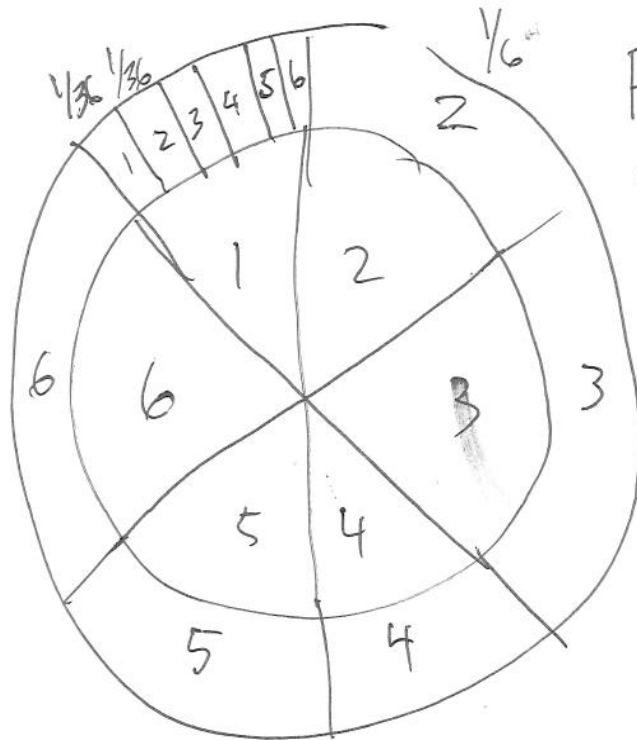


#3 on  
quiz

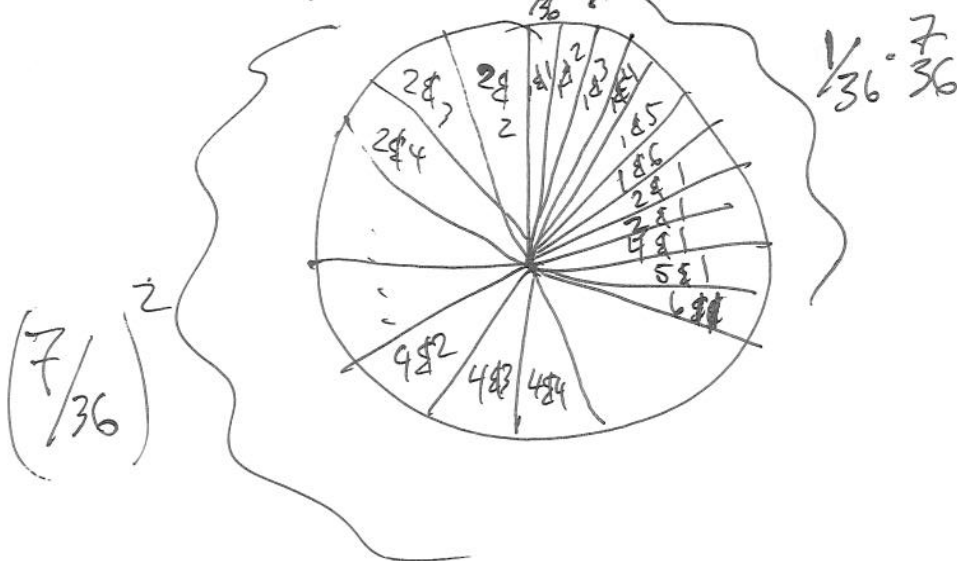


$$\begin{aligned}
 P(\text{roll 1 die} = 2) &= \frac{7}{36} \\
 &= P(\text{roll 1 die} = 3) \\
 &= P(\text{roll 1 die} = 4) \\
 &= P(\text{roll 1 die} = 5) \\
 &= P(\text{roll 1 die} = 6)
 \end{aligned}$$

