




# Verification Games

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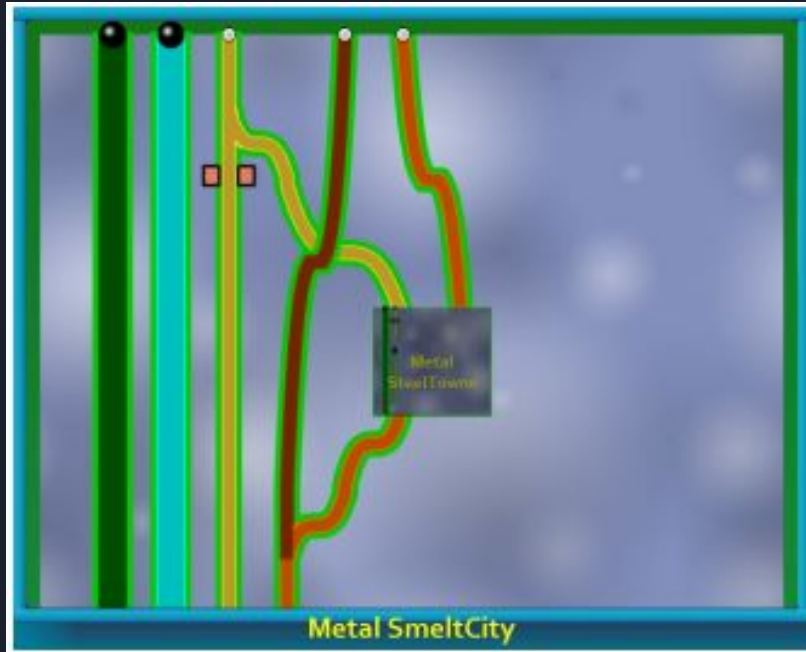
# What is verification? Why is it important?

Verification is the act of assessing the correctness of a program with respect to a certain specification.

Verification lets you know truths about a program that can be valuable when considering the task a program is designed for.

1996, Ariane-5 rocket exploded  
40 seconds after take off due to  
an error caused by casting 64-bit  
floating point numbers to 16-bit  
signed integers.

# Current Concepts



- ❖ Many different groups have used games for formal verification
  - StormBound/Monster Proof
  - CircuitBot/Dynamakr
  - GhostMap/GhostMap: Hyperspace
  - Xylem/Binary Fission
  - Flow Jam
  - Pipe Jam (pictured left)
  - Paradox
- ❖ Other crowdsourced games
  - Fold.it
  - Astro Drone
  - EteRNA



# Current Concepts

## Where are they?

**502 Bad Gateway**

nginx/1.4.6 (Ubuntu)

From proofbygames.bbn.com

Ghost Map: Hyperspace has encountered an error and will now restart.

We apologize for the inconvenience.

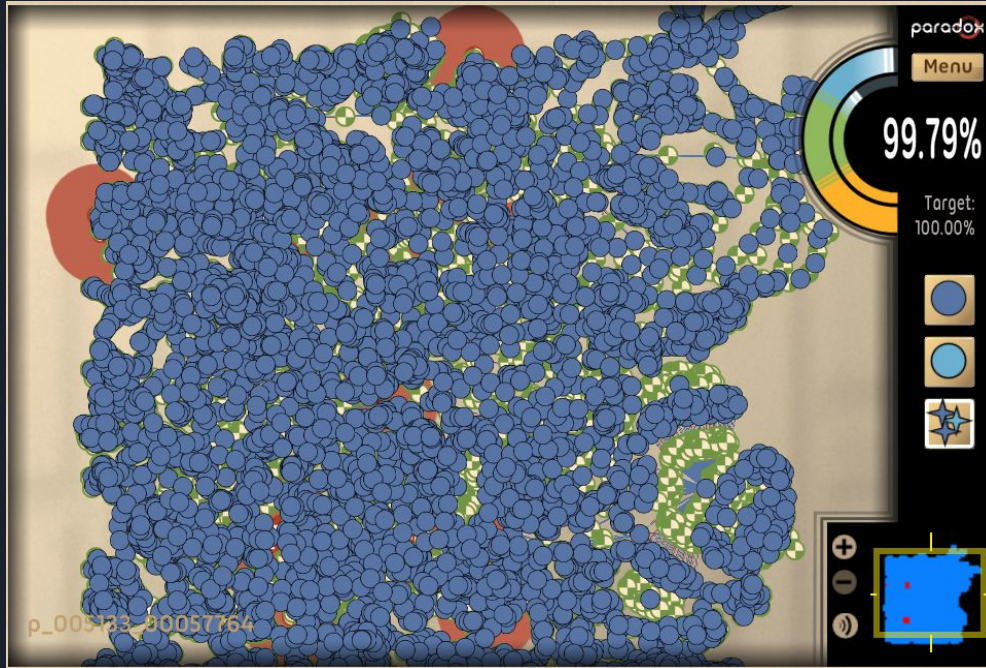
This has been automatically reported to our developers.

