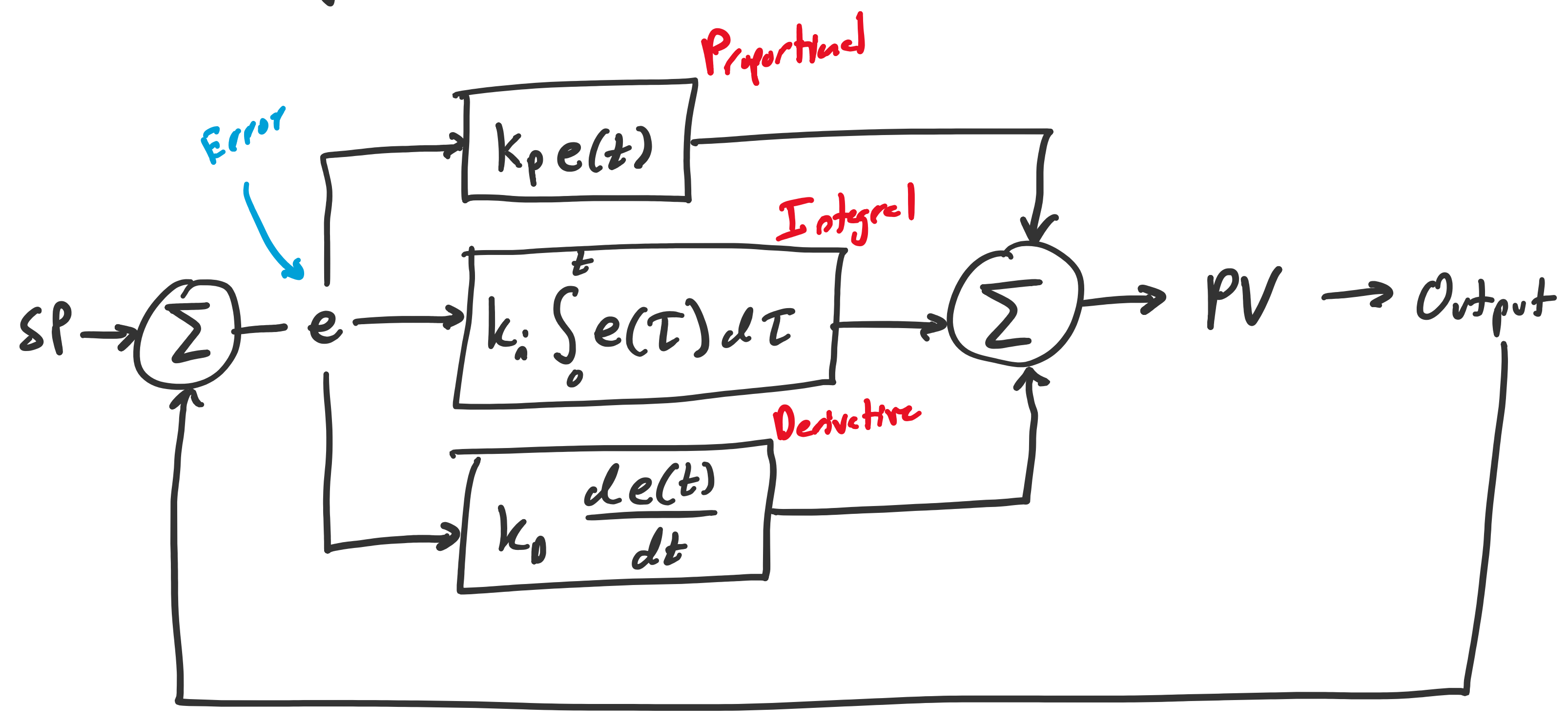
PID Control

Friday, August 15, 2025 6:34 PM

Core idea:

- Feedback control system



- Proportional - Responds to Error. Linear relationship → as e↑, P↑
- Integral - Responds to accumulation of past error.
  - Eliminates steady state error, "stuck" near target
- Derivative - Responds to Error's rate of change
  - Provides damping & prevents overshoot
- Output = $K_p e(t) + K_i \int_0^t e(\tau)d\tau + k_d \frac{de(t)}{dt}$

  We adjust these

Simple Example

Temperature controller (classic!)

Set up

- Target = 70 °F

  $k_p = 2$, $k_i = .1$, $k_d = .5$

  Assume that $T_F = T_i + (.1)(\text{Output})$

- Starting temp = 60 °F

Calculations

I reuse this for T_i

T	T_i	e(t)	P	I	D	O	T_F
0	60	+10	20	0	0	20	62
1	62	+8	16	1.8	-1.0	16.8	63.7
2	64	+6	12	2.4	-1.0	13.4	65.3
3	65	+5	10	2.9	-.5	12.4	66.2
4	66	+4	8	3.3	-.5	10.8	67.1
5	67	+3	6	$\underbrace{3.6}$	-.5	9.1	67.9

Notice how I builds to "unstick"

T=1 calcs

$e = 70 - 62 = 8$

$P = k_p e(t) = (2)(8) = 16$

$I = k_i \sum_0^1 e(t) = (.1)[10+8] = 1.8$

$D = k_d(e(1) - e(0)) = (.5)(8-10) = -1.0$

$O = 16 + 1.8 - 1.0 = 16.8$

Graph