the gamedesigninitiative at cornell university

Lecture 13

# Data-Driven Design

# Take-Away for Today

- What is “data-driven” design?
  - How do the programmers use it?
  - How to the designers/artists/musicians use it?
- What are the benefits of data-driven 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?

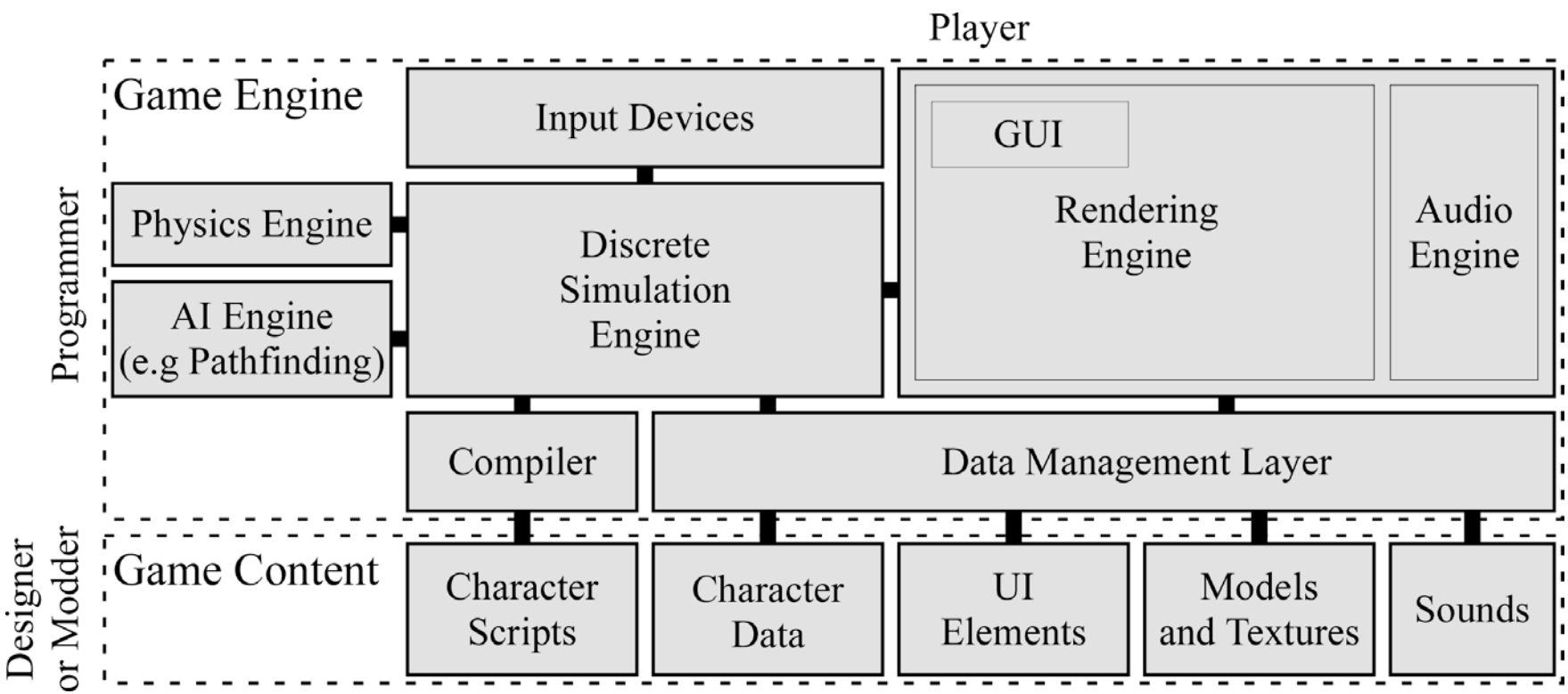
# Recall: Game Components

- **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 Driven 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 XML or other data file formats
  - User interface in XML or other data files
  - Character behavior specified through scripts

# Architecture: The Big Picture



# Why Data Driven Design?

- Games involve many actors:
  - Programmers: Create the game engine
    - Focus on technological development
  - Designers: Create the game content
    - Typically artistic/behavioral content

