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 armament, 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

1 Train or Plane?

As far as cost and safety are concerned, train and plane provide equally good ways of getting from Las Pulgas to San Francisco. However, the trip takes 8 hours by train, and 3 hours by plane, unless the San Francisco airport proves to be fogged in, in which case the plane trip takes 15 hours. According to the weather forecast, there are 7 chances out of 10 that San Francisco will be fogged in. Draw up a probability matrix based on the weather forecast, and a desirability matrix based on the travel times (putting minus signs before the times given above, since short trips are preferred), and decide whether to take the train or plane.

2 The Point of Balance

In problem 1, what must the probability of fog be, if plane and train are to be equally good choices?

3 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. Example: the variant of problem 1 in which the conditions relevant to going by plane are still fog or not (at the airport), but the conditions relevant to going by train are quite different: snow or not (in a mountain pass). For the act of going by plane, the probability × desirability entries would be as in problem 1:

	Fog	No fog	
Plane	$.7 \times -15$	$.3 \times -3$	-11.4

(The desirability of going by plane is shown at the right.) But if the probability of snow in the pass is .5, and the train trip takes 10 hours or

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:

	Snow	No snow	
Train	$.5 \times -10$	$.5 \times -8$	-9.0

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.

	Fog and snow	Fog and no snow	No fog but snow	No fog and no snow
Plane				
Train				

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

Nonsmokers	23%
Cigar and pipe smokers	25%
Cigarette smokers:	
Less than 1/2 pack a day	27%
1/2 to 1 pack a day	34%
1 to 2 packs a day	38%
2 or more packs a day	41%

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 = Continue to smoke 2 or more packs of cigarettes a day
S = Switch from cigarettes to pipes and cigars
Q = Quit smoking altogether

He sees the relevant conditions as these two:

D = Die before the age of 65
L = 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.

	D	L
C	0	100
S	-1	99
Q	-5	95

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).

	D	L
C	$d + c$	$d + c + l$
S	d	$d + l$

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.

7 Pascal's Wager

The agent is trying to decide whether or not to undertake a course of action designed to overcome his intellectual scruples and lead to belief in God. He takes the consequence matrix to be the following.

	God exists	There is no God
Succeed in believing	Eternal life	Finite life, deluded
Remain an atheist	A bad situation	The presumed status

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