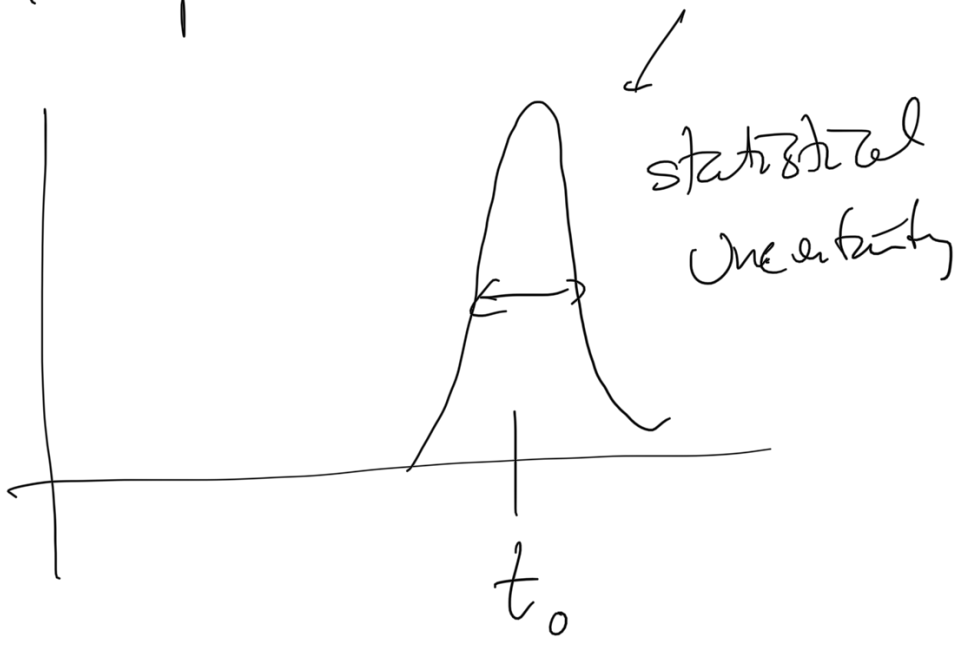
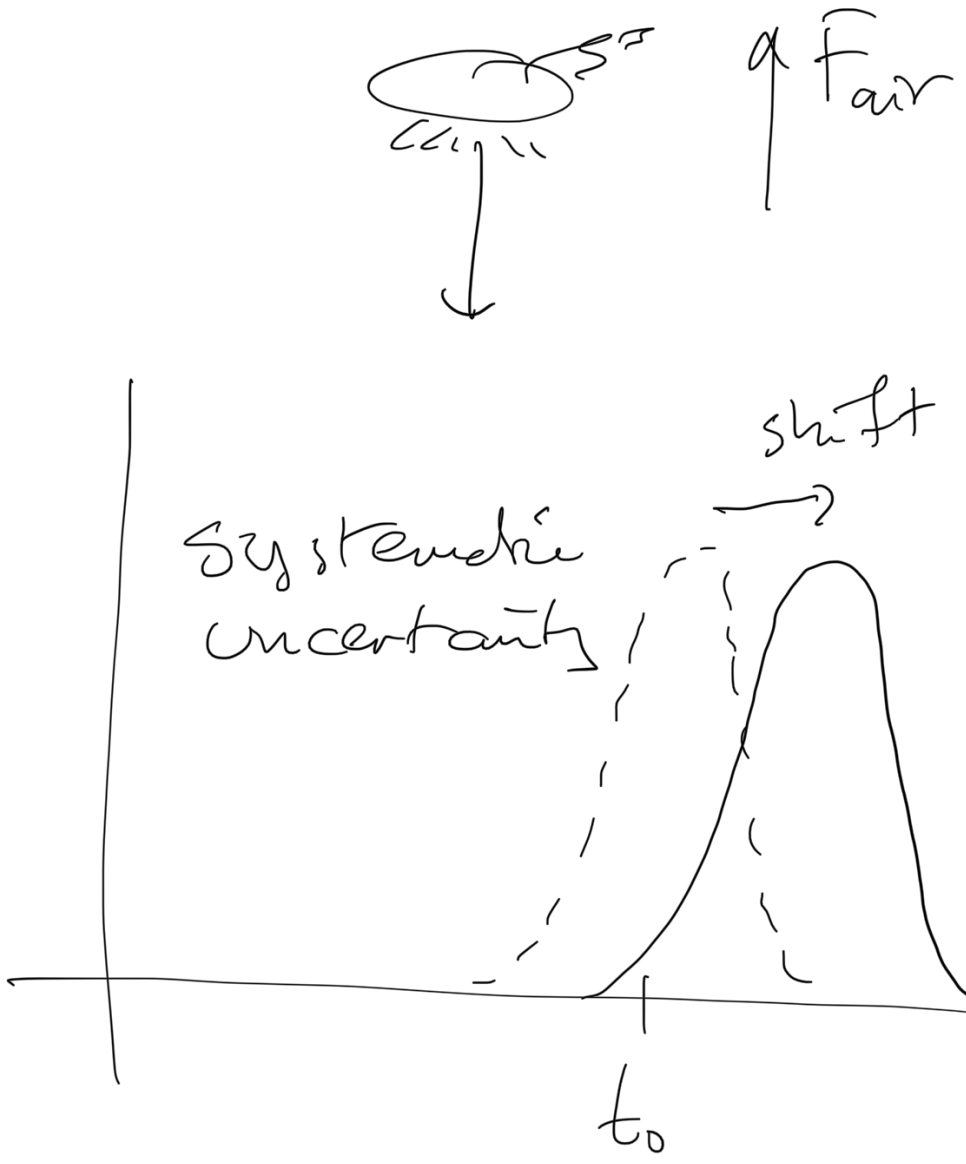
Physics 341 - Lecture III

