Introduction to LaTeX

Math 3170

September 14, 2016

1 Introduction

This document will give an introduction to LaTeX. This language has two primary modes: text mode, which formats spacing accordingly as it sees fit, and $math mode which removes all spaces$ and turns all letters into variables. You can also display math like this

$$Now it is displayed.$$

To start a new paragraph we skip two lines (press return twice).

This is now a new paragraph.

2 Generating functions

We've seen a number of generating functions so far in this class.

(a) The Fibonacci sequence has generating function

$$\frac{x}{1-x-x^2} = \sum_{n=0}^{\infty} f_n x^n. \tag{2.1}$$

(b) The generalized binomial coefficients, given by

$$(1+x)^a = \sum_{k\geq 0} \binom{a}{k} x^k. \tag{2.2}$$

(c) The Catalan numbers have generating function

$$\frac{1-\sqrt{1-4x}}{2x} = \sum_{n\geq 0} c_n x^n. \tag{2.3}$$

We will see other examples other than (2.1), (2.2) and (2.3).

3 Other counting problems

Some other things we will want to count in the coming days are

Integer partitions. How can you split up positive integers into positive sums of integers?

Integer compositions. What if order matters?

Set partitions. How can you split up sets into unions of sets?

Set compositions. What if order matters?

A *set partition* $\{A_1, A_2, \ldots, A_\ell\}$ of a set B is a set of subsets $A_1, A_2, \ldots, A_\ell \subseteq B$ such that

(SP1) $B = A_1 \cup A_2 \cup \cdots \cup A_\ell$,

(SP2) for each $1 \leq i < j \leq \ell$, we have $A_i \cap A_j = \emptyset$.

We define the nth *Bell number* b_n to be the number

$$b_n = \#\{\text{set partitions of } \{1, 2, \ldots, n\}\}.$$

3.1 Other things to do with LaTeX

We can create matrices pretty easily using the array environment, so

$$\left(\begin{array}{c|cc} 1 & 1000 & 1 \\ \hline 0 & 1 & 0 \\ 0 & 0 & 1 \end{array}\right) \qquad \left(\begin{array}{c|rr} 1 & 1000 & 1 \\ \hline 0 & 1 & 0 \\ 0 & 0 & 1 \end{array}\right).$$

Theorem 3.1. *For $n \in \mathbb{Z}_{\geq 0}$,*

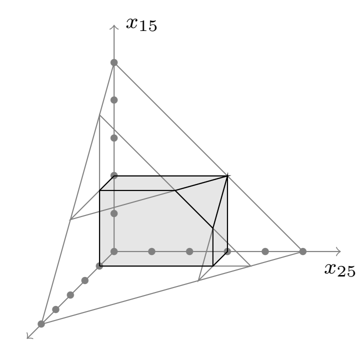
$$c_n = |\mathcal{D}_n|.$$

Proof. We had a lot in this proof, but the last steps involved,

$$\begin{aligned} |\mathcal{D}_n| &= |\mathcal{T}_n| - |\mathcal{B}_n| \\ &= \binom{2n}{n} - \binom{2n}{n+1} \\ &= \frac{(2n)!}{n!(n-1)!}\left(\frac{1}{n} - \frac{1}{n+1}\right), \end{aligned}$$

and so on. $\square$

$$\begin{array}{|c|c|} \hline \Pi & \\ \hline \multicolumn{1}{c|}{} & \Pi \\ \cline{2-2} \end{array}$$



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