Error text: connection fail: 04 connecting to <http://ghostmap.verigames.com/pbgserver/api/games/1/players/0163652b14c60083fe06150c/info/>

OK

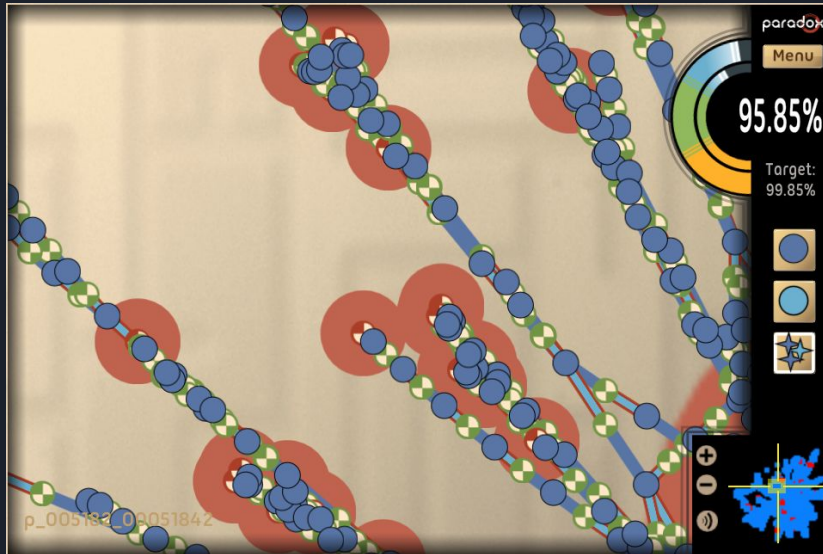
# Current Concepts

The exception



- ❖ Paradox shows you the whole program at once
- ❖ The user changes variables to eliminate conflicts (marked in red)
- ❖ The goal is to have the smallest number of conflicts

# Current Concepts



- ❖ Paradox Close Up
  - Paradox runs on flash and can be slow and unappealing when run in a browser
- ❖ Complexity has no abstraction
- ❖ Flash is losing support soon



## Our Approach

- ❖ Resurrect Flow Jam
- ❖ Port existing code to Haxe
- ❖ Assess the viability of FlowJam
- ❖ Restructure code to an entity-component-system design
- ❖ Add new mechanics to create new or augment existing dynamics



