

# Lecture 22

Oktay ÖLMEZ

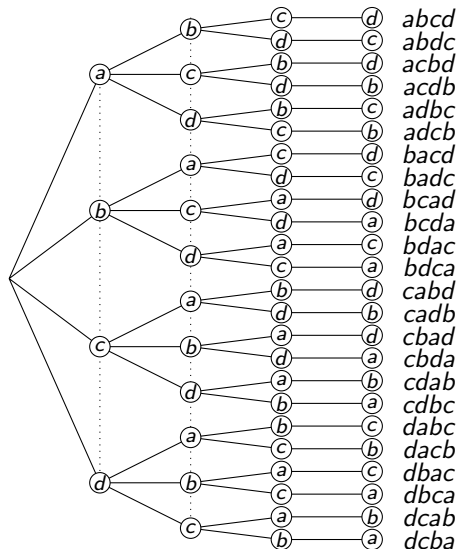
March 30, 2020

A **list** is an ordered sequence of objects. A list is denoted by an opening parenthesis, followed by the objects, separated by commas, followed by a closing parenthesis. For example  $(a, b, c, d, e)$  is a list consisting of the first five letters of the English alphabet, in order. The objects  $a, b, c, d, e$  are called the **entries** of the list; the first entry is  $a$ , the second is  $b$ , and so on. If the entries are rearranged we get a different list, so, for instance,

$$(a, b, c, d, e) \neq (b, a, c, d, e).$$

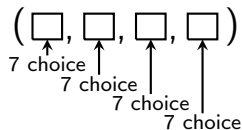
Unlike sets, lists can have repeated entries. Thus  $(5, 3, 5, 4, 3, 3)$  is a perfectly acceptable list, as is  $(S, O, S)$ . The **length** of a list is its number of entries. So  $(5, 3, 5, 4, 3, 3)$  has length six, and  $(S, O, S)$  has length three.

# Counting

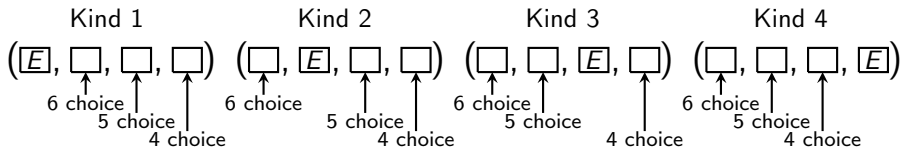


A standard license plate consists of three letters followed by four numbers.  
For example, JRB-4412 and MMX-8901 are two standard license plates.  
How many different standard license plates are possible?

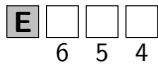
Imagine the list as containing four boxes that we fill with selections from



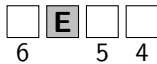
the letters *A*, *B*, *C*, *D*, *E*, *F* and *G*, as illustrated below.



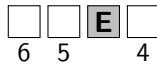
Kind 1



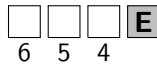
Kind 2



Kind 3



Kind 4





$n$	Symbols	Length $n$ sequences	$n!$
0	$\{\}$	$()$	1
1	$\{a\}$	$a$	1
2	$\{a, b\}$	$ab, ba$	2
3	$\{a, b, c\}$	$abc, acb, bac, bca, cab, cba$	6
4	$\{a, b, c, d\}$	$abcd, acbd, bacd, bcad, cabd, cbad,$ $abdc, acdb, badc, bcda, cadb, cbda,$ $adbc, adcb, bdac, bdca, cdab, cdba,$ $dabc, dacb, dbac, dbca, dcab, dcba,$	24
$\vdots$	$\vdots$	$\vdots$	$\vdots$

*abc acb bac bca cab cba*  
*abd adb bad bda dab dba*  
*acd adc cad cda dac dca*  
*bcd bdc cbd cdb dbc dcb*