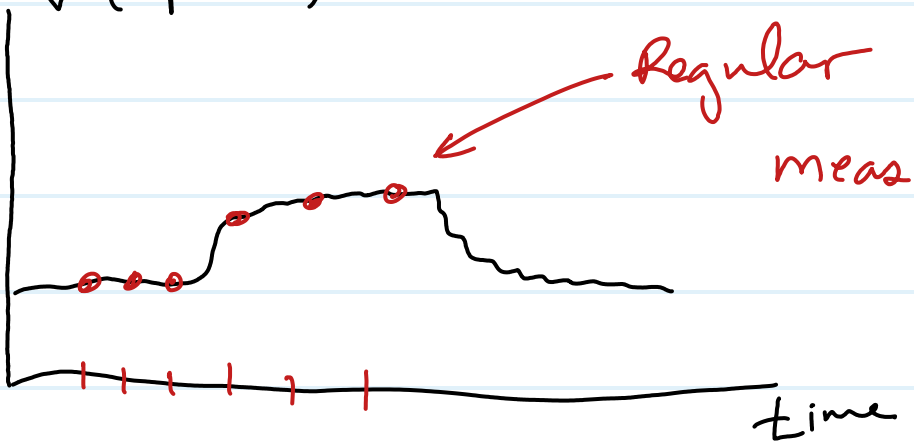
Bike Ride Data

v (speed)



Brackets mean average

Total or Interval?

What is average speed? (or velocity)

$$\langle v \rangle = \frac{\Delta x}{\Delta t}$$

Can Write as sum or integral?

$$\langle v \rangle = \frac{\int v \cdot dt}{\int dt} \approx \frac{\sum v_i \cdot t_i}{\sum t_i}$$

$$= \frac{\Delta t \cdot \sum v_i}{\Delta t \sum 1} = \frac{\sum v_i}{N} = \frac{1}{N} \sum v_i$$

assuming Δt is uniform!

What if data is from Strava?

STRAVA Dashboard Training Maps Challenges

RELATIVE EFFORT

Steady progress

You're building fitness nicely. Try to keep the remainder of the week under 109.

