
One of your hw problems for tomorrow 7-12-10 was designed to get your attention. I'd asked you to determine the probability of getting exactly 5000 heads in 10000 tosses of a coin. How can we be sure of the accuracy of our answer? Here is a solution on a MacBook Pro running *Mathematica*.

The following calculation of the binomial coefficient is exact.

$$10\,000!$$
$$5000! \, 5000!$$

Out[13]=

15917902635324389483375972736415211886530058374576145504283191035177726371200957
98663262853944222217743358598299322620558046329087080207398508798721959584896204
17578664585801840995875120689143315978135317405145347319967052139450253847727733
60083120537844882395127432175550288318092736464428179545934936890023546288054736
62829272132209197268030621578397698552486834508478688949946112620233602352989894
58928488427591110374321646235202929095545845304023492927787143123978410362592908
30007542173305536549242536830628153072965334088925565069087515064761594462237620
43268522300626782112593759516571153428482453331810686840952840042846995043592578
17996430741389422649447586626281862183757541280362546881388544759125956185871468
45438186146366235072846821144165546574399328400579417002212869168618937974722788
62022397883728976020496710189761906178593058261688081175561177969603798092821748
55477301204105813490546271598511886613777441541105636943056820725244819431050256
48749457962883760429507987291417800530102414934072257975983486021164009854572318
30964186336888983121455970724694544566517890819353860625660293683165225062715958
24234037562793787332887113614352737971292965638066368798136853809235306441396478
97981427998980441958797431047888940127197101544121684009634465293952852430671000
38066963076992572201044263118365330490675121982700124367744533393638700228117925
35618814009571973175044979333952276086203573893932977683234377126461503016956149
96011950820670589112787564401832800247788557058059427173965561724727970366569861
80808019655412357565646555654339707955136421179968234829408914932867170470389361
58996297545140449708716896119990505242038078767450450863985246304067167020269491
25606462058300176130062228475751066256610619377143558721853780962002691381630596
17562968278767106594650407547672280714758216870191663242582016858932814549418496
33219010250326331594361831605955344426680189751351988451293306946591872301020473
20872118128461116396416576556893394074097665692587872816840693520731443017872513
61780157927471147290158311709071711945782984829441643598406584733847077194186596
51955333974514346503817616197612616157040354559466774548777412765471478663541418
80011196260295733526594568658436972130968698361264056499020792424780535414096306
95666030711959315691726268023515182087865155469373796387605046437155479530978766
50816797000176926659286918757094175117347665748132703540903393455409827319346571
30920200412827961158882797284732350179796997256267197282634701775660633130401607
55515205233184045927567976122446793241948469193929185204523945776759533268690674
43192793756095658856432124228522403516658454319704009054696329636363817791559641
20500568570269037283806038851971340361162904005663342046894176159382456860877054
52693904560388837559732156292227663423267910309912054892793591354641456968021307
92488795541350742383065293811197486421347908348956557941526999776837834147059039
19974789150191636363967759194538753518015249805221045070170550883809354420902245
5222930021060372371375638589078163387440553649120

$C[10000, 5000]$ is a very large number! It counts all the ways that 5000 heads can be located in 10000 positions.

The probability of getting exactly 5000 heads in 10000 tosses is the product of this very large number by the very tiny probability $.5^{100}$ of each sequence of 10000 heads and tails. We can determine this product to 10 decimals if we wish. I've used 1/2 instead of 0.5 which tells *Mathematica* I wish to have the exact answer rounded to 10 decimals.

$$\text{In}[18]= \mathbf{N}\left[\frac{10\,000!}{5000! \, 5000!} (1/2)^{10\,000}, 10\right]$$

Out[18]= 0.007978646139

So, by putting a lot of computing muscle into it we find the ten decimal accurate answer to the probability of getting 5000 heads in 10000 tosses is ~ 0.007978646139 .

So your calculator doesn't have that kind of computing power? You can use an approximation. I will present one in class.