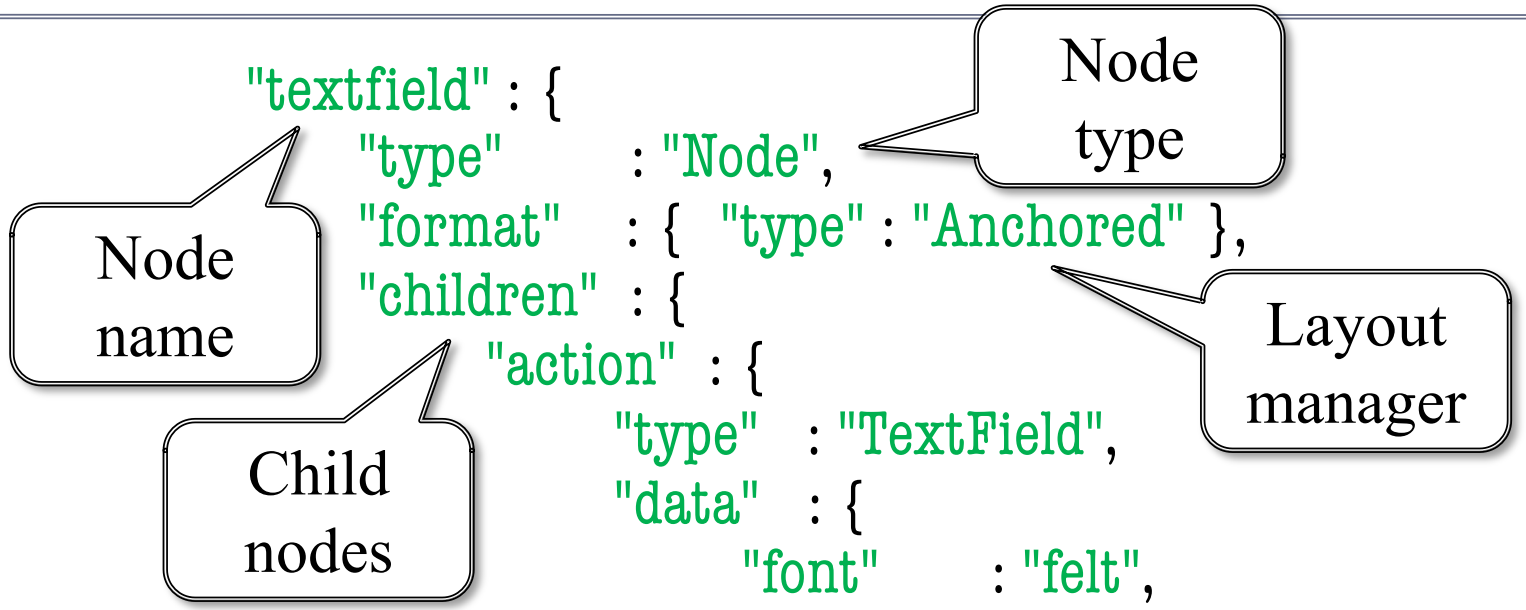
LibGDX Support: com.badlogic.gdx.scenes



CUGL: JSON for Scene Graphs



CUGL: JSON for Scene Graphs

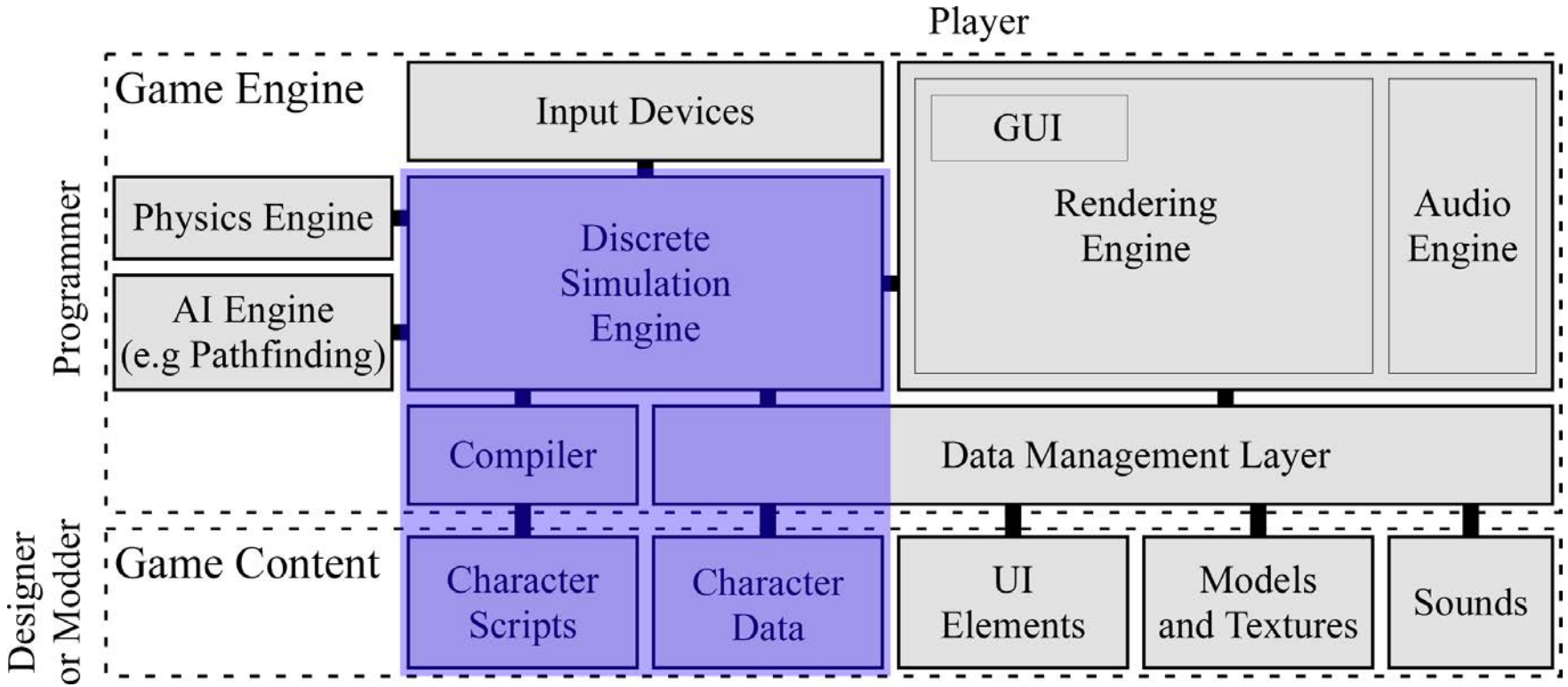
```
"textfield" : {
    "type"      : "Node",
    "format"    : { "type" : "Anchored" },
    "children"  : {
        "action" : {
            "type"   : "TextField",
            "data"   : {
                "font"      : "felt",
                "text"      : "Edit me",
                "size"      : [600,80],
                "anchor"    : [0.5,0.5]
            },
            "layout" : {
                "x_anchor" : "center",
                "y_anchor" : "top"
            }
```

