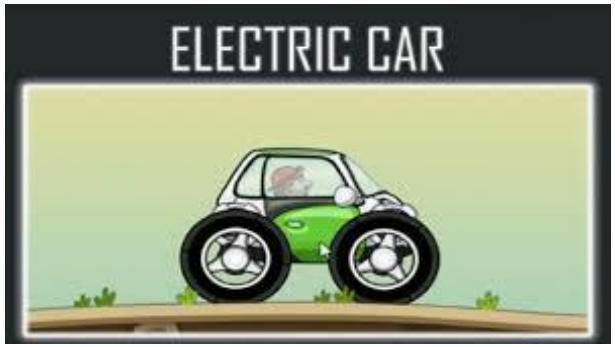
POSTER ID 13
STATISTICAL VIDEO GAME STEM

MASON CHEN



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PROBLEM STATEMENTS

- Kids are playing video games for too long
- Most video games are not developing critical thinking
- Parents do not want kids to play video games

OBJECTIVES

- Convert video games to STEM Projects
- Learn Science and Statistics while Playing Video Games

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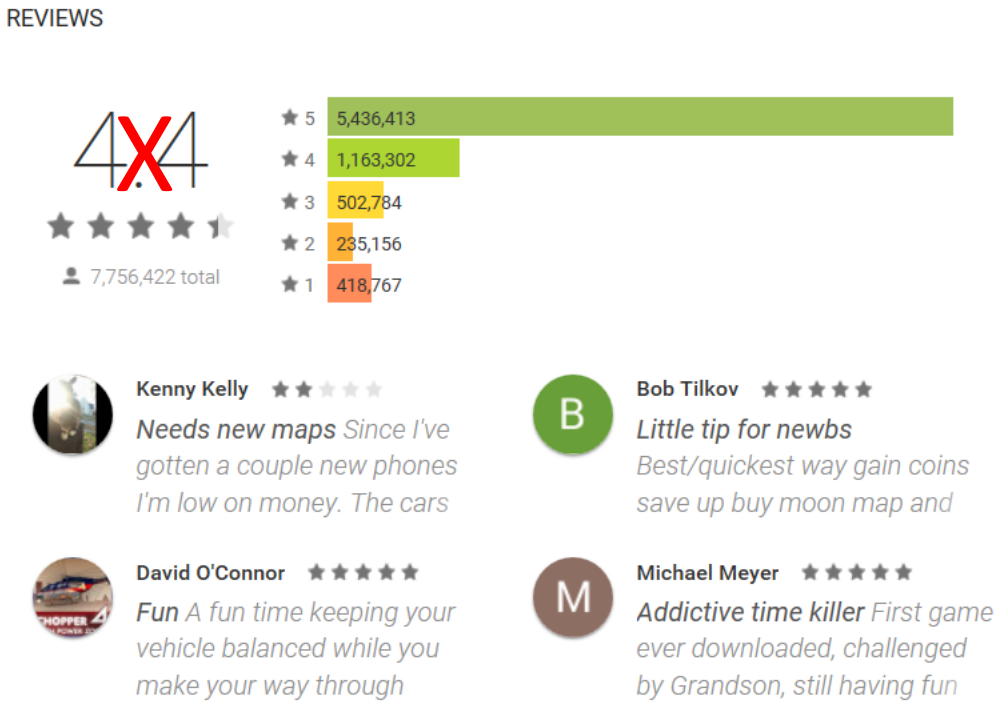
CHOOSE *RIGHT* VIDEO GAMES



Not based on the Commercial Rating (**4.4 Stars shown**), but based on potential of applying statistical Data-Driven problem solve approach

- Embedded Database : record mileage of each car for each stage, car technology upgrade status

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LITERATURE RESEARCH

The object of the game is to collect coins while driving through racing stages. Driving consumes gas, which players can replenish by picking up gas canisters along the way. The player "dies" if they run out of gas or hit the avatar's head on the ground. Coins may also be earned by performing "tricks", difficult maneuvers in the air, or by reaching set distances during given stages. Coins may be spent on vehicle purchases or upgrades, or to unlock new stages.