THIS WEEK

M T W T F S S

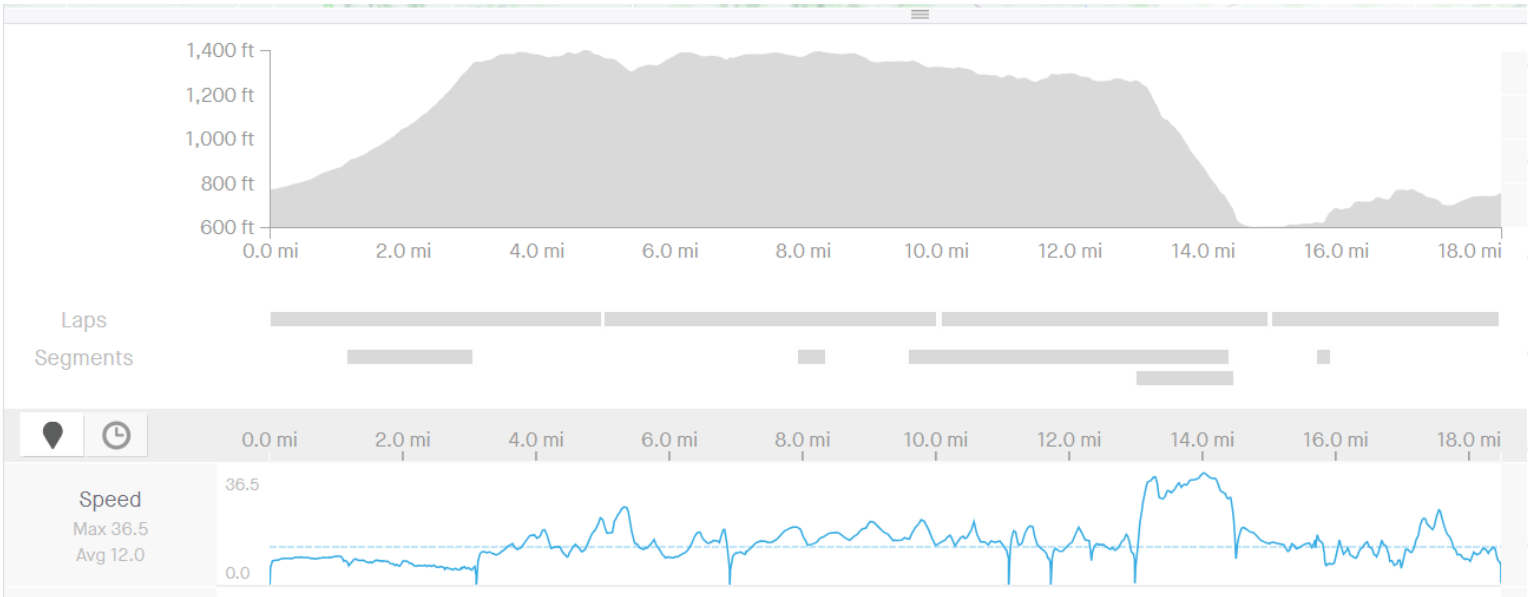
Score	Range
105	55-109

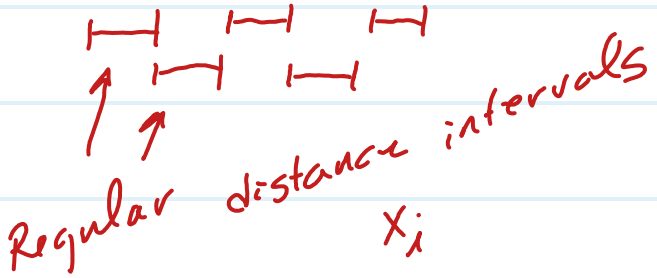
Nathan Moore

Yesterday at 8:08 PM · Winona County, Minnesota

Evening Ride

Distance	Elev Gain	Time
18.48 mi	850 ft	1h 32m





Data is v_i, x_i

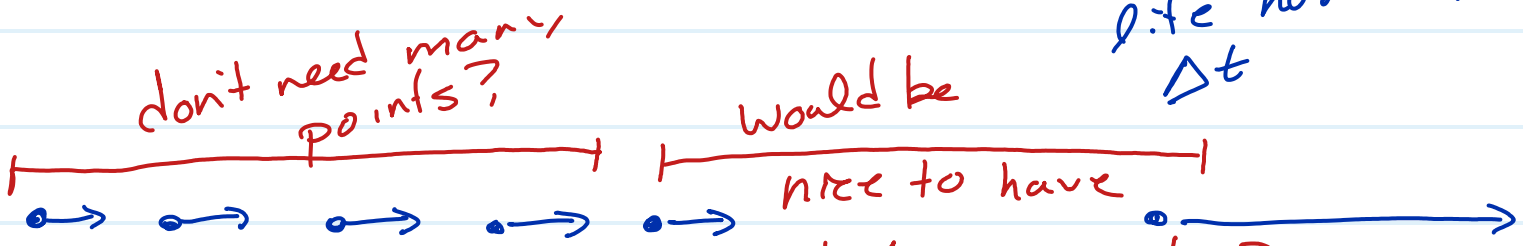
How do you get avg speed/velocity from that?

Start w/ definition

$$\langle v \rangle = \frac{\int v(t)\,dt}{\int dt} \approx \frac{\sum v_i \cdot t_i}{\sum t_i}$$

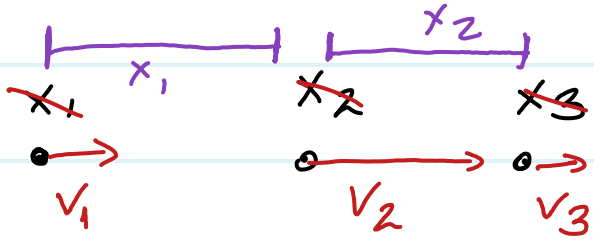
is this fixed?