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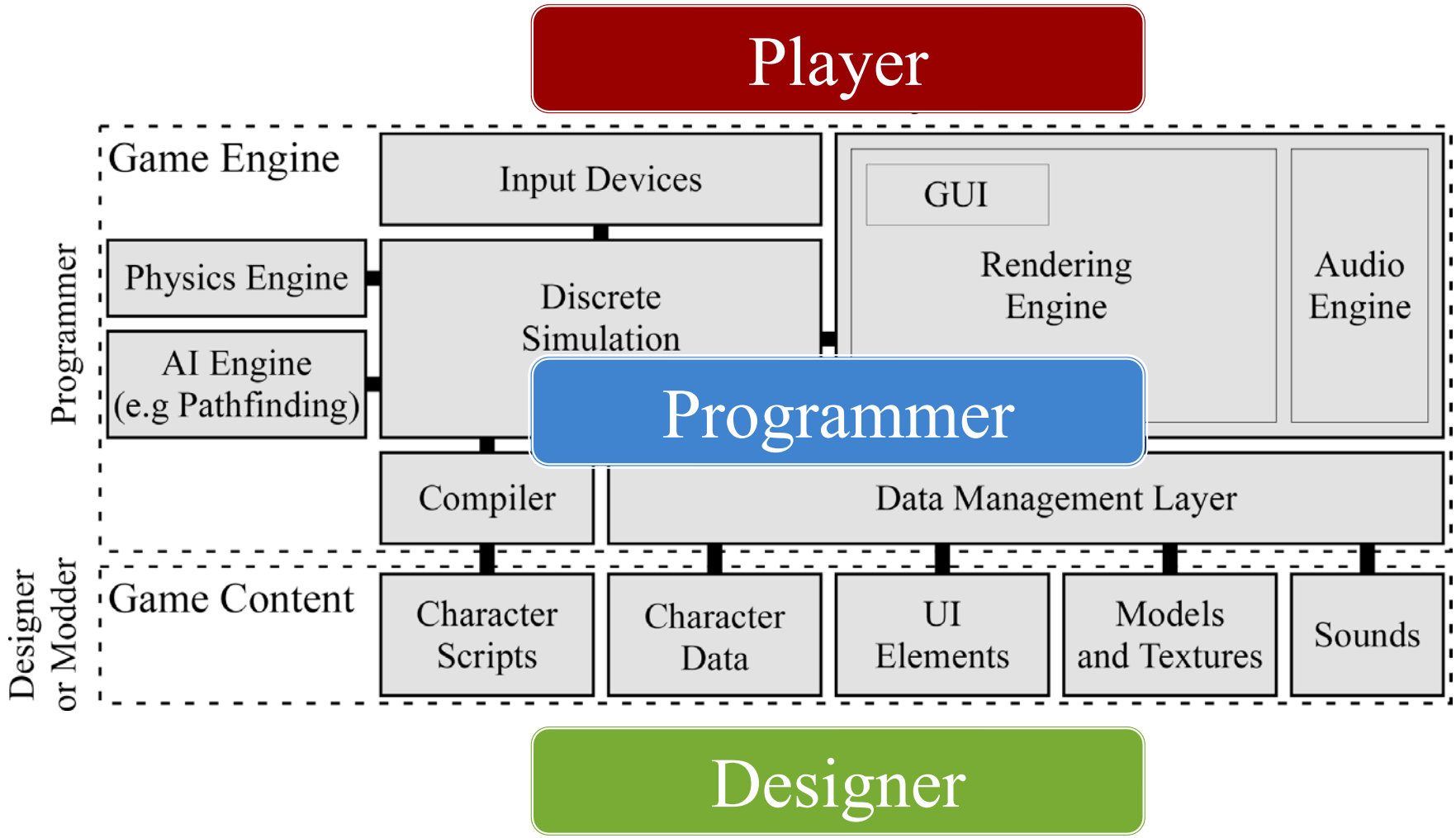
  - Players: Interact with the game
  - Modders: Modify the game content
    - Post-market "designers"
- Optimize the **production pipeline**

# Architecture: The Big Picture



# The Benefits of Modding

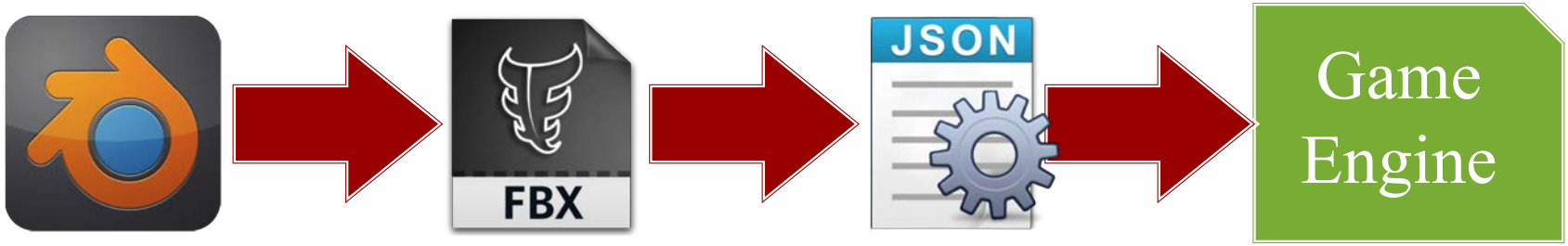
- Can extend the life span of the game
  - Keep the game content fresh over many years
  - If gamers are playing, will buy DLC!
- Community can add new game play
  - *Counter Strike* was a community mod
  - New quests and items for *Skyrim*
- Open up game to new markets
  - *Starcraft* in training and education

