

Modeling and Analysis; Performance Modeling

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Abstract

Principles and concepts of modeling performance.

Distribution

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The figure consists of two panels comparing modeling approaches for an elevator. The top panel, titled 'empirical model t_{emp} elevator', shows a scatter plot of time (t) in seconds versus floor number (n) in meters. The data points are approximately (1, 2), (2, 4), (3, 6), (4, 8), (5, 10), (6, 12), (7, 14), (8, 16), (9, 18), (10, 20). A linear regression line is drawn through the points, labeled with the equation t_{emp} = a * n + b. Text in the panel states: 'Empirical model: a model based on observations and measurements. An empirical model describes the observations. An empirical model provides no understanding.'

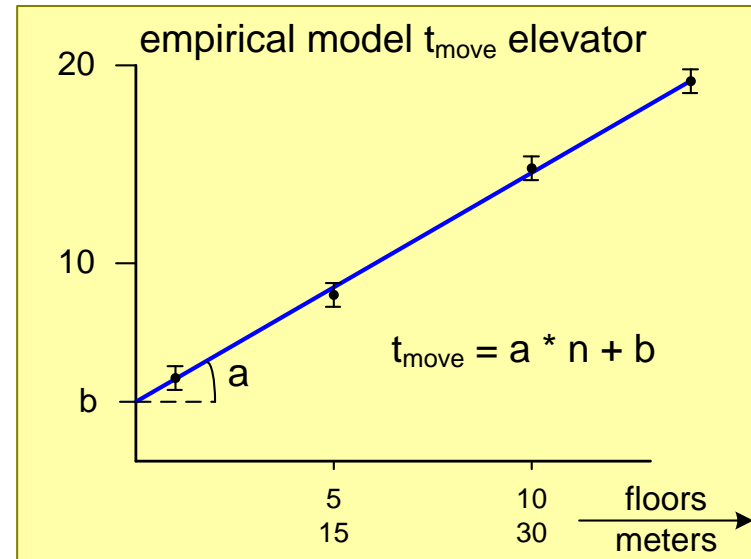
The bottom panel, titled 'first principle model t_{1st} elevator', shows the same data points and regression line. It includes the following text: 'First principle model: a model based on theoretical principles. A first principle model explains the desired property from first principles from the laws of physics. A first principle model requires values for incoming parameters to calculate results.' Below the text, it lists the equations: v = dv/dt, a = dv/dt, s = ∫v dt, Position in case of uniform acceleration: s = s₀ + v₀t + 1/2 a t², t_{1st} = ∫ ds / v, s = v * t, s(t) = 1/2 a t², t_{1st} = ∫ ds / v, t_{1st} = ∫ ds / v, t_{1st} = ∫ ds / v.

Empirical versus First Principle Models

Empirical model: a model based on **observations** and **measurements**.

An empirical model **describes** the observations.

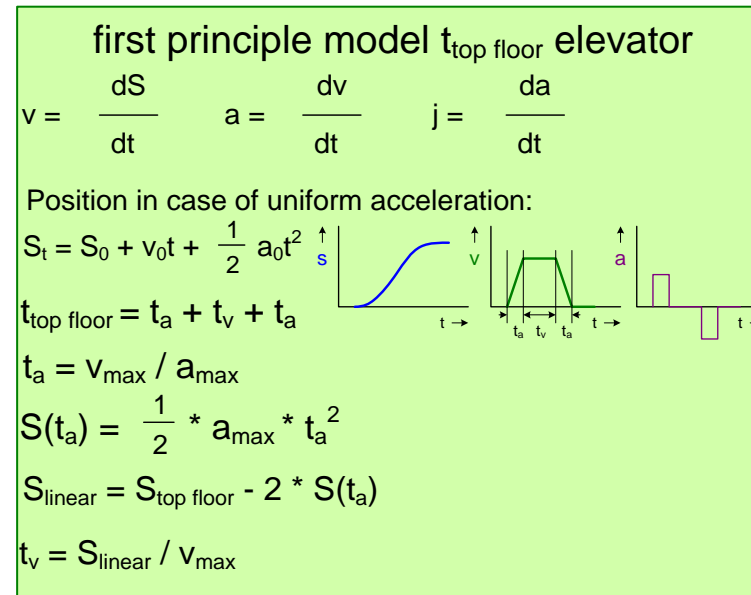
An empirical model provides **no understanding**.



First principle model: a model based on **theoretical** principles.

A first principle model **explains** the desired property from first principles from the **laws of physics**.

