

DELFL Breakout Session

Data Analytics Powering Game Strategies



Presented by Peter Choi

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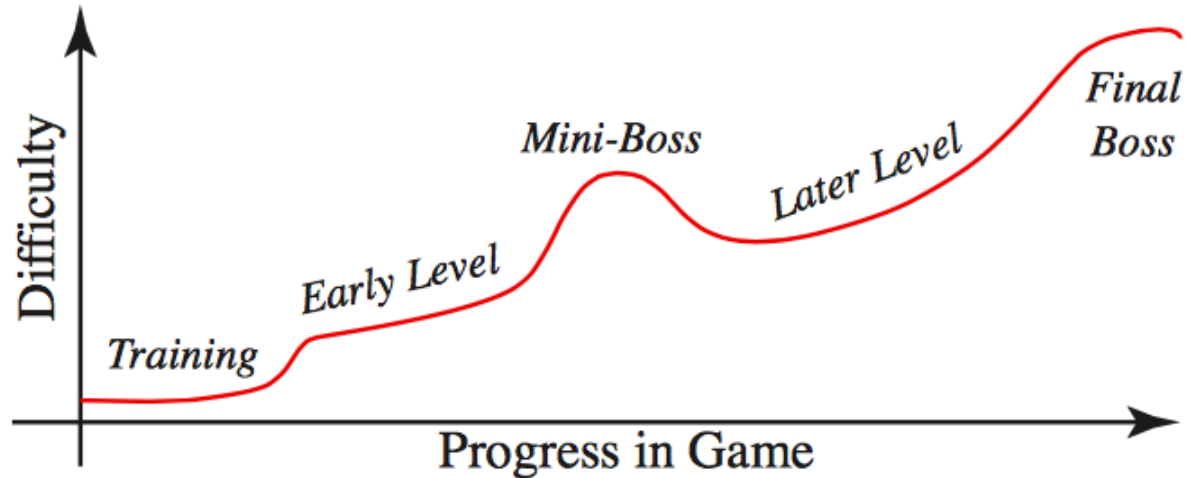
Game Balance



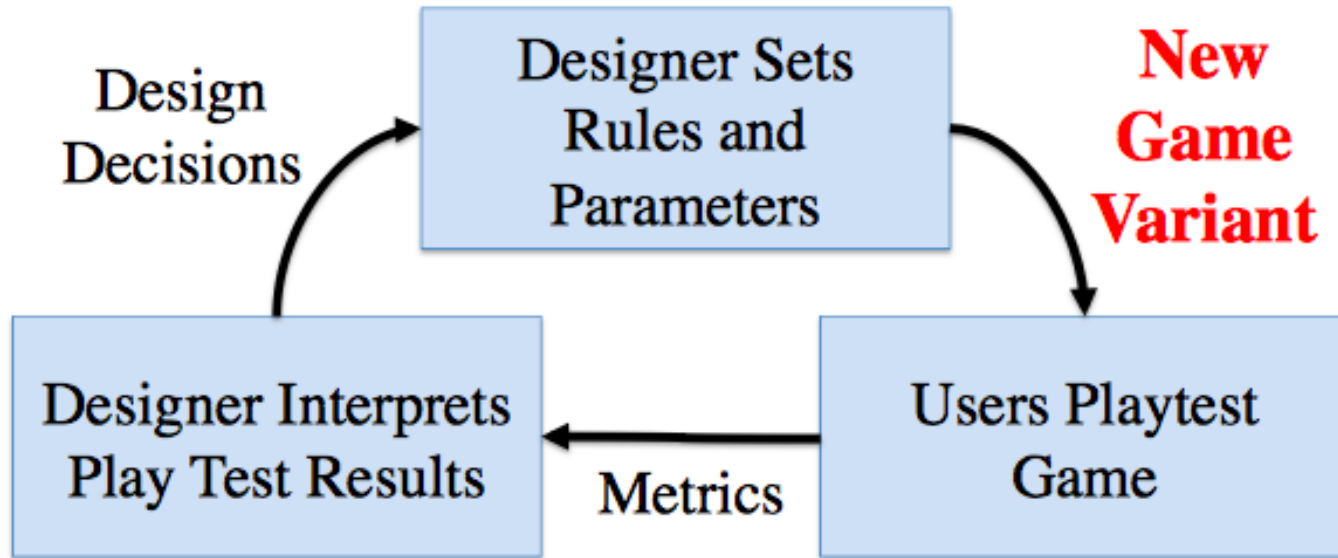
Adjusting game elements to make a coherent and enjoyable **game** experience

https://game-studies.fandom.com/wiki/Game_Balance

https://www.slideshare.net/amyjokim/gamification-101-design-the-player-journey/148-Hearts_Clubs_Diamonds_Spades_Players