# 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** | lib GDX |



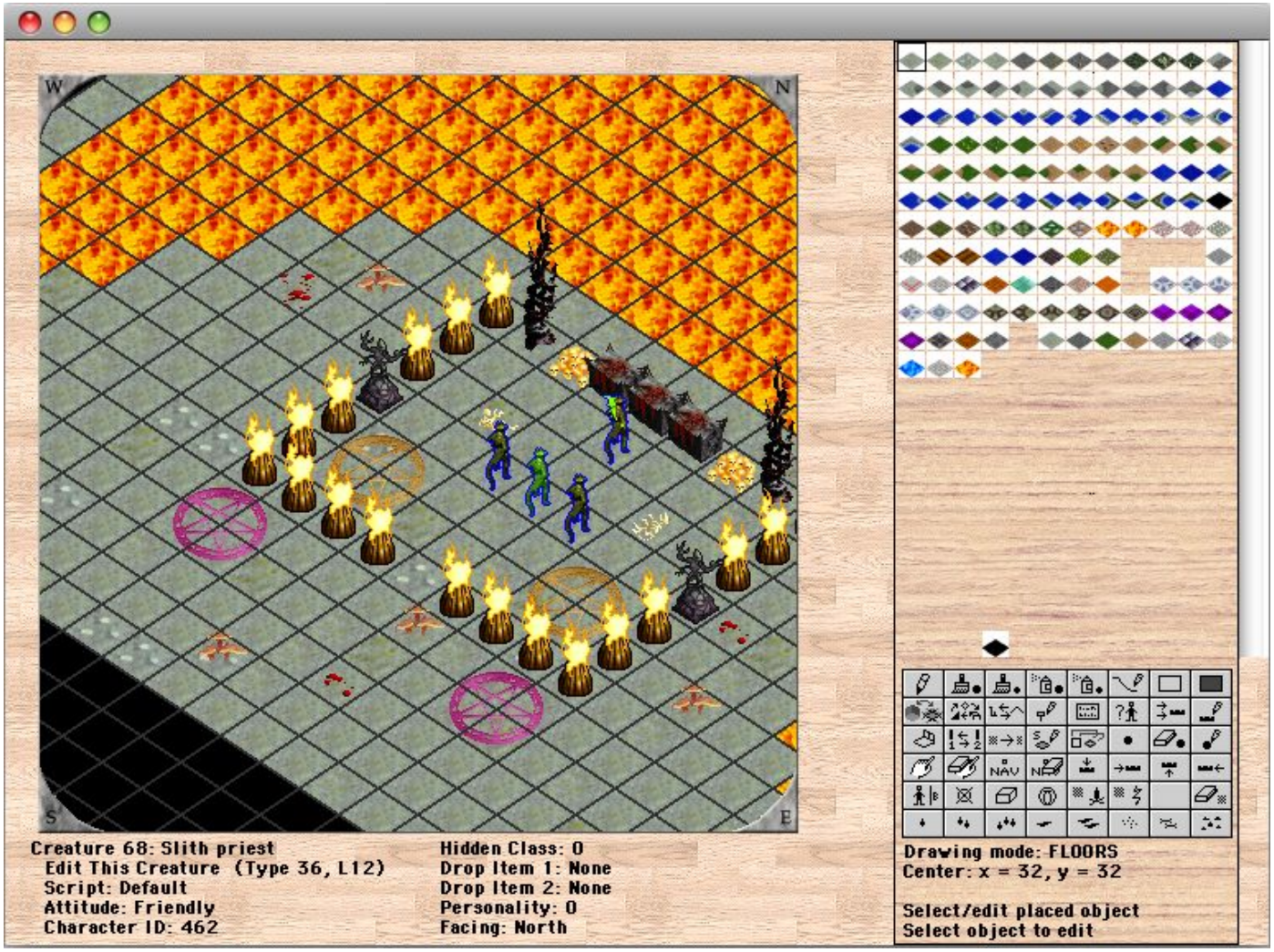
# Content Creation Tools

- **Level editor**
  - Create challenges and obstacles
  - Place objects in the world
  - Tune parameters (physics, difficulty, etc.)
- **Scripting Languages**
  - Define character behavior
  - Script triggers and events
  - Layout the user interface