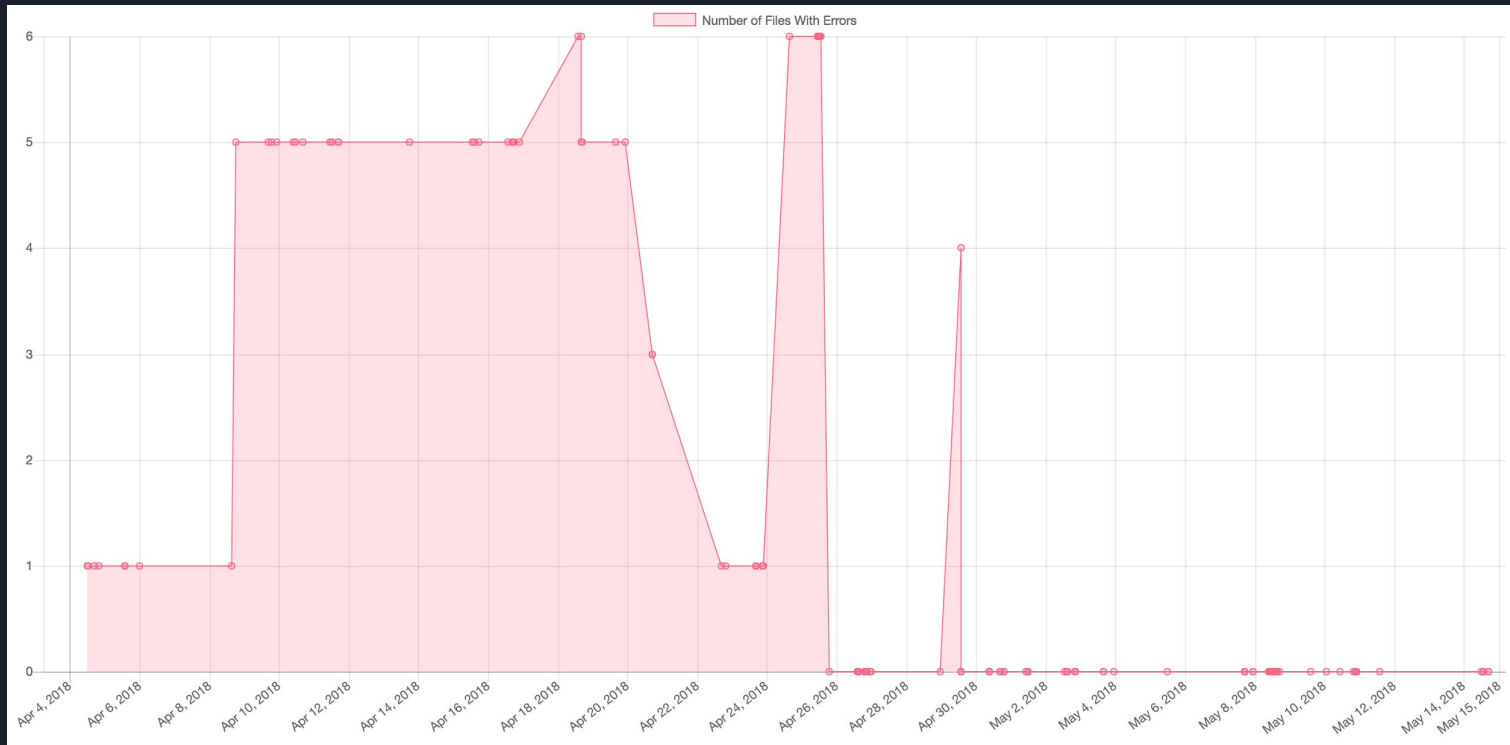
# Port

The current code base is written in ActionScript3, which is the language used by Adobe's Flash Player browser plugin, which will not be supported after 2020.

The code for FlowJam is in the process of being ported into Haxe, which is an open source language with easy cross platform support for HTML5, iOS, Android, and many others.



# Port History





# Assess Game Viability

Once we have a working prototype of FlowJam we plan on conducting player studies to assess the gameplay for viability.

