FORECAST WEATHER WITH A DECK OF PLAYING CARDS

Allen E. Staver

Northern Illinois University
DeKalb, Illinois 60115

You don't have to be a psychic or a meteorologist, but you too can forecast with 60% accuracy, specifically whether a day is going to be wet or dry in any given month for any location in the world. Meteorologists define a dry day as one having zero or less than .01 inch of precipitation. Over this amount is considered a wet day. In order to make these forecasts it helps to know the number of days of precipitation normally occurring in the month and locality in which you are interested. This information can be obtained from a climatology book such as the "Climatic Atlas of the United States," a publication of the United States Department of Commerce, or by calling a Weather Service office. Assuming you found that in past years there was an average of 9 wet days in the 30-day month for which you are preparing a forecast, which incidentally is the average for the United States, you would take 9 black cards representing wet days and 21 red cards for the dry days. (Correspond the number of cards with the number of days in the month). Now shuffle these 30 cards and place them face down. Turning one card at a time face up, record on the calendar the forecast represented by the first card on the first day of the month. Turn the second card face up and likewise record its forecast on the second day. Repeating this same procedure for all the remaining cards, giving each day a forecast, you will then be ready to look at the results and determine your accuracy. Each day record on the calendar whether the day was wet or dry and at the end of the month count the correct forecasts and figure the percentage of accuracy. There is the possibility that you can be from 0 to 100% correct, but after several months you will find that your overall average will be 60% correct. Figure 1 is an illustration with the forecasts and observations placed upon it. Correct predictions are marked with "C," wrong ones with "X."

Tables 1 and 2 show how well this system can be expected to work under all possible combinations of climatologically expected and actually observed number of wet days in a 30-day month. Table 2 is an expanded view of a portion of Table 1. Using Figure 1, which is an example of a 30-day month, an attempt will be made to illustrate how these tables can be used to obtain the expected accuracy. Looking at Table 2, taking the line that has 9 climatically wet days, if the month actually produces 10 wet days, the point of intersection reveals that 17 of the forecasts are expected to be correct: 56.7% accuracy. If the month actually produces only 7 or 8 wet days, that intersected point shows 18 forecasts should be correct: 60% accuracy. Note: Each fraction in the table could be reduced to its lowest denominator, if so desired. At the end of the month, when it is known that 8 wet days occurred, the table shows that 17-12/15 of the 30 forecasts should be correct. Rounded to the nearest whole number, the example gave 18 expected correct forecast days. The month's record revealed 19 correct forecast days; giving 63.3% accuracy for the month.

In order to show how the numbers in Tables 1 and 2 were obtained, an explanation of how 17-12/15 was calculated follows. To do this, consider Figure 2, which illustrates the four possible outcomes, forecast versus observed. In our example there were forecasts of 9 wet days and 21 dry days. The month produced 8 wet days and 22 dry days, therefore the totals around the border of Figure 2 were known. The number in the upper-left corner of Figure 2 can be obtained by taking 9/30 times 8, or by taking 8/30 times 9, in other words there were 9 chances out of 30 of hitting each of the 8 wet days, or viewed from another standpoint, there were 8 chances out of 30 of hitting each of the 9 days which were forecast to be wet. In either case the answer is 2-6/15. The other number needed is the other category of correct forecasts, the lower-right corner. Again there are 2 ways of obtaining the 15-6/15, by taking 21/30 times 22 or taking 22/30 times 21. The total expected number of correct forecasts is 2-6/15 when precipitation was both forecast and observed, plus the 15-6/15 successful dry-day forecasts, a total of 17-12/15, as inserted in Table 2. For the example month shown in Figure 1 these came out to be 3 plus 16, which equals 19 correct forecasts; 19 divided by 30 equals 63.3% accuracy. For months containing 28, 29 or 31 days similar tables can be calculated by using the same process with the appropriate number of days. Further statistical treatment could expand each compartment in Table 2 into how often 18 correct forecasts would occur (the most likely number), or 19, or 17, or any other number of correct forecasts between 0 and 30.
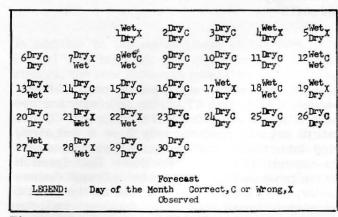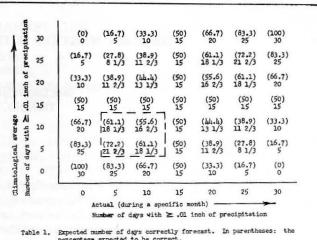
Forecast grid (Figure 1):

```
                    1 Wet/Dry X   2 Dry/Dry C   3 Dry/Dry C   4 Wet/Dry X   5 Wet/Dry X
6 Dry/Dry C  7 Dry/Wet X   8 Wet/Wet C  9 Dry/Dry C  10 Dry/Dry C  11 Dry/Dry C  12 Het/Wet C
13 Dry/Wet X 14 Dry/Dry C 15 Dry/Dry C 16 Dry/Dry C 17 Wet/Dry X 18 Wet/Wet C 19 Wet/Dry X
20 Dry/Dry C 21 Dry/Wet X 22 Dry/Wet X 23 Dry/Dry C 24 Dry/Dry C 25 Dry/Dry C 26 Dry/Dry C
27 Wet/Dry X 28 Dry/Wet X 29 Dry/Dry C 30 Dry/Dry C
```

                          Forecast
LEGEND: Day of the Month   Correct, C or Wrong, X
                          Observed

Figure 1. Example of Wet-Day, Dry-Day Forecasts and their verification.

