

# A Segue from Segways

## PID controllers

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# Motivation

- Control theory is relevant for all engineering majors
  - Process control for ChemE
  - Robotics for everything else
- PID controllers are ubiquitous in control theory
- Self-balancing stuff are cool
- Know that you might end up programming **these**

- What is control theory?



# What is a PID?

- A history lesson



- An algorithm

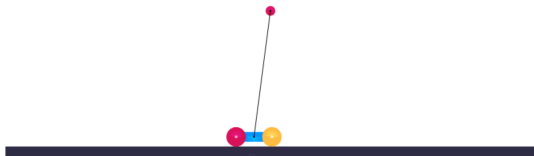
$$u(t) = K_p e(t) + K_i \int_0^t e(t') dt' + K_d \frac{de(t)}{dt}$$

(that's actually not that scary)

# Let's get tuning!

Go to: <https://SASE-Labs-2021.github.io/inverted-pendulum>

[Simulation](#) [Sensor](#) [Code](#)



$K_p$

$K_i$

$K_d$

Restart Engine

See [this gif](#)

## What happens when we increase ...?

Parameter	Rise time	Overshoot	Settling time	Steady-state error	Stability
$K_p$	Decrease	Increase	Little change	Decrease	Decrease
$K_i$	Decrease	Increase	Increase	Eliminate	Decrease
$K_d$	Little change	Decrease	Decrease	Little change	Increase

# Next steps

- Build something self-balancing with Arduino or MicroPython
- An excuse to learn reinforcement learning or genetic algorithms  
*Can you teach a computer to do this?*
- Appreciate steering wheels and thermostats a little more
- Share your very own PID!