Idle Capitalist

Idle Capitalist is an idle clicker game inspired by [AdVenture Capitalist](#) in which the player invests funds into certain businesses to generate revenue. The project was created for educational purposes as part of James' **#GameInAWeek** challenge and is released freely under an MIT license. It may be of interest to those looking for a starting point in creating an idle game in Unity for mobile. Bugs and feedback welcomed! [@defuncart](#)

Game Mechanics

Incremental games (also known as idle or clicker games) are video games whose gameplay consists of the player performing simple actions such as clicking on the screen repeatedly to earn currency (Wikipedia). In *Idle Capitalist* the player invests funds into certain businesses to generate revenue, starting out with a single lemonade stand. This section will discuss in brief the various game mechanics used throughout the game.

Business

A Business generates revenue either by the player manually clicking[1] or by assigning a manager. Purchasing more than one business (i.e. leveling up) multiplies the earnings linearly. Earnings can be increased further by buying or earning Upgrades (discussed later). Here is a summary of the key parameters:

Term	Explanation
Initial Cost	The initial cost in dollars to unlock the business.
Cost Multiplier	A constant multiplier which increases the cost to upgrade the business to the next level.
Initial Time	The time in seconds it initially takes to produce one unit.
Time Multiplier	A multiplier (raised to the power of level) which reduces the time taken to produce a unit.
Initial Profit	The initial profit in dollars from producing one unit.
Profit Multiplier	A multiplier which increases the profit from producing one unit. This will be discussed in more detail below.
Milestone	When a business reaches level 25, 50, 100, 200 etc., the business is said to have reached a milestone.
Cash Per Second	This is the cash earned per second by the business. It is displayed on screen after being unlocked by hiring an 'efficient' Manager.

Idle Capitalist utilizes the same parameters as *AdVenture Capitalist* (Wikia 2018), however time multiplier is a per-level increase as opposed to a milestone increase.

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[1] Clicking on a business, starts a timer. When this timer runs out, the businesses produces a unit with an assigned profit. Each business (regardless of level) can only produce a single unit at any given time.

Time

At level **X**, the time to produce one unit is given by

$$TIME_X = T_o \times (T_M)^X$$

where T_0 is the initial time required and T_M is the time multiplier. Note that T_M defaults to $\sqrt[25]{\frac{1}{2}}$. Thus at level 25, multiplier is 0.5 (twice as fast), at level 50, multiplier is 0.25 (four times as fast) etc. At level 166 the time to produce an additional unit becomes virtually zero (0.01).

Costs

At level **X**, the cost to upgrade the business to the next level is given by

$$COST_X = C_0 \times (C_M)^X$$

where C_0 is the initial cost and C_M is the cost multiplier. This formula can be verified by using the Lemonade Stand business from AdVenture Capitalist where C_0 = 3.738318 and C_M = 1.07.

Level 1	4	Level 2	4.28	Level 3	4.58	Level 4	4.90	Level 5	5.24
Level 6	5.61	Level 7	6.00	Level 8	6.42	Level 9	6.87	Level 10	7.35

For instance, $C_1 = C_0 \ast C_M$, that is 4 = 3.738318 * 1.07. Likewise, $C_2 = C_0 \ast (C_M)^2$, that is, 4.28 = 3.738318 * 1.07² (or 4 * 1.07).

Cost to Upgrade by Y Levels

So at Level **X**, the cost to upgrade by **Y** number of levels would be

$$\sum_{n=X}^{Y} C_0 \times (C_M)^n$$

For instance,

$$\sum_{n=1}^{3} = C_0 \times C_M + C_0 \times C_M{}^2 + C_0 \times C_M{}^3 = C_0 \times (C_M + C_M{}^2 + C_M{}^3)$$

$$= 3.738318 \, (1.07 + 1.07^2 + 1.07^3) = 12.86 \qquad \text{or simply} \qquad 4 + 4.28 + 4.58 = 12.86$$

This sum can be alternatively written as

$$COST_Y = C_0 \times \frac{C_M{}^X \times (C_M{}^Y - 1)}{C_M - 1}$$

which is computationally easier to calculate than a summation loop (Pecorella 2016). As Idle Capitalist allows the appointment of managers which can reduce costs, the final formula is then

$$COST_Y = C_0 \times \frac{C_M{}^X \times (C_M{}^Y - 1)}{C_M - 1} \times (1 - R)$$

where $0 \leq R < 1$ is the cost reduction rate. As costs can never be zero, **R** must be less than one.