(1) GitHub, Google Classroom, Colaboratory, and all that

(2) More on uncertainties in experimental data



air resistance

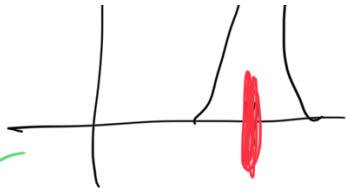


① stat. uncertainty — PRECISION

→ deviations from expected value around the mean.

right curve

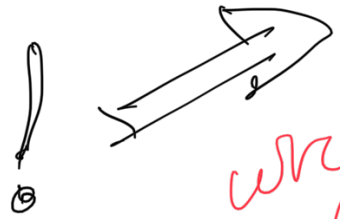
imprecise



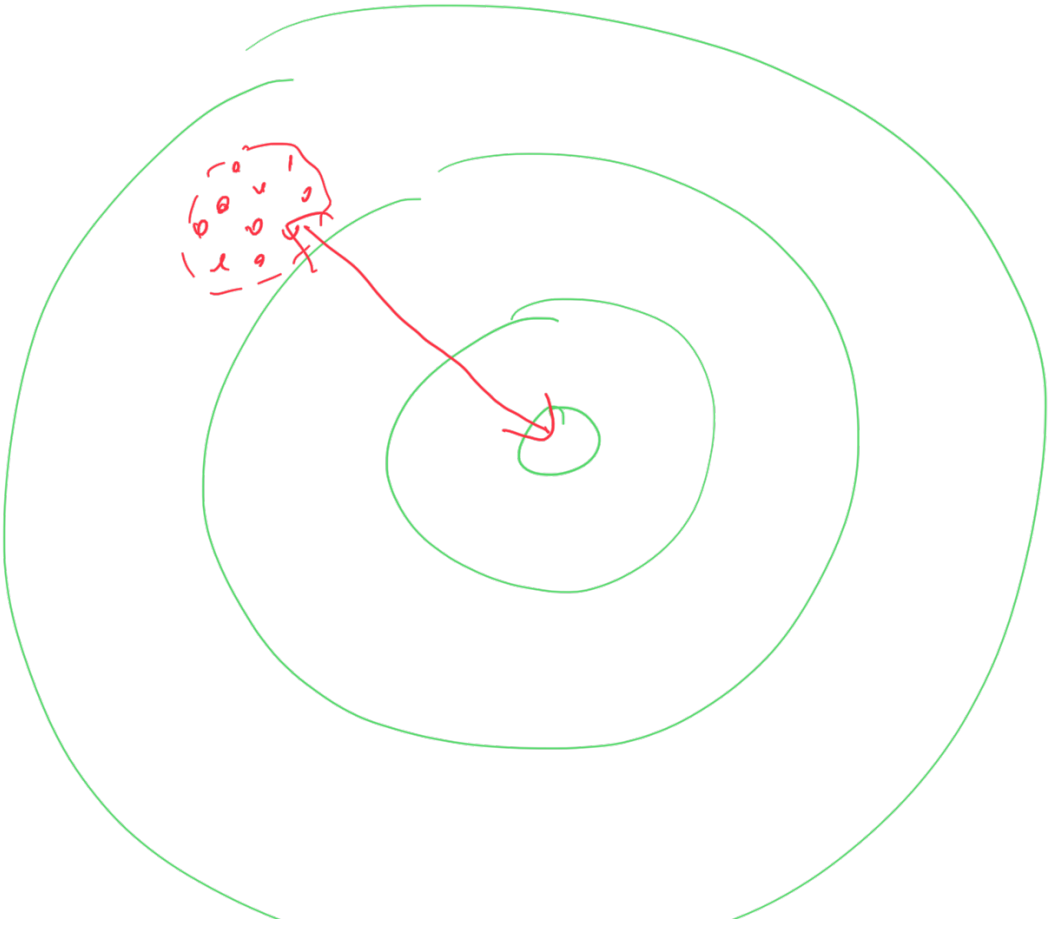
ACCURACY

(2) Systematic uncertainty

→ shift from the expected value.



wrong answer