$$P(\text{roll 1 die} = 1) = \frac{1}{36}$$

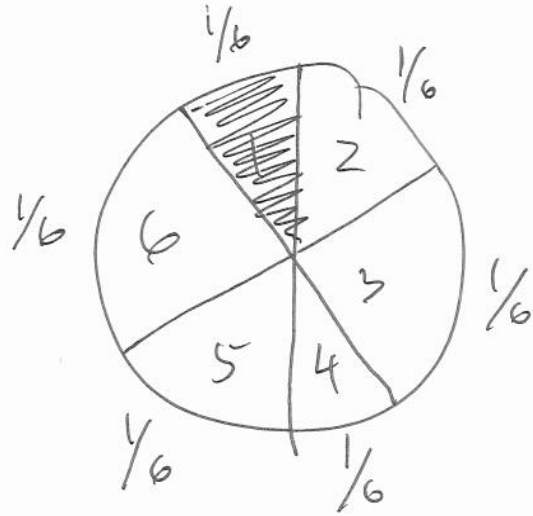
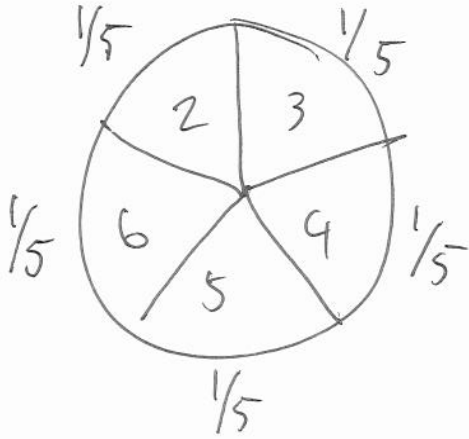
$$\begin{aligned}
 P(\text{two dice total } 7) &= P(1 \& 6) + P(2 \& 5) + P(3 \& 4) \\
 &\quad + P(4 \& 3) + P(5 \& 2) + P(6 \& 1)
 \end{aligned}$$

$$= 2 \cdot \frac{1}{36} \cdot \frac{7}{36} + 4 \cdot \frac{1}{36} \cdot \frac{7}{36} = \frac{14 + 4 \cdot 49}{6^4}$$



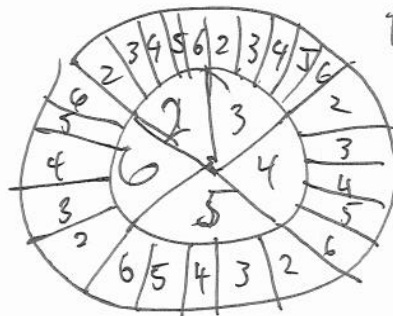
$$\left(\frac{7}{36}\right)^2$$

#4  
 on 9/18 One die



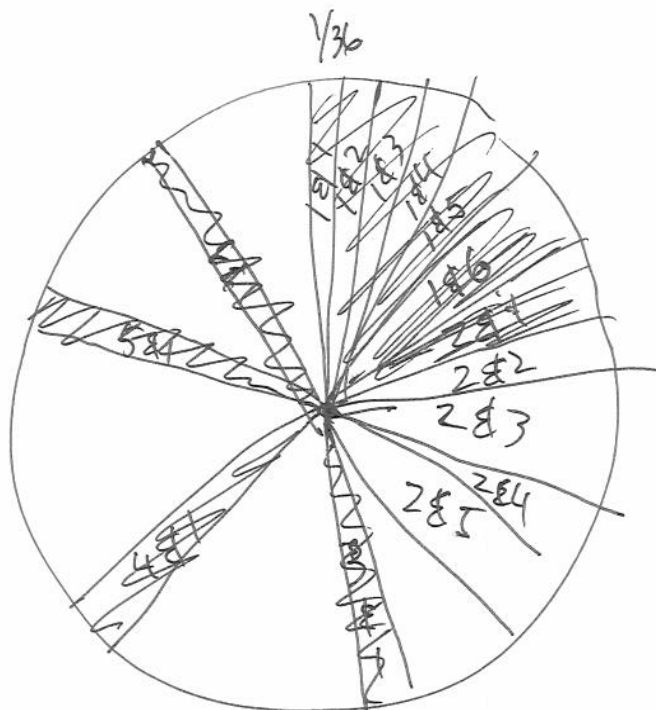
$$\begin{aligned}
 &P(\text{roll } x \mid \text{roll is not } 1) \\
 &= \frac{P(\text{roll } x \ \& \ \text{roll is not } 1)}{P(\text{roll is not } 1)} \\
 &= \frac{\frac{1}{6}}{\frac{5}{6}} = \frac{1}{5}
 \end{aligned}$$

