

Math 312 Lectures 6 and 7

More About Nondimensionalization

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In these notes, we first look at an example of nondimensionalizing a differential equation, and then we look at another application of dimensional analysis.

Nondimensionalizing the Logistic Equation

Recall the logistic equation:

$$\frac{dP}{dt} = r \left(1 - \frac{P}{K} \right) P, \quad P(0) = P_0, \quad (1)$$

where $r > 0$ and $K > 0$ are constants. We'll follow the steps outlined in the previous lectures to nondimensionalize this differential equation. Table 1 lists the variables and parameters.

To create the nondimensional time variable τ , we must divide t by something that has the dimension \mathcal{T} . The only choice here is $1/r$, so we define

$$\tau = \frac{t}{\left(\frac{1}{r}\right)} = rt. \quad (2)$$

To create the nondimensional dependent variable y , we must divide P by something that has the dimension \mathcal{N} . We have two choices here, K or P_0 . I'll use K , and leave the choice of P_0 as an exercise. We have

$$y = \frac{P}{K} \quad (3)$$

Variable or Parameter	Meaning	Dimension
t	time	\mathcal{T}
P	size of the population	\mathcal{N}
r	per capita growth rate of a small population	\mathcal{T}^{-1}
K	carrying capacity	\mathcal{N}
P_0	initial size of the population	\mathcal{N}

Table 1: The list of variables and parameters for the logistic equation, along with their dimensions. \mathcal{T} means *time* and \mathcal{N} means an *amount* or *quantity*.

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