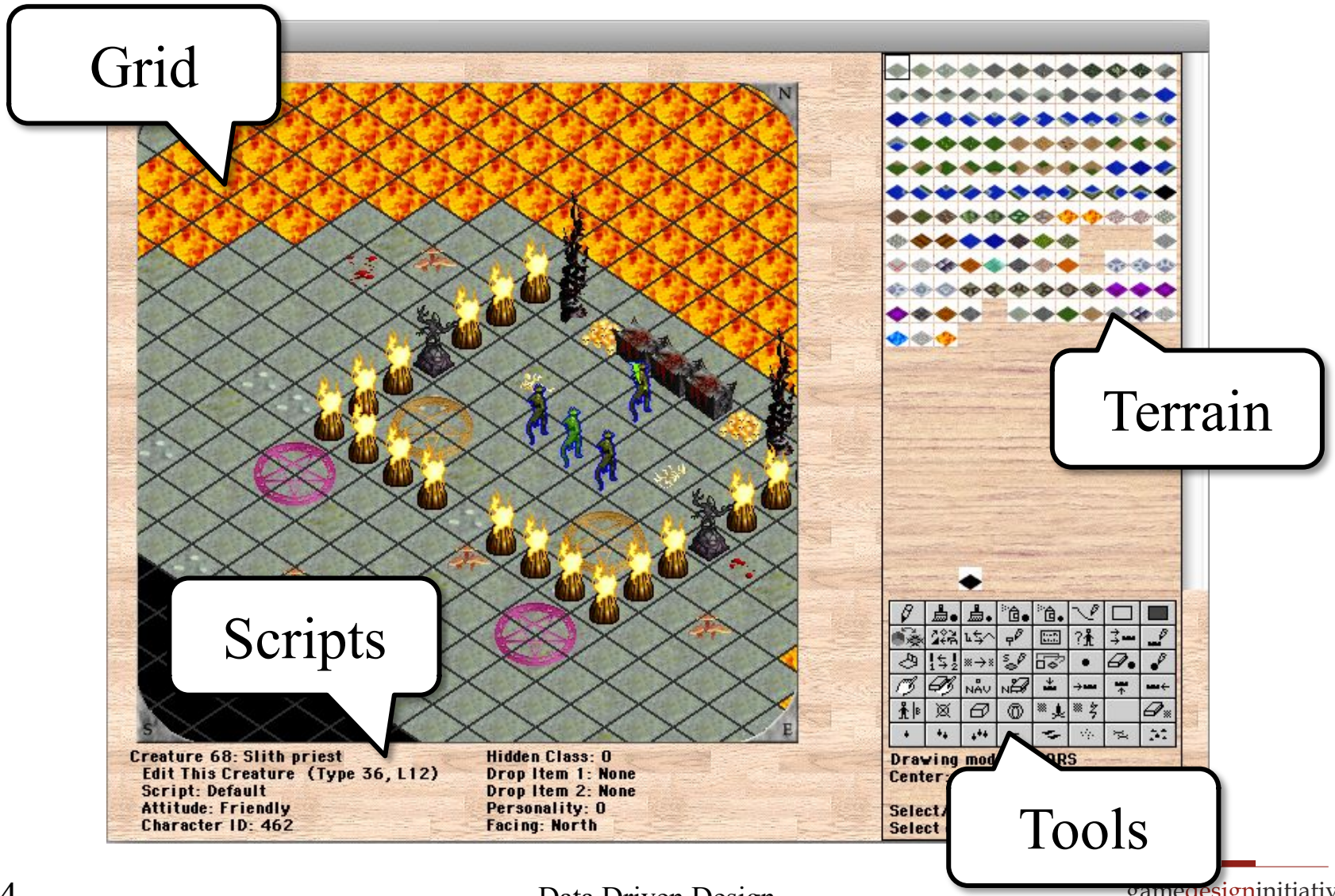
# Level Editor Features

- **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*



# 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**

# Levels and Game Architecture

- 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

# Serialization and XML

## Advantages

- **Human readable**
  - Easy for modders
- **Extendible**
  - Easy to add new tags
  - Easy to track versions
- **Portable**
  - Readers on all OSs

## Disadvantages

- **Overhead**
  - Parsers not efficient
- **Verbose**
  - Everything is text
  - Tags take up space
- **No Free-Lunch**
  - Only portable if code is

# Modern Alternative: JSON

## 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
}}}
```

# Modern Alternative: JSON

## XML

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

XmlReader

## JSON

```
{
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JsonReader

# Content Creation Tools

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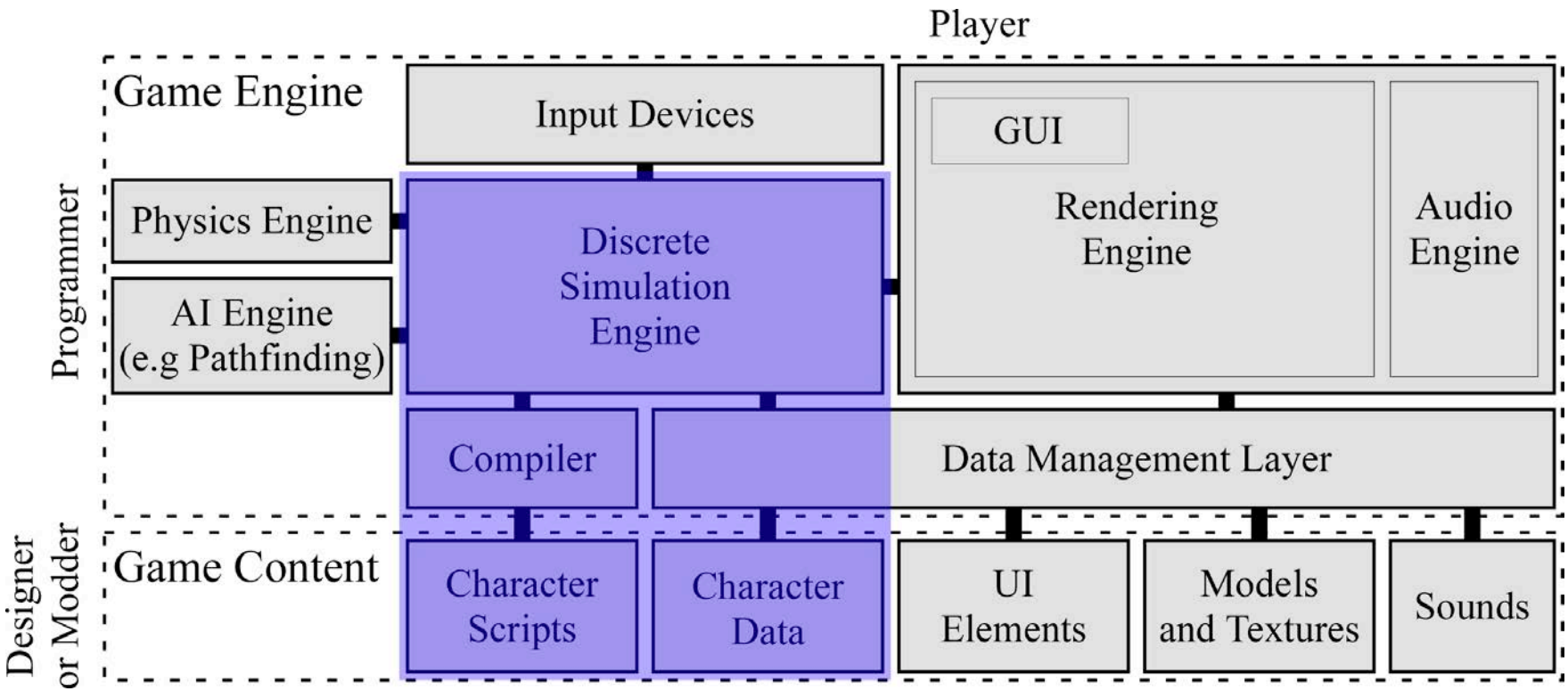
Won't cover

