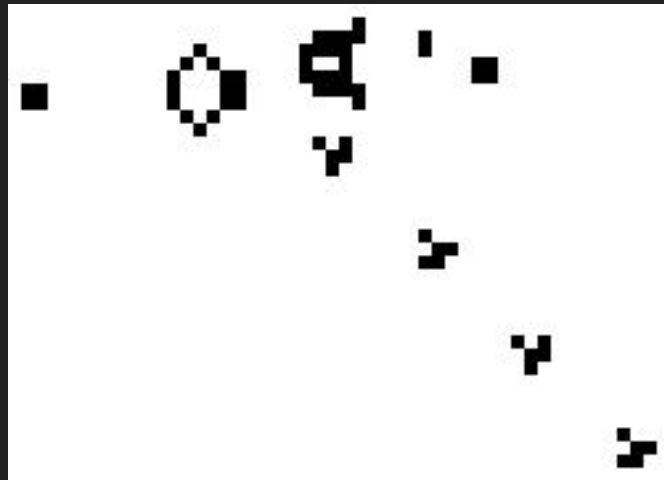


# Systems

## Systems: Elements, Interconnections, Purpose

“A system is a set of things people, cells, molecules, or whatever—interconnected in such a way that they produce their own pattern of behavior over time.”

- Donella Meadows



## Systems: Elements, Interconnections, Purpose

“A system is an interconnected set of elements that is coherently organized in a way that achieves something.”

- Donella Meadows



## Systems: Elements, Interconnections, Purpose

“A system is more than the sum of its parts. It may exhibit adaptive, dynamic, goal-seeking, self-preserving, and sometimes evolutionary behavior.”

- Donella Meadows

# To be a System, it must have:

Elements, Interconnections and a Purpose/Function

# Systems: Elements, Interconnections, Purpose

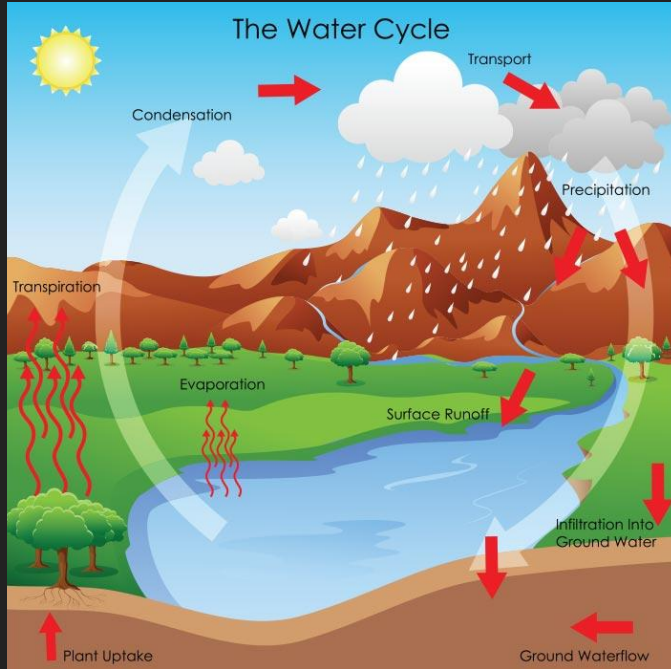
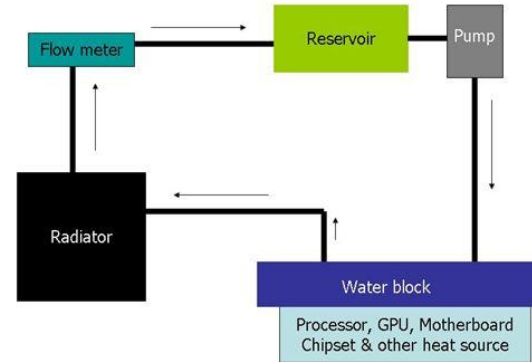


Fig 1: Water-cooling System



## Systems: Elements, Interconnections, Purpose

Often, interconnections in systems are through the flow of information.

Accuracy and timeliness of information effects behaviors in the system.

Example:

Teams, Companies, Systems in your body.



## Systems: Elements, Interconnections, Purpose

Systems can be contained within other systems.