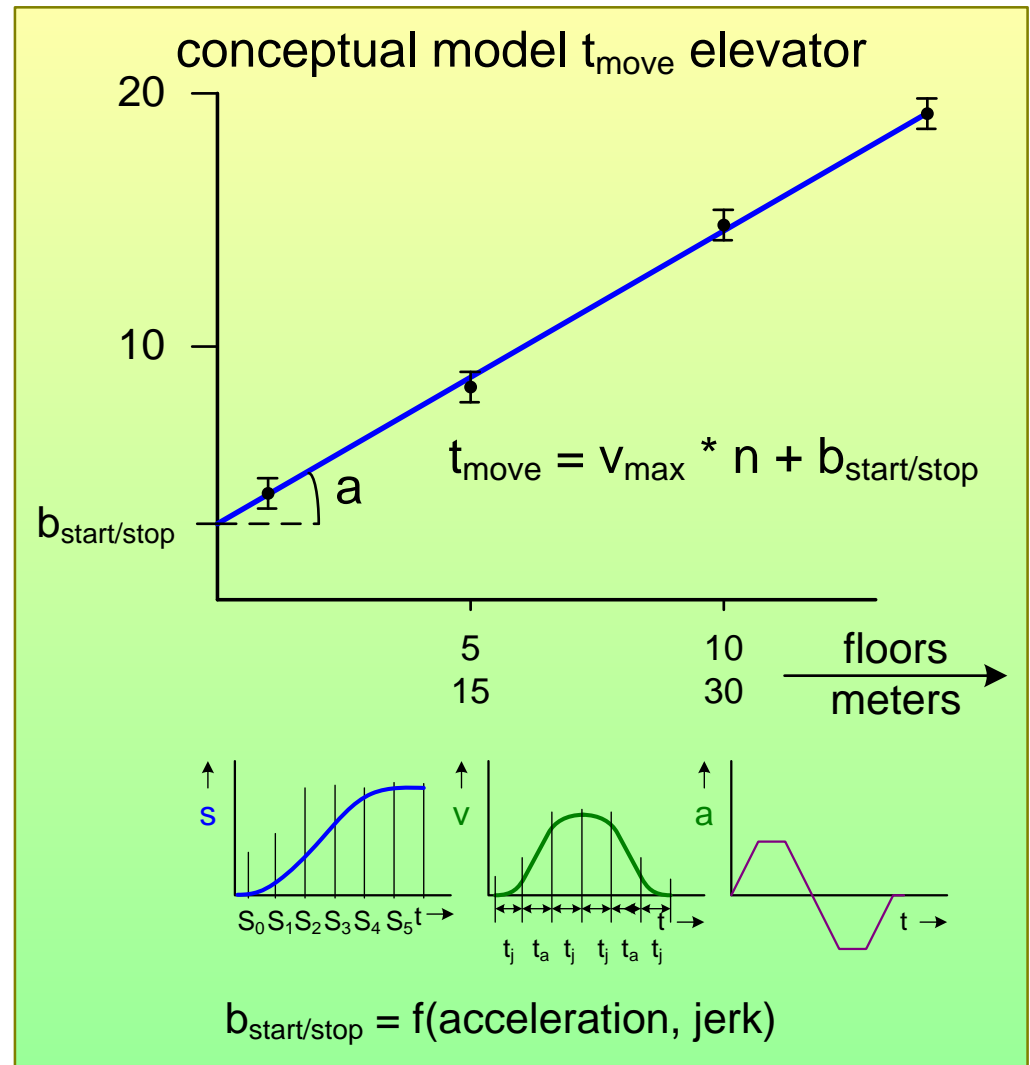
A first principle model **requires values** for **incoming parameters** to calculate results.



Conceptual = Hybrid of Empirical and First Principle

Conceptual model: a model **explaining observations** and **measurements** using a selection of **first principles**.

A conceptual model is a **hybrid** of empirical and first principle models; **simple** enough to **understand** and to **reason, realistic** enough to make **sense**.



From Zero to Higher Order Formulas

0th order main function
 main parameters

*most simple
order of magnitude*

constant velocity
 $t_{\text{top floor}} = S_{\text{top floor}} / v_{\text{max}}$

1st order add most significant
 secondary contributions

improved estimation

constant acceleration
 $t_{\text{top floor}} = S_{\text{top floor}} / v_{\text{max}}$
 $- a_{\text{max}} * t_a^2 / v_{\text{max}} + 2 * v_{\text{max}} / a_{\text{max}}$

2nd order add next level of
 contributions

more accurate, understanding

constant jerk
 $t_{\text{top floor}} \sim S_{\text{top floor}} / v_{\text{max}} - a_{\text{max}} * t_a^2 / v_{\text{max}}$
 $+ 2 * v_{\text{max}} / a_{\text{max}} + 2 * a_{\text{max}} / j_{\text{max}}$