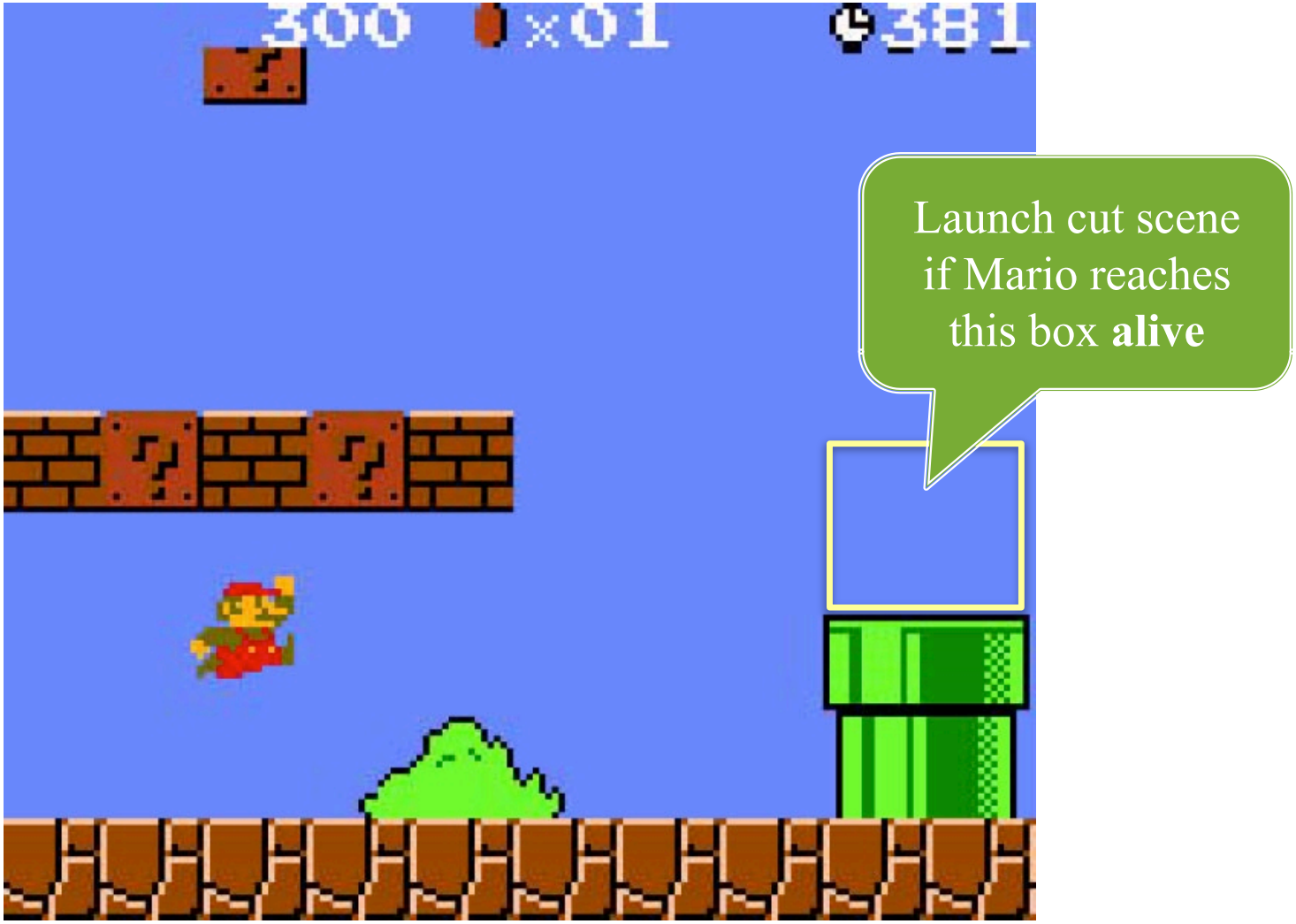
# Scripting



# 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

Attribute Editor (localhost:1676 JurneyRemoteDesktop chris.jurney) - [squad_plan]

