The
Chance Master 1000 User's Guide

The Absolute Basics

—First, don't stake anything on the computations provided by the Chance Master 1000! I'm just one guy and may have blundered a line of code.
—All calculations spool to the text field on the Chance Master 1000 main window. This data can be saved as a text file in the normal way. Data from this text field can by copied and pasted into the other text entry fields within the program for complex or many-step computations.
—Use integers where integers are expected.
—The "Enter Data as Text" fields expect numbers. For user convenience, a subroutine scrubs out all extraneous characters, including spacing characters such as tabs and returns.
—A value of probability, the great ally of theorists, must be between 0 and 1. A 0 probability event cannot occur, a 1 probability event must occur.
—New in version 1.1.000+: Thanks to Bob Delaney and his marvelous MPCalc Engine, the Chance Master 1000 now effortlessly handles exceedingly large and small numbers.

Functions

The following offers very brief explanations using Chance Master 1000's various Calculators.

Gaming / Conversions

Straightforward. If you're not used to it, "odds" can be a bit tricky. In common parlance odds are usually expressed as odds against, such as "that scrawny horse is a ninety-nine to one shot." This usage is really an artifact of gambling, where the house payout is given first. Even to those very familiar with gaming, odds can be the source of great confusion and misunderstanding. For this reason, expressions of chance, or if booking, lines, are often preferred.

Gaming / Value / Parlays

For convenience, the data field accepts both expressions of chance (1 in ____) and probability. Calculation is executed as a simple compound probability.

Example: What's the probability of rolling 4 Aces in a row with a standard die? Enter "6 6 6 6" into data field (to describe four events, each with a 1 in 6 chance), select "Pick 'em All" and hit Calculate: p = 0.00077.

Gaming / Value / Dice

Unlike all the other Calculators on the Chance Master 1000, the Dice Calculator relies on nested loops which enumerate all cases. For this reason, unusual scenarios involving many-sided dice (such as five 50-sided dice) may take a while to execute.

This, for anyone who's interested, is a curiosity of theory. Mathematics offers two clever ways to solve dice problems, *polynomial multiplication* and *convolution*. Amazingly, both methods require solutions which involve at least as many individual steps as possible outcomes. I am unaware of any straight functional representation of dice problems, and am interested in hearing from anyone who knows of such. Anyway...

Example: What is the probability of rolling a 20 when tossing four 8-sided dice? Enter "8 8 8 8" in data field, "20" in outcome field and Calculate: p = 0.0769.

Gaming / Value / Lotteries

The user will notice the distinction between "Lotteries" and "Lottos." In loose conversation the two terms are used interchangeably; however, traditionally a lottery describes a game in which numbers are pulled from discrete pools of values and must match the player's picks in order, whereas in a lotto, the values are all pulled from the same pool, and do not need to match the order of the player's picks. One way to visualize this is that if a friend is telling you the winning lotto numbers, you don't care in what order he reads them, and you also know that no two numbers will repeat (with the possible exception of a bonus number). If someone is telling you lottery winners, the order of the numbers is important, and you may have duplicate numbers. In slightly more high brow terms, a lotto hand is a *combination*, a lottery hand is not. It's no accident that lotto, bingo, keno, and *combo* all end in "o".

State lotteries are very simple games. The number range is almost always 0-9, and most every game is a pick-4.

Gaming / Value / Bernoulli Streaks

The Chance Master 1000 solves success streaks using the system provided by the indefatigable Feller:

$$qx\left(1+px+\ldots+p^{r-1}x^{r-1}\right)=1$$

{where p is probability of trial success; r is the streak length; q is p'; n (below) is the number of trials}

The unique positive root (x) is extracted and substituted in the following geometric series approximation:

$$q_{nostreak}\sim\frac{1-px}{q(r+1-rx)}\cdot\frac{1}{x^{n+1}}$$

Example: What's the probability that in 200 coin tosses, we'll get a streak of 5 heads OR BETTER? How about 20 heads OR BETTER? Enter "5" in the first field ("Success Streak..."), enter "200" in the second field ("Trials where..."), and ".5" in the third (and last) field. Calculate: p ~ 0.9659. That's very close to 96.6%. —Now enter "12" in the first field, hit Calculate: p ~ 0.02296. That's a tad over 2%.