Layout manager

Node data

Info for parent layout

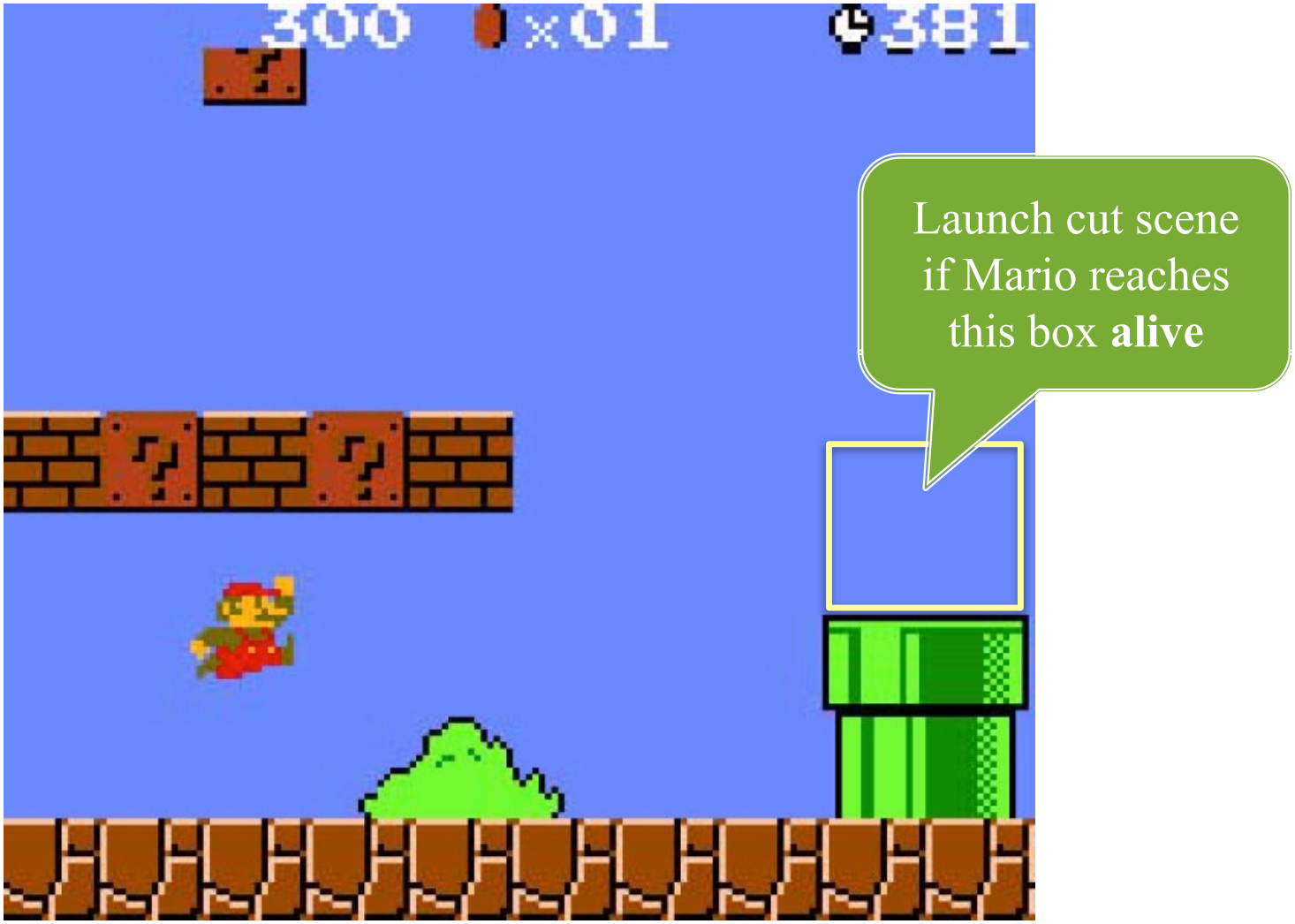
Scripting Languages



Why Scripting?

- **Character AI**
  - Software only aware of high level actions
  - Specific version of each action is in a script
- **Triggers**
  - Actions happen in response to certain events
  - Think of as an `if-then` statement
    - **`if`**: check if trigger should fire
    - **`then`**: what to do if trigger fires

Triggers and Spatial Boundaries



Ways of Scripting

- Static **functions/constants** exposed in editor
  - Script is just the name of function to call
  - Used in the sample level editor
  - Typically good enough for this course
- Use standard **scripting language**
  - **Examples**: Lua, stackless python
  - A lot of overhead for this class
  - Only if writing high performance in C/C++