if  $x$   
 $= 2, 3, 4, 5, 6$



$$P(\text{roll } 7 \text{ with } \text{dice} \neq 1) = \frac{4}{25}$$

#5 on  
quit



$$\begin{aligned} P(\text{roll } 7 \mid \text{don't have a die showing } 1) &= \\ \frac{P(\text{roll } 7 \& \text{ don't have a die showing } 1)}{P(\text{don't have die showing } 1)} &= \\ \frac{4/36}{25/36} &= \frac{4}{25} \end{aligned}$$

The index of coincidence is defined as

$$I_c = \frac{\text{number of pairs of equal letters in ciphertext}}{\text{the total number of pairs of letters}}$$

That is if we set

- $N_\alpha$  = the number of occurrences of the letter  $\alpha$  in the cyphertext

- 

$$D_c = \sum_{\alpha=A}^Z \binom{N_\alpha}{2}$$

$D_c$  represents the number of pairs of equal letters in the cyphertext.

- then  $I_c = \frac{D_c}{\binom{N}{2}}$
- where  $N$  = the number of letters in the cyphertext

The index of coincidence is invariant under monoalphabetic cyphers and we estimate under this condition that  $N_\alpha = N * p_{\sigma(\alpha)}$  for some permutation of the alphabet  $\sigma$  and so

$$\begin{aligned} I_c &= \frac{\sum_{\alpha=A}^Z (N_\alpha^2 - N_\alpha)}{N(N-1)} = D_c = \sum_{\alpha=A}^Z \binom{N_\alpha}{2} \\ &\approx \frac{N^2 (\sum_{\alpha=A}^Z p_\alpha^2) - N}{N(N-1)} \\ &= \frac{N(.065) - 1}{N-1} \\ &\approx .065 \end{aligned}$$

$$\binom{N_\alpha}{2} = \frac{N_\alpha(N_\alpha - 1)}{2}$$

$$\frac{\binom{N}{2}}{\binom{N_\alpha}{2}} = \frac{N(N-1)}{N_\alpha(N_\alpha - 1)}$$

## Some Monkey Words

The letters of the following words were chosen at random with equal probability.

