and the second expression must be greater by 50 than the first, regardless of $p$.

The advocate of nuclear disarmament might amplify his argument by inserting an extra premise, namely, that the probability of war, whatever it is, is practically the same no matter which act is performed. Thus, he might concede the existence of a deterrent effect of nuclear disarmament but believe that this is almost exactly cancelled by an increased danger of accidental war. He may amend his argument in this way, but he cannot then present it as an argument which makes no assumptions about the probability matrix. In its original form, the argument was indeed invalid.

1.6 Problems

Train or Plane:

As far as cost and safety are concerned, train and plane provide equally good ways of getting from Las Palmas to San Francisco. However, the trip takes 5 hours by train and 2 hours by plane; unless the San Francisco airport proves to be logged in, in which case the plane trip takes 15 hours. According to the weather forecast, there are chances out of 10 that San Francisco will be logged in. Draw up a probability matrix and determine whether the trip by train or plane is less expensive.

Beyond Matrices:

Many problems are simplified if we use different sets of relevant conditions for different acts in a way that is impossible in the usual matrix formulation. An example: the variant of problem I described previously - given a set of cards each showing a card with a number, the problem is to determine whether there are any two numbers that are the same. If we use the same cards for eight different problems, then we can determine whether there are any two numbers that are the same for each problem.
8, depending on whether or not there is snow in the pass, the relevant
information about going by train would be shown in a row of a different
matrix, with different column headings:

<table>
<thead>
<tr>
<th></th>
<th>Snow</th>
<th>No snow</th>
<th>(-9.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train</td>
<td>0.5 \times 10</td>
<td>0.5 \times 8</td>
<td></td>
</tr>
</tbody>
</table>

Then, in order to see that going by train is preferable, there is no need
to use the standard matrix format, as below. Problem: discuss (and, if
possible, overcome) the difficulties of filling in the blanks of the standard
matrix with probabilities and utilities on the basis of the information given
so far.

<table>
<thead>
<tr>
<th></th>
<th>Fog and snow</th>
<th>Fog and no snow</th>
<th>No fog but snow</th>
<th>No fog and no snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plane</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4 The Heavy Smoker

In *The Consumers Union Report on Smoking and the Public Interest*
(Consumers Union, Mt. Vernon, N.Y., 1963, p. 69), figures provided by
the American Cancer Society are reproduced as follows.

Percentage of American Men Aged 35 Expected to Die
before Age 65

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonsmokers</td>
<td>23%</td>
</tr>
<tr>
<td>Cigar and pipe smokers</td>
<td>25%</td>
</tr>
<tr>
<td>Cigarette smokers:</td>
<td></td>
</tr>
<tr>
<td>Less than 1/2 pack a day</td>
<td>27%</td>
</tr>
<tr>
<td>1/2 to 1 pack a day</td>
<td>34%</td>
</tr>
<tr>
<td>1 to 2 packs a day</td>
<td>38%</td>
</tr>
<tr>
<td>2 or more packs a day</td>
<td>41%</td>
</tr>
</tbody>
</table>

The agent is a 35-year-old American man who has found that if he smokes
cigarettes at all, he smokes 2 or more packs a day. He sees his options
as these three:

\[ C = \text{Continue to smoke 2 or more packs of cigarettes a day} \]
\[ S = \text{Switch from cigarettes to pipes and cigars} \]
\[ Q = \text{Quit smoking altogether} \]

He sees the relevant conditions as these two:

\[ D = \text{Die before the age of 65} \]
\[ L = \text{Live to age 65 or more} \]
Supposing that his views about probabilities are derived in the obvious way from the foregoing statistics and that his notions of desirability are given by the following matrix, compute the desirabilities of the three options and identify the one he chooses if he follows the Bayesian rule.

<table>
<thead>
<tr>
<th>D</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0</td>
</tr>
<tr>
<td>S</td>
<td>−1</td>
</tr>
<tr>
<td>Q</td>
<td>−5</td>
</tr>
</tbody>
</table>

5 Nicotine Addiction

Suppose that in problem 4 the agent does not see Q as an option: he lacks the willpower required to quit. Suppose, too, that his probability matrix derives from the Consumers Union figures, but that concerning his desirability matrix we know only that it has the following form, with lowest desirability (d) assigned to dying before age 65 in spite of having switched, and with l and c being positive, independent increments in desirability contributed by longevity (l) and cigarette-smoking (c).

<table>
<thead>
<tr>
<th>D</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>d + c</td>
</tr>
<tr>
<td>S</td>
<td>d + l</td>
</tr>
<tr>
<td>d</td>
<td>d + c + l</td>
</tr>
</tbody>
</table>

The agent does switch to pipes and cigars. Show that therefore c can have been no more than 16% of l.

6 The Dominance Principle

According to this principle (which is of limited applicability, according to the version of Bayesianism propounded here), an act is preferable to any other act that it dominates. Compare and contrast the ordering of the three acts in problem 4 by dominance with that by estimated desirability:

<table>
<thead>
<tr>
<th>God exists</th>
<th>There is no God</th>
</tr>
</thead>
<tbody>
<tr>
<td>Succeed in believing</td>
<td>Eternal life</td>
</tr>
<tr>
<td>Remain an atheist</td>
<td>A bad situation</td>
</tr>
</tbody>
</table>

He takes the desirabilities to be as follows, where x and y are finite, and