

**Table 4** Binomial Probability Distribution  $C_{n,r} p^r q^{n-r}$

This table shows the probability of r successes in n independent trials, each with probability of success p.

| n | r | p    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|---|---|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|   |   | .01  | .05  | .10  | .15  | .20  | .25  | .30  | .35  | .40  | .45  | .50  | .55  | .60  | .65  | .70  | .75  | .80  | .85  | .90  | .95  |
| 2 | 0 | .980 | .902 | .810 | .723 | .640 | .563 | .490 | .423 | .360 | .303 | .250 | .203 | .160 | .123 | .090 | .063 | .040 | .023 | .010 | .002 |
|   | 1 | .020 | .095 | .180 | .255 | .320 | .375 | .420 | .455 | .480 | .495 | .500 | .495 | .480 | .455 | .420 | .375 | .320 | .255 | .180 | .095 |
|   | 2 | .000 | .002 | .010 | .023 | .040 | .063 | .090 | .123 | .160 | .203 | .250 | .303 | .360 | .423 | .490 | .563 | .640 | .723 | .810 | .902 |
| 3 | 0 | .970 | .857 | .729 | .614 | .512 | .422 | .343 | .275 | .216 | .166 | .125 | .091 | .064 | .043 | .027 | .016 | .008 | .003 | .001 | .000 |
|   | 1 | .029 | .135 | .243 | .325 | .384 | .422 | .441 | .444 | .432 | .408 | .375 | .334 | .288 | .239 | .189 | .141 | .096 | .057 | .027 | .007 |
|   | 2 | .000 | .007 | .027 | .057 | .096 | .141 | .189 | .239 | .288 | .334 | .375 | .408 | .432 | .444 | .441 | .422 | .384 | .325 | .243 | .135 |
|   | 3 | .000 | .000 | .001 | .003 | .008 | .016 | .027 | .043 | .064 | .091 | .125 | .166 | .216 | .275 | .343 | .422 | .512 | .614 | .729 | .857 |
| 4 | 0 | .961 | .815 | .656 | .522 | .410 | .316 | .240 | .179 | .130 | .092 | .062 | .041 | .026 | .015 | .008 | .004 | .002 | .001 | .000 | .000 |
|   | 1 | .039 | .171 | .292 | .368 | .410 | .422 | .412 | .384 | .346 | .300 | .250 | .200 | .154 | .112 | .076 | .047 | .026 | .011 | .004 | .000 |
|   | 2 | .001 | .014 | .049 | .098 | .154 | .211 | .265 | .311 | .346 | .368 | .375 | .368 | .346 | .311 | .265 | .211 | .154 | .098 | .049 | .014 |
|   | 3 | .000 | .000 | .004 | .011 | .026 | .047 | .076 | .112 | .154 | .200 | .250 | .300 | .346 | .384 | .412 | .422 | .410 | .368 | .292 | .171 |
|   | 4 | .000 | .000 | .000 | .001 | .002 | .004 | .008 | .015 | .026 | .041 | .062 | .092 | .130 | .179 | .240 | .316 | .410 | .522 | .656 | .815 |
| 5 | 0 | .951 | .774 | .590 | .444 | .328 | .237 | .168 | .116 | .078 | .050 | .031 | .019 | .010 | .005 | .002 | .001 | .000 | .000 | .000 | .000 |
|   | 1 | .048 | .204 | .328 | .392 | .410 | .396 | .360 | .312 | .259 | .206 | .156 | .113 | .077 | .049 | .028 | .015 | .006 | .002 | .000 | .000 |
|   | 2 | .001 | .021 | .073 | .138 | .205 | .264 | .309 | .336 | .346 | .337 | .312 | .276 | .230 | .181 | .132 | .088 | .051 | .024 | .008 | .001 |
|   | 3 | .000 | .001 | .008 | .024 | .051 | .088 | .132 | .181 | .230 | .276 | .312 | .337 | .346 | .336 | .309 | .264 | .205 | .138 | .073 | .021 |
|   | 4 | .000 | .000 | .000 | .002 | .006 | .015 | .028 | .049 | .077 | .113 | .156 | .206 | .259 | .312 | .360 | .396 | .410 | .392 | .328 | .204 |
|   | 5 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .005 | .010 | .019 | .031 | .050 | .078 | .116 | .168 | .237 | .328 | .444 | .590 | .774 |
| 6 | 0 | .941 | .735 | .531 | .377 | .262 | .178 | .118 | .075 | .047 | .028 | .016 | .008 | .004 | .002 | .001 | .000 | .000 | .000 | .000 | .000 |
|   | 1 | .057 | .232 | .354 | .399 | .393 | .356 | .303 | .244 | .187 | .136 | .094 | .061 | .037 | .020 | .010 | .004 | .002 | .000 | .000 | .000 |
|   | 2 | .001 | .031 | .098 | .176 | .246 | .297 | .324 | .328 | .311 | .278 | .234 | .186 | .138 | .095 | .060 | .033 | .015 | .006 | .001 | .000 |
|   | 3 | .000 | .002 | .015 | .042 | .082 | .132 | .185 | .236 | .276 | .303 | .312 | .303 | .276 | .236 | .185 | .132 | .082 | .042 | .015 | .002 |
|   | 4 | .000 | .000 | .001 | .006 | .015 | .033 | .060 | .095 | .138 | .186 | .234 | .278 | .311 | .328 | .324 | .297 | .246 | .176 | .098 | .031 |
|   | 5 | .000 | .000 | .000 | .000 | .002 | .004 | .010 | .020 | .037 | .061 | .094 | .136 | .187 | .244 | .303 | .356 | .393 | .399 | .354 | .232 |
|   | 6 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .004 | .008 | .016 | .028 | .047 | .075 | .118 | .178 | .262 | .377 | .531 | .735 |
| 7 | 0 | .932 | .698 | .478 | .321 | .210 | .133 | .082 | .049 | .028 | .015 | .008 | .004 | .002 | .001 | .000 | .000 | .000 | .000 | .000 | .000 |
|   | 1 | .066 | .257 | .372 | .396 | .367 | .311 | .247 | .185 | .131 | .087 | .055 | .032 | .017 | .008 | .004 | .001 | .000 | .000 | .000 | .000 |
|   | 2 | .002 | .041 | .124 | .210 | .275 | .311 | .318 | .299 | .261 | .214 | .164 | .117 | .077 | .047 | .025 | .012 | .004 | .001 | .000 | .000 |
|   | 3 | .000 | .004 | .023 | .062 | .115 | .173 | .227 | .268 | .290 | .292 | .273 | .239 | .194 | .144 | .097 | .058 | .029 | .011 | .003 | .000 |
|   | 4 | .000 | .000 | .003 | .011 | .029 | .058 | .097 | .144 | .194 | .239 | .273 | .292 | .290 | .268 | .227 | .173 | .115 | .062 | .023 | .004 |
|   | 5 | .000 | .000 | .000 | .001 | .004 | .012 | .025 | .047 | .077 | .117 | .164 | .214 | .261 | .299 | .318 | .311 | .275 | .210 | .124 | .041 |
|   | 6 | .000 | .000 | .000 | .000 | .000 | .001 | .004 | .008 | .017 | .032 | .055 | .087 | .131 | .185 | .247 | .311 | .367 | .396 | .372 | .257 |
|   | 7 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .004 | .008 | .015 | .028 | .049 | .082 | .133 | .210 | .321 | .478 | .698 | .932 |