zotwz kjptg uudrx mtagh gaqvl uhuaf oymcu iljaa jancm bxpbi cvcdo oceza wrgzg  
wweuk phqvq rqtwq axqqm yxng h rsxch gsocp sssda jmjhl kykml kdefv tmafc ncsiu  
anunv hcwyy ueikr ifzta abjrq kiaez abjka hufwa fjenl ptpqm exjhx vzmeg uayxu  
dkxid agsst gutif qzmyc lwood sobrh tkjoq vkghf rgxad frywd bkwql uvcpk qjdkk  
mugak krwcb gpgsf dwsxu vafik sxiev lejjq pznet fjtqc jhnic vojrv ucfib nuzgb  
xahvu lvwyq spvtf zdxob aigfa wgjeq wcqoe bbmbm fdrvx znhbo ovxqu lzznh vmdjj  
kfkig jnugp xxgnf hhliw oveje mvujj hqucs plcuo aijqt hlgdj pvhhi jwyqo wbbho  
qcwtc ahbyt xbvrc kvcby etllo bgouc lwver ewzpj yhysb grtba betir hekem mhjwl  
zflze jtalc gxvhz rkaxp qastv ibuzn jvqvt vtxgw nvnlj muqwx nddwh gggrk jqgrp  
xxahd tbvuw hgjya bnoqg yfwap gohru huluh xmhtu kbbxv toywf imblw shacr taaqv  
xyamm ggbcy ykial aipgv osyqq iwwrw ivhpj ybugr rscvx zbdgy ndesm endwt tbgmd  
yroti vvqas xbixy qzckh ayzaz bmsns macws skbqb orcva mxaah wdjax rpfwa tgepf  
ckjgv msyiv nkemr lksbd fyrtv sgxlb ryqbd zkjed uornf fgcft harsx xonas pttlr  
qrraj hwerm oanup pqkww wmtog sjblk hdgac etadi ljlql tfkla bfxug dwfow corfo  
qnwjd tnaib sicil bukam jxhix uyygr yhfxq goxor vgxsb ngnka pojfr mgoni rntkk  
yjxua llggz yyuzf bijhf pfctu hnipg oczle glfli lozhs qcvmw ueuyl jnuxp xzpaz  
otkvt jtaws ejigu xiqin txded zghgb jtovo oiaqa moiar yklzv kxmpe rtxwz qpvkz  
chqxl mixcz kchjw xeljr hryqr kdbyp tirep whomf eoxwh iblae gbary qqhmi wcaam  
vkyup zlkjx fwium pwske xfchv xxcap tauyz jqodr lehsc ssvos avjoh pbqif kpuch  
bhmvv yojmr dhfvw gwruc xjywu fmlqe joqbi pwhci hcnjq xwktm sslpc ktwwd biwbl  
hqtzx yisnt tpovm vbdxk nibab ukxqo ahyzk vrwhb fgezq tkves veqlr pjiww dheql  
zgyyt gjbjp npobo rcncd pxaqj rzolr ibtfe ddfri ahglo cjfcf kjqrp cacwt aipoe  
jcnrd nnnhi efugo blkhi ahvjj rxoxq mbcnn wlvqd ryoel optj grotg gnien jvruf  
atedb piprx bywxl wluvw shxix xmxxm aodlg mbfxk otpix rcfgo ylffg jyzvx wyvbe  
exovx fgrqz umawo uyfua mzruo muols rpfyf fwkto tgdpn erwbi zqsva eyyxf mleas  
trwhd nmosb kknqo nfiwm jaxhq woxeq sqipi xemfj cpqcq yhkvb zyelo mnaky rovgt  
yzrek grdzc qvkog pgpxp ggghz lclgc osdrd biedw eujdz onvuz dcuoc vothj rtodx  
dygqw ezhkf vghih vzyzy aswum ulwcd jxsgf aibfp iwmwq qepaw npazz pwbzj aqqo  
jrfys ccegi anrge yrzzw hkwvs csrmo kpcov bvsqk cmhlv kapoo mszcc zzoql vpzxp  
wsiyx oiljc joriz nrfm prifj nnkaa zmdym kahue nicek zlxbo kelin wtvxd hekse

## Some English Monkey Words

A monkey types on a keyboard but this time the frequencies of letters that he types are the same as one would find in average English text.