Table 1. Expected number of days correctly forecast. In parentheses: the percentage expected to be correct.

Climatological average (Number of days with ≥ .01 inch of precipitation) vs Actual (during a specific month) Number of days with ≥ .01 inch of precipitation.

Clim. avg ↓ / Actual →	0	5	10	15	20	25	30
30	(0) 0	(16.7) 5	(33.3) 10	(50) 15	(66.7) 20	(83.3) 25	(100) 30
25	(16.7) 5	(27.8) 8 1/3	(38.9) 11 2/3	(50) 15	(61.1) 18 1/3	(72.2) 21 2/3	(83.3) 25
20	(33.3) 10	(38.9) 11 2/3	(44.4) 13 1/3	(50) 15	(55.6) 16 2/3	(61.1) 18 1/3	(66.7) 20
15	(50) 15	(50) 15	(50) 15	(50) 15	(50) 15	(50) 15	(50) 15
10	(66.7) 20	(61.1) 18 1/3	(55.6) 16 2/3	(50) 15	(44.4) 13 1/3	(38.9) 11 2/3	(33.3) 10
5	(83.3) 25	(72.2) 21 2/3	(61.1) 18 1/3	(50) 15	(38.9) 11 2/3	(27.8) 8 1/3	(16.7) 5
0	(100) 30	(83.3) 25	(66.7) 20	(50) 15	(33.3) 10	(16.7) 5	(0) 0

Figure 2. Expected number of correct and incorrect forecasts.

	Forecast Wet	Forecast Dry	
Observed Wet	2 6/15	5 9/15	8
Observed Dry	6 9/15	15 6/15	22
	9	21	

Table 2. Details of the most applicable (dashed portion) of Table 1.

Clim. Avg ↓ / Actual →	5	6	7	8	9	10	11	12
12	(56.7) 17	(56.0) 16 12/15	(55.3) 16 9/15	(54.7) 16 6/15	(54.0) 16 3/15	(53.3) 16	(52.7) 15 12/15	(52.0) 15 9/15
11	(58.9) 17 10/15	(58.0) 17 6/15	(57.1) 17 2/15	(56.2) 16 13/15	(55.3) 16 9/15	(54.4) 16 5/15	(53.6) 16 1/15	(52.7) 15 12/15
10	(61.1) 18 5/15	(60.0) 18	(58.9) 17 10/15	(57.8) 17 5/15	(56.7) 17	(55.6) 16 10/15	(54.4) 16 5/15	(53.3) 16
9	(63.3) 19	(62.0) 18 9/15	(60.7) 18 3/15	(59.3) 17 12/15	(58.0) 17 6/15	(56.7) 17	(55.3) 16 9/15	(54.0) 16 3/15
8	(65.6) 19 10/15	(64.0) 19 3/15	(62.4) 18 11/15	(60.9) 18 4/15	(59.3) 17 12/15	(57.8) 17 5/15	(56.2) 16 13/15	(54.7) 16 6/15
7	(67.8) 20 5/15	(66.0) 19 12/15	(64.2) 19 4/15	(62.4) 18 11/15	(60.7) 18 3/15	(58.9) 17 10/15	(57.1) 17 2/15	(55.3) 16 9/15
6	(70.0) 21	(68.0) 20 6/15	(66.0) 19 12/15	(64.0) 19 3/15	(62.0) 18 9/15	(60.0) 18	(58.0) 17 6/15	(56.0) 16 12/15
5	(72.2) 21 10/15	(70.0) 21	(67.8) 20 5/15	(65.6) 19 10/15	(63.3) 19	(61.1) 18 5/15	(58.9) 17 10/15	(56.7) 17

Expected accuracy can be increased by loading the deck with fewer than the climatological number of wet days in dry areas, or more than the climatological number of wet days in rainy areas; however, poorer results are then obtained, if the month is abnormal in the opposite sense. After the forecast has been prepared, the greater the number of dry days (in dry regions) the better the expected accuracy. It is obvious for some months in desert regions that forecasting all dry days will produce near 100% accuracy. Similarly for very rainy regions a forecast of precipitation for every day of the month will often produce 80% accuracy. Although it is possible to use this method to predict with a high percentage of accuracy for the desert and rainy regions, there is a stronger need to determine the days when the moisture or dryness would occur for the benefit of those areas.

Meteorologists know that they must predict more correctly than the percentages shown in Tables 1 and 2 in order to have skill. Weather almanacs are prepared with a similar system as this one and possibly a few other statistics. So you, too, can make your own high-percentage predictions. By laying out your cards for past months you can check your "forecasts" immediately against known records and have confidence in your predictions for the future.