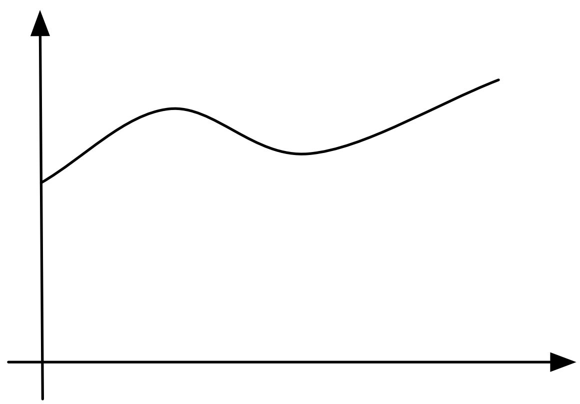
Lecture 1.8 – Implementation YouTube:

$$u(t) = k_P e(t) + k_I \int_0^t e(\tau) d\tau + k_D \frac{de(t)}{dt}$$

- How turn something as strange as an integral into something implementable?

Δt (sample time) $\quad \dot{e} \approx \dfrac{e_{new} - e_{old}}{\Delta t}$



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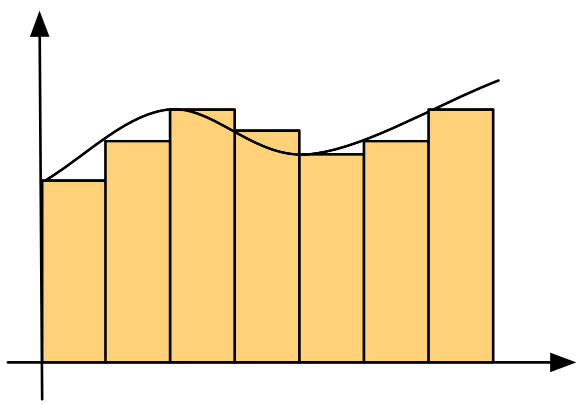

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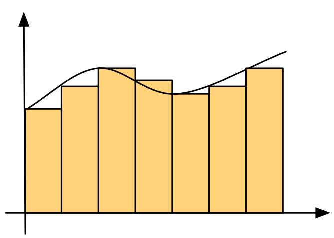

$$\int_0^t e(\tau)d\tau \approx \boxed{\sum_{k=0}^{N} e(k\Delta t)} \Delta t = \Delta t E$$

$$\Delta t E_{new} = \Delta t \sum_{k=1}^{N+1} e(k\Delta t) = \Delta t e((N+1)\Delta t) + \Delta t E_{old}$$

$$E_{new} = E_{old} + e$$

Implementation

- Each time the controller is called

$$\frac{e - e_{old}}{\Delta t} k_D \rightarrow k_D'$$

read in the new e

```
read e;
e_dot=e-old_e;
E=E+e;
u=kP*e+kD*e_dot+kI*E;
old_e=e;
```

store the current e as e old for the next time interval calculation

$$k_I \int = \Delta t E k_I \rightarrow k_I'$$

Note: The coefficients now include the sample time and must be scaled accordingly