ccgai teeir euerd ommal iltom eeoyz uneep risrf ocoee ifspo maxpu eerci upomr  
samiu eeitr eeopo cuoic uelnr eoeew usleo mestr etfok thiee ocart tssss rseaa  
anior oisda fteoa doals oiatl uyvre tiiit hifhq loean pvoom nuala appes aicha  
capts ttwnh rsios fohlh efsmh hnfee wtdwo ptnip toipi eretn jrpsh suodo rtuee  
eosrf ueats tsetd aalet tplcf eanin tetdt evaos lefee dffsm eotfu seber keega  
ehafe raaes uhtan nnspr dogoh esncn oooed hrrnu umrky hrhbe rttsn daofu otiqi  
deeps fnaso atnrr heaes sinfa ogoeh oxint tdehr wsest reknd hcpte iaogg tdfro  
ttsiu nrrle jpeof xyatt asdis aopon aoyrh ahsos dytic unswa efdrt eodrd toiro  
efeni seief hnvaio itieu ffdht pottr exewo darnh teeos yilem taros rclof octns  
ltdte liatr altsi eescr tsiru oavre dtiay esait kttha fpdqt iteas ooocf rtmee  
rwtez isaru ptask uneea cbsoi sedsr tocre nitda utous ehtia dnifi ratla defls  
yiuib aldcn neyed dqsse ogtsi wiexu erpas rsoyr ocpdi oitdu opsju neesh sneea  
htnol smrtf ionfd ntcoo himam arhyv olodp eanei roaie clued fecrm haeei opnar  
hilau tprrt etaen htnfs naahi tiavf dorat idcmp nlyic eeirr nmgi h cuuie sopeo  
lifdg rowni lftif eodfe ceese haeei pfnrp yenin aaeoi drnll nawtl anite eoeor  
oreel ehtrt wrree ortcd rrran seijj yeodf qetwl instb ynrcx rdcth ftrne oearth  
eospr qclea ntyep emifo raotx eaodx eklai rntpn rcaw euvaio caiiio udlvt eghte  
swel ltase axpth ypati hotfn xoevt hotor oomcr yhlof eosscc maego sahdw waopo  
reeza elrdn itgen sauwu otdpe meeor wtnot dnvtt leuen eeeod tsdml nendf lnhta  
chdeo rrrli kmolx nfwul ptste ntdwe ptehn pnosn dnoet hnols adtes asnen heoey  
dofsr oyprg foiaa sosie nceoe suxlp eirpe tarac nyaot oedfa oaivf edgfn orgrt  
nmrer noaes xeisi dttex mteiw ptwot afkwi deiee nludn iiinn nitlr tripb elret  
eedrl ngsan tacse foudh oinnu xiiep footh rdlep ryvtn nlstn fneit ewemr eryae  
pssnu ctmye ncnem aosnm ounnn ouswn tmref nnnol msplt meptc ebyke smeni inecl  
edoen rncrtr airwn mbere oanty sefcp eekdo steat eahir ootaf tfdel oslor oerop  
enmst nssda gesrf nmtie staem uhfil erpun retel pdoea evwmr dnuvi aetme fwdeo  
avlag syera nsnth eidns mitcc refst tfede lpsrw nswtn snere iloaa ioesy ispr  
yuacm eoene rdrum rrtmy ubmol taemr ansst xeccs rrltn osnne nnern onsir mnite  
stwss utrst iudeo dnnau tyllt etnoo ereho nslyl elpee sryen yctsm camee uheuw

## Some Bi-letter English Monkey Words

A monkey types on a keyboard, the first letter appears with frequency in an English word, the second through fourth letters are chosen with a probability using a bi-letter frequency table given that the previous letter has been chosen.

thint oucon dingi these ryere veega manen elers dengi hedda hesnc rmiss isonk  
ticic utasu thede thore ighab banan dilet sinyu nthea rived there xched tenor  
omobo diome emeth esast nyazz nscec rikir asthe everr blari disul hengi rinea  
denth dmewo lralt rapol ldbre dities menti hesce osece oriom thear lloas ponoo  
thesi ntiai beare veaki seere awhes suert theco ldent lenda sizal ingai irove  
searm ereye atere antrn sunga endea plthe overu amese cyebl nynds hsere rtopl  
pathe oares rstht stsut fennt enthe vangh ounen asile ninti xpess thegh speni  
cigio tsore rendd halla erise siath erere sstra stsou theta ffant ingam onsty  
reria costi denoa ezogr eewar gicau indma erofe tosth hetye teror uleem nicad  
checo presa ilila derer fontr lasst ibuta atsth lirru maled doror expus grahe  
nlsew rlune unche tourk shedr idens istis cenge sofic ruthe errgh rerga nftst  
odata taler anthe renim lymer eulld cende ngsta piopo ctour shall ndowa sengs  
didos ndyin nthed toffi segha aveal hesee engom nenhi lesiv rksti susel wante  
ofrra enero edemi mpast armop herel evede theys theco epotr lempi nsted rsper  
omema ngeat satin pulli orunt erang peese ntiso istit ended resed rteem lldas  
cathe evest nssll raicu entth errys ceeca theyy tiong hecle seske inogh tlufo  
pstav itofo giems feden eeaya erous cousc ikeng sulde scers derth renio penth  
stuan shend calic whiso ndics eroro mprer spapo erint tluge tithe narda orkre  
ecrad eromi ordst erofi iomim atofe trmin whall famer xcost stale sldev edowa  
ourio dedut enerm narot nvily ndeys ndise samm egati ychis thamb dansh lomem  
rmoni praut sesiv oumut erthe ethod enepa erkan poida lentl rorch fresi thess  
inthe ctans ppomi halye owero sitye oneth oryei oulor whali deist eathe inicy  
esfon gesti rleme ndesw wheat olalo eedit titha tanat isona haned ngrer tonmo  
tryst ulyor tewed conce kerd lexar isoma savio dyent ainow senior cirsc utest  
finin acewe weryo redee sofor nstta sousi kstco emese delin hedle demev ppain  
nyesh sithe eatea witue ededi eathe wicel nther kesin latex foken ecoup londi  
thofo esive arkeg ngrer deply anthe sermo peour rontl ayerc redul ncoti ullor  
overt ttror tipom abyri aslld orient eyoch mersa heaye ameat ronef sedei utidc  
usper rares issth ysand amast nicec ereth ithan stson aysoi damia nsais shani  
dsoth trket sstrb rolylly onthe retec egron stomy thena ooitv rvesi esagh putro