29 Different Cars

C(29, 1)* C(28,1)= 812 Pairing Combinations, time consuming if we will play “hard” not play “smart”

28 Different Stages

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TAKE STEM PROJECT APPROACH

- **Science**: Physics and Mechanics (Kinematics, Dynamics, Friction, Circular Motion, Energy, Work, Power, Momentum, Gravity…)
- **Technology**: Upgrade Engine, Tire, Suspension, Fuel, Battery, 4WD, Downforce, Boost, Screw …
- **Engineering**: Failure Modes, Systematic Root Cause and Problem Solving within (schedule, cost, quality) constraints
- **Math**: Geometry, Trigonometry, Statistics

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ENGINEERING FAILURE ANALYSIS

- Can not climb steep hills (power)
- Unstable over the bumps
- Slippery on Ice, Sands, Water, Mud (poor traction/friction)
- Can't survive less/excess gravity
- Poor Aerodynamics control
- Extreme Environment (Hot/Cold)
- Car is too tall or/and too long
- Toxic Pollution, Volcano Lava
- Run out of gas/energy
- Can't complete circular motion
- Poor Collision Momentum
- Poor Kinematics Control
- Not visible at Nights, Foggy

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LEARN SCIENCE AND TECHNOLOGY

- **Upgrade Engine**: result in power increase. Higher horsepower helps climb hills and make longer jumps
- **Upgrade Suspension**: lower weight point and improved shock absorption which can improve stability at high speeds and more stable on bumps
- **Upgrade Tires/Tracks**: result in better traction and better power delivery to the ground
- **Upgrade 4WD**: improve all wheel drive system. Result in better traction and better vehicle handling
- **Upgrade MID-AIR/Aerodynamics Control**: makes bike turn faster in mid-air and allow more control on landing
- **Upgrade Fuel/Battery**: improve the fuel tank size or energy efficiency, and make it possible to drive further
- **Upgrade Downforce**: push cars downwards at higher speeds. Improve traction.

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COLLECT RAW DATA

Car Type	Countryside	Seasons	Desert	Acrtic	Highway	Cave	Moon	Boot Camp	MARS
Rally Car	1003	1249	1122	1568	1587	1094	737	994	877
Hippie Van	849	2249	619	834	983	1023	499	503	360
Monster Truck	1023	1286	1064	806	1443	1030	482	996	428
Finger Screw	840	608	704	652	1024	995	498	507	898
Jeep	537	515	855	439	891	678	497	131	872
Motocross Bike	460	508	493	757	1096	647	608	370	627
Race Car	756	603	469	489	1049	915	487	253	423
Police Car	534	830	501	442	575	993	492	371	283
Super Diesel 4x4	692	527	411	443	983	995	498	366	604
Electric Car	404	373	502	542	1039	616	595	368	775
Onewheeler	606	191	412	399	485	458	351	170	432
Tractor	536	496	472	396	574	448	483	170	425
Quad Bike	608	348	475	280	496	656	473	153	449
Tourist Bus	443	226	473	393	526	140	483	169	251

Started with 14 cars and 9 stages and recorded the highest score for each combination