## Systems: Elements, Interconnections, Purpose

### Elements

Variable Resources (oil, wood)

People (students, professors)

Buildings

Players, Monsters, Loot

May be self-replenishing (at a certain rate).

## Systems: Elements, Interconnections, Purpose

### Interconnections

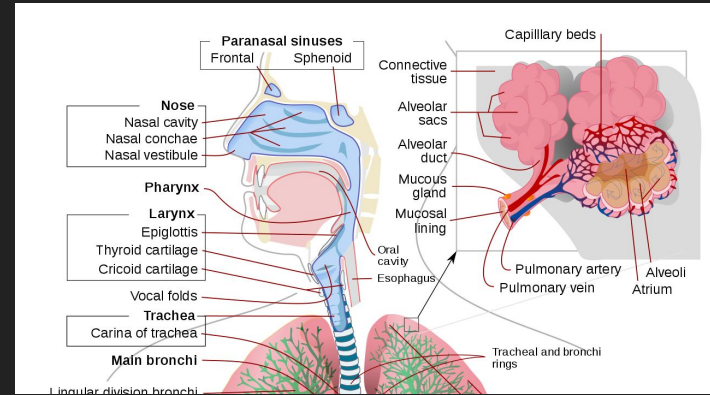
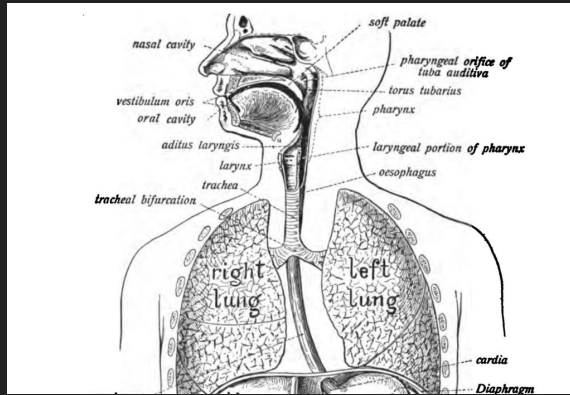
Cause and Effect

Linear Relationships (when A changes, B changes proportionally)

Non-linear relationships (when A changes, B changes in a non-linear fashion such as conditional, exponential, etc.)

Game rules are modeled this way

## Systems: Elements, Interconnections, Purpose



Changing Interconnections greatly alters the system

## Systems: Elements, Interconnections, Purpose

### Purpose / Function

#### Purpose

- Fluctuation of variable resources

- Self-sustaining / Self-perpetuating

#### Functions

- Provides Balance

- Provides some optimal output

## Systems: Elements, Interconnections, Purpose

### Purpose / Function

Purpose is based on behavior, not on stated goals!

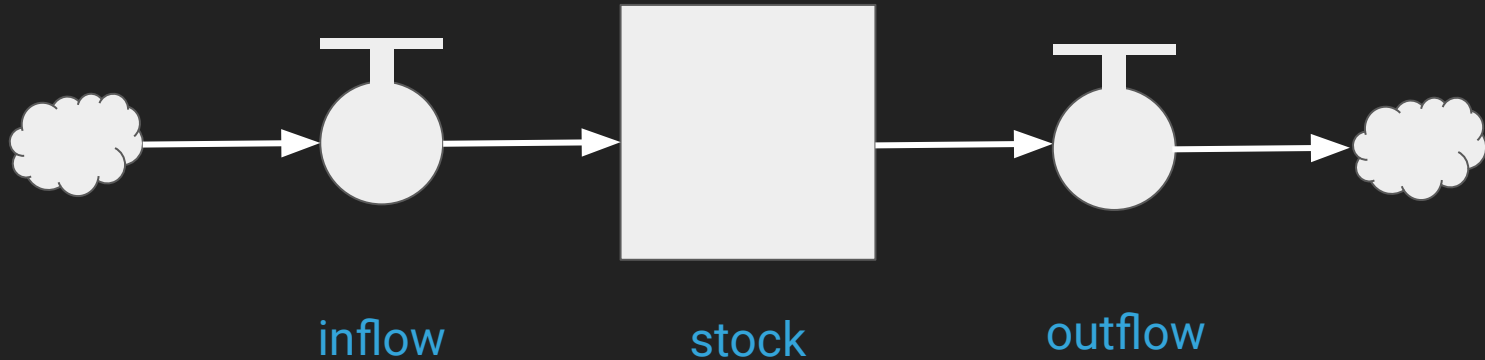
A system should keep sub-purposes in harmony with the primary function of the system as a whole.