Maximum Number of Levels Player Can Upgrade By

Another useful formula discussed in (Pecorella 2016) is the maximum number of levels that the player can upgrade their business by given **CASH** amount of dollars:

$$MAX_Y = floor(log_{C_M}(C_M{}^X - CASH \times \frac{1-C_M}{C_o}) - x)$$

Rearranging and incorporating reduced costs by the appointment of an 'efficient' manager, this formula becomes

$$MAX_Y = floor(log_{C_M}(\frac{CASH \times (C_M - 1)}{C_0 \times (1-R) \times C_M{}^X} + 1))$$

Profit

At level **X**, the profit from producing one unit is given by

$$PROFIT_X = (P_0 \times X) \times P_M$$

where P_0 is the initial profit and P_M is the profit multiplier. Unlike cost or time, profit multiplier isn't a constant, instead a combination of factors unlocked throughout the lifespan of the game. The actual profit multiplier formula is

$$P_M = MS_M \times UG_M \times PS_M$$

where MS_M is the total milestone multiplier, UG_M is the total upgrade multiplier and PS_M is the total prestige multiplier. The rest of this section will discuss these multipliers in detail.

Milestone

When a business reaches a milestone, the player receives a profit multiplier. One approach would be to simply double the multiplier at each milestone. However, this has the side effect of relegating older businesses to being largely irrelevant as newer ones dominate once purchased. To illustrate this point, let's considers a log scale of profits from the first five businesses of AdVenture Capitalist (Pecorella 2016).

Level	Business 1	Business 2	Business 3	Business 4	Business 5
25	x2	x2	x2	x2	x2
50	100	x2	x2	x2	x2	x2

Total Profit for Each Business Type
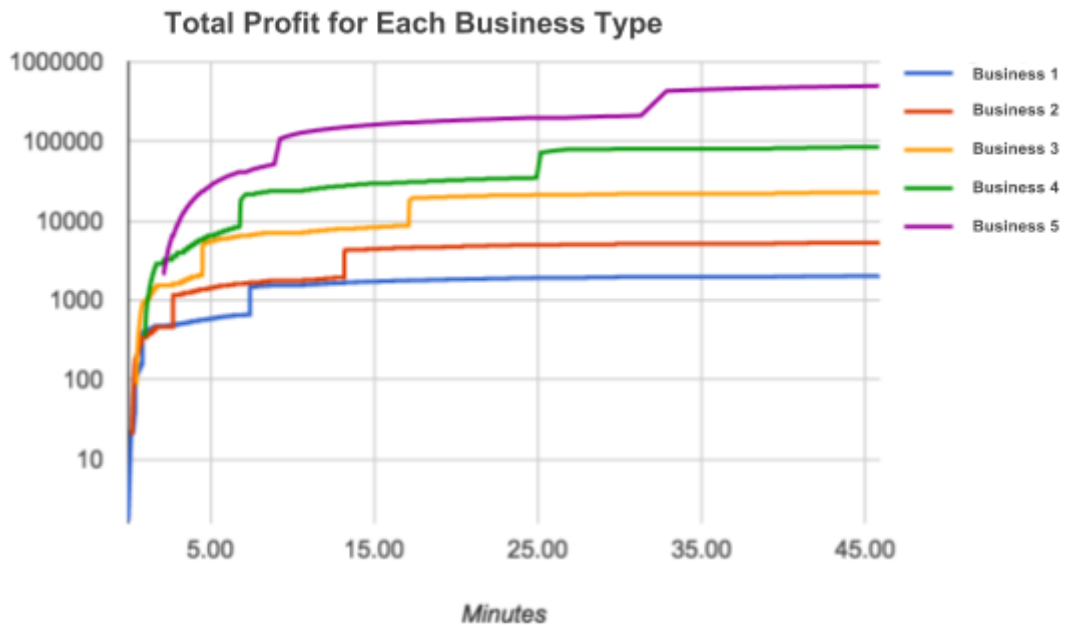
Clearly once a new business is bought, it is not financially worthwhile to continue upgrading the older businesses. This isn't a very interesting game mechanic. If we instead modify these multipliers, we can create a very different scenario (Pecorella 2016).