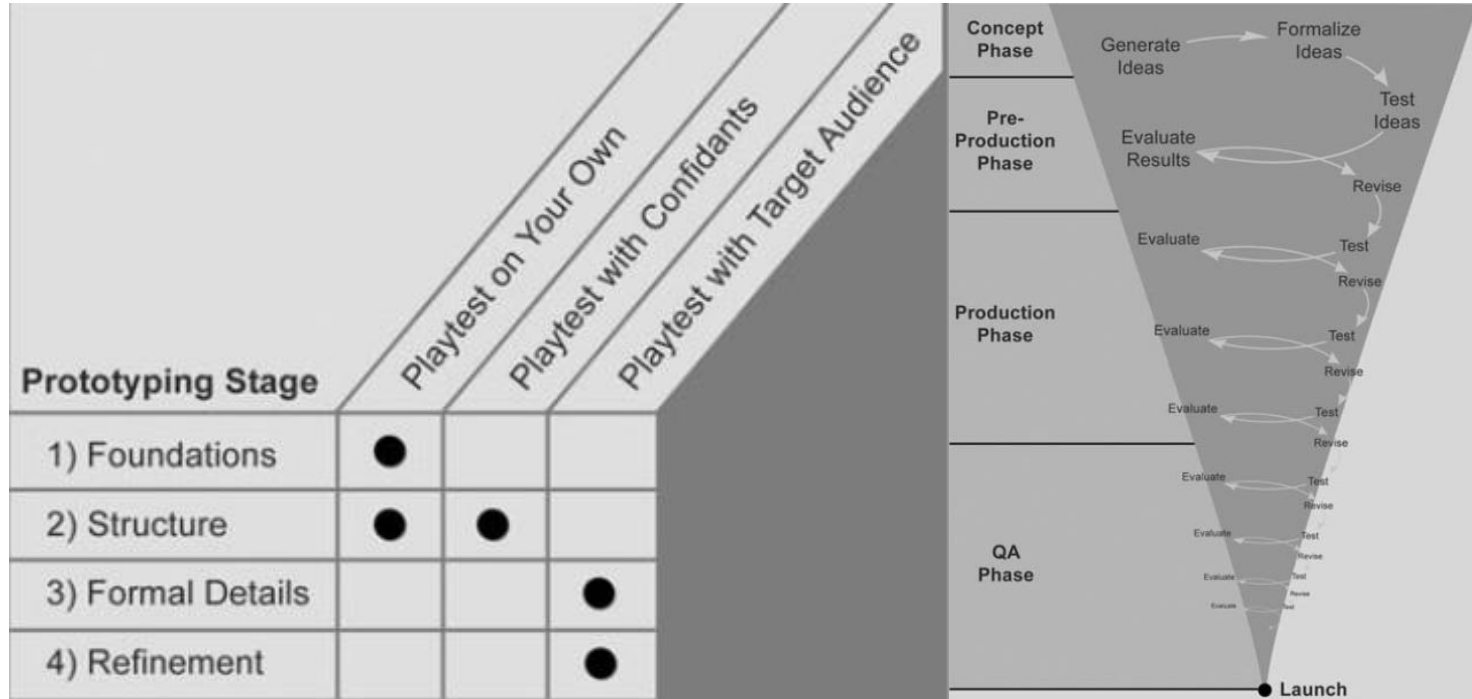
Game Balance



Game Balance



Playtest : A selected group of users play unfinished versions of a game to work out flaws



Case Studies : FisheeR



- Learning the results from the FlappyJ
- Design FisheeR with similar theme but new assets

https://www.researchgate.net/publication/277905831_Game_Play_Evaluation_Metrics



Case Studies : FisheeR



- Made 5 improvement in terms of five metrics
- Do the playtest again and find out the score has increased.

Metrics Type	Score	Total
User Control	7	
Average Time	7	
Sound	4	
Social Media	4	
Game Adv.	2	
Feeling	10	
Total		34

Metrics Type	Score	Total
User Control	8	
Average Time	7	
Sound	8	
Social Media	8	
Game Adv.	4	
Feeling	12	
Total		47

Key Metrics after Launch



User Acquisition	User Retention	App Monetization
<ul style="list-style-type: none">• New Users• Daily Active User	<ul style="list-style-type: none">• Retention Rate• Churn Rate	<ul style="list-style-type: none">• Conversion Rate• Average Revenue Per Daily Active User• Customer Lifetime Value• User Acquisition Cost• Average Transaction Value
In Game Metrics	Progression Metrics	
<ul style="list-style-type: none">• Source• Sink• Flow	<ul style="list-style-type: none">• Start• Fail• Complete	