Table 4 continued

| n  | r  | p    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|----|----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|    |    | .01  | .05  | .10  | .15  | .20  | .25  | .30  | .35  | .40  | .45  | .50  | .55  | .60  | .65  | .70  | .75  | .80  | .85  | .90  | .95  |      |
| 8  | 0  | .923 | .663 | .430 | .272 | .168 | .100 | .058 | .032 | .017 | .008 | .004 | .002 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 1  | .075 | .279 | .383 | .385 | .336 | .267 | .198 | .137 | .090 | .055 | .031 | .016 | .008 | .003 | .001 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 2  | .003 | .051 | .149 | .238 | .294 | .311 | .296 | .259 | .209 | .157 | .109 | .070 | .041 | .022 | .010 | .004 | .001 | .000 | .000 | .000 | .000 |
|    | 3  | .000 | .005 | .033 | .084 | .147 | .208 | .254 | .279 | .279 | .257 | .219 | .172 | .124 | .081 | .047 | .023 | .009 | .003 | .000 | .000 | .000 |
|    | 4  | .000 | .000 | .005 | .018 | .046 | .087 | .136 | .188 | .232 | .263 | .273 | .263 | .232 | .188 | .136 | .087 | .046 | .018 | .005 | .000 | .000 |
|    | 5  | .000 | .000 | .000 | .003 | .009 | .023 | .047 | .081 | .124 | .172 | .219 | .257 | .279 | .279 | .254 | .208 | .147 | .084 | .033 | .005 | .000 |
|    | 6  | .000 | .000 | .000 | .000 | .001 | .004 | .010 | .022 | .041 | .070 | .109 | .157 | .209 | .259 | .296 | .311 | .294 | .238 | .149 | .051 | .000 |
|    | 7  | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .008 | .016 | .031 | .055 | .090 | .137 | .198 | .267 | .336 | .385 | .383 | .279 | .000 |
|    | 8  | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .004 | .008 | .017 | .032 | .058 | .100 | .168 | .272 | .430 | .663 | .000 |
| 9  | 0  | .914 | .630 | .387 | .232 | .134 | .075 | .040 | .021 | .010 | .005 | .002 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 1  | .083 | .299 | .387 | .368 | .302 | .225 | .156 | .100 | .060 | .034 | .018 | .008 | .004 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 2  | .003 | .063 | .172 | .260 | .302 | .300 | .267 | .216 | .161 | .111 | .070 | .041 | .021 | .010 | .004 | .001 | .000 | .000 | .000 | .000 | .000 |
|    | 3  | .000 | .008 | .045 | .107 | .176 | .234 | .267 | .272 | .251 | .212 | .164 | .116 | .074 | .042 | .021 | .009 | .003 | .001 | .000 | .000 | .000 |
|    | 4  | .000 | .001 | .007 | .028 | .066 | .117 | .172 | .219 | .251 | .260 | .246 | .213 | .167 | .118 | .074 | .039 | .017 | .005 | .001 | .000 | .000 |
|    | 5  | .000 | .000 | .001 | .005 | .017 | .039 | .074 | .118 | .167 | .213 | .246 | .260 | .251 | .219 | .172 | .117 | .066 | .028 | .007 | .001 | .000 |
|    | 6  | .000 | .000 | .000 | .001 | .003 | .009 | .021 | .042 | .074 | .116 | .164 | .212 | .251 | .272 | .267 | .234 | .176 | .107 | .045 | .008 | .000 |
|    | 7  | .000 | .000 | .000 | .000 | .000 | .001 | .004 | .010 | .021 | .041 | .070 | .111 | .161 | .216 | .267 | .300 | .302 | .260 | .172 | .063 | .000 |
|    | 8  | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .004 | .008 | .018 | .034 | .060 | .100 | .156 | .225 | .302 | .368 | .387 | .299 | .000 |
|    | 9  | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .005 | .010 | .021 | .040 | .075 | .134 | .232 | .387 | .630 | .000 | .000 |
| 10 | 0  | .904 | .599 | .349 | .197 | .107 | .056 | .028 | .014 | .006 | .003 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 1  | .091 | .315 | .387 | .347 | .268 | .188 | .121 | .072 | .040 | .021 | .010 | .004 | .002 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 2  | .004 | .075 | .194 | .276 | .302 | .282 | .233 | .176 | .121 | .076 | .044 | .023 | .011 | .004 | .001 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 3  | .000 | .010 | .057 | .130 | .201 | .250 | .267 | .252 | .215 | .166 | .117 | .075 | .042 | .021 | .009 | .003 | .001 | .000 | .000 | .000 | .000 |
|    | 4  | .000 | .001 | .011 | .040 | .088 | .146 | .200 | .238 | .251 | .238 | .205 | .160 | .111 | .069 | .037 | .016 | .006 | .001 | .000 | .000 | .000 |
|    | 5  | .000 | .000 | .001 | .008 | .026 | .058 | .103 | .154 | .201 | .234 | .246 | .234 | .201 | .154 | .103 | .058 | .026 | .008 | .001 | .000 | .000 |
|    | 6  | .000 | .000 | .000 | .001 | .006 | .016 | .037 | .069 | .111 | .160 | .205 | .238 | .251 | .238 | .200 | .146 | .088 | .040 | .011 | .001 | .000 |
|    | 7  | .000 | .000 | .000 | .000 | .001 | .003 | .009 | .021 | .042 | .075 | .117 | .166 | .215 | .252 | .267 | .250 | .201 | .130 | .057 | .010 | .000 |
|    | 8  | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .004 | .011 | .023 | .044 | .076 | .121 | .176 | .233 | .282 | .302 | .276 | .194 | .07  | .000 |
|    | 9  | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .002 | .004 | .010 | .021 | .040 | .072 | .121 | .188 | .268 | .347 | .387 | .315 | .000 |
|    | 10 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .006 | .014 | .028 | .056 | .107 | .197 | .349 | .599 | .000 |
| 11 | 0  | .895 | .569 | .314 | .167 | .086 | .042 | .020 | .009 | .004 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 1  | .099 | .329 | .384 | .325 | .236 | .155 | .093 | .052 | .027 | .013 | .005 | .002 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 2  | .005 | .087 | .213 | .287 | .295 | .258 | .200 | .140 | .089 | .051 | .027 | .013 | .005 | .002 | .001 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 3  | .000 | .014 | .071 | .152 | .221 | .258 | .257 | .225 | .177 | .126 | .081 | .046 | .023 | .010 | .004 | .001 | .000 | .000 | .000 | .000 | .000 |
|    | 4  | .000 | .001 | .016 | .054 | .111 | .172 | .220 | .243 | .236 | .206 | .161 | .113 | .070 | .038 | .017 | .006 | .002 | .000 | .000 | .000 | .000 |
|    | 5  | .000 | .000 | .002 | .013 | .039 | .080 | .132 | .183 | .221 | .236 | .226 | .193 | .147 | .099 | .057 | .027 | .010 | .002 | .000 | .000 | .000 |