Level	Business 1	Business 2	Business 3	Business 4	Business 5
25	x3	x5	x4	x2	x1.5
50 | 100	x2 | x10	x10	x8	x2	x2

Total Profit for Each Business Type
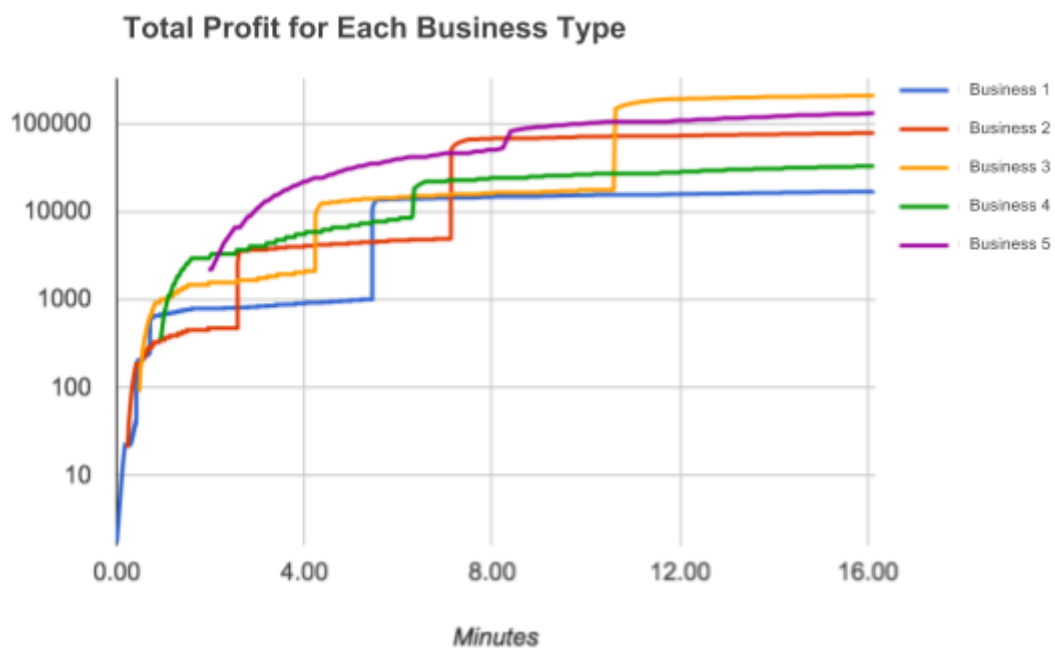
Now as the player progresses through the game, different businesses take priority by having the larger impact on profits.
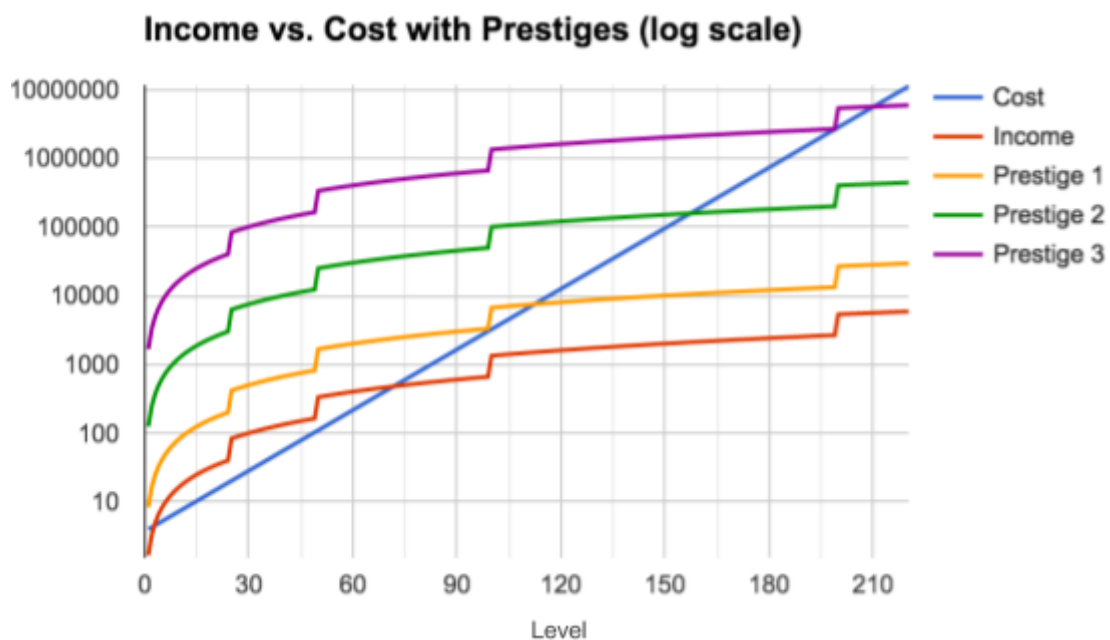
Upgrades