<https://gameanalytics.com/blog/metrics-all-game-developers-should-know.html>

<https://www.cooladata.com/19-metrics-every-mobile-games-needs-track/>

12 Most Common Types of Game Balance



- Fairness
- Challenge versus Success
- Meaningful Choices
- Skill vs Choice
- Head vs Hands
- Competition vs Cooperation
- Short vs Long
- Rewards
- Punishment
- Freedom vs Controlled Experience
- Simple vs Complex
- Detail vs Imagination
- https://game-studies.fandom.com/wiki/Game_Balance

Numeric Relationship



In a single game, elements can form diverse numeric relationships

Example : Super Mario Bros

<https://gamebalanceconcepts.wordpress.com/2010/07/14/level-2-numeric-relationships/>

- **Coins:**
 - 100-to-1 relationship between Coins and Lives
 - collecting 100 coins awards an extra life
 - 1-to-200 relationship between Coins and Score
 - collecting a coin gives 200 points
- **Time**
 - 100-to-1 relationship between Time and Score
 - a time bonus at the end of each level
 - An inverse relationship between Time and Lives
 - Running out of time costs you a life.



Numeric Relationship

- **Enemies:**
 - killing enemies gives you from 100 to 1000 score
 - Depending on the enemy
 - An inverse relationship between Enemies and Lives
 - An enemy sometimes will cost you a life
- **Lives:**
 - Losing a life resets the Coins, Time and Enemies on a level.
- **Relationship between Lives and Score:**
 - There is indirect link between Lives and Score
 - Losing a Life resets a bunch of things that give scoring opportunities
- **Score**
 - The central resource in *Super Mario Bros*
 - Everything is tied to Score.



How to Balance?



Three Possible Changes

1. How many enemies you kill and their relative risks
 2. How many coins you find in a typical level
 3. How much time you typically complete the level with.
- **A Global Change** : Change the amount of score granted to the player from each of these things
 - **A Local Change** : Vary the number of coins and enemies, the amount of time, or the length of a level
 - **These Changes Adjust:**
 - A player's expected total score
 - How much each of these activities (coin collecting, enemy stomping, time completion) contributes to the final score.

Quantitative Balance Analysis



- Instrumented Gameplay Analysis
 - Maximizing the insight derived from human playtests.
 - Common approaches
 - Telemetry
 - Heatmaps
 - Tools : DeltaDNA, Game analytics, Google analytics SDK

Telemetry



What is telemetry ?

- The raw units of data that are derived remotely from somewhere
- For example, an installed client submitting data about how a user interacts with a game, transaction data from an online payment system or bug fix rates.

Operationalization

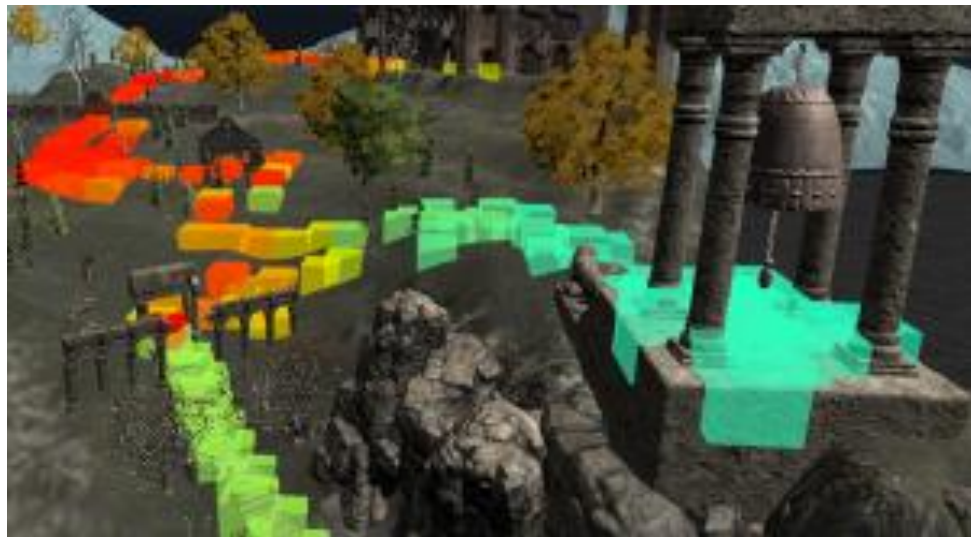
- In order to work with telemetry data, the attribute data needs to be *operationalized*.
- This means deciding a way of expressing the attribute data.
 - For example, deciding that the locational data tracked from player characters (or mobile phone users) should be organized as a number describing the sum of movement in meters

<https://gameanalytics.com/blog/what-is-game-telemetry.html>

Heatmaps

GAMING
INSPIRES

- Visualize what happens in your game
- For example, you can visualize that area inside your game where most of the players died.
- From that data, you can decide if certain level needs some changes or maybe that was exactly what you expected.

