An experiment in price setting

When you first load this notebook you should get a message asking if you want to automatically evaluate all of the initialization cells in this notebook; select yes. Otherwise, you may need to select Evaluation->Evaluate Initialization Cells from the menu. Initialization cells are input cells marked as containing definitions needed to use the notebook. For this notebook the initialization starts an interactive experiment consisting of an output cell with dynamic controls. The initialization cell here is closed so you don’t (have to) read the program but can go directly to the experiment.

This experiment is a game. You are the producer of a new product. You have some fixed costs and a specified, incremental, marginal cost for each unit you produce and sell. You will set the price for this product. How many units you sell will be determined by this price, but you don’t know what this will be beforehand. Thus you will want to try various prices, judging the demand for your product, in an effort to maximize the profit you will make.

You will have ten trials. For each trial, you will set a price by adjusting the pricing slider at bottom or entering a price in the box and then clicking the bottom marked “Try”, the program will determine the corresponding demand and enter this demand and your profit for this trial in the table. When you have entered the last price the program will print out information about this trial, the actual optimal price, demand, and profit, and a score determined from your profit given as a percentage of the maximum profit you could have obtained. Plots of the demand function sample points for your prices, and a plot of profit as a function of your price are displayed. Clicking on the button marked “Restart” reruns the game with a new demand, fixed and marginal costs.

In[1]:= Clear[numtrials, pricevariables, demandvariables, 
        profitvariables, heldpricevariables, variablenames, formatnumber, 
        demand, demandslope, demandintercept, profit, marginalcost, 
        fixedcost, datatable, pcontrol, trial, reinitialize, optimumsoln, 
        optimumprice, optimumdemand, optimumprofit, p, q, r, i];
numtrials = 10;
pricevariables = Table[Unique["p"], {numtrials}];
demandvariables = Table[Unique["q"], {numtrials}];
profitvariables = Table[Unique["r"], {numtrials}];
heldpricevariables = Map[HoldPattern, pricevariables];
variablenames = 
    Join[Map[ToString, Join[pricevariables, demandvariables, profitvariables]], 
        {"fixedcost", "marginalcost", "demandslope"},
"demandintercept", "pcontrol", "trial"]);
formatnumber[x_, f_] := If[NumberQ[x], ToString[NumberForm[x, f]], "]];
demand[p_] := Max[0, demandslope * p + demandintercept];
profit[p_] := (p - marginalcost) * demand[p] - fixedcost;
datatable = MapThread[With[{i = #1, p = #2, q = #3, r = #4},
{Dynamic[If[trial == i, InputField[Dynamic[p, (p = #); pcontrol = p) &],
FieldSize -> 3], Dynamic[formatnumber[p, {5, 2}]]]},
Dynamic[formatnumber[q, {5, 2}]], Dynamic[formatnumber[r, {7, 2}]]] &,
{Range[numtrials], pricevariables, demandvariables, profitvariables}];
reinitialize := Module[{},
Apply[Clear, variablenames];
marginalcost = Round[RandomReal[UniformDistribution[{1., 25.}]], 0.01];
demandslope = RandomReal[UniformDistribution[{-4., -0.25}]];
demandintercept = UniformDistribution[-demandslope * {marginalcost, 200. - marginalcost}];
fixedcost = Round[RandomReal[UniformDistribution[0., -(demandslope * marginalcost + demandintercept)^2 / demandslope / 4]]], 0.01];
 optimumsoln = FindMaximum[profit[p], {p, 0, 100}];
 optimumprice = p /. optimumsoln[[2]]; 
 optimumdemand = demand[optimumprice];
 optimumprofit = profit[optimumprice];
 trial = 1;
 pcontrol = marginalcost;
 Evaluate[heldpricevariables[[trial]]] = pcontrol;
reinitialize;
Column["Experiment #1",
 Dynamic["Fixed cost per trial = " <> ToString[formatnumber[fixedcost, {5, 2}]]],
 Dynamic["Marginal cost per unit demand = " <>
 ToString[formatnumber[marginalcost, {5, 2}]]],
TableForm[datatable, TableHeadings ->
{Range[numtrials], "price", "demand", "profit"}],
Row[Slider[Dynamic[pcontrol, (pcontrol = #); If[trial <= numtrials,
 Evaluate[heldpricevariables[[trial]]] = pcontrol &) &], {0, 100, 0.01}],
"
", Button["Try", If[trial <= numtrials, Evaluate[demandvariables[[trial]]] =
 demand[pricevariables[[trial]]]; Evaluate[profitvariables[[trial]]] =
 profit[pricevariables[[trial]]]; trial = trial + 1;]
If[trial <= numtrials, Evaluate[heldpricevariables[[trial]]] = pcontrol")],
Dynamic[If[trial > numtrials, Column[
{
"", "Average price = " <> formatnumber[Mean[pricevariables], {5, 2}]],
 "Average demand = " <> formatnumber[Mean[demandvariables], {5, 2}]],
 "Average profit = " <> formatnumber[Mean[profitvariables], {7, 2}]],
 "",
(*"Demand = "<formatnumber[demandslope,6,3]>*
" price + "<formatnumber[demandintercept,6,3]>*
"Optimum price = " <> formatnumber[optimumprice, {5, 2}]],
 "Optimum demand = " <> formatnumber[optimumdemand, {5, 2}]],
 "Optimum profit = " <> formatnumber[optimumprofit, {7, 2}]],
 ""]
"Score (% of optimum profit) = " <> 
formatnumber[100 * Mean[profitvariables] / optimumprofit, {4, 2}] <> 
", 
"", 
Dynamic[Show[{ParametricPlot[{demand[p], p}, 
    {p, Min[pricevariables] - 1., Max[pricevariables] + 1.}, 
    PlotStyle -> {Dashing[0.01]}, AspectRatio -> 1 / GoldenRatio], 
    ListPlot[Transpose[{demandvariables, pricevariables}]], 
    PlotStyle -> {PointSize[0.02]}, Joined -> False, PlotRange -> All}], 
AxesLabel -> {"demand", 
price"}, ImageSize -> 72 * 6]], 
Dynamic[Show[{Plot[profit[p], {p, Min[pricevariables] - 1., 
Max[pricevariables] + 1.}, PlotStyle -> {Dashing[0.01]}], 
ListPlot[Transpose[{pricevariables, profitvariables}]], PlotStyle -> 
{PointSize[0.02]}, Joined -> True, Mesh -> All, PlotRange -> All}], 
AxesLabel -> {"price", "profit"}, ImageSize -> 72 * 6]], 
Row[{Button["Restart", reinitialize, ImageSize -> Automatic]]}], 
"
]