At any time, players can choose to buy an upgrade for a one-off price. These upgrades increase the profits of a business by a multiplier, or the profits of all businesses by a multiplier. Note that these upgrades are cumulative. Thus if the player buys a x3 upgrade and subsequently later a x5 upgrade, then cumulatively the player would have a x15 multiplier.

Prestige

Profit increases linearly while costs increases exponentially. This means that early in the game the player the earning much more per second than the cost of upgrading, however costs will eventually become overwhelming, to the point that the time to upgrade to the next level would become prohibitively long.

The solution to this problem is a prestige system in which the player can reset their game progress in return for a special multiplier which will boost their profits on the next playthrough. Consider the following graph (Pecorella 2016):

Here we can see that around Level 70, the cost to upgrade to the next level becomes higher than the profit received from this upgrade (red income curve). However, if the player reset their game data for a special x2 profit multiplier, on the next play through they could reach roughly Level 100 become costs exceed profit. The result is that each prestige allows the player to get farther through the cost curve before falling behind.

Thus the player should prestige when

1. Each business is already unlocked
2. The cost to upgrade each business to the next level is greater
    than the profits the business would receive from this level

with the added constraint that the business's level is at least five or higher[2].

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[2] This is because **1.** we only want the player to prestige when they are sufficient far into the game and **2.** because for the few levels costs is generally higher than profit.

Prestiging (i.e. *New Game+* in which the player resets their game data for a large bonus) is often tied to a separate currency as this transforms exponential growth back into linear. In *Idle Capitalist* there is only one form of currency and the player receives a double of profits for each business on each prestige.

Cash Per Second

At level **X**, the business' cash per second is given by

$$CPS_X = \frac{PROFIT_X}{TIME_X}$$

where $PROFIT_X$ and $TIME_X$ are the profit from producing a unit and time produce a unit respectively.

Managers

Like upgrades, at any point the player may choose to hire an *manager* for a one-off sum. However unlike upgrades which increase profits, a manager 'takes control' of the business thus automating the unit produce procedure and saving the player the effort of repeated clicking. Along with these 'standard' managers, there are 'efficient' managers which show the business' *Cash Per Second* and reduce costs by 10%.

Offline Earnings

Offline earnings occur between gaming sessions when the app is closed/backgrounded. For this to occur, the player needs to have a manager running the business. These offline earnings is the simply

$$PROFIT_{OFFLINE} = \sum^{business} CPS \times TIME_{OFFLINE}$$

that is, the sum of the product of cash per second and time offline for each business. These offline earnings are a good instant reward for when the player opens the game, however they should receive the same profits as if they had been playing the game 'online'. To satisfy this, we multiply by a multiplier **OM**, where **0 < OM < 1**. In addition, we can set a maximum offline time limit.