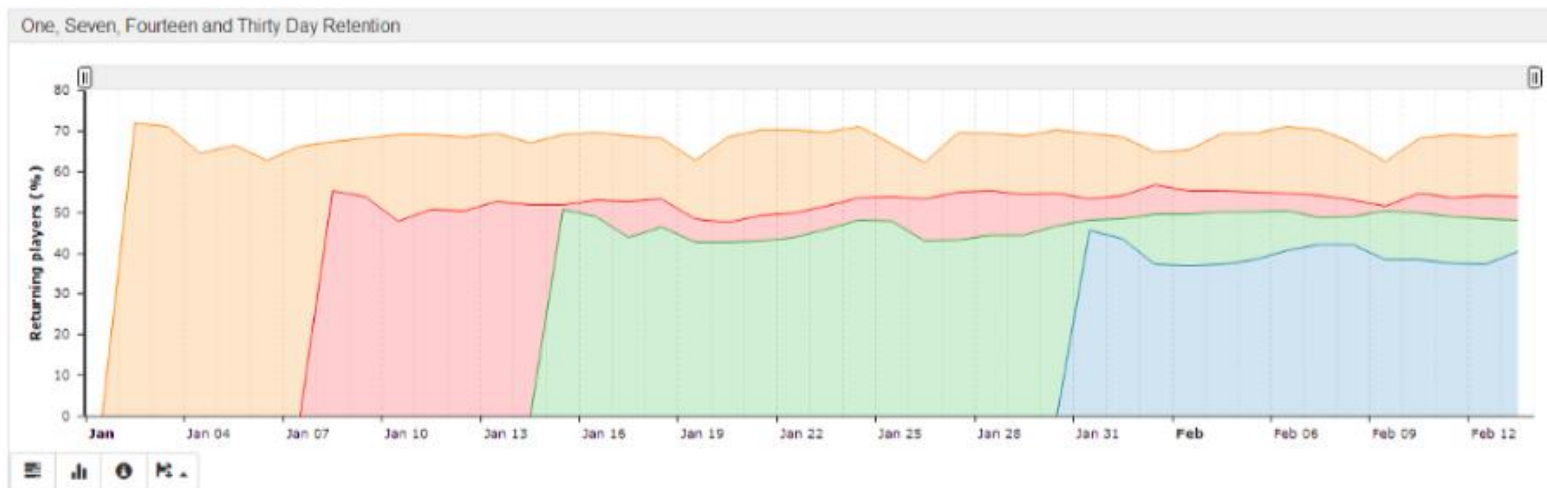


<https://gamedevelopertips.com/game-analytics-analyze-games/>

Tools: DeltaDNA



- The Analyze section contains tools that run SQL analytics queries against the Vertica Data Warehouse to build custom charts and reports
- <https://docs.deltadna.com>



Other Tools



Game Analytics

- <https://gameanalytics.com>

Google Analytics for Firebase

- Event-based data model
- <https://firebase.google.com/docs/analytics>
- <https://www.bounteous.com/insights/2018/02/20/choosin-g-between-firebase-and-google-analytics-sdks-app-tracking/>

Quantitative Balance Analysis



- Automated analysis
 - Evaluate games without the use of any human players at all
 - Examples
 - Tree Search
 - Genetic Programming
 - Differential Evolution Optimization
 - Clustering
 - Procedural Content Generation
 - Reinforcement learning and Q-Learning.

Automated analysis



Player Modelling

1. Timing Accuracy
2. Aiming Accuracy
3. Strategic Thinking
4. Inequity Aversion
5. Learning

<http://game.engineering.nyu.edu/wp-content/uploads/2015/04/isaksen-thesis-FINAL-2017-05-01A.pdf>

Tools



Appium

- <http://appium.io>
- <https://www.youtube.com/watch?v=WFBfRk-GLRo>

Detox

- <https://medium.com/reactive-hub/detox-vs-appium-ui-tests-in-react-native-2d07bf1e244f>

Tools



The Build Verification System Development (BVS-Dev)

- Automated Testing for LOL (League of Legends)
- <https://technology.riotgames.com/news/automated-testing-league-legends>

Prowler.io

- <https://www.prowler.io/blog/ai-tools-for-automated-game-testing>

T-Plan Limited

- <https://www.t-plan.com/game-test-automation/>

Case Study : Candy Crush



There are currently 5000 levels in Candy Crush and Players have spent 73 billion hours – or 8.3 million years – playing Candy Crush Saga since its launch in 2012



