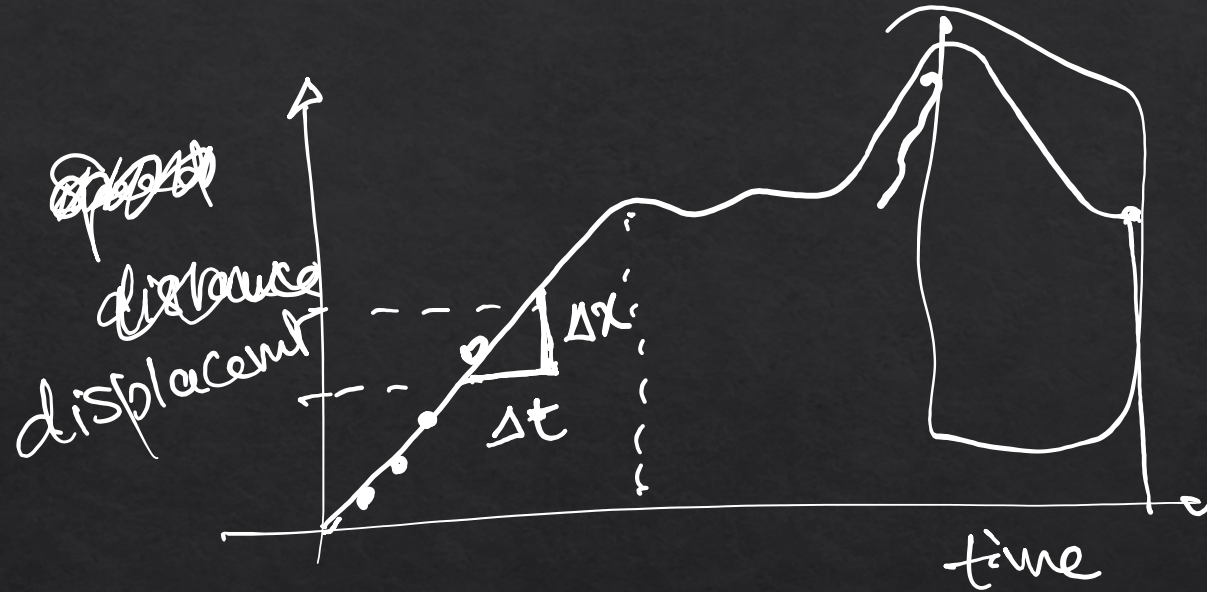


Computer Graphics

Lecture 6: Numerical integration

Kartic Subr

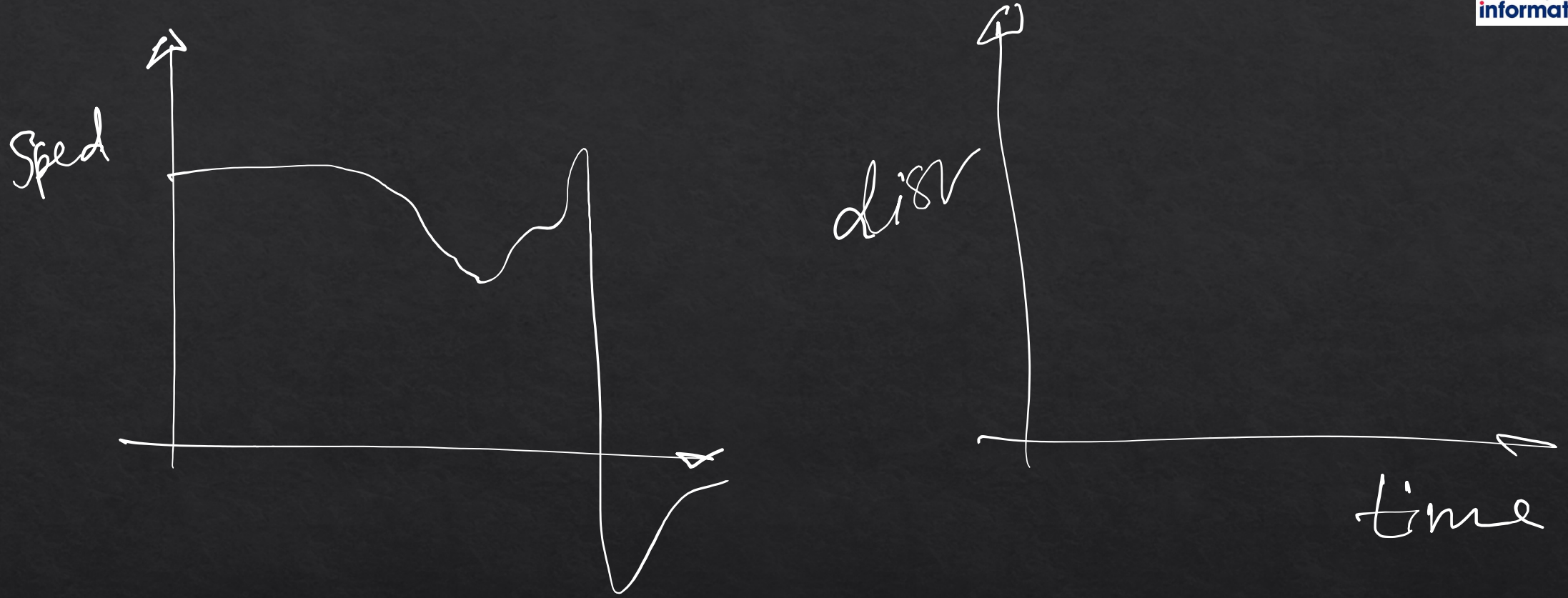
Speed and distance