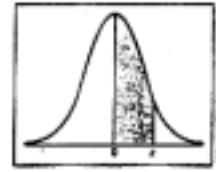


Table 4 continued

| n  | r    | p    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|    |      | .01  | .05  | .10  | .15  | .20  | .25  | .30  | .35  | .40  | .45  | .50  | .55  | .60  | .65  | .70  | .75  | .80  | .85  | .90  | .95  |      |
| 16 | 2    | .010 | .146 | .275 | .277 | .211 | .134 | .073 | .035 | .015 | .006 | .002 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |      |
|    | 3    | .000 | .036 | .142 | .229 | .246 | .208 | .146 | .089 | .047 | .022 | .009 | .003 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 4    | .000 | .006 | .051 | .131 | .200 | .225 | .204 | .155 | .101 | .057 | .028 | .011 | .004 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 5    | .000 | .001 | .014 | .056 | .120 | .180 | .210 | .201 | .162 | .112 | .067 | .034 | .014 | .005 | .001 | .000 | .000 | .000 | .000 | .000 | .000 |
|    | 6    | .000 | .000 | .003 | .018 | .055 | .110 | .165 | .198 | .198 | .168 | .122 | .075 | .039 | .017 | .006 | .001 | .000 | .000 | .000 | .000 | .000 |
|    | 7    | .000 | .000 | .000 | .005 | .020 | .052 | .101 | .152 | .189 | .197 | .175 | .132 | .084 | .044 | .019 | .006 | .001 | .000 | .000 | .000 | .000 |
|    | 8    | .000 | .000 | .000 | .001 | .006 | .020 | .049 | .092 | .142 | .181 | .196 | .181 | .142 | .092 | .049 | .020 | .006 | .001 | .000 | .000 | .000 |
|    | 9    | .000 | .000 | .000 | .000 | .001 | .006 | .019 | .044 | .084 | .132 | .175 | .197 | .189 | .152 | .101 | .052 | .020 | .005 | .000 | .000 | .000 |
|    | 10   | .000 | .000 | .000 | .000 | .000 | .001 | .006 | .017 | .039 | .075 | .122 | .168 | .198 | .198 | .165 | .110 | .055 | .018 | .003 | .000 | .000 |
|    | 11   | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .005 | .014 | .034 | .067 | .112 | .162 | .201 | .210 | .180 | .120 | .056 | .014 | .001 | .000 |
|    | 12   | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .004 | .011 | .028 | .057 | .101 | .155 | .204 | .225 | .200 | .131 | .051 | .006 | .000 |
|    | 13   | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .009 | .022 | .047 | .089 | .146 | .208 | .246 | .229 | .142 | .036 | .000 |
|    | 14   | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .002 | .006 | .015 | .035 | .073 | .134 | .211 | .277 | .275 | .146 | .000 |
|    | 15   | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .009 | .023 | .053 | .113 | .210 | .329 | .371 | .000 |
|    | 16   | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .010 | .028 | .074 | .185 | .440 | .000 |
|    | 20   | 0    | .818 | .358 | .122 | .039 | .012 | .003 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 1  |      | .165 | .377 | .270 | .137 | .058 | .021 | .007 | .002 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |      |
| 2  |      | .016 | .189 | .285 | .229 | .137 | .067 | .028 | .010 | .003 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |      |
| 3  |      | .001 | .060 | .190 | .243 | .205 | .134 | .072 | .032 | .012 | .004 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |      |
| 4  |      | .000 | .013 | .090 | .182 | .218 | .190 | .130 | .074 | .035 | .014 | .005 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |      |
| 5  |      | .000 | .002 | .032 | .103 | .175 | .202 | .179 | .127 | .075 | .036 | .015 | .005 | .001 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |      |
| 6  |      | .000 | .000 | .009 | .045 | .109 | .169 | .192 | .171 | .124 | .075 | .037 | .015 | .005 | .001 | .000 | .000 | .000 | .000 | .000 | .000 |      |
| 7  |      | .000 | .000 | .002 | .016 | .055 | .112 | .164 | .184 | .166 | .122 | .074 | .037 | .015 | .005 | .001 | .000 | .000 | .000 | .000 | .000 |      |
| 8  |      | .000 | .000 | .000 | .005 | .022 | .061 | .114 | .161 | .180 | .162 | .120 | .073 | .035 | .014 | .004 | .001 | .000 | .000 | .000 | .000 |      |
| 9  |      | .000 | .000 | .000 | .001 | .007 | .027 | .065 | .116 | .160 | .177 | .160 | .119 | .071 | .034 | .012 | .003 | .000 | .000 | .000 | .000 |      |
| 10 |      | .000 | .000 | .000 | .000 | .002 | .010 | .031 | .069 | .117 | .159 | .176 | .159 | .117 | .069 | .031 | .010 | .002 | .000 | .000 | .000 |      |
| 11 |      | .000 | .000 | .000 | .000 | .000 | .003 | .012 | .034 | .071 | .119 | .160 | .177 | .160 | .116 | .065 | .027 | .007 | .001 | .000 | .000 |      |
| 12 |      | .000 | .000 | .000 | .000 | .000 | .001 | .004 | .014 | .035 | .073 | .120 | .162 | .180 | .161 | .114 | .061 | .022 | .005 | .000 | .000 |      |
| 13 |      | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .005 | .015 | .037 | .074 | .122 | .166 | .184 | .164 | .112 | .055 | .016 | .002 | .000 |      |
| 14 |      | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .005 | .015 | .037 | .075 | .124 | .171 | .192 | .169 | .109 | .045 | .009 | .000 |      |
| 15 |      | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .005 | .015 | .036 | .075 | .127 | .179 | .202 | .175 | .103 | .032 | .002 |      |
| 16 |      | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .005 | .014 | .035 | .074 | .130 | .190 | .218 | .182 | .090 | .013 |      |
| 17 |      | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .004 | .012 | .032 | .072 | .134 | .205 | .243 | .190 | .060 |      |
| 18 |      | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .010 | .028 | .067 | .137 | .229 | .285 | .189 |      |
| 19 |      | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .002 | .007 | .021 | .058 | .137 | .270 |      |
| 20 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .001 | .003 | .012 | .039 | .122 | .358 |      |      |

