

## SHOW ALL PERMUTATIONS OR COMBINATIONS OF LETTERS USING EXCEL VBA

YOSHIDA, Hajime  
Kawaijuku Educational Institution /  
Association of Mathematical Instruction, Japan

Abstract: In teaching permutations or combinations, teacher shows all of the patterns of them to students at first, generally using tree diagram. For example, "CAT" has 6 permutations: CAT, CTA, ACT, ATC, TCA, TAC. But since then, problem is only to calculate the value of permutations/combinations. It is difficult and painful to show all of them by handwork for man because of large number. But computer can do it easily. This program "JK" shows all of the permutations/combinations of input letters. It gives reality to the students, such as large number of permutations/combinations.

### Teaching of Permutations and Combinations

In Japan, almost students learn "Permutations and Combinations" at the first grade of upper secondary school, age 15-16. At first lesson, teacher shows all of the patterns of permutations or combinations. Probably at most  $4! = 24$  patterns or  ${}_6C_3 = 20$  patterns. Or more you can? After showing all patterns, to calculate the value of permutations or combinations is only the problem for students. Therefore students are hard to feel the reality of permutations or combinations.

In primary school, when teaching of "Large numbers", such as "million", some teachers usually make actual one million tile on a floor of gym. Let one be 1cm square, one million be 10m square. This seems real to students.

"Anno's Mysterious Multiplying Jar" is a very helpful picture book to understand factorials.

There is a jar. In the jar, there is a sea. On the sea, there is an island. On the island, there are 2 countries. On each country, there are 3 hills. On each hill, there are 4 castles. :
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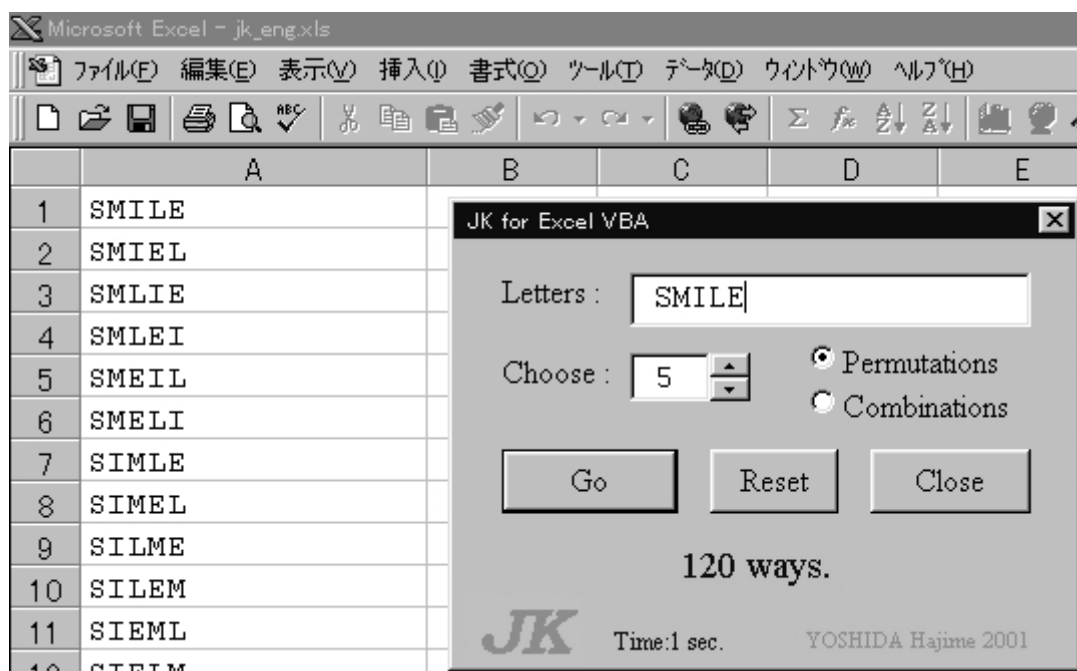
This book shows  $1!$  to  $8! = 40320$  dots on the pages. But, if we want to show  $10! = 3628800$  dots, more 180 pages are needed. This also seems real to students.