$$\frac{\Delta t}{\Delta t} \rightarrow \frac{\Delta x}{\Delta t} \rightarrow \frac{dx}{dt}$$



Integrals



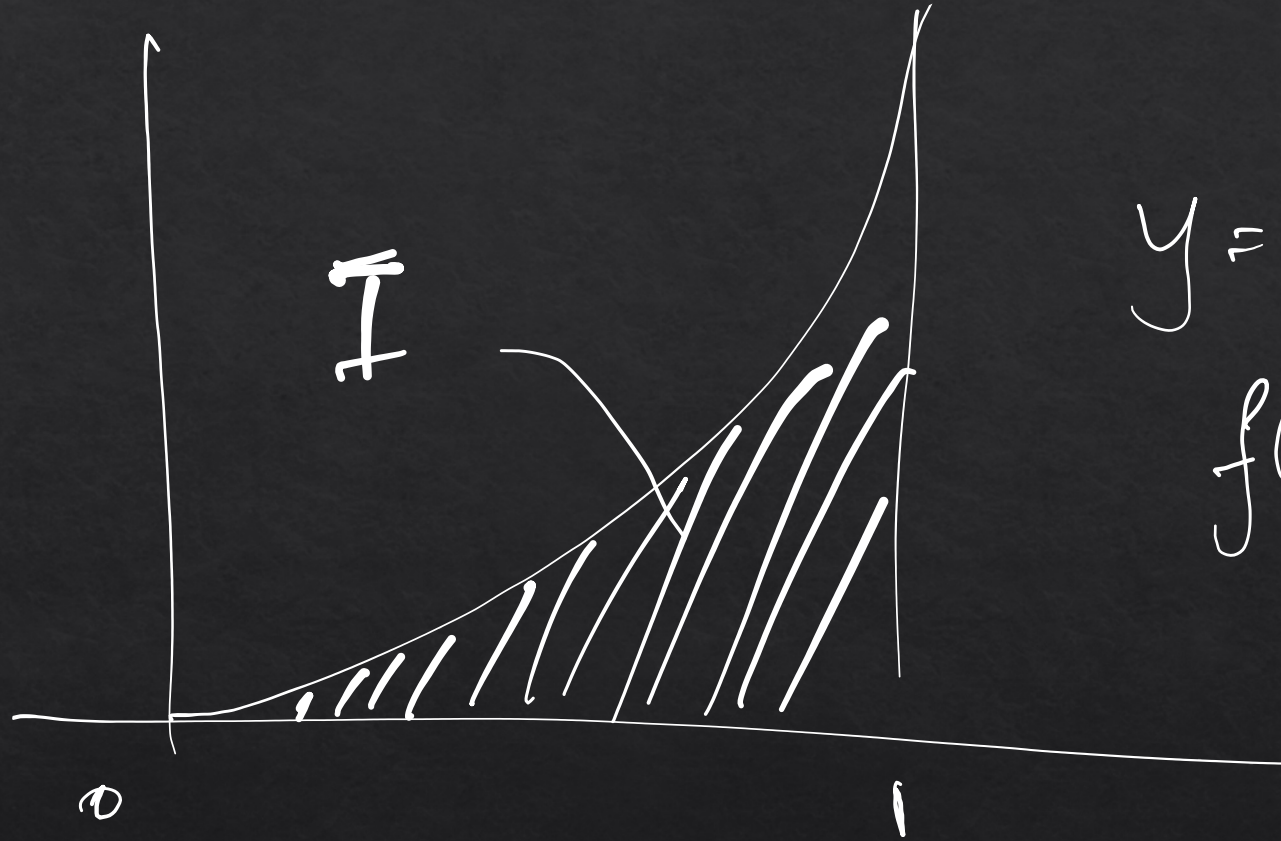
$$\frac{dx}{dt}$$

antidifferentiation

Approximation?