**Table 5** Areas of a Standard Normal Distribution

The table entries represent the area under the standard normal curve from 0 to the specified value of  $z$ .



| $z$ | .00   | .01   | .02   | .03   | .04   | .05   | .06   | .07   | .08   | .09   |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0.0 | .0000 | .0040 | .0080 | .0120 | .0160 | .0199 | .0239 | .0279 | .0319 | .0359 |
| 0.1 | .0398 | .0438 | .0478 | .0517 | .0557 | .0596 | .0636 | .0675 | .0714 | .0753 |
| 0.2 | .0793 | .0832 | .0871 | .0910 | .0948 | .0987 | .1026 | .1064 | .1103 | .1141 |
| 0.3 | .1179 | .1217 | .1255 | .1293 | .1331 | .1368 | .1406 | .1443 | .1480 | .1517 |
| 0.4 | .1554 | .1591 | .1628 | .1664 | .1700 | .1736 | .1772 | .1808 | .1844 | .1879 |
| 0.5 | .1915 | .1950 | .1985 | .2019 | .2054 | .2088 | .2123 | .2157 | .2190 | .2224 |
| 0.6 | .2257 | .2291 | .2324 | .2357 | .2389 | .2422 | .2454 | .2486 | .2517 | .2549 |
| 0.7 | .2580 | .2611 | .2642 | .2673 | .2704 | .2734 | .2764 | .2794 | .2823 | .2852 |
| 0.8 | .2881 | .2910 | .2939 | .2967 | .2995 | .3023 | .3051 | .3078 | .3106 | .3133 |
| 0.9 | .3159 | .3186 | .3212 | .3238 | .3264 | .3289 | .3315 | .3340 | .3365 | .3389 |
| 1.0 | .3413 | .3438 | .3461 | .3485 | .3508 | .3531 | .3554 | .3577 | .3599 | .3621 |
| 1.1 | .3643 | .3665 | .3686 | .3708 | .3729 | .3749 | .3770 | .3790 | .3810 | .3830 |
| 1.2 | .3849 | .3869 | .3888 | .3907 | .3925 | .3944 | .3962 | .3980 | .3997 | .4015 |
| 1.3 | .4032 | .4049 | .4066 | .4082 | .4099 | .4115 | .4131 | .4147 | .4162 | .4177 |
| 1.4 | .4192 | .4207 | .4222 | .4236 | .4251 | .4265 | .4279 | .4292 | .4306 | .4319 |
| 1.5 | .4332 | .4345 | .4357 | .4370 | .4382 | .4394 | .4406 | .4418 | .4429 | .4441 |
| 1.6 | .4452 | .4463 | .4474 | .4484 | .4495 | .4505 | .4515 | .4525 | .4535 | .4545 |
| 1.7 | .4554 | .4564 | .4573 | .4582 | .4591 | .4599 | .4608 | .4616 | .4625 | .4633 |
| 1.8 | .4641 | .4649 | .4656 | .4664 | .4671 | .4678 | .4686 | .4693 | .4699 | .4706 |
| 1.9 | .4713 | .4719 | .4726 | .4732 | .4738 | .4744 | .4750 | .4756 | .4761 | .4767 |
| 2.0 | .4772 | .4778 | .4783 | .4788 | .4793 | .4798 | .4803 | .4808 | .4812 | .4817 |
| 2.1 | .4821 | .4826 | .4830 | .4834 | .4838 | .4842 | .4846 | .4850 | .4854 | .4857 |
| 2.2 | .4861 | .4864 | .4868 | .4871 | .4875 | .4878 | .4881 | .4884 | .4887 | .4890 |
| 2.3 | .4893 | .4896 | .4898 | .4901 | .4904 | .4906 | .4909 | .4911 | .4913 | .4916 |
| 2.4 | .4918 | .4920 | .4922 | .4925 | .4927 | .4929 | .4931 | .4932 | .4934 | .4936 |
| 2.5 | .4938 | .4940 | .4941 | .4943 | .4945 | .4946 | .4948 | .4949 | .4951 | .4952 |
| 2.6 | .4953 | .4955 | .4956 | .4957 | .4959 | .4960 | .4961 | .4962 | .4963 | .4964 |
| 2.7 | .4965 | .4966 | .4967 | .4968 | .4969 | .4970 | .4971 | .4972 | .4973 | .4974 |
| 2.8 | .4974 | .4975 | .4976 | .4977 | .4977 | .4978 | .4979 | .4979 | .4980 | .4981 |
| 2.9 | .4981 | .4982 | .4982 | .4983 | .4984 | .4984 | .4985 | .4985 | .4986 | .4986 |
| 3.0 | .4987 | .4987 | .4987 | .4988 | .4988 | .4989 | .4989 | .4989 | .4990 | .4990 |
| 3.1 | .4990 | .4991 | .4991 | .4991 | .4992 | .4992 | .4992 | .4992 | .4993 | .4993 |
| 3.2 | .4993 | .4993 | .4994 | .4994 | .4994 | .4994 | .4994 | .4995 | .4995 | .4995 |
| 3.3 | .4995 | .4995 | .4995 | .4996 | .4996 | .4996 | .4996 | .4996 | .4996 | .4997 |
| 3.4 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4998 |
| 3.5 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 |
| 3.6 | .4998 | .4998 | .4998 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 |