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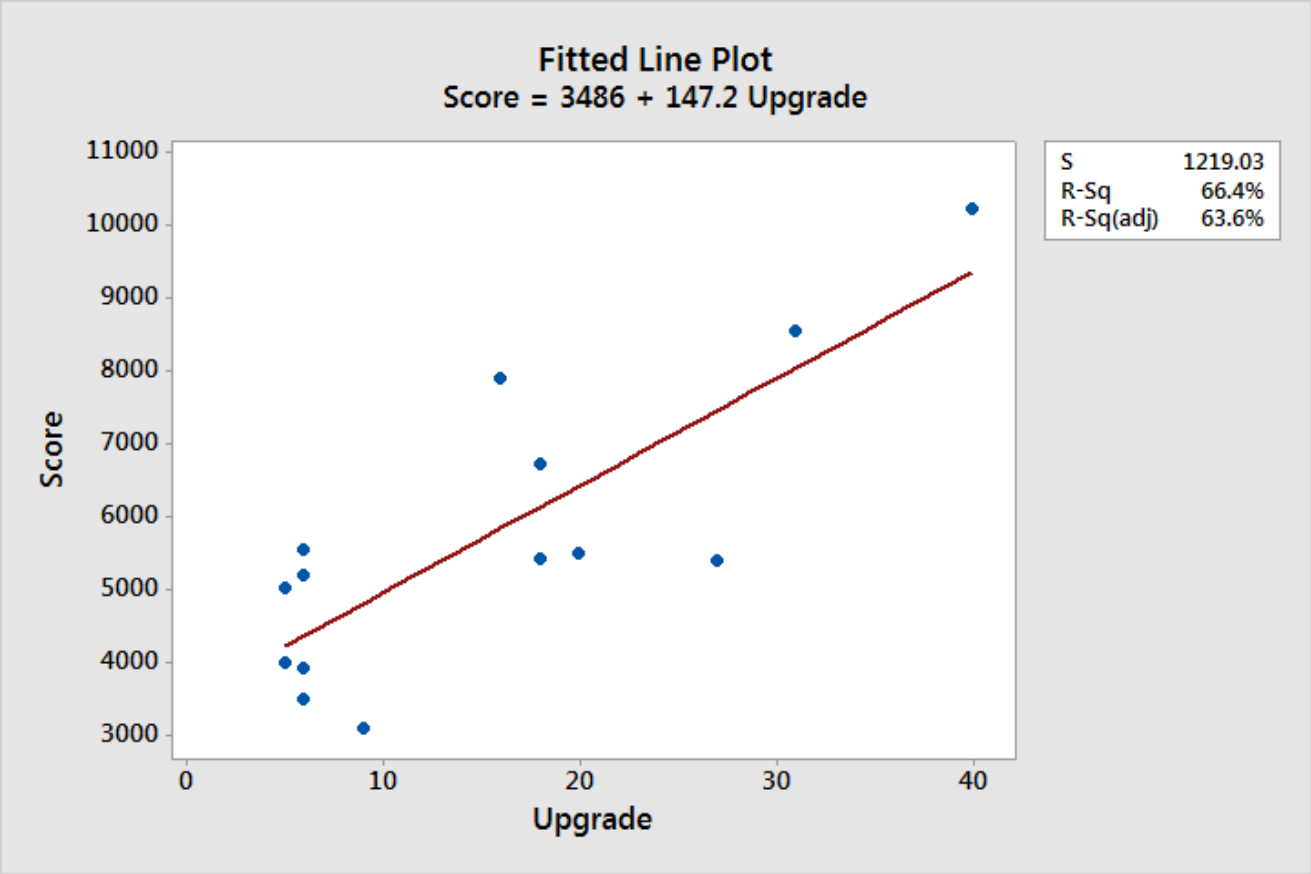
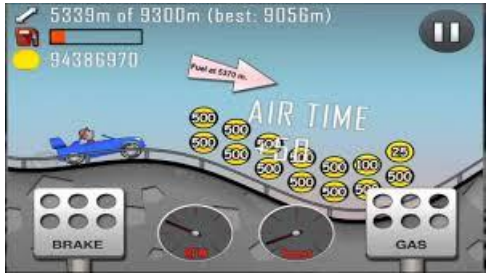
PROTOTYPE MODEL

Define Performance Index= Score (mileage)/ Upgrade Units

Performance Index= 147.2 Meter/Upgrade Unit





Predictive Model R-Square Accuracy is 66.4% (Not Very Accurate)

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CONDUCT ROOT CAUSE ANALYSIS

- Did not study the challenges for each stage
- Did not assign the right car to the right stage
- Did not upgrade the right technology for the right car
- Did not apply Science and Technology to resolve the Engineering Failure Modes
- Did not apply the Statistics to direct the upgrading strategy

DEVELOP SOLUTIONS

- Group Stages with similar challenges by Data Mining Clustering
- Develop Right Car for right Cluster Based on Performance Index
- Identify the Right Technology for each Stage Cluster and understand the Science behind the pattern

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HOW TO UPGRADE TECHNOLOGY

Strategy:

- Stage Challenges
- Upgrade Car
- STEM Approach

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DEVELOP *RIGHT* CAR FOR *RIGHT* STAGES

Car Type	Field A	Field B	Field C
Rally Car	3346	5271	1614
Hippie Van	4121	2939	859
Monster Truck	3339	4309	910
Finger Screw	2443	2887	1396
Jeep	1730	2316	1369
Motocross Bike	1615	2716	1235
Race Car	2274	2260	910
Police Car	2357	1889	775
Super Diesel 4x4	2214	2203	1102
Electric Car	1393	2451	1370
Onewheeler	1255	1466	783
Tractor	1480	1612	908
Quad Bike	1612	1404	922
Tourist Bus	809	1561	734

Field A (Hills and Collision): Countryside, Seasons, Cav, Mountains, Xmas, Forest

Field B (Traction and Friction): Desert, Arctic, Beach, Artic Cave, Boot Camp, Mudpool, Highway

Field C (Gravity and Circular Motion): Moon, MARS, Alien Planet, Roller Coaster, Rainbow

- Group similar stages into the same field (A, B, C)
- Repopulate the score distribution in the new fields
- Assign and split cars into fields

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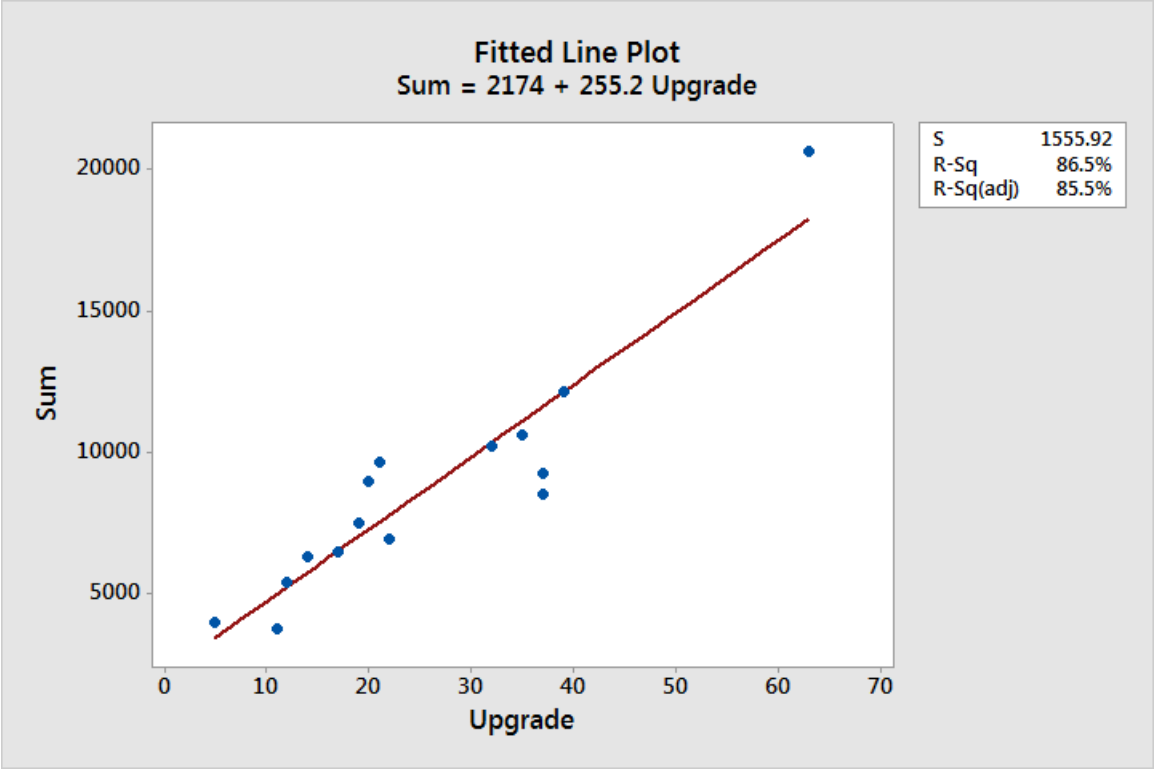
OPTIMUM MODEL