(Example: Students, Professors, Admins and Role based Teams)

# Stock and Flow

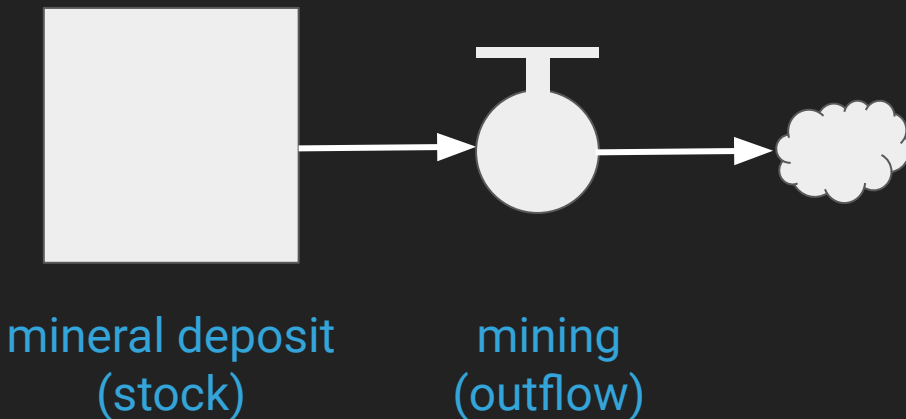
Stock are the elements you can see/count at any time.

# Stock and Flow



# Variable Resource

Non-replenishing / Not self-replicating





## Systems: Stock and Flow

Stock allows the inflow rate and outflow rate can be decoupled.

If all of the inflows match the outflows, the system will stay in equilibrium.

Many systems are designed to regulate and change flows.

Feedback Loops help to maintain a behavior over time.

# Game Designers!

Systems are dynamic.

We are interested in what is happening over time.

# Feedback Loops

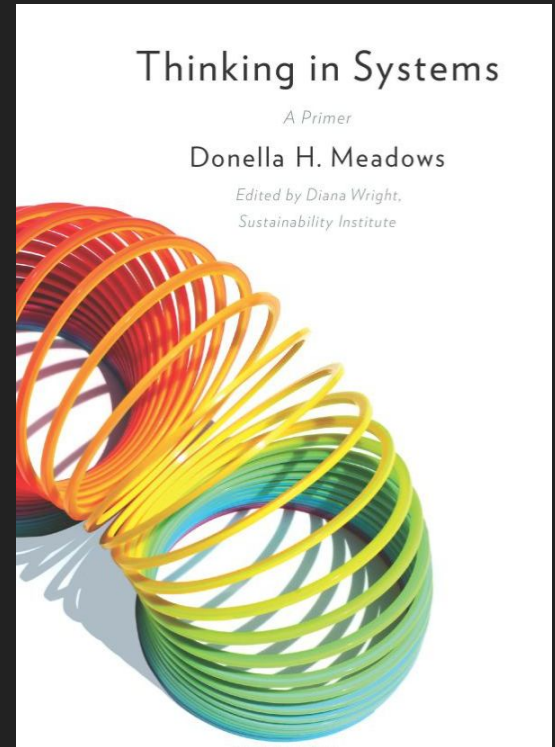
“Systems of information-feedback control are fundamental to all life and human endeavor, from the slow pace of biological evolution to the launching of the latest space satellite. . . . Everything we do as individuals, as an industry, or as a society is done in the context of an information-feedback system.”

— Jay W. Forrester

## Systems: Feedback Loops

“A feedback loop is a closed chain of causal connections, from a stock through a set of decisions or rules or physical laws or actions that are dependent on the level of stock, and back again through a flow to change the stock.”