Even for teachers, it is hard and painful to show all of the patterns  $5!$  or more by handwork. But computer can do it. *Mathematica* or other kind of math-system has a function of showing permutations. Unfortunately, these math-systems are not popular in Japanese high school yet. *Excel* is more popular for teachers and students. And it is a convenient and powerful tool for mathematics and its education. Moreover, *Excel VBA* (Visual Basic for Applications) is a powerful programming language.

*JK for Excel* is a worksheet with VBA program to show all the patterns of both permutations and combinations. *JK* stands for *Junretsu* (permutation) and *Kumiawase* (combination) in Japanese.

## Examples

(1) “SMILE” has 5 letters, and all different. Input “SMILE” and click “GO”.

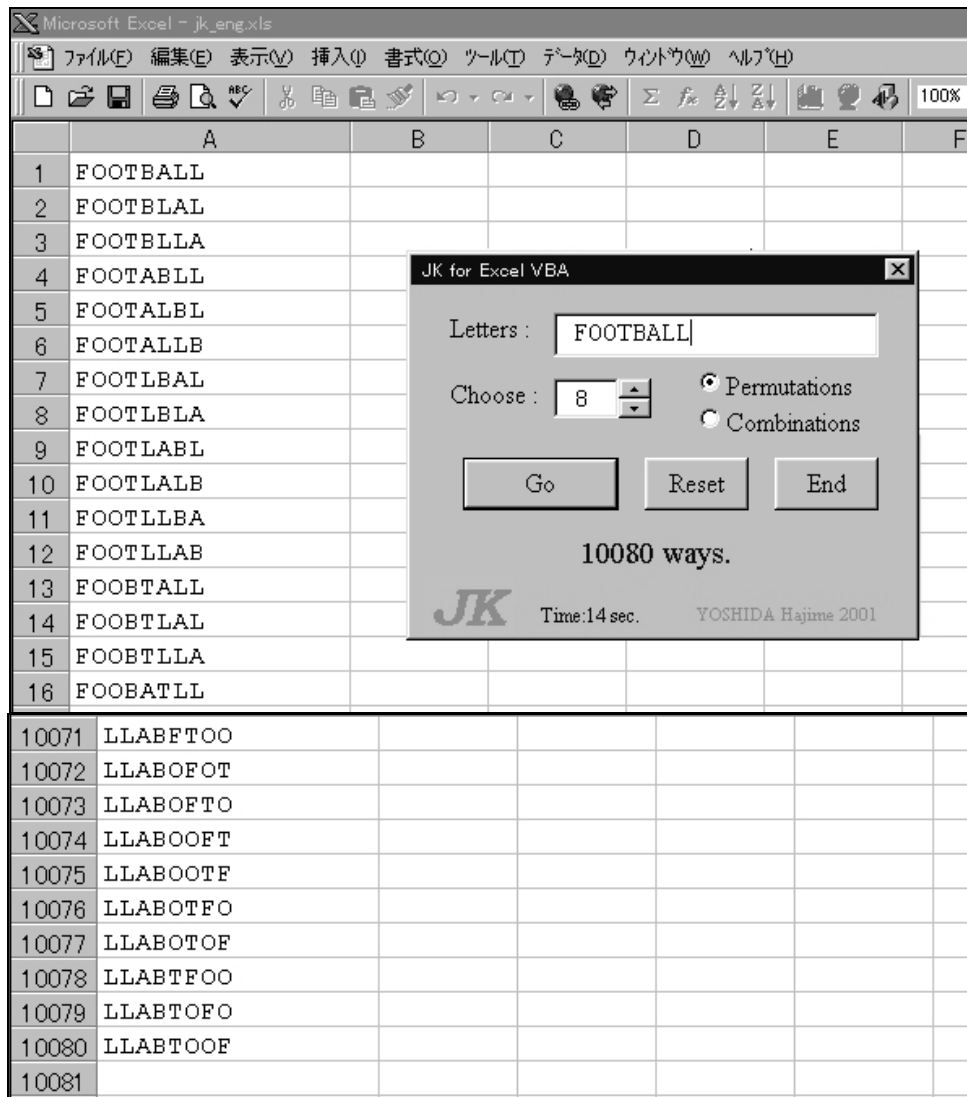


All the patterns of the permutations are follows.

1	SMILE	21	SEIML	41	MLESI	61	ILSME	81	LMISE	101	ESLMI
2	SMIEL	22	SEILM	42	MLEIS	62	ILSEM	82	LMIES	102	ESLIM
3	SMLIE	23	SELM I	43	MESIL	63	ILMSE	83	LMESI	103	EMSIL
4	SMLEI	24	SELM I	44	MESLI	64	ILMES	84	LMEIS	104	EMSLI
5	SMEIL	25	MSILE	45	MEISL	65	ILESM	85	LISME	105	EMISL