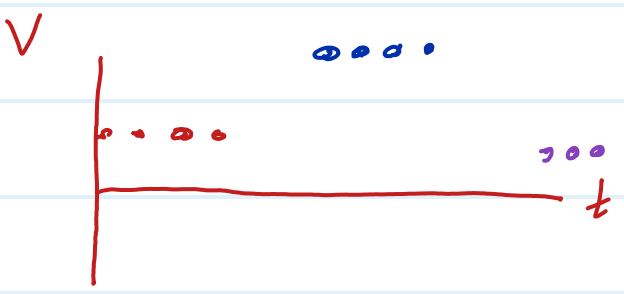
long battery life has adaptive Δt



I don't have t_i but I do have $t_i \approx \frac{x_i}{v_i}$

hop Not place





something like this?

So then Definition $\frac{1}{T}\int v\,dt$

$$\langle v \rangle \cong \frac{\sum v_i \cdot t_i}{\sum t_i} = \frac{\sum v_i \cdot \frac{x_i}{v_i}}{\sum x_i/v_i}$$

$$= \frac{\sum x_i}{\sum x_i/v_i}$$

assume x_i = fixed?

$x_i = \Delta x$

$$\langle v \rangle = \frac{x_i \cdot \sum 1}{x_i \cdot \sum 1/v_i} = \frac{\Delta x \cdot N}{\Delta x \cdot \sum 1/v_i}$$

What a wierd expression!

number of steps/data points

$$\langle v \rangle = \frac{N}{\sum 1/v_i} \cdot \frac{1}{N} \cdot \frac{1}{N}$$

$$\langle v \rangle = \frac{1}{\frac{1}{N} \cdot \sum 1/v_i} = \frac{1}{\langle 1/v_i \rangle}$$

???

Does it work ???

if data is v_i, x_i pairs

w/ Regular $x_i = \Delta x$

Is it true?

Assumptions: • Data is Regular Δx or Δt sampled

• Math is correct?

• Averages have enough points to approach integral form?

Let's try it out w/ Excel

time-velocity data t_i and V_i

t_i	V_i	x_i
0	$V_0 + at$	$x_0 + V_0 \cdot t + \frac{1}{2} a t^2$
5		
10 seconds		

Not needed?

Set $a =$

$V_0 =$

$\Delta t =$

$x_0 =$

in top Row of Excel

What's the "Math" Right answer for this

$$\langle v \rangle = \frac{\int v_0 \, dt}{\int dt} = \frac{\int (v_0 + at) \, dt}{\int dt}$$

$$= \frac{v_0 \cdot t + \frac{1}{2} a t^2 \Big|_0^T}{t \Big|_0^T}$$

$$= \frac{v_0 \cdot T + a/2 \, T^2}{T}$$

theoretical Target

$$\boxed{\langle v \rangle = v_0 + a/2 \cdot T}$$

Check v_i, t_i data via average of v_i column

does $\frac{1}{N} \sum v_i$ match ???

Now, wierd task: Fake data for x_i and v_i Representation

$a =$ $\Delta x =$

$V_0 =$ Fix all these

$x_0 =$ Values

What is $v(x)$??? solve for t and plug in?

$$X = X_0 + V_0 \cdot t + \tfrac{1}{2} a t^2$$

$$0 = (X_0 - X) + V_0 \cdot t + \tfrac{a}{2} \cdot t^2$$

$A = a/2$ $B = V_0$ $C = (x - x_0)$

$$t = \frac{-V_0 \pm \sqrt{V_0^2 - 4 \cdot a/2 \cdot (x - x_0)}}{2 \cdot (a/2)}$$

do this in Excel

then $V = V_0 + a \cdot t$

in Excel

X	Compute t_+	Compute t_-	V
x_0			$V_0 + a \cdot t$
$x_0 + \Delta x$			
$x_0 + 2\Delta x$	.....		.....
$x_0 + 3 \cdot \Delta x$			

Finally!!!

does average of V ↑ (V_i, x_i) match theory ↓

$$\langle V \rangle = V_0 + a/2 \cdot T$$

what about average of $1/V$ for V_i x_i pairs. works?

$$\langle V \rangle = \frac{1}{\frac{1}{N}\sum V_i}$$