Scripting in *Dawn of War 2*

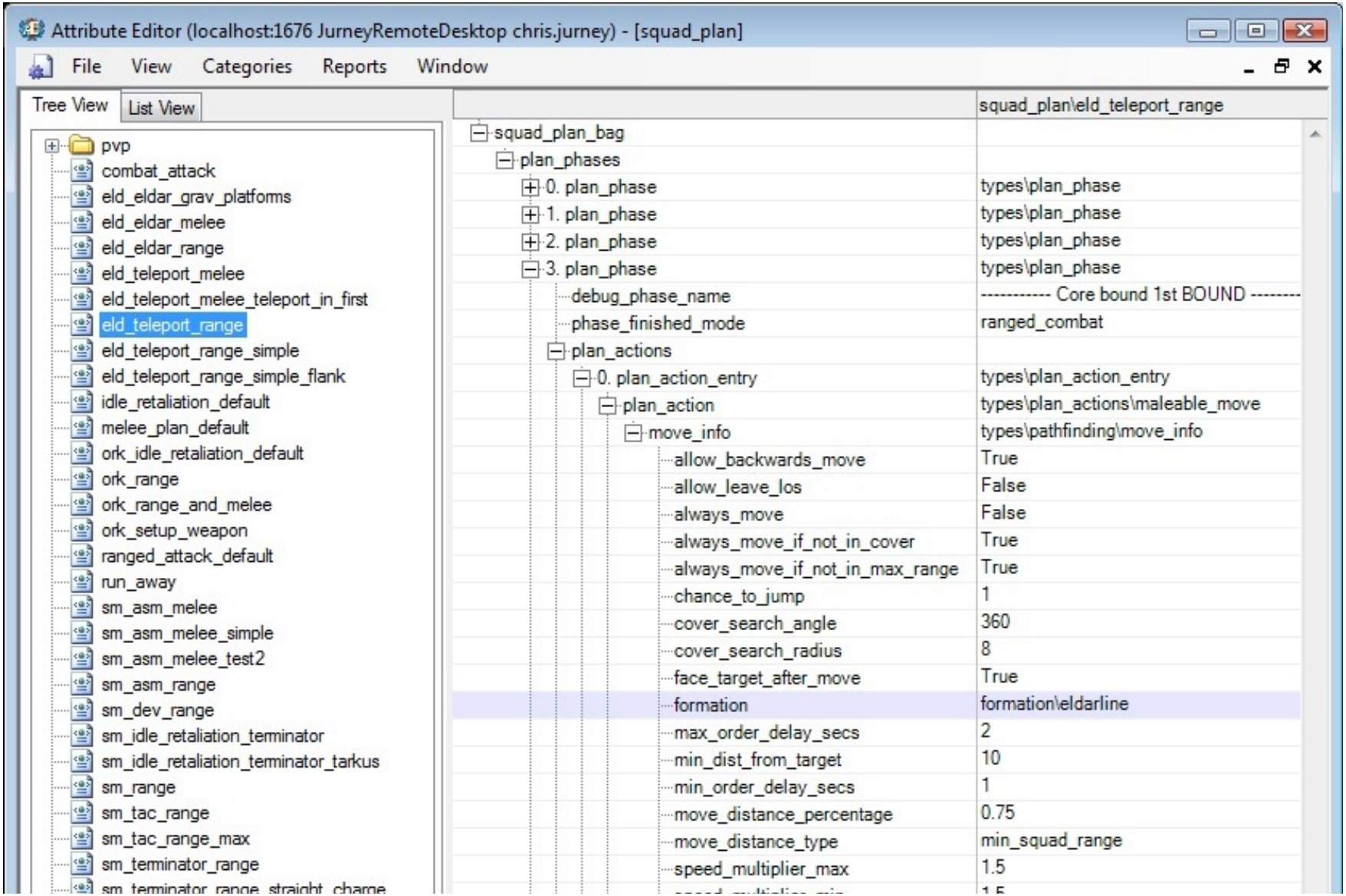
infantry-plan.squadai * Sc1

File Edit Search View Tools Options Language Buffers Help

1 assault-building-plan.lua | 2 sniper-plan.squadai | 3 infantry-plan.squadai *

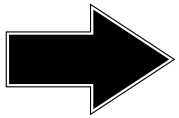
```
16  ------------------------------------------------------------------------------
17  -- plan
18
19  plan =
20  {
21      ------------------------------------------------------------------------------
22      -- phase0: Before First Bound
23          {
24          type = DATA_PHASE,
25          name = "START PLAN: all move NO COVER NO BACKWARDS",
26          --
27          {
28              apply_to = {ET_Core, ET_RFlank, ET_LFlank},
29              actions =
30              {
31                  ACTION_MOVE_POSTURE_EXT( DT_MAX_SQUAD_RANGE, .95, 4.0, 30.0, "squad_formations/squad_ai.lua"
32              }
33          },
34      },
35      {
36          type = DATA_PHASE,
37          name = "1st SQUAD BOUND -- LOOK FOR COVER",
38          --
39          {
40              apply_to = {ET_Core, ET_RFlank, ET_LFlank},
41              actions =
42              {
43                  ACTION_MOVE_POSTURE( DT_MAX_SQUAD_RANGE, 0.85, 10.0, 60.0, "squad_formations/squad_ai.lua",
44              }
45          },
46      },
47
48      ------------------------------------------------------------------------------
49      -- phase2 -- BOUND 1 CORE (core runs in an drops to prone)
50      {
51          type = DATA_PHASE,
52          name = "Core 1st Bound"
```

Simpler: XML Specification



JSON/XML as a “Scripting Language”

```
"myevent" : {
    "id" : 4,
    "sparkle" : {
        "color" : "blue",
        "size" : 2,
        "duration" : 3,
    },
    "buff" : {
        "attrib" : "health",
        "value" : 4,
    },
    "sound" : "magic4"
}
```



```
codefrag = "
switch (triggerId) {
  ...
  case 4:
    sparkleCharacter(BLUE,2,3);
    buffCharacter(HEALTH,4);
    playSound(MAGIC4);
    break;
  ...
}"
```