What is the uncertainty in a calculated quantity (based on raw quantities)

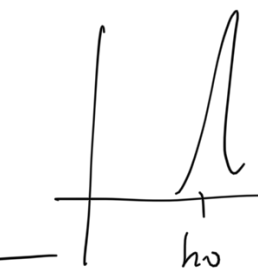
$$h = \frac{1}{2} g t^2$$

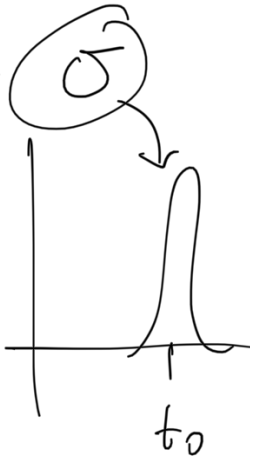
$$g = \frac{2h}{t^2}$$

$h = h_0 \pm \delta h_0$

$t = t_0 \pm \delta t_0$

δg ?





① Brute Force Method

$$g = \frac{2h}{t^2}$$

$h = h_0 \pm \delta h_0$ Truth $h = h_0 + \delta h_0$

$t = t_0 \pm \delta t_0$ $t = t_0 - \delta t_0$

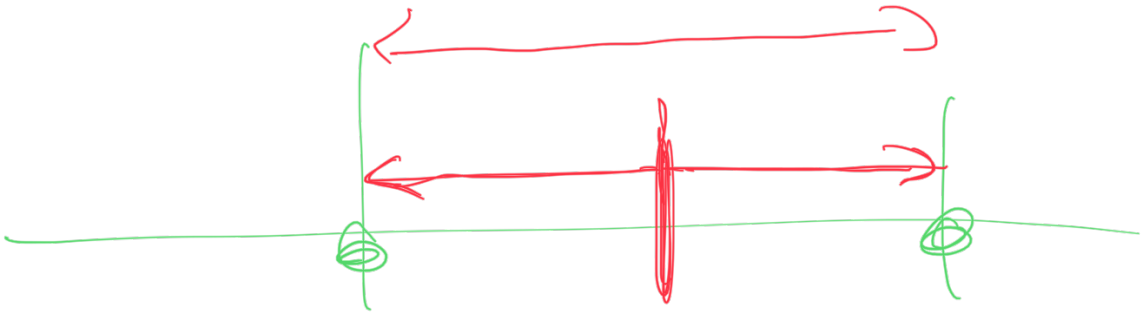
$$g = \frac{2(h_0 + \delta h_0)}{(t_0 - \delta t_0)^2}$$