Gaming / Value / Bernoulli Bulk Success

The Chance Master 1000 uses the standard binomial form:

$$p_{bulksuccess} = \frac{n!}{r!(n-r)!} p^r q^{n-r}$$

{where p is probability of trial success; r is the number of successes sought; q is p'; n is the number of trials}

Note concerning OR BETTER cases: When trials < 800, cases are looped additively; otherwise, Simpson's Approximation is used.

Example: When rolling one standard 6-sided die 50 times, what's the probability we'll get 10 OR BETTER (same as saying "10 or more") Aces? How about 20 OR BETTER Aces? Enter "10" in the first field ("Total Successes..."), enter "50" in the second field ("Trials where..."), and ".16666667" in the third (and last) field. Calculate: p = 0.31696. That's very close to 31.7%. —Now enter "20" in the first field, hit Calculate: p = 0.000075. That's only 75 in a million! Big difference.

Gaming / Objects / Cards

Familiarity with the Cards Calculator is best achieved by tinkering around with the presets.

All calculations solve AND ONLY cases. In other words, if you desire a hand of 3 Aces in a 7 card deal, the probability returned will describe only 3 Ace hands—it will not include (by addition) the probability of a 4 Ace hand. The reason for this is that the notion of card hand *betterness* is not mathematical—it is simply a construct of whatever card game you happen to be playing.

"Specific" describes a hand built with a specific value, that is, 3 Aces, or 3 Jacks, as opposed to any trey ("Any").

"Outside OK" means that the junk cards (if any) can themselves form matches. For example, a 9 card hand seeking a "Specific (Outside OK)" 4 of a kind can describe the 4 of a kind (of whatever desired value, say Aces), but also allow that the five junk cards might themselves contain, say, a pair of Jacks.

"No Outside," on the other hand, does not permit any matching values among the junk cards.

"Sets," which is not illustrated by any of the presets, simply describes multiple matches. For example, suppose we're after 4 Kings and 4 Deuces off an 8-card deal. We set Type to "Specific" (whether outside help is permitted or not doesn't matter since there are no junk cards), enter 4 of a kind, x 2 sets, then calculate.

Gaming / Objects / Races

The most convenient way to describe a race, though perhaps not the most practical, is by asserting each contestant's *finishing shares*, which is essentially the same thing as their chance of winning. Imagine a race between two perfectly matched speedsters, A and B. We could describe their finishing shares in the following way: A has 5, B has 5. Or, A has 1, B has 1. Or, A has 1,000, B has 1,000. We can describe their finishing shares in any way so long as they're equal. Imagine a race between C, D, and E. Suppose C has got twice as much chance of winning as D, and D has got twice as much chance of winning as E. We could describe their finishing shares as follows: E has 1, D has 2, C has 4. This is the data that the data field expects on this Calculator.

Unlike all the other data fields on the **Chance Master 1000**, the order the shares are entered into the data field is important. An entry of, say, 5,3,2,1 describes a race of four contestants in which the favorite (a 5 in 11 shot—remember, there's 11 total shares here, 5+3+2+1=11) is sought to win, the next best (a 3 in 11 shot) is sought for second, third best (2 in 11) for third, and the dog (a 1 in 11 hope) is sought to hobble up the rear.

Gaming / Objects / Lottos

A lotto draw pulls balls, each with a unique number, from a common pool. In a lotto, the order the draw numbers come up is unimportant (see Lotteries). A lotto, therefore, is solved as a combination.

The **Chance Master 1000** interface refers to a "bonus number." This is a generic term; different games have different names for this extra draw number, such as "powerball," or "wild number."