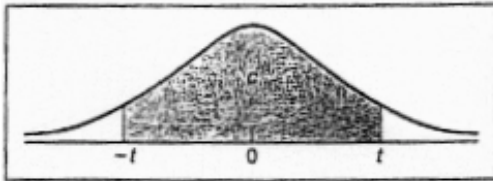
For values of  $z$  greater than or equal to 3.70, use 0.4999 to approximate the shaded area under the standard normal curve.

**Table 6** Student's t Distribution

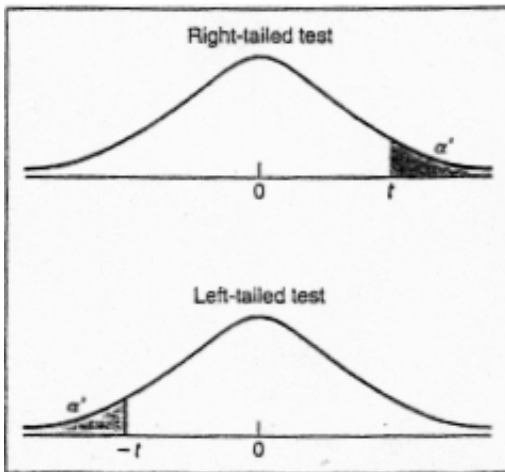
Student's t values generated by Minitab Version 9.2

|  | <b>c</b>    | 0.750 | 0.800 | 0.850 | 0.900 | 0.950  | 0.980  | 0.990  |
|--|-------------|-------|-------|-------|-------|--------|--------|--------|
|  | <b>a'</b>   | 0.125 | 0.100 | 0.075 | 0.050 | 0.025  | 0.010  | 0.005  |
|  | <b>a''</b>  | 0.250 | 0.200 | 0.150 | 0.100 | 0.050  | 0.020  | 0.010  |
|  | <b>d.f.</b> |       |       |       |       |        |        |        |
|  | 1           | 2.414 | 3.078 | 4.165 | 6.314 | 12.706 | 31.821 | 63.657 |
|  | 2           | 1.604 | 1.886 | 2.282 | 2.920 | 4.303  | 6.965  | 9.925  |
|  | 3           | 1.423 | 1.638 | 1.924 | 2.353 | 3.182  | 4.541  | 5.841  |
|  | 4           | 1.344 | 1.533 | 1.778 | 2.132 | 2.776  | 3.747  | 4.604  |
|  | 5           | 1.301 | 1.476 | 1.699 | 2.015 | 2.571  | 3.365  | 4.032  |
|  | 6           | 1.273 | 1.440 | 1.650 | 1.943 | 2.447  | 3.143  | 3.707  |
|  | 7           | 1.254 | 1.415 | 1.617 | 1.895 | 2.365  | 2.998  | 3.499  |
|  | 8           | 1.240 | 1.397 | 1.592 | 1.860 | 2.306  | 2.896  | 3.355  |
|  | 9           | 1.230 | 1.383 | 1.574 | 1.833 | 2.262  | 2.821  | 3.250  |
|  | 10          | 1.221 | 1.372 | 1.559 | 1.812 | 2.228  | 2.764  | 3.169  |
|  | 11          | 1.214 | 1.363 | 1.548 | 1.796 | 2.201  | 2.718  | 3.106  |
|  | 12          | 1.209 | 1.356 | 1.538 | 1.782 | 2.179  | 2.681  | 3.055  |
|  | 13          | 1.204 | 1.350 | 1.530 | 1.771 | 2.160  | 2.650  | 3.012  |
|  | 14          | 1.200 | 1.345 | 1.523 | 1.761 | 2.145  | 2.624  | 2.977  |
|  | 15          | 1.197 | 1.341 | 1.517 | 1.753 | 2.131  | 2.602  | 2.947  |
|  | 16          | 1.194 | 1.337 | 1.512 | 1.746 | 2.120  | 2.583  | 2.921  |
|  | 17          | 1.191 | 1.333 | 1.508 | 1.740 | 2.110  | 2.567  | 2.898  |
|  | 18          | 1.189 | 1.330 | 1.504 | 1.734 | 2.101  | 2.552  | 2.878  |
|  | 19          | 1.187 | 1.328 | 1.500 | 1.729 | 2.093  | 2.539  | 2.861  |
|  | 20          | 1.185 | 1.325 | 1.497 | 1.725 | 2.086  | 2.528  | 2.845  |
|  | 21          | 1.183 | 1.323 | 1.494 | 1.721 | 2.080  | 2.518  | 2.831  |
|  | 22          | 1.182 | 1.321 | 1.492 | 1.717 | 2.074  | 2.508  | 2.819  |
|  | 23          | 1.180 | 1.319 | 1.489 | 1.714 | 2.069  | 2.500  | 2.807  |
|  | 24          | 1.179 | 1.318 | 1.487 | 1.711 | 2.064  | 2.492  | 2.797  |
|  | 25          | 1.178 | 1.316 | 1.485 | 1.708 | 2.060  | 2.485  | 2.787  |
|  | 26          | 1.177 | 1.315 | 1.483 | 1.706 | 2.056  | 2.479  | 2.779  |
|  | 27          | 1.176 | 1.314 | 1.482 | 1.703 | 2.052  | 2.473  | 2.771  |
|  | 28          | 1.175 | 1.313 | 1.480 | 1.701 | 2.048  | 2.467  | 2.763  |
|  | 29          | 1.174 | 1.311 | 1.479 | 1.699 | 2.045  | 2.462  | 2.756  |
|  | 30          | 1.173 | 1.310 | 1.477 | 1.697 | 2.042  | 2.457  | 2.750  |
|  | 35          | 1.170 | 1.306 | 1.472 | 1.690 | 2.030  | 2.438  | 2.724  |
|  | 40          | 1.167 | 1.303 | 1.468 | 1.684 | 2.021  | 2.423  | 2.704  |
|  | 45          | 1.165 | 1.301 | 1.465 | 1.679 | 2.014  | 2.412  | 2.690  |
|  | 50          | 1.164 | 1.299 | 1.462 | 1.676 | 2.009  | 2.403  | 2.678  |
|  | 55          | 1.163 | 1.297 | 1.460 | 1.673 | 2.004  | 2.396  | 2.668  |
|  | 60          | 1.162 | 1.296 | 1.458 | 1.671 | 2.000  | 2.390  | 2.660  |
|  | 90          | 1.158 | 1.291 | 1.452 | 1.662 | 1.987  | 2.369  | 2.632  |
|  | 120         | 1.156 | 1.289 | 1.449 | 1.658 | 1.980  | 2.358  | 2.617  |
|  | cc          | 1.15  | 1.28  | 1.44  | 1.645 | 1.96   | 2.33   | 2.58   |