This is text, not compiled code

JSON/XML as a "Scripting Language"

```
codefrag = "
switch (triggerId) {
  ...
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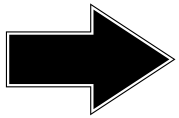
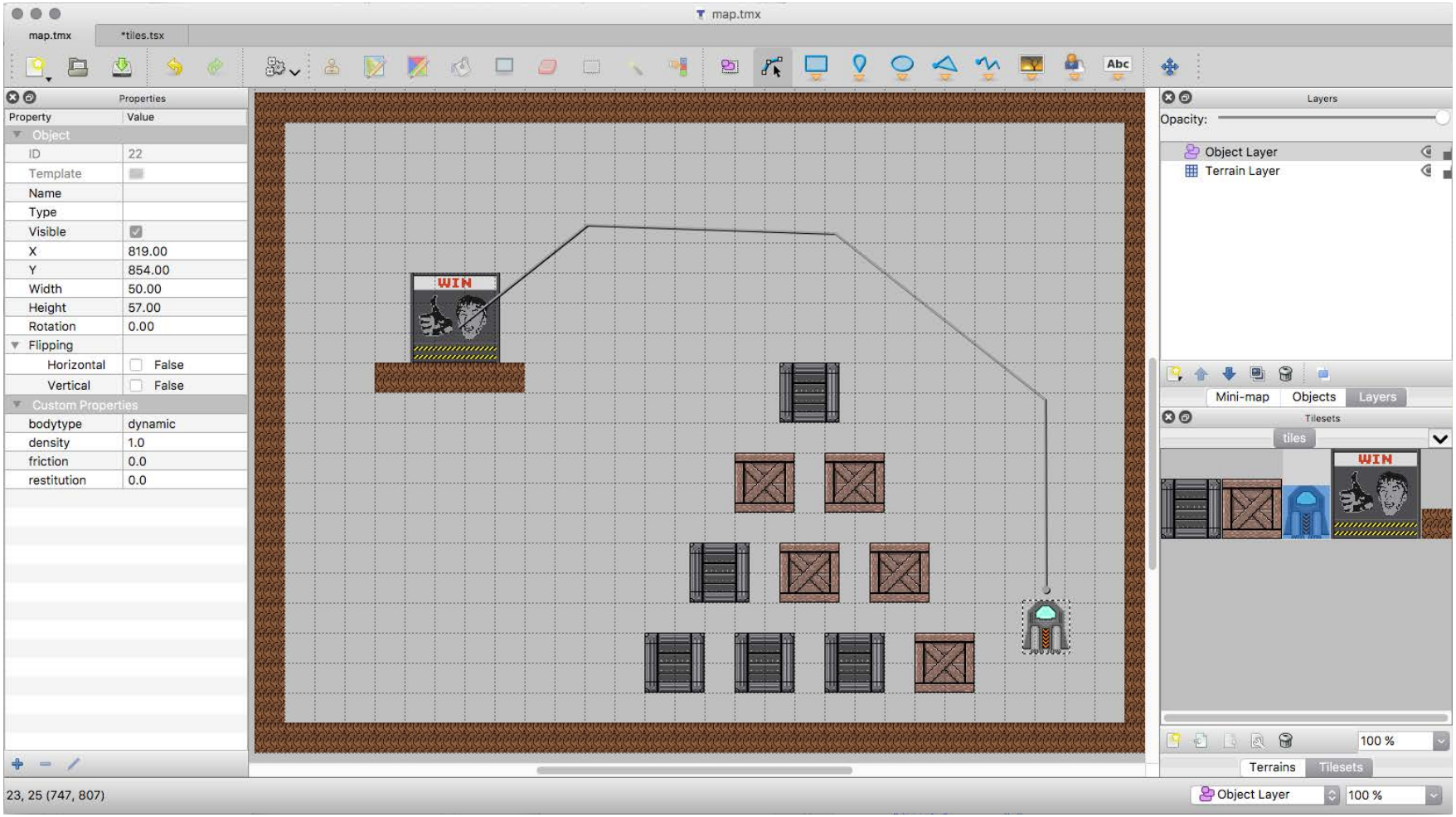