6	SMELI	26	MSIEL	46	MEILS	66	ILEMS	86	LISEM	106	EMILS
7	SIMLE	27	MSLIE	47	MELSI	67	IESML	87	LIMSE	107	EMLSI
8	SIMEL	28	MSLEI	48	MELIS	68	IESLM	88	LIMES	108	EMLIS
9	SILME	29	MSEIL	49	ISMLE	69	IEMSL	89	LIESM	109	EISML
10	SILEM	30	MSELI	50	ISMEL	70	IEMLS	90	LIEMS	110	EISLM
11	SIEML	31	MISLE	51	ISLME	71	IELSM	91	LESMI	111	EIMSL
12	SIELM	32	MISEL	52	ISLEM	72	IELMS	92	LESIM	112	EIMLS
13	SLMIE	33	MILSE	53	ISEML	73	LSMIE	93	LEMSI	113	EILSM
14	SLMEI	34	MILES	54	ISELM	74	LSMEI	94	LEMIS	114	EILMS
15	SLIME	35	MIESL	55	IMSLE	75	LSIME	95	LEISM	115	ELSMI
16	SLIEM	36	MIELS	56	IMSEL	76	LSIEM	96	LEIMS	116	ELSIM
17	SLEMI	37	MLSIE	57	IMLSE	77	LSEMI	97	ESMIL	117	ELMSI
18	SLEIM	38	MLSEI	58	IMLES	78	LSEIM	98	ESMLI	118	ELMIS
19	SEMIL	39	MLISE	59	IMESL	79	LMSIE	99	ESIML	119	ELISM
20	SEMLI	40	MLIES	60	IMELS	80	LMSEI	100	ESILM	120	ELIMS

Since *JK* is a worksheet of *Excel*, output patterns can be written to a text file.

(2) “FOOTBALL” has 8 letters. 2“O”s and 2“L”s are identical. Number of permutations of “FOOTBALL” is  $\frac{8!}{2! \times 2!} = 10080$ . *JK* shows all of them.



Since maximum of rows = 65536 in *Excel* (97, 2000, or 2002), *JK* can show following patterns.