Case Study : Candy Crush

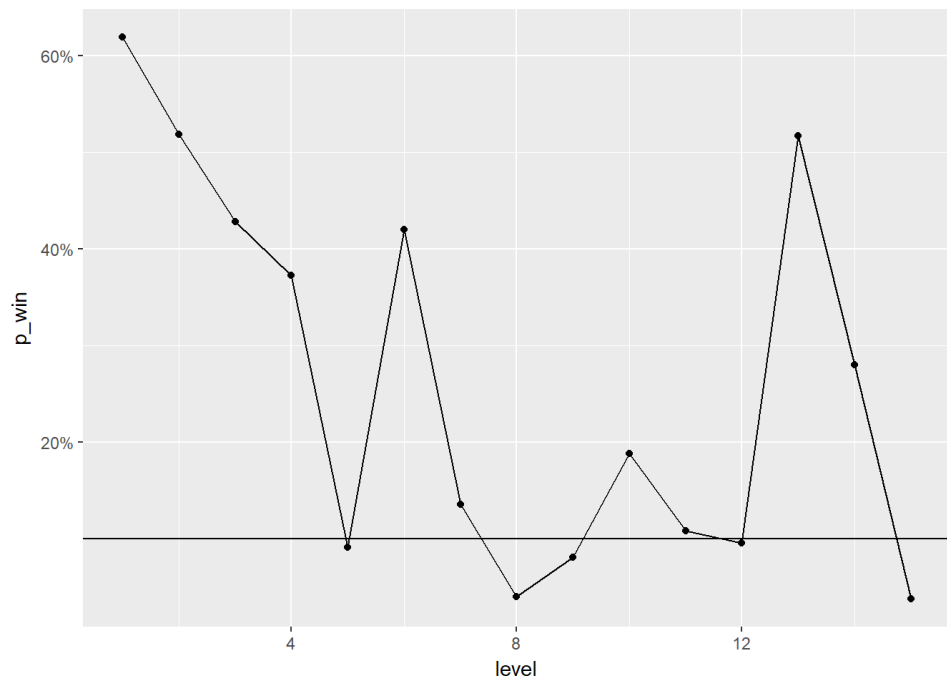


Difficulty code summary (details [here](#))

None · Very Easy · Easy · Somewhat Easy · Medium · Somewhat Hard · Hard · Very Hard · Extremely Hard · Nearly Impossible · Variable

Whole-world 1

E1	1	2	3	4	5	6	7	8	9	10					
E2	11	12	13	14	15	16	17	18	19	20					
E3	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
E4	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
E5	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
E6	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
E55	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815
E56	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830
E57	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845
E58	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860
E59	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875
E60	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890



Candy Crush Level Difficulty Profile (Sample Sets)

Case Study : Candy Crush



- It used to discovered that almost all of the people who stopped playing did so after failing to make it past level 65.
- The information was passed on to the game design team, which made some coding tweaks to remove one particularly difficult element in that level.
- Success rates went up, and more players stuck with the game longer



Case Studies: Battle Island



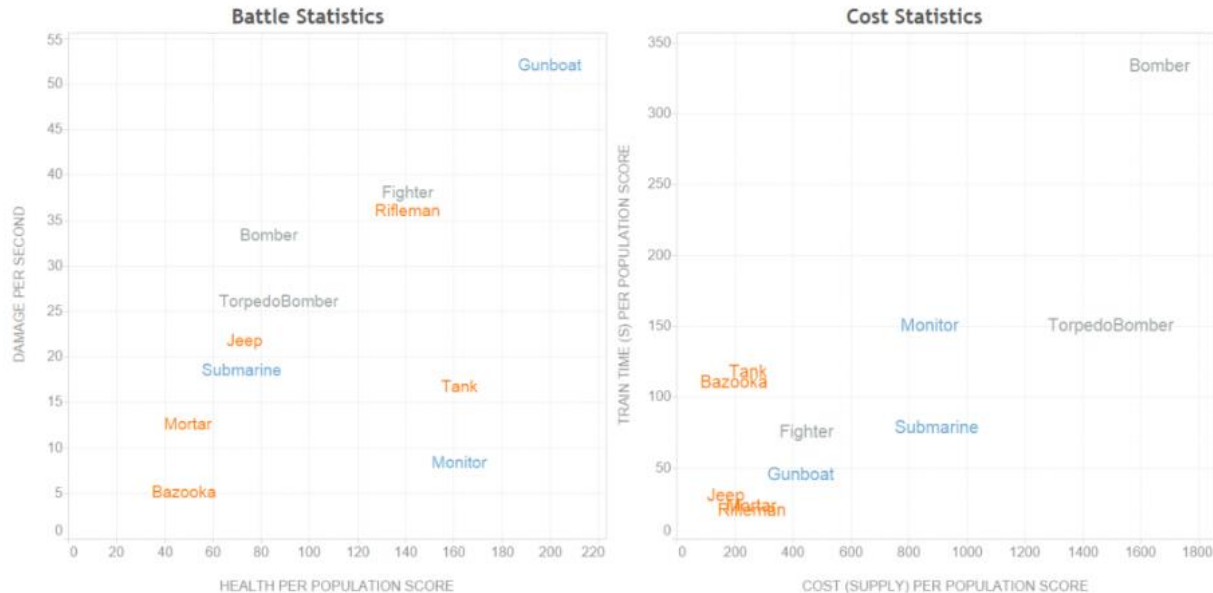
- Battle Islands is WW2-themed battle strategy game
 - Battle Islands has three types of unit; Army, Navy and Air Force
 - The army is the first unit type available in Battle Islands, where the Rifleman gets introduced within the tutorial and opening sequence.
 - https://battleislands.fandom.com/wiki/Battle_Islands_Wiki