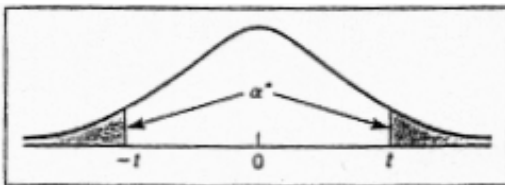
c is a confidence level:



a' is the level of significance for a one-tailed test:

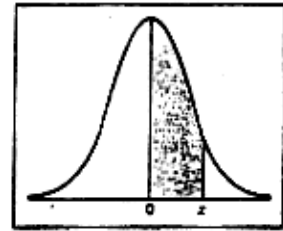


a'' is the level of significance for a two-tailed test



### Areas of a Standard Normal Distribution

The table entries represent the area under the standard normal curve from 0 to the specified value of  $z$ .



| $z$ | .00   | .01   | .02   | .03   | .04   | .05   | .06   | .07   | .08   | .09   |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0.0 | .0000 | .0040 | .0080 | .0120 | .0160 | .0199 | .0239 | .0279 | .0319 | .0359 |
| 0.1 | .0398 | .0438 | .0478 | .0517 | .0557 | .0596 | .0636 | .0675 | .0714 | .0753 |
| 0.2 | .0793 | .0832 | .0871 | .0910 | .0948 | .0987 | .1026 | .1064 | .1103 | .1141 |
| 0.3 | .1179 | .1217 | .1255 | .1293 | .1331 | .1368 | .1406 | .1443 | .1480 | .1517 |
| 0.4 | .1554 | .1591 | .1628 | .1664 | .1700 | .1736 | .1772 | .1808 | .1844 | .1879 |
| 0.5 | .1915 | .1950 | .1985 | .2019 | .2054 | .2088 | .2123 | .2157 | .2190 | .2224 |
| 0.6 | .2257 | .2291 | .2324 | .2357 | .2389 | .2422 | .2454 | .2486 | .2517 | .2549 |
| 0.7 | .2580 | .2611 | .2642 | .2673 | .2704 | .2734 | .2764 | .2794 | .2823 | .2852 |
| 0.8 | .2881 | .2910 | .2939 | .2967 | .2995 | .3023 | .3051 | .3078 | .3106 | .3133 |
| 0.9 | .3159 | .3186 | .3212 | .3238 | .3264 | .3289 | .3315 | .3340 | .3365 | .3389 |
| 1.0 | .3413 | .3438 | .3461 | .3485 | .3508 | .3531 | .3554 | .3577 | .3599 | .3621 |
| 1.1 | .3643 | .3665 | .3686 | .3708 | .3729 | .3749 | .3770 | .3790 | .3810 | .3830 |
| 1.2 | .3849 | .3869 | .3888 | .3907 | .3925 | .3944 | .3962 | .3980 | .3997 | .4015 |
| 1.3 | .4032 | .4049 | .4066 | .4082 | .4099 | .4115 | .4131 | .4147 | .4162 | .4177 |
| 1.4 | .4192 | .4207 | .4222 | .4236 | .4251 | .4265 | .4279 | .4292 | .4306 | .4319 |
| 1.5 | .4332 | .4345 | .4357 | .4370 | .4382 | .4394 | .4406 | .4418 | .4429 | .4441 |
| 1.6 | .4452 | .4463 | .4474 | .4484 | .4495 | .4505 | .4515 | .4525 | .4535 | .4545 |
| 1.7 | .4554 | .4564 | .4573 | .4582 | .4591 | .4599 | .4608 | .4616 | .4625 | .4633 |
| 1.8 | .4641 | .4649 | .4656 | .4664 | .4671 | .4678 | .4686 | .4693 | .4699 | .4706 |
| 1.9 | .4713 | .4719 | .4726 | .4732 | .4738 | .4744 | .4750 | .4756 | .4761 | .4767 |
| 2.0 | .4772 | .4778 | .4783 | .4788 | .4793 | .4798 | .4803 | .4808 | .4812 | .4817 |
| 2.1 | .4821 | .4826 | .4830 | .4834 | .4838 | .4842 | .4846 | .4850 | .4854 | .4857 |
| 2.2 | .4861 | .4864 | .4868 | .4871 | .4875 | .4878 | .4881 | .4884 | .4887 | .4890 |
| 2.3 | .4893 | .4896 | .4898 | .4901 | .4904 | .4906 | .4909 | .4911 | .4913 | .4916 |
| 2.4 | .4918 | .4920 | .4922 | .4925 | .4927 | .4929 | .4931 | .4932 | .4934 | .4936 |
| 2.5 | .4938 | .4940 | .4941 | .4943 | .4945 | .4946 | .4948 | .4949 | .4951 | .4952 |
| 2.6 | .4953 | .4955 | .4956 | .4957 | .4959 | .4960 | .4961 | .4962 | .4963 | .4964 |
| 2.7 | .4965 | .4966 | .4967 | .4968 | .4969 | .4970 | .4971 | .4972 | .4973 | .4974 |
| 2.8 | .4974 | .4975 | .4976 | .4977 | .4977 | .4978 | .4979 | .4979 | .4980 | .4981 |
| 2.9 | .4981 | .4982 | .4982 | .4983 | .4984 | .4984 | .4985 | .4985 | .4986 | .4986 |
| 3.0 | .4987 | .4987 | .4987 | .4988 | .4988 | .4989 | .4989 | .4989 | .4990 | .4990 |
| 3.1 | .4990 | .4991 | .4991 | .4991 | .4992 | .4992 | .4992 | .4992 | .4993 | .4993 |
| 3.2 | .4993 | .4993 | .4994 | .4994 | .4994 | .4994 | .4994 | .4995 | .4995 | .4995 |
| 3.3 | .4995 | .4995 | .4995 | .4996 | .4996 | .4996 | .4996 | .4996 | .4996 | .4997 |
| 3.4 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4998 |
| 3.5 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 |
| 3.6 | .4998 | .4998 | .4998 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 |