Includes:

- ❖ Directly observing players
- ❖ Collecting & analyzing gameplay data
- ❖ Iterating on the game with the data and playtesting again



# Restructure

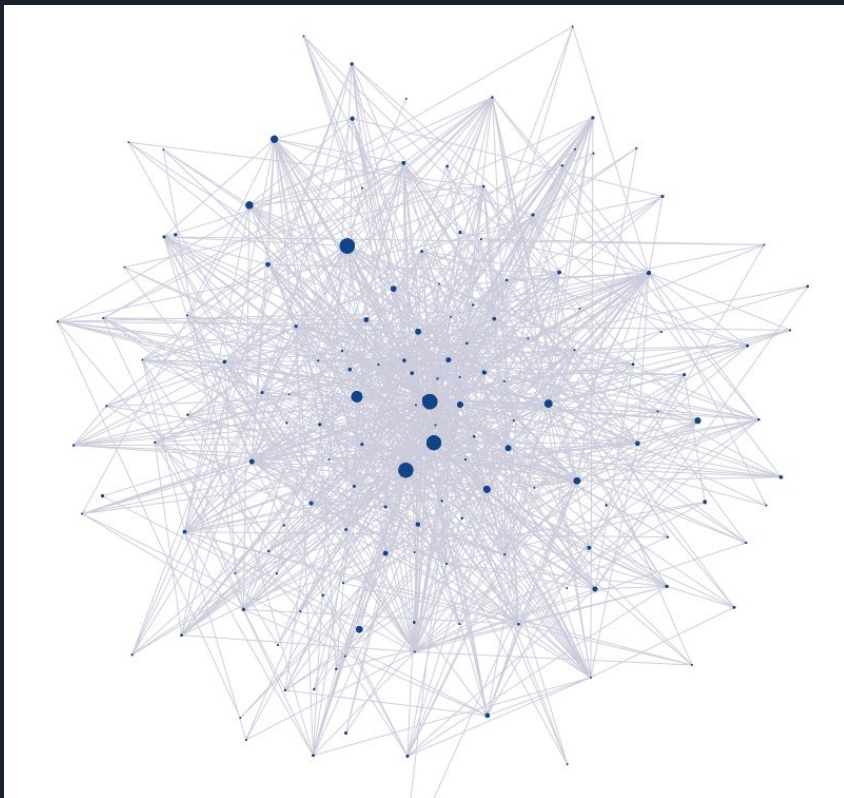
The current code base is in a state not consistent with a modular system architecture.

Once the code is ported and operable we plan to restructure the code to an Entity-Component-System architecture for the purpose of future maintenance and the extendability of the game as a whole.

We will tackle three classes that we have identified as crucial to the code's current structure and that have high coupling between other modules and restructure them, as well as restructuring the game's top-level architecture.