Case Studies: Battle Island



- Battle versus Cost Statistics
 - Certain units seem to offer high military power (gunboat, fighter, rifleman etc) at a very moderate cost.



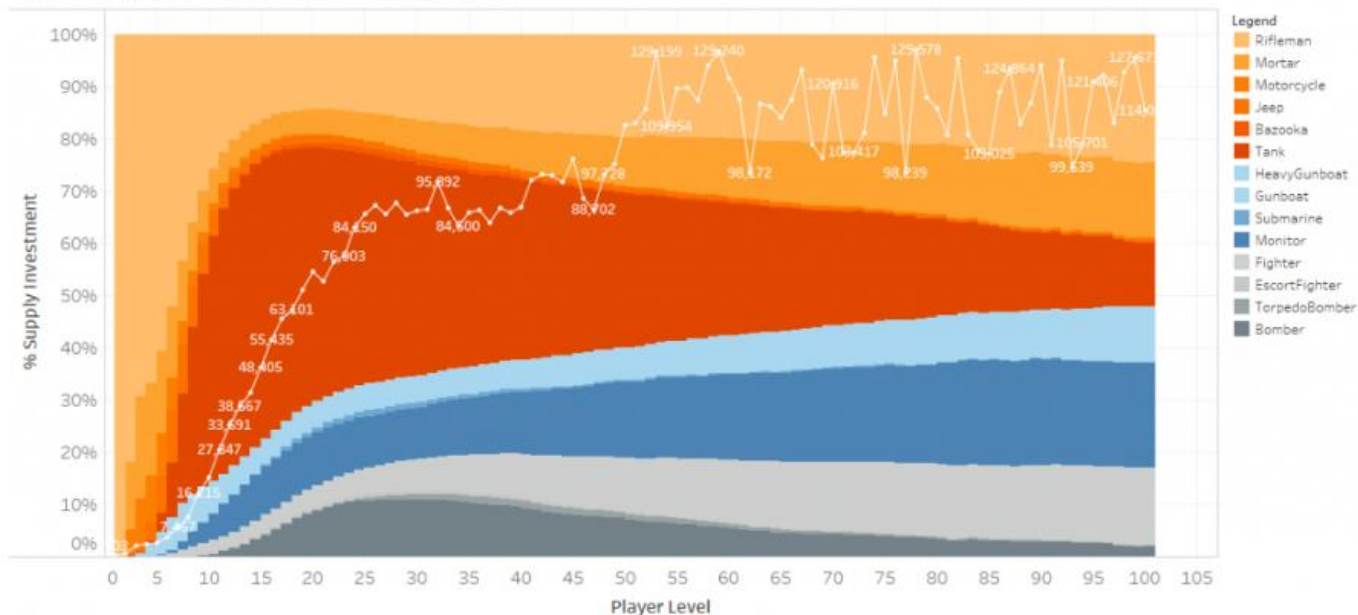
Case Studies: Battle Island



The investment of players toward the different units in the game at all stages of progression (from level 1 to level 100)

The average gain per battle tends to stabilize after level 20. Players prefer to create armies of riflemen to target low-level players, instead of creating stronger units to attack the higher-level players. This prevents players from investing in new units, so it offer insights that the power of rifleman needs to be rebalanced.

Player Supply investment on Units along Levels



Case Studies: Battle Island



Looking into the user's retention, 35% of them leave the game after just 3 days.

- Many paying players left the game at HQ4, without reaching HQ5.
- To re-balance this, we implemented a game feature which increased player gains at HQ4.
- A 'division bonus system' was unlocked at HQ4 in the game, which gave additional supplies to the player in case of a PVP victory, and which ramps-up with the progression of the player.
- This incentivize the player toward PVP, to give a sense of progression and make up for the steep cost curve of the game.