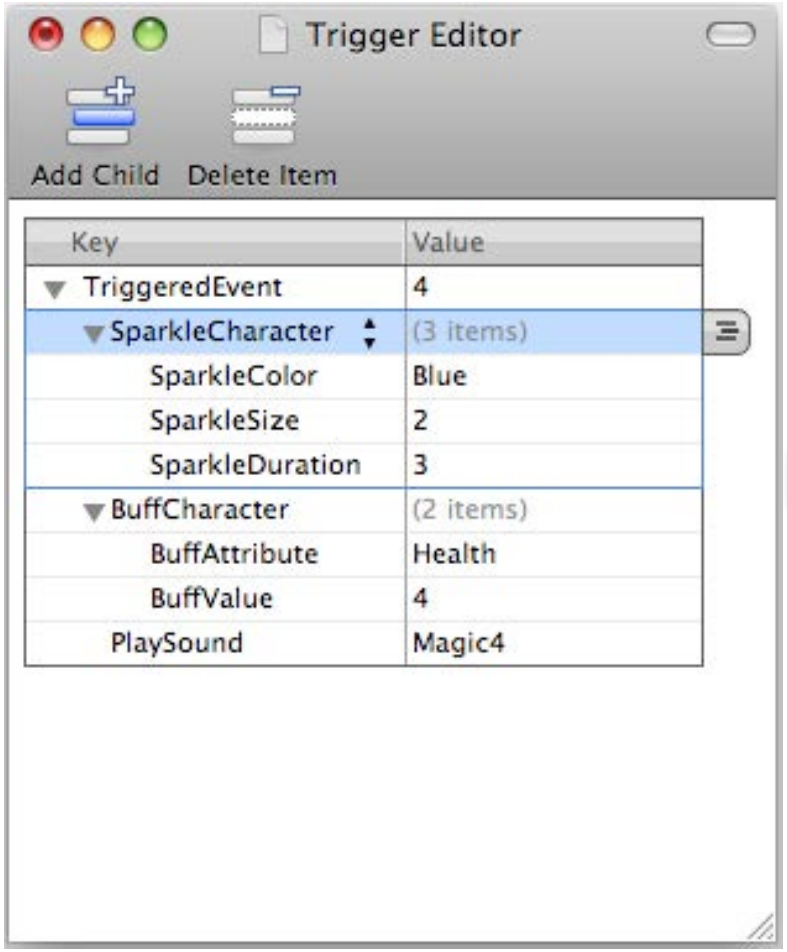
File View Categories Reports Window

Tree View | List View

- pvp
  - combat_attack
  - eld_eldar_grav_platforms
  - eld_eldar_melee
  - eld_eldar_range
  - eld_teleport_melee
  - eld_teleport_melee_teleport_in_first
  - eld_teleport_range
  - eld_teleport_range_simple
  - eld_teleport_range_simple_flank
  - idle_retaliation_default
  - melee_plan_default
  - ork_idle_retaliation_default
  - ork_range
  - ork_range_and_melee
  - ork_setup_weapon
  - ranged_attack_default
  - run_away
  - sm_asm_melee
  - sm_asm_melee_simple
  - sm_asm_melee_test2
  - sm_asm_range
  - sm_dev_range
  - sm_idle_retaliation_terminator
  - sm_idle_retaliation_terminator_tarkus
  - sm_range
  - sm_tac_range
  - sm_tac_range_max
  - sm_terminator_range
  - sm_terminator_range_straight_charge

| | squad_plan\eld_teleport_range |
|---|---|
| squad_plan_bag | |
| plan_phases | |
| 0. plan_phase | types\plan_phase |
| 1. plan_phase | types\plan_phase |
| 2. plan_phase | types\plan_phase |
| 3. plan_phase | types\plan_phase |
| debug_phase_name | ---------- Core bound 1st BOUND -------- |
| phase_finished_mode | ranged_combat |
| plan_actions | |
| 0. plan_action_entry | types\plan_action_entry |
| plan_action | types\plan_actions\maleable_move |
| move_info | types\pathfinding\move_info |
| allow_backwards_move | True |
| allow_leave_los | False |
| always_move | False |
| always_move_if_not_in_cover | True |
| always_move_if_not_in_max_range | True |
| chance_to_jump | 1 |
| cover_search_angle | 360 |
| cover_search_radius | 8 |
| face_target_after_move | True |
| formation | formation\eldarline |
| max_order_delay_secs | 2 |
| min_dist_from_target | 10 |
| min_order_delay_secs | 1 |
| move_distance_percentage | 0.75 |
| move_distance_type | min_squad_range |
| speed_multiplier_max | 1.5 |