Performance Index= 255.2 Meter/Upgrade Unit (70% Improvement from 147.2)



Predictive Model Accuracy R-Square is 86.5% from 66.4%

Significantly improved the Performance Index and Model Accuracy

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MODEL BENCHMARKING

Literature Reference: Best vehicles

Countryside - Tank
Desert - Tank
Arctic - Tank
Highway – Race car
Cave – Rally car
Moon - Tank
Mars – Rally car
Alien Planet - Hovercraft
Arctic Cave - Snow Mobile
Forest – Truck or Tractor
Mountain - Tank
Mud pool - Tank
Volcano - Tank
Beach - Hovercraft
Roller coaster – Race car
Night - Tank
Rooftops - Race car / Dragster

Our Results

- ✓ Country Side- Tank
- ✓ Desert- Tank
- ✓ Artic- Tank
- ❖ **Highway- Tank (Race Car 2nd)**
- ✓ Cave- Rally Car
- ✓ Moon- Tank
- ✓ MARS- Rally Car
- ✓ Alien Planet- Hovercraft
- ❖ **Arctic Cave- Tank (Snow Mobile 2nd)**
- ✓ Forest- Truck
- ✓ Mountain- Tank
- ✓ Volcano- Tank
- ❖ **Beach- Tank (Hovercraft 2nd)**
- ✓ Roller Coaster- Race Car
- ✓ Night- Tank
- ✓ **Rooftops- Tank (Race Car not good)**

Match 12/16 predictions from the reference

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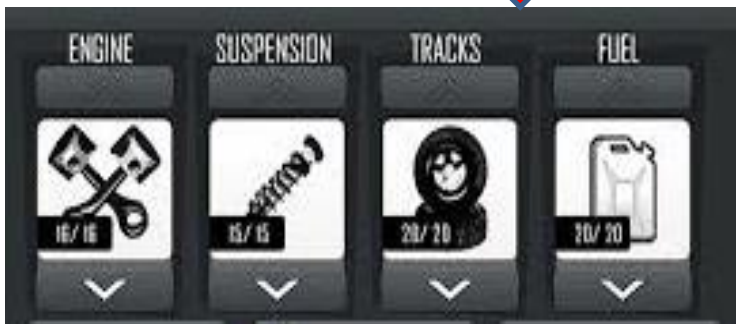
WHY TANK IS THE BEST

(HIGH POWER, HIGH TORQUE, TRACK DESIGN)

Vehicle		Power output	Power/weight	Torque
Mid-sized car	Toyota Camry 2.4 L	118 kW (158 hp)	79 kW/t (106 hp/t)	218 N·m (161 lbf·ft)
Sports car	Lamborghini Murciélago 6.5 L	471 kW (632 hp)	286 kW/t (383 hp/t)	660 N·m (490 lbf·ft)
Racing car	Formula One car 3.0 L	710 kW (950 hp)	1,065 kW/t (1,428 hp/t)	350 N·m (260 lbf·ft)
Main battle tank	Leopard 2, M1 Abrams	1,100 kW (1,500 hp)	18.0 to 18.3 kW/t (24.2 to 24.5 hp/t)	4,700 N·m (3,500 lbf·ft)
Locomotive	SNCF Class T 2000	1,925 kW (2,581 hp)	8.6 kW/t (11.5 hp/t)	

Continuous Track

The large surface area of the tracks distributes the weight of the vehicle better than steel or rubber tires , enabling tank to traverse soft ground with less likelihood of becoming stuck due to sinking.



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CONCLUSIONS

- Integrate Science, Technology, Engineering, and Mathematics in one ASA Poster STEM Project
- Group similar stages and assign the right cars
- Improve both Performance Index & Model Accuracy
- **Kids can play video games while learning statistics**

FUTURE WORK

- How to use fewer Cars to Cover all 28 Stages
- How to earn Money Faster at particular Stages

REFERENCES

https://play.google.com/store/apps/details?id=com.fingersoft.hillclimb&hl=en
https://en.wikipedia.org/wiki/Hill_Climb_Racing_(video_game)

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