- Donella Meadows

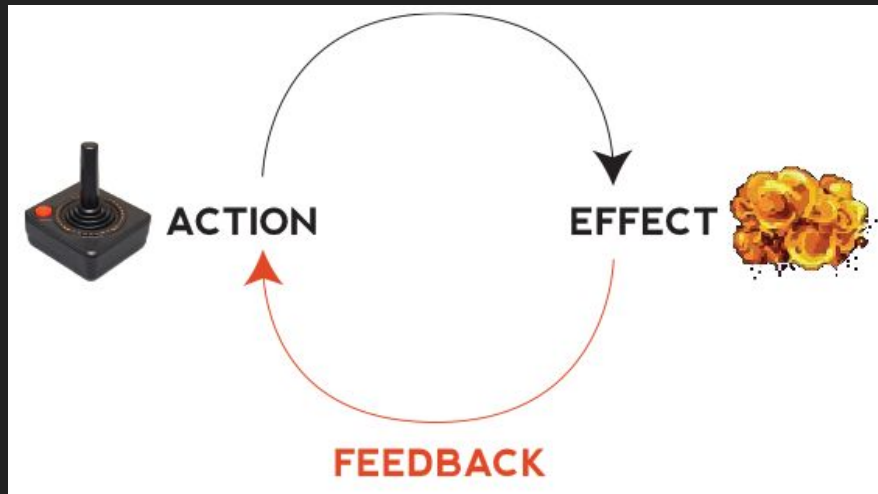


## Systems: Feedback Loops

Feedback Loops are good things!

Information Feedback  
Physical, Visual, Audio

Balancing Loop  
Equilibrating / Goal-Seeking



# Runaway Feedback Loops

## Reinforcement Loops

Provide more input stock the more that is there  
(and less the less that is there)

## Systems: Reinforcement Loops

Reinforcement loops happen when a part of a system has the ability to reproduce itself (or fraction itself).



# System Traps

Seemingly unrelated systems will exhibit  
the same behaviors (and problems)  
due to similar elements, interconnections and purpose.



# Tragedy of the Commons

In a shared resource system, individuals acting in their own self-interest is against a common good and ruin the resource for all.

Gain goes to one, while pain is shared.

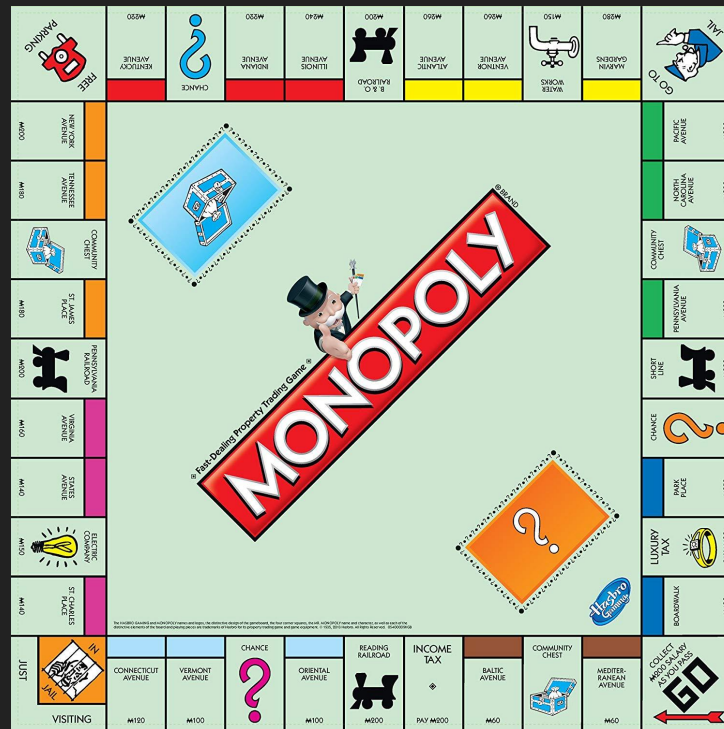
Issues with delayed information flow.



# Success to the Successful

Whenever the winners of a competition receive as a reward the ability to compete (win) more effectively.

Monopoly is broken (on purpose) to illustrate this is a bad thing!



# Video Time!

<https://www.youtube.com/watch?v=KFNxJVTJleE>

Richard Garriot :Creator of the Ultima Series  
(and my Game Design hero)

Talks about Ultima Online's Virtual Ecology  
(that failed)

# Let's Discuss

What were the elements in the system?

What were the interconnections/relationships in the system?

What was the purpose/function of the system?

What went wrong? Other ideas to fix it?