For values of  $z$  greater than or equal to 3.70, use 0.4999 to approximate the shaded area under the standard normal curve.

**Some Levels of Confidence and Their Corresponding Critical Values**

| Level of Confidence $c$ | Critical Value $z_c$ |
|-------------------------|----------------------|
| 0.75                    | 1.15                 |
| 0.80                    | 1.28                 |
| 0.85                    | 1.44                 |
| 0.90                    | 1.645                |
| 0.95                    | 1.96                 |
| 0.99                    | 2.58                 |

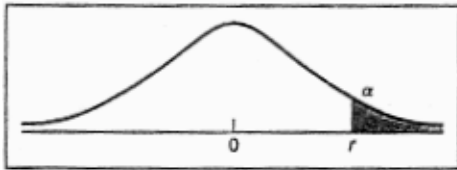
**Commonly Used Critical Values  $z_0$  from the Standard Normal Distribution**

| Type of Test | Level of Significance |            |
|--------------|-----------------------|------------|
|              | 0.05                  | 0.01       |
| Left-tailed  | - 1.645               | -2.33      |
| Right-tailed | 1.645                 | 2.33       |
| Two-tailed   | $\pm 1.96$            | $\pm 2.58$ |

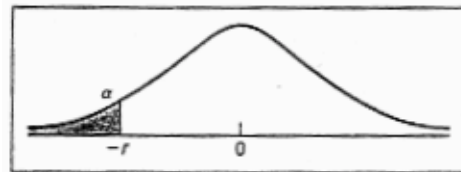
**Table 8** Critical Values of Pearson Product-Moment Correlation Coefficient,  $r$

| $n$ | $\alpha = 0.01$ |           | $\alpha = 0.05$ |           |
|-----|-----------------|-----------|-----------------|-----------|
|     | one tail        | two tails | one tail        | two tails |
| 3   | 1.00            | 1.00      | .99             | 1.00      |
| 4   | .98             | .99       | .90             | .95       |
| 5   | .93             | .96       | .81             | .88       |
| 6   | .88             | .92       | .73             | .81       |
| 7   | .83             | .87       | .67             | .75       |
| 8   | .79             | .83       | .62             | .71       |
| 9   | .75             | .80       | .58             | .67       |
| 10  | .72             | .76       | .54             | .63       |
| 11  | .69             | .73       | .52             | .60       |
| 12  | .66             | .71       | .50             | .58       |
| 13  | .63             | .68       | .48             | .53       |
| 14  | .61             | .66       | .46             | .53       |
| 15  | .59             | .64       | .44             | .51       |
| 16  | .57             | .62       | .42             | .50       |
| 17  | .56             | .61       | .41             | .48       |
| 18  | .54             | .59       | .40             | .47       |
| 19  | .53             | .58       | .39             | .46       |
| 20  | .52             | .56       | .38             | .44       |
| 21  | .50             | .55       | .37             | .43       |
| 22  | .49             | .54       | .36             | .42       |
| 23  | .48             | .53       | .35             | .41       |
| 24  | .47             | .52       | .34             | .40       |
| 25  | .46             | .51       | .34             | .40       |
| 26  | .45             | .50       | .33             | .39       |
| 27  | .45             | .49       | .32             | .38       |
| 28  | .44             | .48       | .32             | .37       |
| 29  | .43             | .47       | .31             | .37       |
| 30  | .42             | .46       | .31             | .36       |

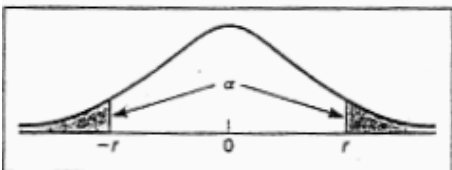
For a right-tailed test, use a positive  $r$  value:



For a left-tailed test, use a negative  $r$  value:



For a two-tailed test, use a positive  $r$  value and negative  $r$  value:





## Frequently Used Formulas

$n$  = sample size     $N$  = population size     $f$  = frequency

### Chapter 1

Class Width =  $\frac{\text{high} - \text{low}}{\text{number of classes}}$  (increase to next integer)

Class Midpoint =  $\frac{\text{upperlimit} + \text{lowerlimit}}{2}$

Lower boundary = lower boundary of previous class + class width

### Chapter 2

Sample mean  $\bar{X} = \frac{\sum x}{n}$

Population mean  $\mu = \frac{\sum x}{N}$

Range = largest data value - smallest data value

Sample standard deviations  $s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$