# XML as “Scripting Language”




```
<TriggeredEvent id="4">
  <SparkleCharacter>
    <SparkleColor>Blue</SparkleColor>
    <SparkleSize>2</SparkleSize>
    <SparkleDuration>3
     </SparkleDuration>
  </SparkleCharacter>
  <BuffCharacter>
    <BuffAttribute>Health
     </BuffAttribute>
    <BuffValue>4</BuffValue>
    <PlaySound>Magic4</PlaySound>
  </BuffCharacter>
</TriggeredEvent>
```

# XML as “Scripting Language”

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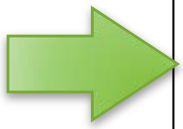
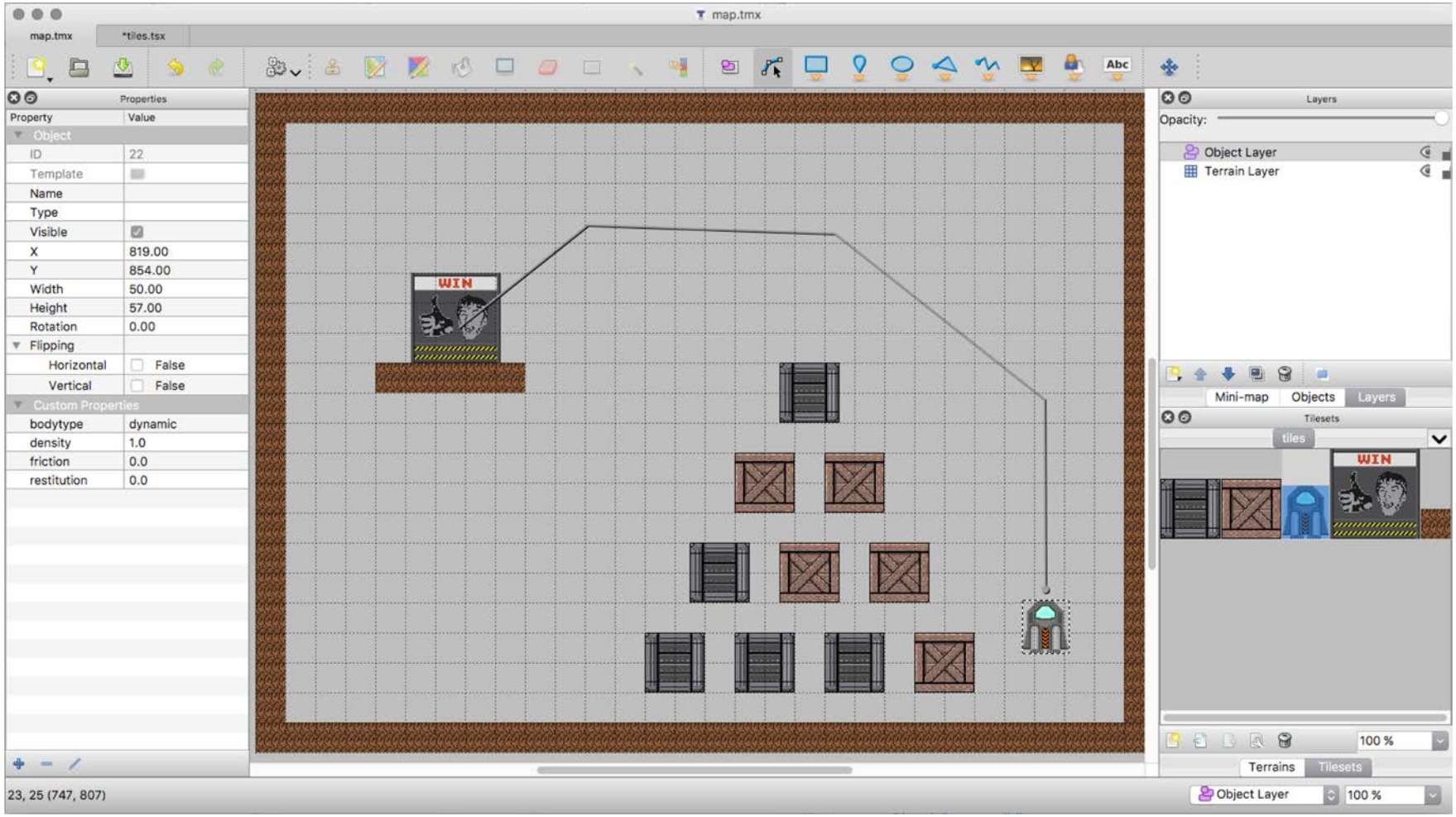


```
switch (triggerIdentifier) {
 ...
 case 4:
  sparkleCharacter(BLUE,2,3);
  buffCharacter(HEALTH,4);
  playSound(MAGIC4);
  break;
 ...
}
```

