Optimizing Car Production with Game Theory

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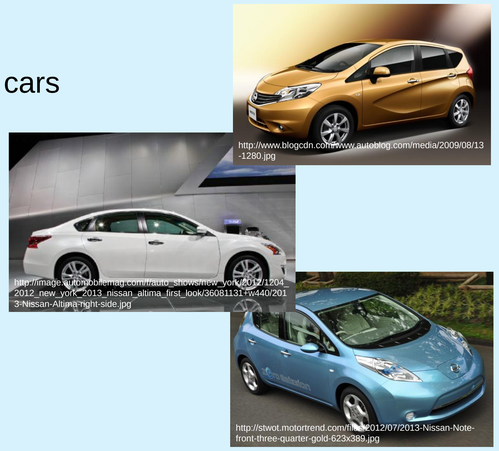
INTRODUCTION

A car company's profit is optimized using game theory given that they can produce:

- Gas-powered cars
- Hybrid cars
- Electric cars



CREATING UTILITIES

- Game theory is applied to the problem
  - Two players: car company and the consumer
  - Utility functions give a numerical value to individual preferences
- A utility function is created for the car company:

$U_c(v) = I_v - M_v + (T_v/n)$ where

$U_c(v)$ is the utility for selling vehicle v

I_v is the income for selling the vehicle

M_v is the cost of manufacturing the vehicle

T_v is the tax credit the company receives for making the vehicle

n is the number of vehicles manufactured

- Then a utility function for the consumer:

$U_k(v) = C_v + P_v \cdot \varphi_k + F_v \cdot \sigma_k + R_v \cdot \alpha_k$

$U_k(v)$ is the utility of buying the vehicle for consumer k

C_v is the up-front cost of the vehicle

P_v is how much less pollution the vehicle emits than a comparable gas-powered one

F_v is the yearly fuel costs for the vehicle

R_v is the range of the car (electric only)

φ_k, σ_k, and α_k are weighting coefficients based on the consumer

PAYOFF MATRIX

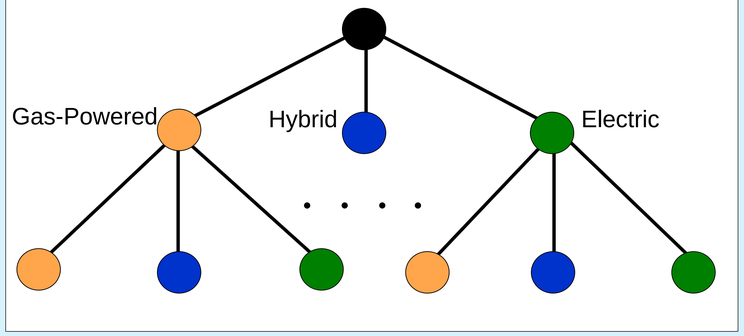
- The payoff matrix represents what each party gets out of each sale scenario

Consumer

Car Company	Buy Vehicle	Don't Buy
Gas-Powered only	$(U_c(g), U_k(g))$	$(-M_g, 0)$
Hybrid only	$(U_c(h), U_k(h))$	$(-M_h, 0)$
Electric only	$(U_c(e), U_k(e))$	$(-M_e, 0)$

- A java program is created and applied to calculate the car company's total profit for marketing every combination of these vehicles
- The algorithm is to be applied to both the Nissan and Ford Motor Companies

A Framework for a Year-to-Year Model



- The java program is extended to accommodate a year-to-year model that maximizes profit over time

CONCLUSIONS & FUTURE WORK

Initial trials indicate that:

- For Ford, focusing on gasoline vehicles is most profitable
- The program requires further refinement and testing on more data

Future work could include:

- Expanding the model to incorporate two car companies as competing players
- Including plug-in hybrid vehicles
- Testing more strategies in the year-to-year model

REFERENCES

1. Hidrue, M.K., Parsons, G.R., Kempton, W., and Gardner, M.P., "Willingness to pay for electric vehicles and their attributes", Resource and Energy Economics, Vol. 33, No. 3, 2011, pp. 686-705