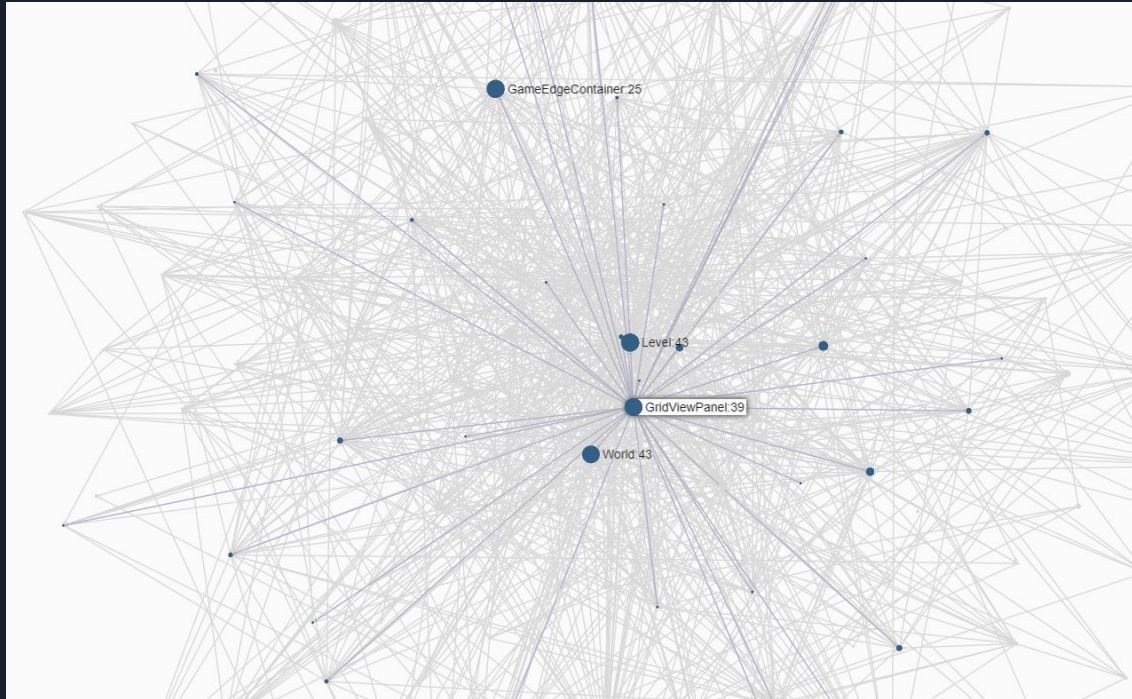
# Restructure

The current state of the graph showing outdegree



- ❖ Number of Modules: 154
- ❖ Average Outdegree: 6.42
- ❖ Max Outdegree: 43 (World/Level)
- ❖ 3-Cycles found: 588

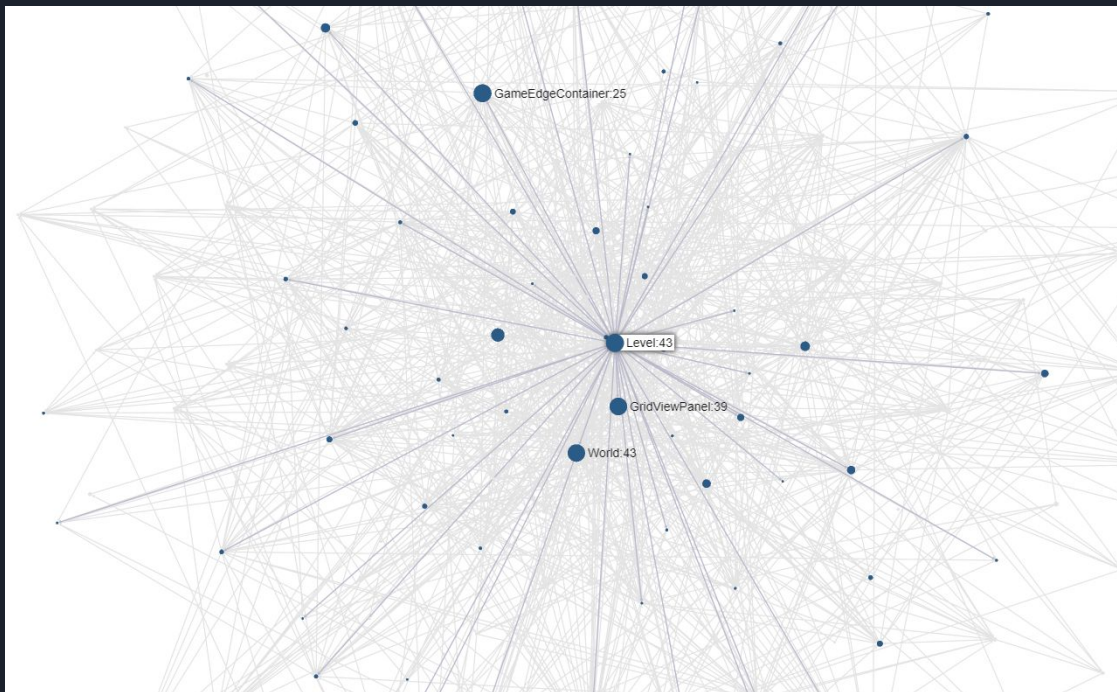
# Restructure GridViewPanel



GridViewPanel references 39 other modules.