Reset

When the player prestiges, a *soft reset* is done in which almost all of the player's progress (money, businesses, managers, upgrades and milestone multipliers) is removed, only prestige multipliers are persisted. There is no option to perform a *hard reset*.

Implementation

Idle Clicker is written in C# using Unity 2017.2. The project utilizes a number of principles explained in more detail in various **#50-Unity-Tips** articles (Leahy 2017-2018). These include, but are not limited to, *Binary Serialization*, *JSON Serialization*, *Singletons*, *LocalizationManager*, *iOS Launch Screen*, *Custom Popups* etc. For more info see **README.md**.

Game Design

Due to the time constraints of developing *Idle Capitalist* within a week, there is no game balancing, instead most of the following data is taken from Wikia (2017) and Pecorella (2016, 2016-2017).

Business

Firstly here is the business data

Business	Initially Unlocked	Initial Cost ($)	Cost Multiplier	Initial Time (s)	Initial Profit ($)	Max Level
Lemonade Stand	Yes	3.738	1.07	0.6	1	200
Newspaper Delivery	No	60	1.15	3	60	200
Car Wash	No	720	1.14	6	540	200
Pizza Delivery	No	8640	1.13	12	4320	200
Fish Boat	No	103680	1.12	24	51840	200
Beer Brewery	No	1244160	1.11	96	622080	200

with the following profit multipliers on milestone reached.

Milestone	Lemonade Stand	Newspaper Delivery	Car Wash	Pizza Delivery	Fish Boat	Beer Brewery
25	x3	x5	x4	x2	x1.5	x1.25
50	x2	x10	x8	x2	x2	x1.5
100	x10	x3	x4	x3	x2	x2
200	x3	x2	x2	x2	x2	x2

NOTE: The game starts with a single free lemonade stand, and the second stand has a price of 4$. As far as formulas are concerned, the first stand has a price equivalent to 4/1.07 ≈ 3.738$.

Managers

The following are the various available purchasable managers:

Name	Description	Cost ($)
Daria Morgendorffer	Runs Lemonade Stand	1000
Lois Lane	Runs Newspaper Delivery	15000

Walter White	Runs Car Wash	100000
Philip J. Fry	Runs Pizza Delivery	500000
Forrest Gump	Runs Fish Boat	1200000
Homer Simpson	Runs Beer Brewery	10000000
Rodger Smith	Beer Brewery 10% Cheaper and shows Cash Per Sec	111111111
Mama Shrimp	Fish Boat 10% Cheaper and shows Cash Per Sec	555555555
Papa John's	Pizza Delivery 10% Cheaper and shows Cash Per Sec	1000000000
Skyler White	Car Wash 10% Cheaper and shows Cash Per Sec	10000000000
Clark Kent	Newspaper Delivery 10% Cheaper and shows Cash Per Sec	100000000000
Wilma Flintstone	Lemonade Stand 10% Cheaper and shows Cash Per Sec	1000000000000

Upgrades

The following are the various available purchasable upgrades:

Name	Description	Cost ($)
Little Umbrellas	Lemonade Stand profit x3	250000
Funny Pages	Newspaper Delivery profit x3	500000
Drive Through Wash	Car Wash profit x3	1000000
Robot Cars	Pizza Delivery profit x3	5000000
Fish Satellite	Fish Boat profit x3	10000000
Happy Hour	Beer Brewery profit x3	25000000
Monopoly	All profits x3	500000000
Novelty Straws	Lemonade Stand profit x3	10000000000
Sports Pages	Newspaper Delivery profit x3	50000000000
Automatic Vacuums	Car Wash profit x3	250000000000
Online Ordering	Pizza Delivery profit x3	1000000000000
Fish Magnets	Fish Boat profit x3	20000000000000
Craft Beer	Beer Brewery profit x3	5000000000000
Monopsony	All profits x3	100000000000000

Other

Offline Profits: Max Time	2 hrs
Offline Profits: Retain Multiplier	5%
Prestige Multiplier	x2

References

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