Warcraft III Tower Balancer by Aphotica
Algorithm Analysis

Discord: https://discord.gg/Qsg6UDn

1. Introduction

This tool provides dynamic calculations to balance tower data sets on Warcraft III by considering various attributes such as damage, attack rate, range, splash damage, spell effects, and utility modifiers. The calculations return a given towers DPS per gold and compares it to all respective towers in a data set to determine if it is balanced, overpowered, or underpowered.

2. Algorithm Steps with Equations and Variable Calculations

Step 1: Average Damage Calculation

avg_damage = base_damage + (dice * (sides_per_die + 1) / 2)

Step 2: Hits Per Second

hits_per_second = 1 / cooldown

Where cooldown is the time between each attack, so hits per second = attack frequency.

Step 3: Base DPS Calculation

base_dps = avg_damage * hits_per_second

This is the damage output per second based on average damage and attack frequency.

Step 4: Range Modifier

range_adjustment = 1 + ((range_val - 200) / (max_range - 200)) ^ n

range_adjusted_dps = base_dps * range_adjustment

range_val = tower's range

max_range = maximum range of a tower in the data set

n (0.6) adjusts steepness of DPS scaling.

The range modifier proportionally increases DPS for longer-ranged towers.

Step 5: Splash Damage Contribution

total_splash_dps = ((full_splash / 100 * range_adjusted_dps) + (medium_splash / 100 * range_adjusted_dps * 0.5) +(small_splash / 100 * range_adjusted_dps * 0.25)) * splash_multiplier

range_adjusted_dps = base_dps * range_adjustment

splash multiplier = the # of units hit in each zone (default: 1.2)

splash percentages are specified for each level.

Step 6: Spell DPS Addition

Spell DPS (if applicable) adds to total DPS based on:

special_dps = spell_dps / spell_dps_cooldown

Where spell_dps is the spell damage, and spell_dps_cooldown is its cooldown period.

Step 7: Poison Effect

Poison damage and slow effect are computed in two parts:

1. Poison DPS: ***total_poison_damage = poison_dps * poison_duration***.

2. Poison Slow: Effective speed of enemies is reduced by 30%, extending their time in range:

extra_time_poison = slow_duration * (1 / (1 - 0.3) - 1), where slow duration is the duration of poison.

Step 8: Additional Hits from Slow Effect

Slow effect prolongs enemy time in range, calculated as:

1) ***extra_time = slow_duration * (1 / (1 - slow_percentage / 100) - 1)***

2) ***slow_dps_contribution = (additional_hits * avg_damage) / slow_duration***

where ***additional_hits = extra_time * hits_per_second***

Step 9: Total DPS Calculation

total_dps = range_adjusted_dps + total_splash_dps + special_dps + slow_dps_contribution

This combines base DPS with splash, spell, slow, and poison effects for the total output.

Step 10: DPS per Gold

dps_per_gold = (total_dps / gold_cost) * 100

Calculates the efficiency ratio for each gold spent on the tower's cost.

DPS per gold is multiplied by 100 to achieve a whole number for easier and deeper analysis

3. Dynamic Balance Range Calculation

Outlier Removal (if enabled) excludes towers with DPS per Gold values outside ***1.5 * IQR***, where ***IQR = Q3 - Q1***.

Then, balance range is set around the mean:

mean_dps_per_gold *= filtered_group['DPS per Gold'].mean()*

std_dps_per_gold *= filtered_group['DPS per Gold'].std(ddof=0) or 10% of mean if std = 0.*

low_range *= mean_dps_per_gold - std_dps_per_gold*

high_range *= mean_dps_per_gold + std_dps_per_gold*

Scaling factor widens range for higher tower tiers: ***scaling_factor = 1 / (tower_num ^ 0.02)***.

Explanation:

1) Outlier Removal uses IQR to exclude extreme values, ensuring a balanced mean.

2) Standard Deviation defines accepted variation for DPS per Gold. If zero, a 10% variation of mean is used.

3) Scaling Factor widens the acceptable range slightly for towers with higher numbers, balancing increased strength with flexibility.

4. Determining Balance

Balance is determined when all three criteria are met:

1) A tower's DPS/Gold falls within the "balancing range" **(i.e. dynamic range of DPS/Gold among all equal towers)**

2) Z-Score between -1 and 1

3) Percentile Rank between 40% and 60%