Case Study : Flappy Bird



- Adopt AI to Generate the dataset for modifying the game parameters in Flappy Bird

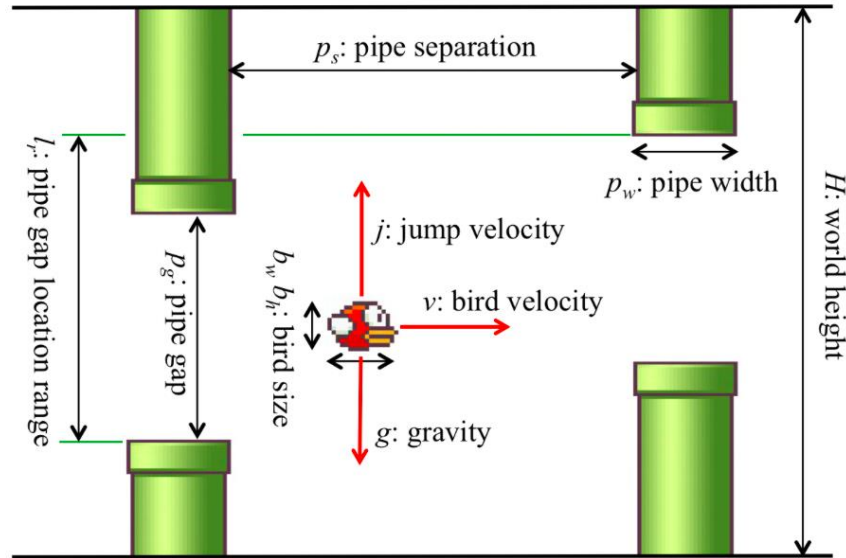
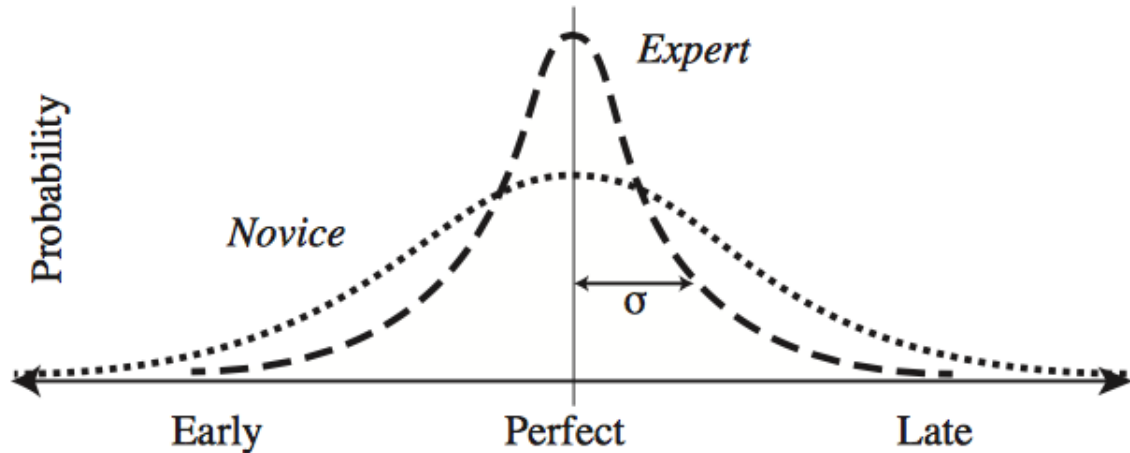


Figure 2.2: Game space parameters for *Flappy Bird*.

Case Study : Flappy Bird



- Create player modelling to analyse the game
- When a player plans to press a button at an exact time, they execute this action with some imprecision.
- This error can be modelled as a normal distribution with standard deviation proportional to a player's imprecision



Case Study : Flappy Bird



- Imperfect precision is modelled in AI by calculating an ideal time t to flap, then adding to t a small perturbation ϵ , drawn randomly from a normal distribution $\mathcal{N}(0, \sigma_p)$ with 0 mean and standard deviation σ_p
- By increasing the standard deviation σ_p , the AI plays less well and makes more errors, leading to a higher difficulty estimate.

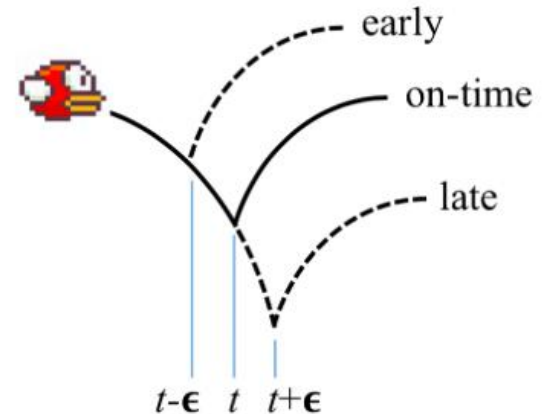
Using the definition of a CDF of a normal distribution [125], we can solve for σ_D :