Experiment 01
Fixed cost per trial = 203.03
Marginal cost per unit demand = 12.51

<table>
<thead>
<tr>
<th>price</th>
<th>demand</th>
<th>profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.48</td>
<td>12.18</td>
<td>76.81</td>
</tr>
<tr>
<td>39.78</td>
<td>0.00</td>
<td>-203.03</td>
</tr>
<tr>
<td>29.57</td>
<td>29.89</td>
<td>306.86</td>
</tr>
<tr>
<td>25.81</td>
<td>41.15</td>
<td>344.29</td>
</tr>
<tr>
<td>22.04</td>
<td>52.45</td>
<td>296.78</td>
</tr>
<tr>
<td>26.88</td>
<td>37.95</td>
<td>342.26</td>
</tr>
<tr>
<td>24.73</td>
<td>44.39</td>
<td>339.38</td>
</tr>
<tr>
<td>26.34</td>
<td>39.56</td>
<td>344.14</td>
</tr>
<tr>
<td>25.81</td>
<td>41.15</td>
<td>344.29</td>
</tr>
<tr>
<td>25.81</td>
<td>41.15</td>
<td>344.29</td>
</tr>
</tbody>
</table>

Try
Average price = 28.23
Average demand = 33.99
Average profit = 253.61

Optimum price = 26.03
Optimum demand = 40.50
Optimum profit = 344.43

Score (% of optimum profit) = 73.63%