Gaming / Objects / Feller's Cells

Here is a theoretic model that hubs for a number of statistical treatments used by physicists, and to some degree, other scientists. The form is not detailed by Feller but easily intimated:

$$A_{FC} = \frac{b!}{b_1!b_2!...b_k!} \cdot \frac{c!}{c_1!c_2!...c_k!} \qquad \text{and} \qquad p = \frac{A_{FC}}{c^b}$$

Example: Imagine you have 5 like objects randomly scattered into 4 (large) bins. What is the probability that one bin will contain 3 objects, one bin will contain 2, and the other two bins contain none? Enter "3 2 0 0" in Data field, hit calculate: p = 0.117.

This sort of object-bin scenario is interesting because, as Feller observes, it involves a "double application" of Arrangements.

Gaming / Objects / Arrangements

The entire concept of Arrangements of Like Objects is a very inconspicuous and softly spoken one in the arena of statistics and game theory. It is, however, ever present and lurking somewhere in just about every important calculation.

Example: Imagine you have a pool of objects, say, fruit—imagine you have 4 apples, 3 oranges, and, lastly, 2 kumquats. For some strange reason you need to place these in a row (assign them unique positions), and you need to determine how many unique orders are possible for these 9 objects. You would need to know how many *Arrangements* are possible with groups of 4, 3, 2 like objects. If you were faced with a crisis involving the positioning of fruit, then using the **Chance Master 1000** would be the least of your worries; however, if you had some analogous scenario, you would enter “4 3 2” into the data field and hit Calculate: Total Arrangements: 1,260.

The form is well known and used elsewhere in this program:

$$A = \frac{n!}{g_1!g_2!...g_k!}$$

Gaming / House vs. Guest / House Vigorish

Useful determining House Vig.

Example: (American Roulette) House offers $36 on a $1 Guest wager if an event (the Guest hitting her number) with p = 0.02631 (1 in 38). Enter data, hit Calculate: Guest Expectation: -2.653%, same as -2.653¢.

Gaming / House vs. Guest / Custom Vigorish

Play House.

Example: Imagine a non-skill activity where the probability of success if 0.2 (1 in 5). Someone hoping for the occurrence of that success wants to offer you his $10 for a wager. You want a 10% vigorish for yourself. Enter data, hit Calculate: $36.

The Sciences / Genetics / Hardy-Weinberg

The workhorse of anthropologists to conservationists to environmentalists to geneticists.

$$1 = p^2 + 2pq + q^2$$

This allows for a fast, ready and reliable surmising of environmental selective forces acting on an organism. For example, if we observe a 30% frequency of the heterozygote, and Hardy-Weinberg says we should expect a 20% occurrence of the heterozygote, we know to look for strong (and immediate) selective agents favoring the heterozygote (or disfavoring the homozygotes).

The Sciences / Genetics / Heterozygosity

Solves for expected occurrence of Aa (heterozygote) carriers in a small population after a variable number of generations:

$$Het_t = Het_0\left(1 - \frac{1}{2N}\right)^t$$

{where Het_0 is starting frequency of Aa carriers; N is population; t is number of generations}

This form has the immanent limitation that it functions poorly where the starting population of Aa carriers is unusually low or high (notice that it returns 0 if no Aa carriers are initially present).

The Sciences / Genetics / Founding Populations

Offers insight into the prospect of poor allele sampling in a founding population.

Example: Imagine a large society (Population X) happily trundling about. Allele A has a frequency of 25% in Population X. Eight members of Population X strike out and form Population x. What's the chance that these eight members will carry, say, exactly eight A alleles? (By the way, that would be a 50% frequency of A in this new founding population, remember, it's two alleles per person). Enter 25, (75 gets automatically entered into the next field), 8, 8, Calculate: p = 0.04588.

Note: The mathematical form is the same as in Bernoulli (Bulk Success).

The Sciences / Genetics / Bulk Fixation

The scenario this calculator solves for is not one typically sought by scientists, at least as far as I know. It is, however, fairly insightful, and worth a few moments of play. Organisms carry many genes in their genetic instructions (the figure for we *sapiens* is ever changing, but currently believed to be somewhere around 70,000). It has been estimated that each of us has, somewhere in our chromosomes, on average of about one potentially bad, or "troublesome" gene—a mutant gene, for example. In large populations, such odd genes are not a concern because they do not displace their more vital counterparts (other more healthy alleles). In small founding populations, however, the story is different. Though the chance of fixation itself doesn't change much with population size, the *rate* of fixation does so dramatically. In small populations, then, fixation of a troublesome allele can occur over just a few generations.