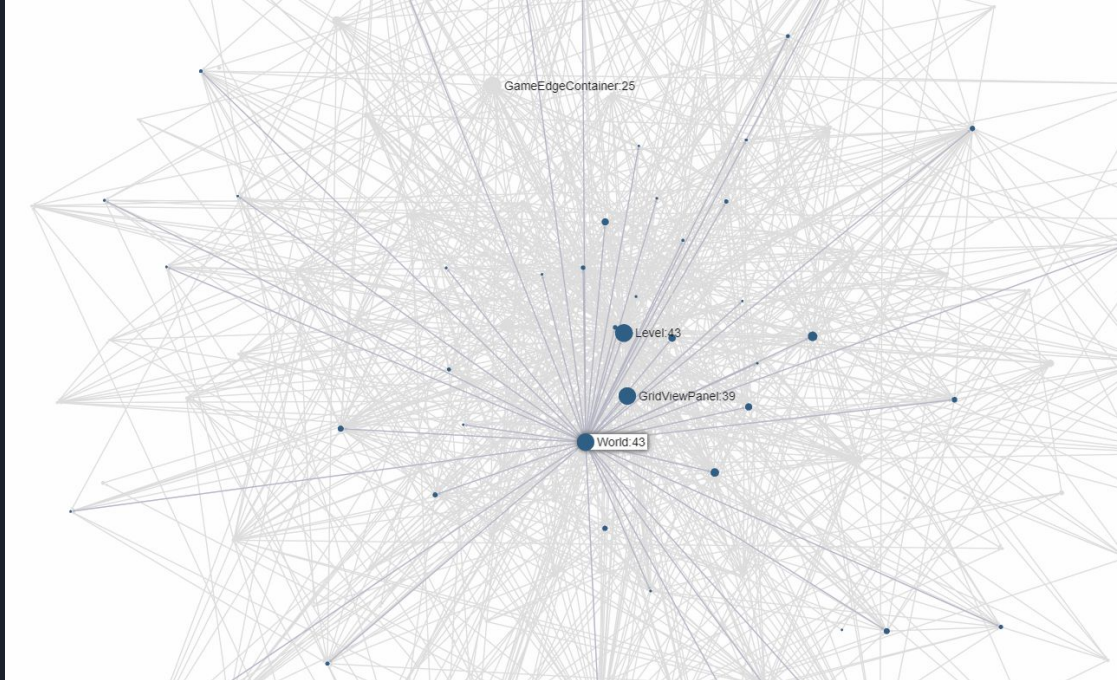
Its proposed task is to handle the game components in a level, but in the code it does much more. These behaviors should be broken off into other modules.

# Restructure Level



Level has 43 references to other modules.