This is text, not compiled code

# The **Tiled** Level Editor



# Using **Tiled** for 3152

## Advantanges

- Supports **almost any game**
  - Only places terrain/objects
  - Your 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 "XML scripts"
  - Also can define patrol paths
- No **built-in parser**
  - To convert XML to classes

# No Built-in Parser?

libgdx.badlogicgames.com/nightlies/docs/api/

Gaming News Research Commentary Financial Travel Shopping Technical TroubleShooting Developer BBQ Misc

TiledMapRenderer (libgdx API) | Download Tiled Map Editor by Thorbjørn - itch.io

com.badlogic.gdx.graphics.profiling
com.badlogic.gdx.input
com.badlogic.gdx.maps
com.badlogic.gdx.maps.objects
com.badlogic.gdx.maps.tiled
com.badlogic.gdx.maps.tiled.objects
com.badlogic.gdx.maps.tiled.renderers
com.badlogic.gdx.maps.tiled.tiles
com.badlogic.gdx.math
com.badlogic.gdx.math.collision
com.badlogic.gdx.net
com.badlogic.gdx.physics.box2d
com.badlogic.gdx.physics.box2d.graphics

**com.badlogic.gdx.maps.tiled**

**Interfaces**

*TiledMapRenderer*
*TiledMapTile*

**Classes**

AtlasTmxMapLoader
AtlasTmxMapLoader.AtlasTiledMapLoaderParam
BaseTmxMapLoader
BaseTmxMapLoader.Parameters
TideMapLoader
TideMapLoader.Parameters
TiledMap
TiledMapImageLayer
TiledMapTileLayer
TiledMapTileLayer.Cell
TiledMapTileSet
TiledMapTileSets
TmxMapLoader
TmxMapLoader.Parameters

**Enums**

TiledMapTile.BlendMode

OVERVIEW PACKAGE CLASS USE TREE DEPRECATED INDEX HELP — libgdx API

PREV CLASS NEXT CLASS FRAMES NO FRAMES

SUMMARY: NESTED | FIELD | CONSTR | METHOD DETAIL: FIELD | CONSTR | METHOD

com.badlogic.gdx.maps.tiled

**Interface TiledMapRenderer**

**All Superinterfaces:**

MapRenderer

**All Known Implementing Classes:**

BatchTiledMapRenderer, HexagonalTiledMapRenderer, IsometricStaggeredTiledMapRenderer, IsometricTiledMapRenderer, OrthoCachedTiledMapRenderer, OrthogonalTiledMapRenderer

class in com.badlogic.gdx.maps.tiled.renderers

```
public interface TiledMapRenderer
extends MapRenderer
```

***Method Summary***

All Methods | Instance Methods | Abstract Methods

| Modifier and Type | Method and Description |
|---|---|
| void | renderImageLayer(TiledMapImageLayer layer) |
| void | renderObject(MapObject object) |
| void | renderObjects(MapLayer layer) |
| void | renderTileLayer(TiledMapTileLayer layer) |

**Methods inherited from interface com.badlogic.gdx.maps.MapRenderer**

render, render, setView, setView

Open "https://libgdx.badlogicgames.com/nightlies/docs/api/com/badlogic/gdx/maps/tiled/renderers/OrthoCachedTiledMapRenderer.html" in a new tab

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com.badlogic.gdx.maps.objects
com.badlogic.gdx.maps.tiled
com.badlogic.gdx.maps.tiled.objects
com.badlogic.gdx.maps.tiled.renderers
com.badlogic.gdx.maps.tiled.tiles
com.badlogic.gdx.math
com.badlogic.gdx.math.collision
com.badlogic.gdx.net
com.badlogic.gdx.physics.box2d
com.badlogic.gdx.physics.box2d.graphics

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com.badlogic.gdx.maps.tiled

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**All Known Implementing Classes:**

BatchTiledMapRenderer
OrthoCach

**Forbidden!**

com.badlogic.gdx.maps.tiled

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*TiledMapRenderer*
*TiledMapTile*

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AtlasTmxMapLo
AtlasTmxMapLoa
BaseTmxMapLoa
BaseTmxMapLoa
TideMapLoader
TideMapLoader.Pa
TiledMap
TiledMapImageLaye
TiledMapTileLayer
TiledMapTileLayer.Ce
TiledMapTileSet
TiledMapTileSets
TmxMapLoader
TmxMapLoader.Parameters

**Enums**

TiledMapTile.BlendMode

Abstract Methods

| Type | Method and Description |
|---|---|
| void | renderImageLayer(TiledMapImageLayer layer) |
| void | renderObject(MapObject object) |
| void | renderObjects(MapLayer layer) |
| void | renderTileLayer(TiledMapTileLayer layer) |

**Methods inherited from interface com.badlogic.gdx.maps.MapRenderer**

render, render, setView, setView

Open "https://libgdx.badlogicgames.com/nightlies/docs/api/com/badlogic/gdx/maps/tiled/renderers/OrthoCachedTiledMapRenderer.html" in a new tab

# 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-driven design has several advantages
  - Faster content production; code reuse is easier
  - Embrace of modder community can add value
- Two major focuses in data-driven 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