```
class MyEvent implements Event {
   void process(int triggerId) {
      switch (triggerId) {
      ...
      case 4:
        sparkleCharacter(BLUE,2,3);
        buffCharacter(HEALTH,4);
         playSound(MAGIC4);
        break;
}}
```

Java Support: javax.tools.JavaCompiler

Final Words: The Tiled Level Editor



Using **Tiled** for 3152

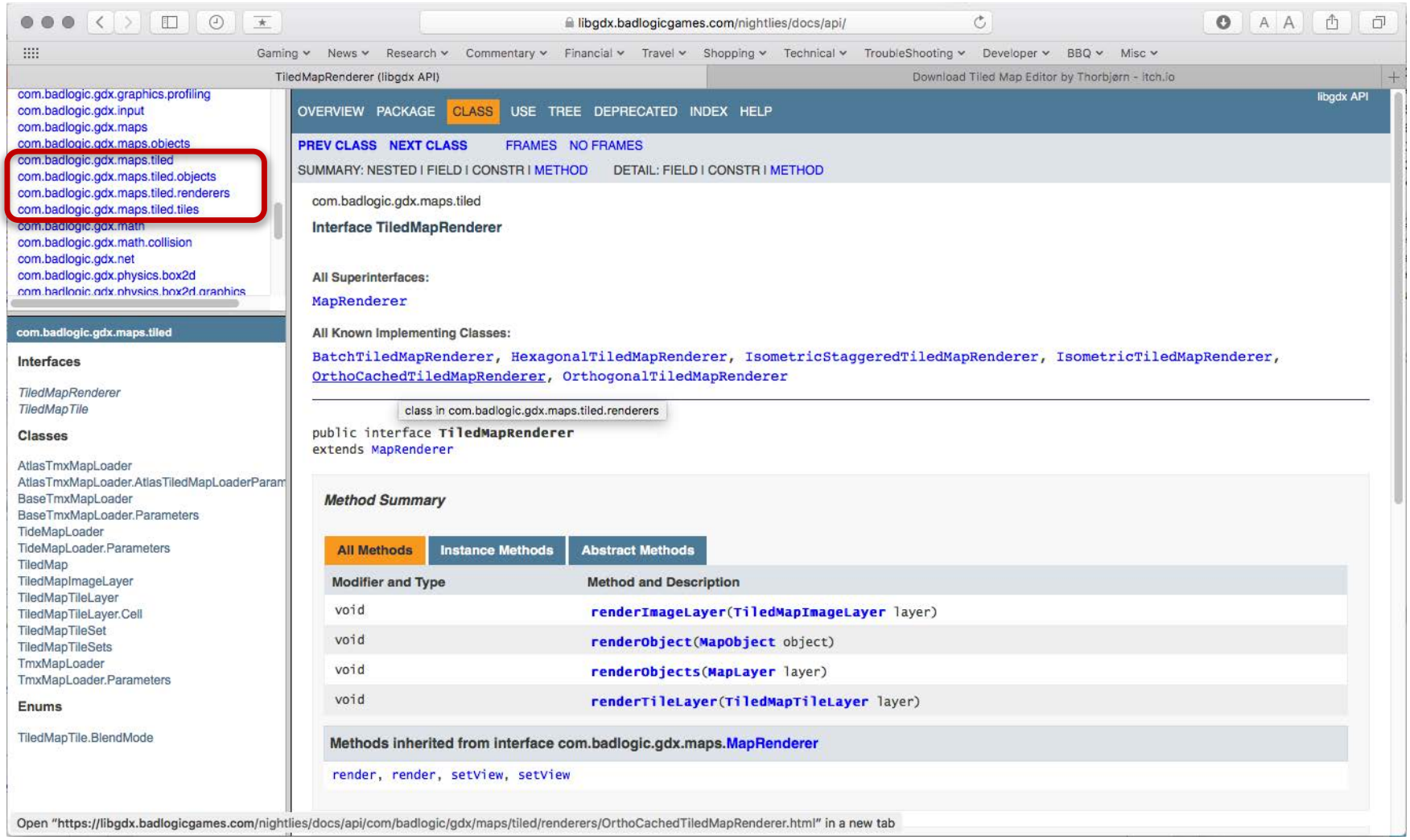
Advantanges

- Supports **almost any game**
  - Only places terrain/objects
  - You interpret placement
  - Allows custom properties
- Supports **custom collisions**
  - Each object has a "hit box"
  - Not just rectangular shapes
- Supports **XML and JSON**

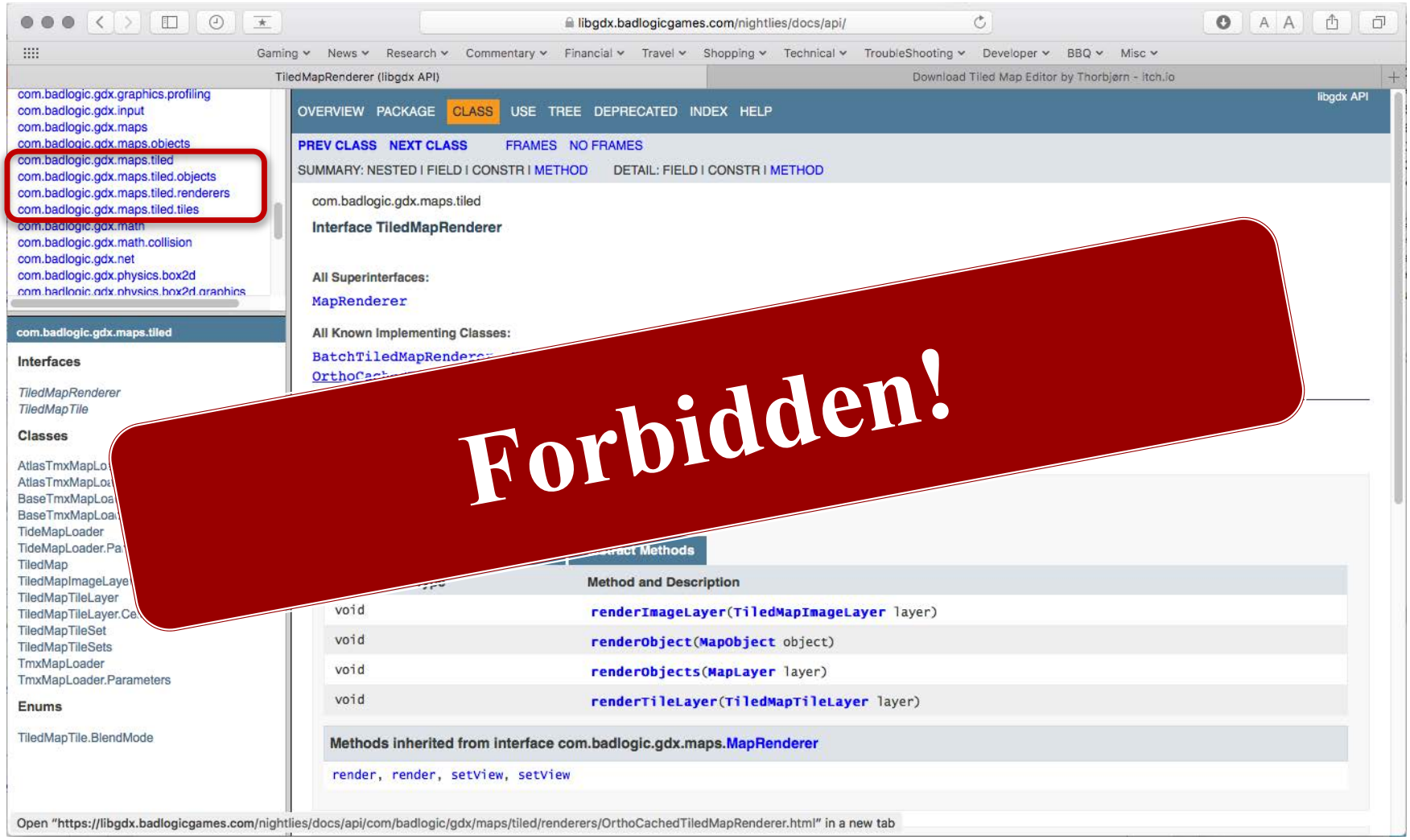
Disadvantages

- No **polygonal terrain**
  - Terrain must fit to the grid
  - NOT how Lab 4 works
- No (real) **AI scripting**
  - At best have "JSON scripts"
  - Also can define patrol paths
- No **built-in parser**
  - To convert JSON to classes

No Built-in Parser?



No Built-in Parser?



The Problem with External Editors

- Editors often come with **runtimes**
  - Premade classes for the editor objects
  - Parser converts JSON/XML into these classes
- This shackles your architecture design
  - You must design your classes around these
  - They often violate MVC in hideous ways
- Reject tools that screw up your architecture!
  - Good tools should be *decoupled* (e.g. box2d)

Summary

- Data-focused design has several advantages
  - Faster content production; code reuse is easier
  - Embrace of modder community can add value
- Two major focuses in data-focused design
  - **Level editors** place content and challenges
  - **Scripts** specify code-like behavior outside of code
- Be careful with 3rd party editors
  - Can streamline your development process
  - But it can also screw up your architecture