Computation formula  $s = \sqrt{\frac{SS_x}{n - 1}}$  where

$$SS_x = \sum x^2 - \frac{(\sum x)^2}{n}$$

Population standard deviation  $\sigma = \sqrt{\frac{\sum (x - \mu)^2}{N}}$

Sample variance  $s^2$

Population variance  $\sigma^2$

Sample Coefficient of Variation  $CV = \frac{s}{\bar{x}} \cdot 100$

Sample mean for grouped data  $\bar{x} = \frac{\sum xf}{n}$

Sample standard deviation for grouped data

$$s = \sqrt{\frac{\sum (x - \bar{x})^2 f}{n - 1}}$$

### Chapter 3

Regression and Correlation

In all these formulas

$$SS_x = \sum x^2 - \frac{(\sum x)^2}{n}$$

$$SS_y = \sum y^2 - \frac{(\sum y)^2}{n}$$

$$SS_{xy} = \sum xy - \frac{(\sum x)(\sum y)}{n}$$

Least squares line  $y = a + bx$  where  $b = \frac{SS_{xy}}{SS_x}$  and

$$a = \bar{y} - b\bar{x}$$

Pearson product-moment correlation coefficient

$$r = \frac{SS_{xy}}{\sqrt{SS_x SS_y}}$$

Coefficient of determination =  $r^2$

### Chapter 4

Probability of the complement of event A

$$P(\text{not } A) = 1 - P(A)$$

Multiplication rule for independent events

$$P(A \text{ and } B) = P(A) \cdot P(B)$$

General multiplication rules

$$P(A \text{ and } B) = P(A) \cdot P(B, \text{given } A)$$

$$P(A \text{ and } B) = P(B) \cdot P(A, \text{given } B)$$

Addition rule for mutually exclusive events

$$P(A \text{ or } B) = P(A) + P(B)$$

General addition rule

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

Permutation rule  $P_{n,r} = \frac{n!}{(n-r)!}$

Combination rule  $C_{n,r} = \frac{n!}{r!(n-r)!}$

### Chapter 5

Mean of a discrete probability distribution  $\mu = \sum xP(x)$

Standard deviation of a discrete probability distribution

$$\sigma = \sqrt{\sum (x - \mu)^2 P(x)}$$

For Binomial Distributions

$r$  = number of successes;  $p$  = probability of success;  
 $q = 1 - p$

Binomial probability distribution  $P(r) = \frac{n!}{r!(n-r)!} p^r q^{n-r}$

Mean  $\mu = np$

Standard deviation  $\sigma = \sqrt{npq}$

### Chapter 6

Raw score  $x = z\sigma + \mu$

Standard score  $z = \frac{x - \mu}{\sigma}$

## Chapter 7

Mean of  $\bar{x}$  distribution  $\mu_{\bar{x}} = \mu$

Standard deviation of  $\bar{x}$  distribution  $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$

Standard score for  $\bar{x}$   $z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$

## Chapter 8

Confidence Interval

for  $\mu$  (when  $n \geq 30$ )

$$\bar{x} - z_c \frac{\sigma}{\sqrt{n}} < \mu < \bar{x} + z_c \frac{\sigma}{\sqrt{n}}$$

for  $\mu$  (when  $n < 30$ )

$d.f. = n - 1$

$$\bar{x} - t_c \frac{s}{\sqrt{n}} < \mu < \bar{x} + t_c \frac{s}{\sqrt{n}}$$

for  $p$  (when  $np > 5$  and  $nq > 5$ )

$$\hat{p} - z_c \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} < p < \hat{p} + z_c \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \text{ where } \hat{p} = r/n$$

Sample Size for Estimating

means  $n = \left(\frac{z_c \sigma}{E}\right)^2$

proportions

$n = p(1-p) \left(\frac{z_c}{E}\right)^2$  with preliminary estimate for  $p$

$n = \frac{1}{4} \left(\frac{z_c}{E}\right)^2$  without preliminary estimate for  $p$

## Chapter 9

Sample Test Statistics for Tests of Hypotheses

for  $\mu$  (when  $n \geq 30$ )  $z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$

for  $\mu$  (when  $n < 30$ );  $t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$  with  $d.f. = n - 1$

for  $p$   $z = \frac{\hat{p} - p}{\sqrt{pq/n}}$  where  $q = 1 - p$

## Chapter 10

Sample Test Statistics for Tests of Hypothesis

for paired difference  $d$   $t = \frac{\bar{d} - \mu_d}{s_d/\sqrt{n}}$  with  $d.f. = n - 1$

difference of means large sample

$$z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

difference of proportions

$$z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\frac{\hat{p}\hat{q}}{n_1} + \frac{\hat{p}\hat{q}}{n_2}}} \text{ where } \hat{p} = \frac{r_1 + r_2}{n_1 + n_2}; \hat{q} = 1 - \hat{p};$$

$$\hat{p}_1 = r_1/n_1; \hat{p}_2 = r_2/n_2$$

Confidence Intervals

for difference of means (when  $n_1 \geq 30$  and  $n_2 \geq 30$ )

$$(\bar{x}_1 - \bar{x}_2) - z_2 \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} < \mu_1 - \mu_2 < (\bar{x}_1 - \bar{x}_2)$$

$$+ z_2 \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

for difference of proportions

where  $\hat{p}_1 = r_1/n_1; \hat{p}_2 = r_2/n_2; \hat{q}_1 = 1 - \hat{p}_1; \hat{q}_2 = 1 - \hat{p}_2$

$$(\hat{p}_1 - \hat{p}_2) - z_2 \sqrt{\frac{\hat{p}_1 \hat{q}_1}{n_1} + \frac{\hat{p}_2 \hat{q}_2}{n_2}} < \hat{p}_1 - \hat{p}_2 < (\hat{p}_1 - \hat{p}_2)$$

$$+ z_2 \sqrt{\frac{\hat{p}_1 \hat{q}_1}{n_1} + \frac{\hat{p}_2 \hat{q}_2}{n_2}}$$

## Chapter 11

$\chi^2 = \sum \frac{(O - E)^2}{E}$  where

$$E = \frac{(\text{row total})(\text{column total})}{\text{sample size}}$$

Tests of independence  $d.f. = (R - 1)(C - 1)$

Goodness of fit  $d.f. = (\text{number of entries}) - 1$

Sample test statistic for  $H_0: \sigma^2 = k; d.f. = n - 1$

$$\chi^2 = \frac{(n-1)s^2}{\sigma^2}$$

Linear Regression

Standard error or estimate  $S_e = \sqrt{\frac{SS_y - bSS_{xy}}{n - 2}}$

$$\text{where } b = \frac{SS_{xy}}{SS_x}$$

Confidence interval for  $y$

$$y_p - E < y_p < y_p + E \text{ where } y_p \text{ is the predicted } y \text{ value}$$

for  $x$  and

$$E = t_c S_e \sqrt{1 + \frac{1}{n} + \frac{(x - \bar{x})^2}{SS_x}} \text{ with } d.f. = n - 2$$