# Tweaking and Fixing

# Tweaking and Fixing

## 1. Initial Stock Sizes

# Tweaking and Fixing

1. Initial Stock Sizes
2. Stock flow parameters

# Tweaking and Fixing

1. Initial Stock Sizes
2. Stock flow parameters
3. Balancing / reinforcing feedback loops



# Tweaking and Fixing

1. Initial Stock Sizes
2. Stock flow parameters
3. Balancing / reinforcing feedback loops
4. Delays in reaction/information

# Tweaking and Fixing

1. Initial Stock Sizes
2. Stock flow parameters
3. Balancing / reinforcing feedback loops
4. Delays in reaction/information
5. Interconnections and structure

# Spreadsheets!

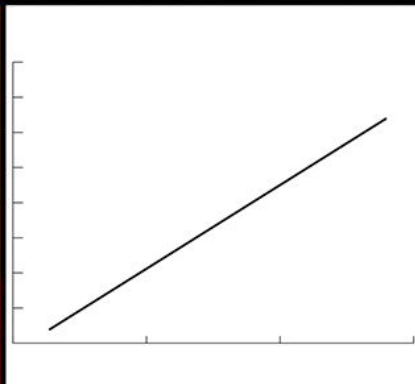
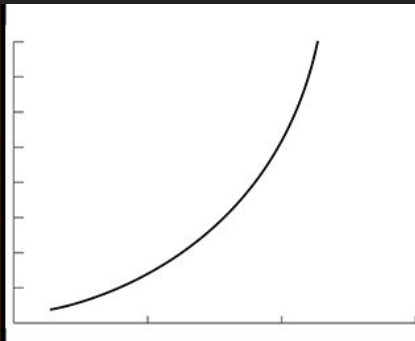
For a complex game system it can be helpful to model and visualize exactly how elements affect each other.

Current Human Ships					
	Solo	Duet	Trio	Quartet	Quintet
Mass	1	1.5	2	2.5	3
Thrust	2250	2250	2250	4000	4000
Rotate	60	40	25	30	25
Roll	1.5	1.3	1	1.2	1
Time to 10k	25s	37s	50s	35s	42s

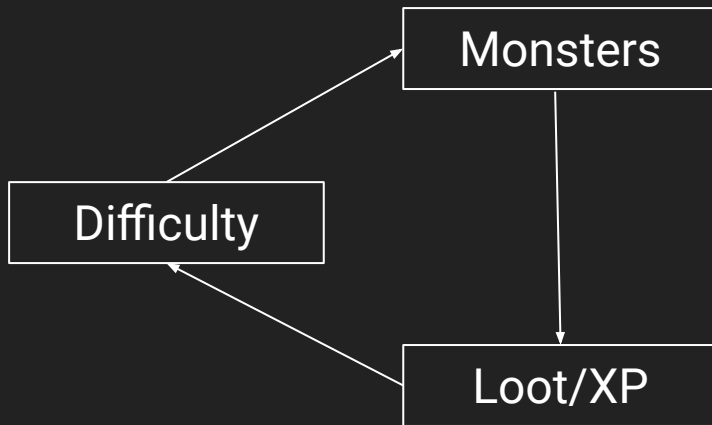
Red	Build Time	Damage Multiplier	Damage	DPS
Nano Torpedo	5	1.2	6	1.2
Light Torpedo	10	1.2	13	1.3
Heavy Torpedo	20	1.2	30	1.5
Splash Torpedo	20	1.2	15	0.75

# Graphs!

Look out for reinforcement loops that cause exponential growth.