Example: Imagine an isolated society of four individuals, Bill, Curt, Amy, and Kim. Bill carries an allele that causes blindness, Curt one that causes unusable hands and one that causes a defective heart, Amy one that causes improper digestion, Kim one that causes very weak lungs. Bill, Curt, Amy, and Kim might be perfectly healthy; these troublesome alleles are not currently being expressed (such mutants could be caused by meiosis too. How the bad allele(s) come about is completely unimportant). Anyway, we can describe this founding population as consisting of 4 people, 3 of them carrying 1 troublesome allele, and 1 of them (Curt) carrying 2. Enter 1,1,1,2 into the data field, Calculate: p = 0.487, with a coalescence time of 8 generations. In other words, in an average time of 8 generations, there's a 49% chance one of those bad alleles will completely displace healthy alleles.

The Sciences / Genetics / Fixation Time

How long will it take for a given loci in a population to fixate?

Example: Imagine a founding population of 12 people. There's a 50% frequency of the allele for brown eyes and a 50% frequency for the blue eyes allele. Enter "50" into the first field "% Frequency of A Allele" (the **Chance Master 1000** automatically enters "50" into the next field), enter "12" in "Population Size," Calculate: t ≈ 16.64 generations. In other words, in an average time of about 17 generations, this population will have nothing but brown or blue eye alleles (which means they will all be either blue- or brown-eyed)

For this the following form is invoked:

$$t \approx 4N(p\log(p) + q\log(q))$$

The Sciences / Physics / Maxwell-Boltzmann

Data field expects integers.

$$p = \frac{r!}{r_1!r_2!\ldots r_n!} \cdot n^{-r}$$

{where r is total number of particles; n is total number of groups (or cells)}

The Sciences / Physics / Bose-Einstein

Data field expects integers.

$$p = \binom{n+r-1}{r}^{-1}$$

The Sciences / Physics / Fermi-Dirac

Data field expects only 0s or 1s; double occupancy is prohibited in the Fermi-Dirac model.

$$p = \binom{n}{r}^{-1}$$

The Sciences / Ecology / Animal Populations

This treatment represents the first truly statistical analysis offered in the Chance Master 1000. With all its bizarre little symbols and its inescapable place in the modern world, statistics can be thought of as a sort of hazy space between empiric truth and mysticism. While game theory solves deductively, statistics solves inductively. The issue of determining the confidence of a guess of a total population based on the occurrence of unique objects within that population is an excellent example. Instead of determining the chance of an occurrence of objects from a known object pool, we must determine the chance that we have a certain object pool based on a known occurrence of objects...

Behold!

$$p = \frac{\displaystyle\sum_{x=P_{\min}}^{P_{\max}} \frac{(x-C_2)!(x-C_1)!}{x!(x-C_1-C_{untagged})!}}{\displaystyle\sum_{x=b}^{\infty} \frac{(x-C_2)!(x-C_1)!}{x!(x-C_1-C_{untagged})!}} \qquad \text{(AP)}$$

{where p is the probability that the total population is between P_{min} and P_{max} ; x is the summation counter (the Total Population as an independent variable); C_1 is the number of tagged objects (first catch); C_2 is the number in the second catch; $C_{untagged}$ is the number of objects in the second catch that bare no tags; and b is conceptually zero, but in practice, to avoid the factorial of negative numbers and hence division by zero, it is the minimum possible population, $C_1 + C_{untagged}$ }.

