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 6C3 = 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.

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 it's 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.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SMILE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SMIEL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SMLIE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>SMLEI</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SMEIL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>SMIEL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>SMLIE</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SMIEL</td>
<td></td>
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<td></td>
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<tr>
<td>9</td>
<td>SMLIE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SMIEL</td>
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<tr>
<td>11</td>
<td>SMLIE</td>
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<tr>
<td>12</td>
<td>SMLIE</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>13</td>
<td>SMLIE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 \( \frac{8!}{2!\times2!} = 10080 \). JK shows all of them.

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

\[
\begin{align*}
8! &= 40320 \\
_9P_6 &= 60480 \\
_9C_3 &= 48620
\end{align*}
\]

(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.

Number of permutations = \( _4P_2 = 12 \).
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.

![Tree diagram of permutation]

**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

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Reference
(Original edition is written in Japanese.)