# Restructure World

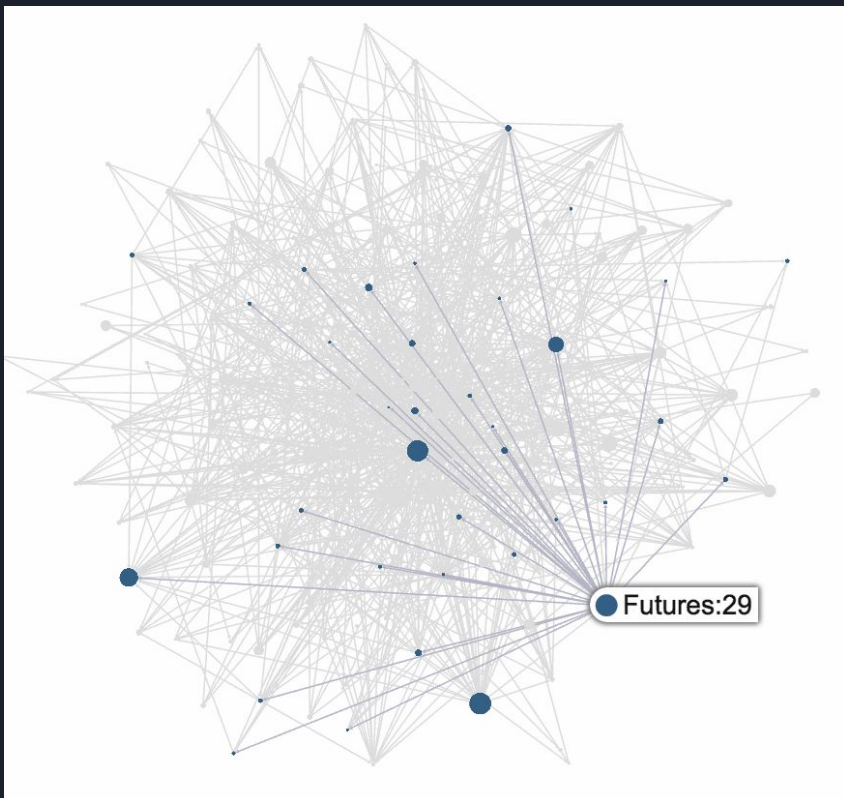


World also has 43 references.

World should handle the representation of the program that is being verified as a whole and keep track of the interactions between levels. Currently it does its own display, handles achievements, and tracks high scores, among many other functionalities.



# Example Target: Google Guava (vs. FlowJam)



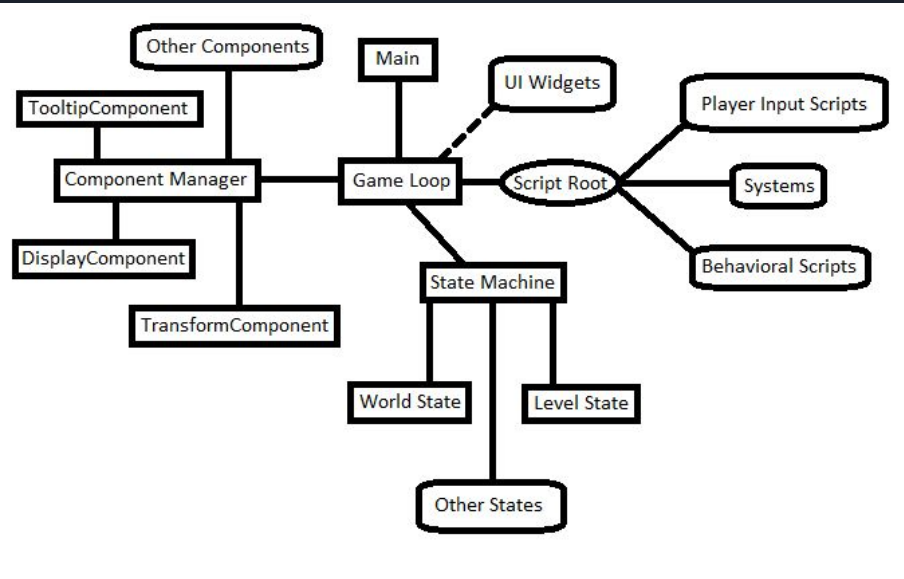
- ❖ Number of Modules: 192 (vs. 154)
- ❖ Average Outdegree: 4.48 (vs. 6.42)
- ❖ Max Outdegree: 30 (vs. 43)
- ❖ 3-Cycles found: 403 (vs. 588)



# Restructure

The architecture of FlowJam is in a state that makes parsing the functionality of modules difficult. We are restructuring these three modules to reduce their coupling and to make the codebase more hierarchical and abstract, improving its comprehensibility and maintainability.

The top-level architecture also needs to be redesigned to conform to an ECS specification so that the restructured modules can be integrated into it.





# Lessons

- ❖ Time: The porting and what happened to PipeJam



Questions?