↑ big ↖ small

big = g_{max}

$g = \dfrac{2(\quad)}{(t_0 + \delta t_0)^2}$

small g_{min}



g_{avg}

g_{min} g_{max}

$$\frac{g_{max} - g_{min}}{2}$$

$$\bar{g} = \overrightarrow{\ln(\cos(x))}$$

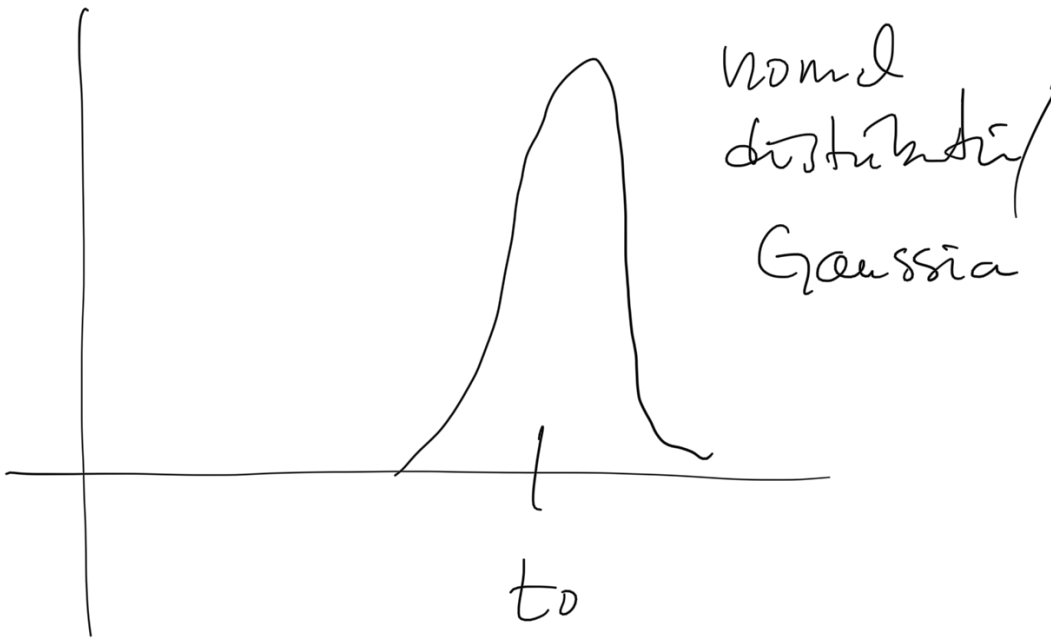
$\tanh_2(z)$

f

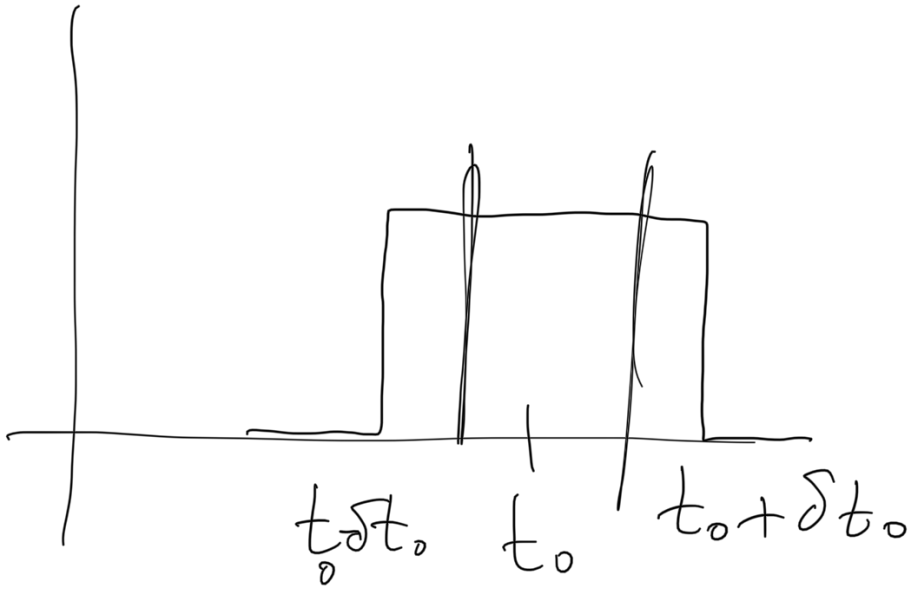
$y \pm \delta y$ $\quad x \pm \delta x$

$z \pm \delta z$

What kind of uncertainty



Uniform Distribution.



Digital Instruments

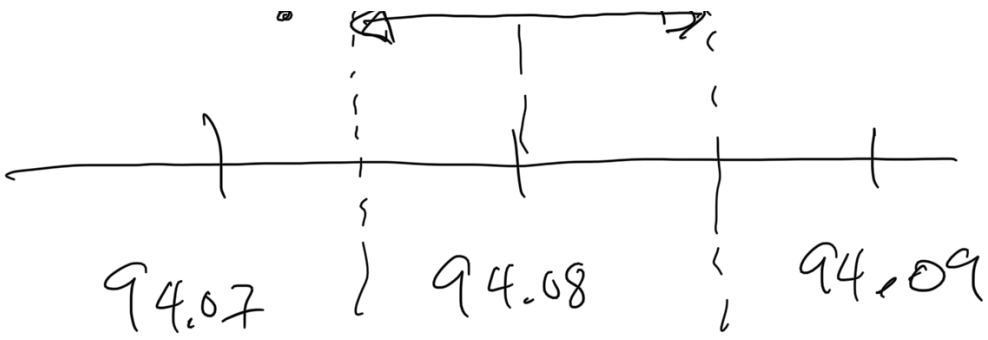
Stopwatch → hundredths of a second.

$$t = 94.08 \text{ s}$$

not 94.07 s

not 94.09 s

$\pm .005$ s



$$(94.08 \pm .005)s$$

"half the smallest division"

This form

$$\delta g = \left|\frac{\partial g}{\partial h}\right| \delta h + \left|\frac{\partial g}{\partial t}\right| \delta t$$

(abs. value)

"chain rule"

$$g = \frac{2h}{t^2}$$

$$\left|\frac{\partial g}{\partial h}\right| = \left|\frac{2}{t^2}\right| \qquad \frac{\partial g}{\partial t} = \left|\frac{-4h}{t^3}\right| = \frac{4h}{t^3}$$

$$\delta g = \left|\frac{2}{t^2}\right| \delta h + \left|\frac{4h}{t^3}\right| \delta t$$

.335

uncertainty in height

uncertainty in time.