$\{x_i\}$

$f(x_i)$



$$y = x^2$$

$$f(x)$$

Newton-Cotes formulae

Closed Newton–Cotes formulas [\[edit \]](#)

This table lists some of the Newton–Cotes formulas of the closed type. For $0 \leq i \leq n$, let $x_i = a + i \frac{b-a}{n} = a + ih$, and the notation f_i be a shorthand for $f(x_i)$.

Closed Newton–Cotes Formulas

n	Step size h	Common name	Formula	Error term
1	$b - a$	Trapezoidal rule	$\frac{h}{2}(f_0 + f_1)$	$-\frac{1}{12}h^3 f^{(2)}(\xi)$
2	$\frac{b - a}{2}$	Simpson's rule	$\frac{h}{3}(f_0 + 4f_1 + f_2)$	$-\frac{1}{90}h^5 f^{(4)}(\xi)$
3	$\frac{b - a}{3}$	Simpson's 3/8 rule	$\frac{3h}{8}(f_0 + 3f_1 + 3f_2 + f_3)$	$-\frac{3}{80}h^5 f^{(4)}(\xi)$
4	$\frac{b - a}{4}$	Boole's rule	$\frac{2h}{45}(7f_0 + 32f_1 + 12f_2 + 32f_3 + 7f_4)$	$-\frac{8}{945}h^7 f^{(6)}(\xi)$

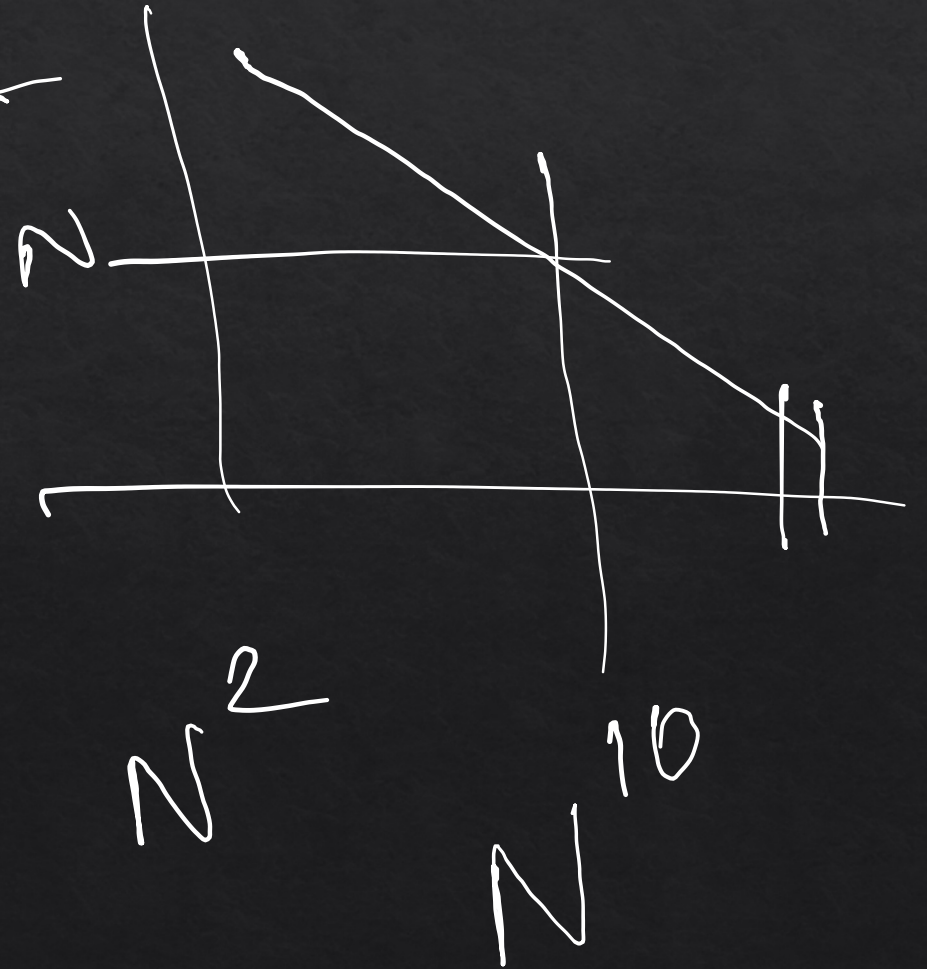
https://en.wikipedia.org/wiki/Newton–Cotes_formulas

Problems?

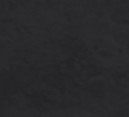
- Computation grows, more per user

- Error

- Errors numerical comp.



A random slide



Area of a circle



$$\frac{\sum f(x_i)}{N}$$

$$x_i \sim [0, 1]$$

Monte Carlo method