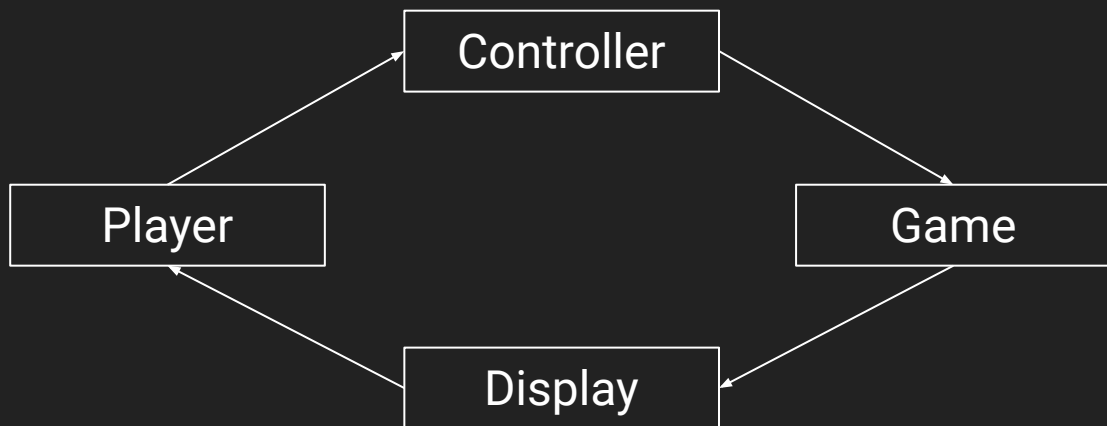


# Games as a System



RPG Game

# Games as a System

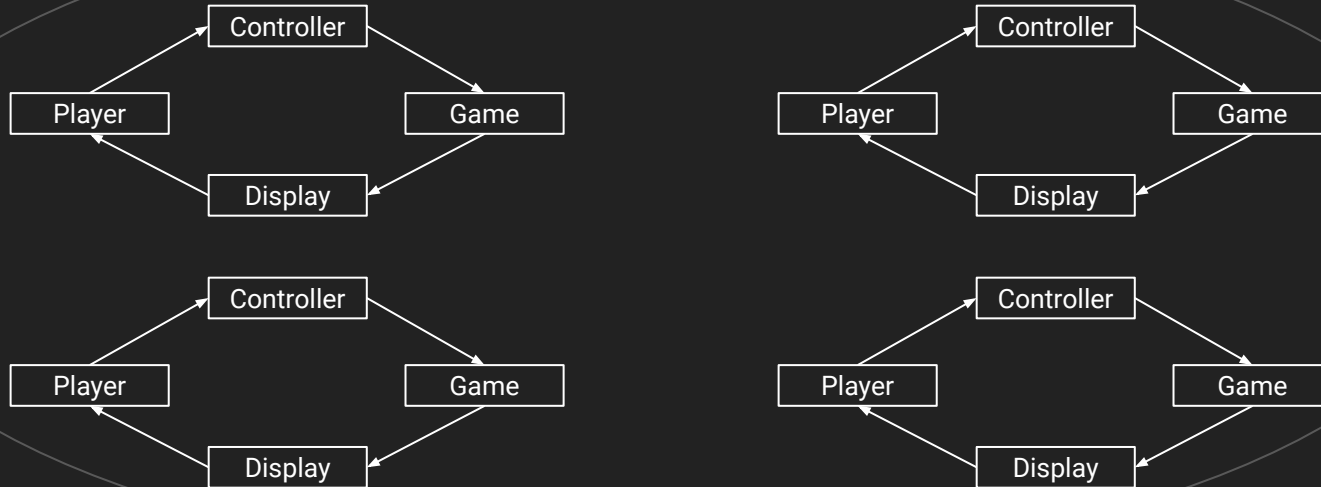


Mechanics

Rules

Feedback

# Games as a System



# Game Designers!

Think in systems...

What is the player's role in the game system and what is the game system's role in the player's play experience?



## Why do people want to play your game?

Mental challenge

Dexterity challenge

Exploration

Social play

Compelling aesthetic / narrative

Achieving mastery / Flow

Creating/Building

Performing



Your Professor 1999

## Why do people want to play your game?

Mental challenge

Dexterity challenge

Exploration

Social play

Compelling aesthetic / narrative

Achieving mastery / Flow

Creating/Building

Performing

What is the game  
designed for?

How does the system  
facilitate it?

How do players interact  
with the system?

## Game System Summary

What is the **purpose** of the game's system for the player.

Think of the **player's** role in the game's system.

What is a **strategy** you are designing for. Is that strategy **interesting** to the player?

Design your **rules** as an interconnected system of stock and flow.

Introduce hard decisions via **balancing** and reinforcing **feedback** loops.

Tweak your system's properties and **playtest**.

If stuck, **modify** the structure (interconnections) of the system.

# Guida's Guide

1. Make a list of all the features you want in your game.
2. Take half that list.
3. Throw that half away.

# Remember Prototyping Goals

Proving that your basic game mechanic is interesting.

Changing the basic game mechanic if it isn't.

Finding new mechanics that **emerge** from your game's systems.

Exploring your concept from all possible sides.

# Prototype 1

(Due next week)

Let's review the requirements!