There are a number of rather interesting asides within this whole issue; I will only briefly address a couple of them here—anyone interested in a detailed description of the above equality is welcome to email me. Feller gives the appearance of diving into this scenario headlong, but then, rather disappointingly, ditches any meaningful analysis, telling the reader: "Notice, incidentally, that [the population] is a fixed number which in no way depends on chance. It is, therefore, **meaningless** to ask for the probability that [the population] is greater than, say 6000" (43, emphasis mine). The only real treatment Feller offers is the "best guess," which is essentially the pedestrian surmising that the best population guess (as meaningless as its probability is), is (the nearest integer less than) C_1 times C_2 divided by C_{tagged}.

Equation AP assumes that there is no initial preference for the population size. That is, all populations are equally likely. Because, in the real world, the objects must come from somewhere, such as fish from a lake, there must be a maximum value (the lake's only so big) and a minimum value (aren't fish social?), and, even better, a reasonable distribution within these bounds. Bayes offers such an adjustment. In a way, this is where the science begins to get hazy. How can a system be both predisposed and random at the same time? (Bayes's treatment is very simple: the random distribution (AP) and the predisposed distribution and multiplied (with weighting, if one chooses) and the whole mess brought to unity).

Moving on.

Example: You're a park ranger. The warden has asked you how many purple-gilled man-eating sponge fish are in Lake Itchi Gitchi. With all due caution, you net, tag, and release 117 animals. The next day you net 95 animals, and find that 11 of them bare tags. Consult **The Chance Master 1000**. Enter 117 as "First Catch," 95 as "Second Catch," and 11 as "Tagged Individuals in Second Catch." Hit "Auto Range" for a ballpark. A best population guess of 1,010 is offered, along with a suggested range of between 808 and 1263. Now hit "Calculate Population." Kick off your shoes, stretch out, maybe freshen up your coffee... when you return a Confidence of 54% is displayed. If, for cosmetic reasons, you want a higher confidence, increase the guess range. Try 750 - 1400. After another wait (on my G4 733 this calculation takes 2:20 minutes), a 70% confidence is gleaned. You can tell the park warden that 1,010 is the most likely population, and that there is a 70% certainty that the population is between 750 and 1,400.

Yet More

The **Chance Master 1000** is a rather unassuming little application. In truth, however, the **Chance Master 1000** is a powerful tool that can analyze countless scenarios.

Here's an example.

Baseball hitting streak

Imagine a baseballer whose batting average is .290. If we assume this Batter X gets 4 at-bats per game and misses no games, what is the chance Batter X will enjoy a 25 game or better hitting streak over the course of an MLB regular season? We can calculate this by first determining the chance Batter X gets at least one hit in a game, then determine the chance of streaking that event over the course of 162 trials (number of MLB regular season games). The former can be handled more than one way with **Chance Master 1000**, we'll use Bernoulli Bulk Success. Go to "Gaming," "Value Pools," then "Bernoulli Bulk Success." We are seeking 1 success amid 4 trials with p = 0.29 OR BETTER. Calculate: p = 0.74588319. Copy this value at the Log. Go to "Bernoulli (Streaks)," paste this value into the "Probability of Success" field. We are seeking a streak of 25 amid 162 trials. Calculate: p ~ 0.0233024338. We can copy this value over to "Gaming," "Conversion," "Probability," and Calculate. Chance is about 1 in 43.

Closing Rumination over Game Theory & Gambling

In the commerce of gaming, the casinos prevail.

There are two ways gamblers may profit (or "beat the odds"). One is outplay competition at skill games. For example, becoming a very good poker player or develop a good statistical treatment for sports betting. The other is to bet winning scenarios—or, "play house."

"Playing house," short of opening your own casino, is carried out through side betting. A discussion all in itself, keep in mind these three maxims:

1. You must know the true expectation of the event.
2. The exact terms of the wager must be exactly expressed, and preferably witnessed by neutrals.
3. People love long odds (or more accurately, they love *the prospect of* big payoffs). This simple and immutable truth fuels lottos across the globe.

Want to Know More?

If you're a novice and want to learn more about game theory, you're out of luck. To my knowledge, no book has ever been written detailing the fundamentals.

Work Cited

Feller, William. An Introduction to Probability Theory and Its Applications. Vol. 1. 2nd ed. New York: John Wiley & Sons, 1961.

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God Bless