$$8! = 40320$$

$${}_9P_6 = 60480$$

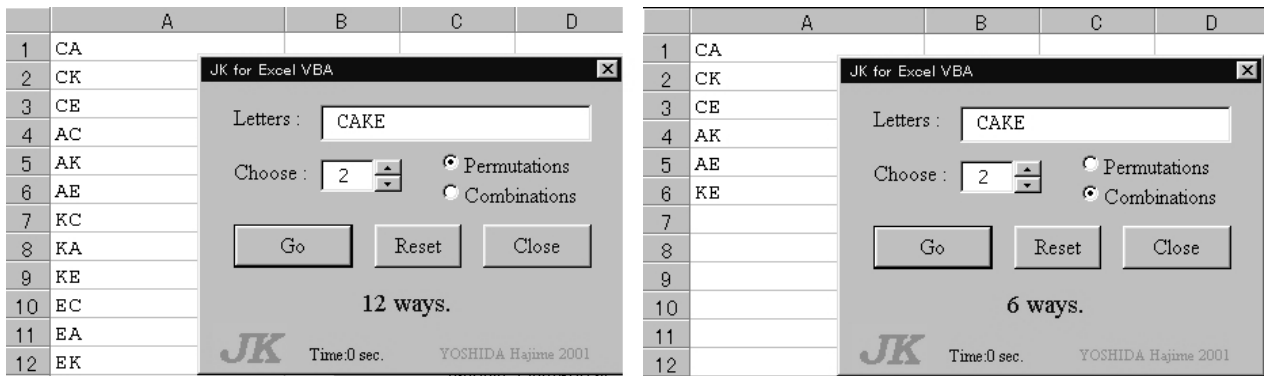
$${}_{18}C_9 = 48620$$

(3) *JK* can show both permutations and combinations. Compare the following examples.

“CAKE” has 4 letters, and all different, take 2 letters at a time.

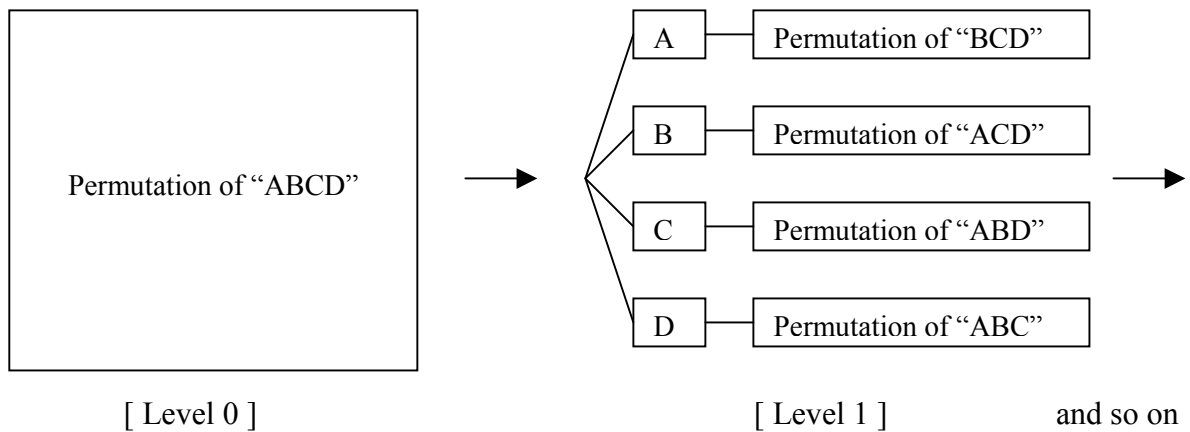
$$\text{Number of permutations} = {}_4P_2 = 12.$$

$$\text{Number of combinations} = {}_4C_2 = 6.$$



### Algorithm of the Program

The main algorithm of *JK* is a “recurrent call”. It is not an unusual algorithm. When we draw a tree diagram, we use this algorithm.



### Outline of *JK for Excel* (English Edition)

Required software: Microsoft Excel 97 or later.

Used Programming Language: Visual Basic for Application (VBA).

Maximum of output: 65536 ways (depends on Excel).

Free for educational use. Downloadable from following web site.

[http://www.ne.jp/asahi/math.edu/ami/myprog/jk\\_eng.htm](http://www.ne.jp/asahi/math.edu/ami/myprog/jk_eng.htm)

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◆ Reference

Anno, M. (1983). *Anno's Mysterious Multiplying Jar*. Putnam.  
(Original edition is written in Japanese.)