$$.335 = .032 + .304$$

$$\delta g = \frac{2}{t^2}\delta h + \frac{4h}{t^3}\delta t$$

2

g $\quad$ $\frac{2h}{t^2}$ $\quad$ $\frac{2h}{t^2}$

$$\frac{\delta g}{g} = \frac{\delta h}{h} + 2\frac{\delta t}{t}$$

% error in g $\quad$ % error in h $\quad$ % error in t

$$g = \frac{2h}{t^2}$$

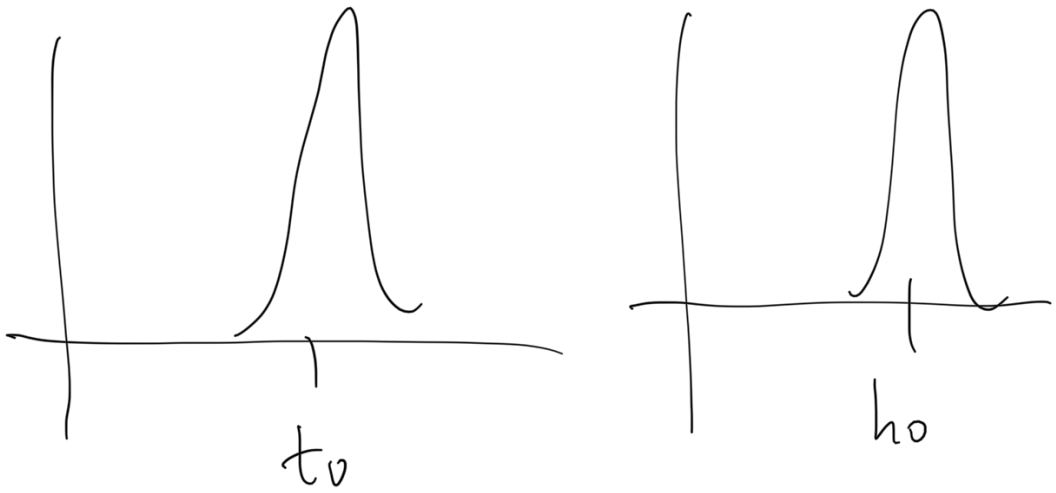
linear

quadratic

$$\frac{\delta g}{g} = \frac{\delta h}{h} + 2\frac{\delta t}{t}$$

$$y = x^3 z^2$$

$$\boxed{\frac{\delta y}{y} = 3\frac{\delta x}{x} + 2\frac{\delta z}{z}}$$

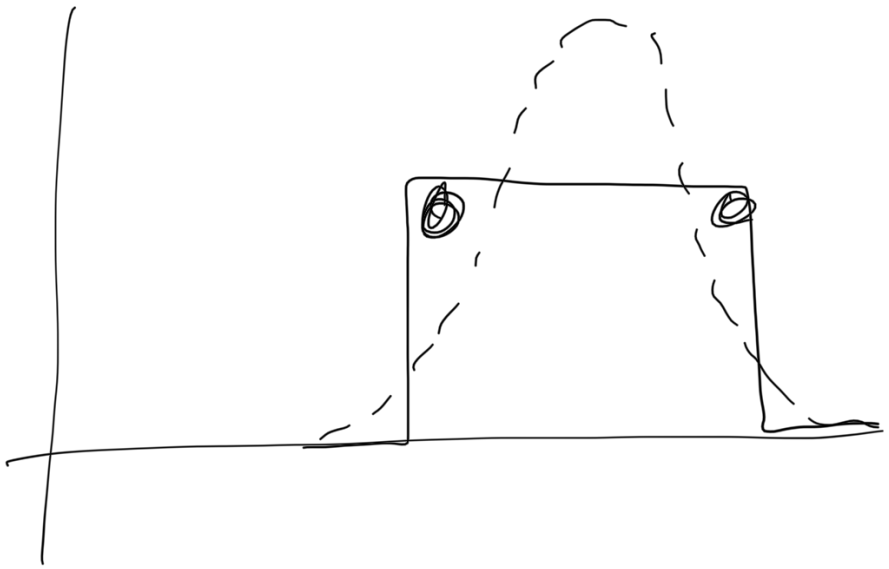


$$(\delta g)^2 = \left(\frac{\partial g}{\partial h}\right)^2 (\delta h)^2 + \left(\frac{\partial g}{\partial t}\right)^2 (\delta t)^2$$

$-x^2$

$$e = 1 + x + \frac{x}{2}$$

$$+ \cdots$$



result = f(a, b, x, z,

t, y, g, v,

m, your own,)

range

[:]

sum