$$\text{CDF}(x, \mu_D, \sigma_D) = \frac{1}{2} \left[1 + \text{erf} \left(\frac{x - \mu_D}{\sigma_D \sqrt{2}} \right) \right] \quad (4.1)$$

$$\delta \leq \text{CDF}(\mu_D + \epsilon, \mu_D, \sigma_D) - \text{CDF}(\mu_D - \epsilon, \mu_D, \sigma_D) \quad (4.2)$$

$$\delta \leq \text{erf} \left(\frac{\epsilon}{\sigma_D \sqrt{2}} \right) \quad (4.3)$$

$$\sigma_D \leq \frac{\epsilon}{\sqrt{2} \text{erf}^{-1}(\delta)} \quad (4.4)$$



Case Studies : Fantasy Game x 100s



- 100s per game session
- Collect real time data for fantasy game
- Gather and analyze the change in players' performances
- Adjust the game parameters in response to players performance to maintain the excitement.
- Finance and sports related scenarios



GoWhale

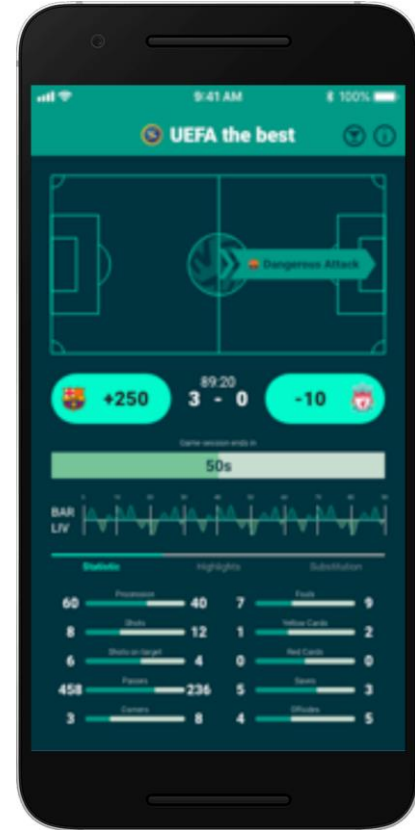
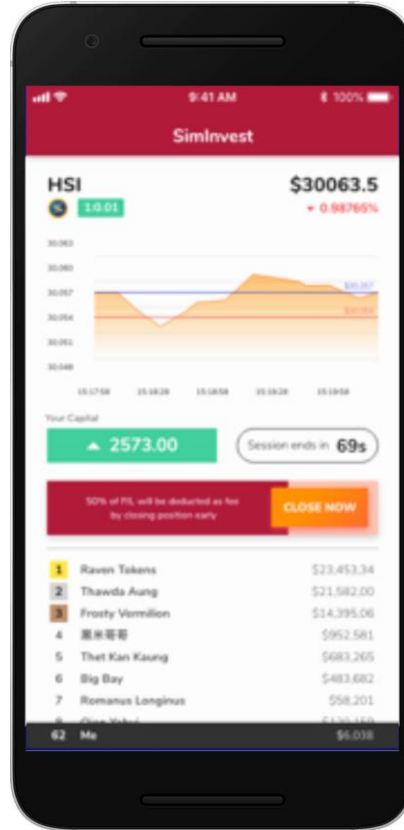
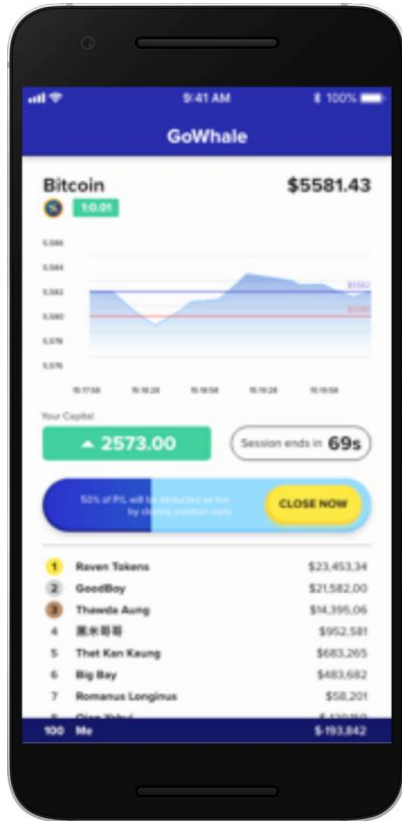


SimInvest



FFF
Football Fan Fantasy

Case Studies : Fantasy Game x100s



OneZone



- Cross play across a wide array of gaming apps
- Online Gaming, Offline Redemption
- Business Model: Franchise
 - Create synergy between gaming apps
- <http://onezone.io>

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