## Some Tri-letter English Monkey Words

A monkey types on a keyboard, the first letter appears with frequency in an English word, the second letter is chosen with a probability using a biletter frequency table given that the first letter has been chosen, the third through fifth letters are chosen using a triletter frequency table given that the previous two letters have already been chosen.

dafcf atoho eledc oldeb osaye illjp ussya insem icing gooke ititi abook ques  
andes thind teonf rsett theof eacbc lalvi ningt oresp egyho dimet iblen seean  
lingw seass putiw regrp diero demar ncrar scorr nadfd serem herse thasc amrmo  
xtran eenki bysit ontau aygrp newha wevea texas endge instc eseen simet reing  
ngalh ddeaf reefa altre renit odewa ayiss hilai rasub vdfae mbnou nconb relev  
nthep xphis escmu preal ddows gauda hstor fuysu froco raway ionsa orxuy orutt  
ereis cifyi emben prabs thell liame untal thepr ffaec overt repa areha escof  
iafcc eusta thema ecukc nftha redit andpa butio edefe eveep hapto astia thshe  
ommex ecaaa theed ntoth atusu hefer comet eveun rside eetth ncomb rtuda bafro  
thict ofthe eprie estra plyst hatmy ypreo shrma olsom mmikm esdan fomme eandr  
fortu eedth lthst sarav esloo ndren aysub yafbo mency didfe theha cofao quica  
ethin martf wnfef tilli thing iaand neice ffanj etsin rdetm ouwro ament quesc  
puton orhic enced merni thats ptrix opedu nsfun thisp ouion eensh aunto tassb  
ngoc stred ngwil aysul andec trike othis hardi ltlip eduas parik ichop pandr  
thers adlim renes udans itsro ionsw pardr viden eebmy conth oasea inmm lasub  
ndefo redek hopho stati solea uitha fiewh maitb egeto dupfq outeb quitr edheg  
ensun atows nanai thaps cafaf nthel iemer sepif enway olbyt tenok ontow thsta  
ester erpos eckim omsag justu avole ngfov raver yinda thess revie estca matto  
rictu froso iaots neisa thiso rould rewro sitze lyous fingo ercec nginm foew  
ingth yiweh inkin toant comes wando melaa ldber escon mike exhav bedto ntake  
orevu necfc fffca ugooc areyo itake hethe rwork neeha ethin suatw plewi tocki  
metpo eryel gnslo ivesl isisy farts tecfc vetry ofthn alged datna emaya itsta  
thego lintu ition lyssi ntemu ticei redat urvex rnary imeno ntwin ellie atiom  
eendd ernee ytemp ienre siloc leget asfor yelll iendt ypros rtmor usthe ionee  
stalb rtwas negat posar ifwco ngssi youta ricss titha ojuhl shrou ymike uened  
trepu bymmu tohen nsfae ctthi montd andwi ranto tardt corfr ervar esbet acour  
iting ectqu lphat chnin mikei wlips nffpr ngead tyow fozth hingi ourli ertom  
enopo niing rsmei educa oters yetty titma sthuf sapet grati helli septo enwe  
enede edtei setwh thexa ngoin ysess ermst temag rtomm nause daryo urdin ngsfd