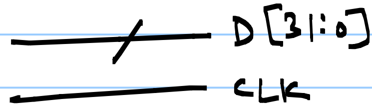
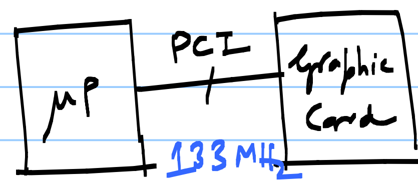
ECE 518 – Lecture 25

Note Title 4/23/2013

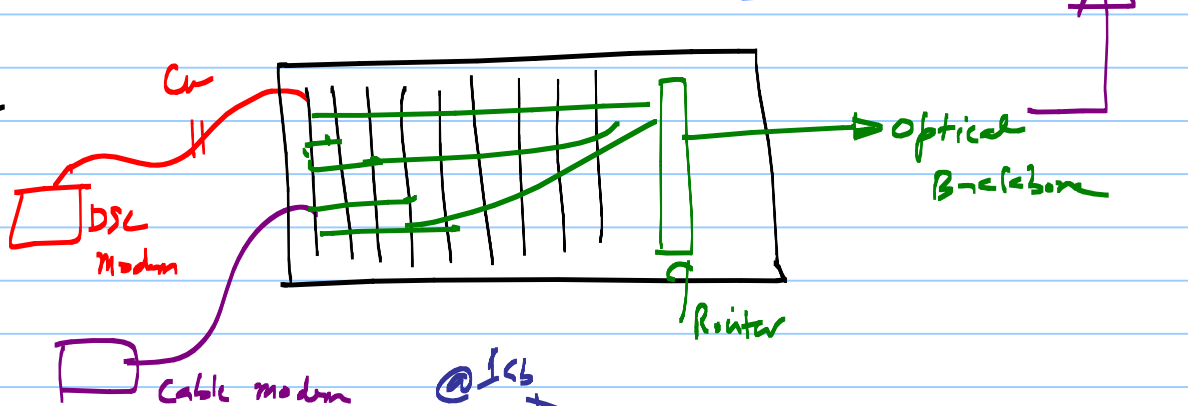
Clock and Data Recovery (CDR)

PCI

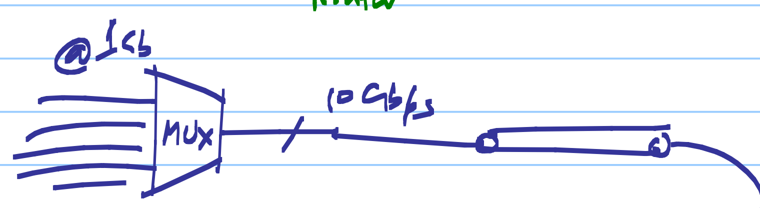




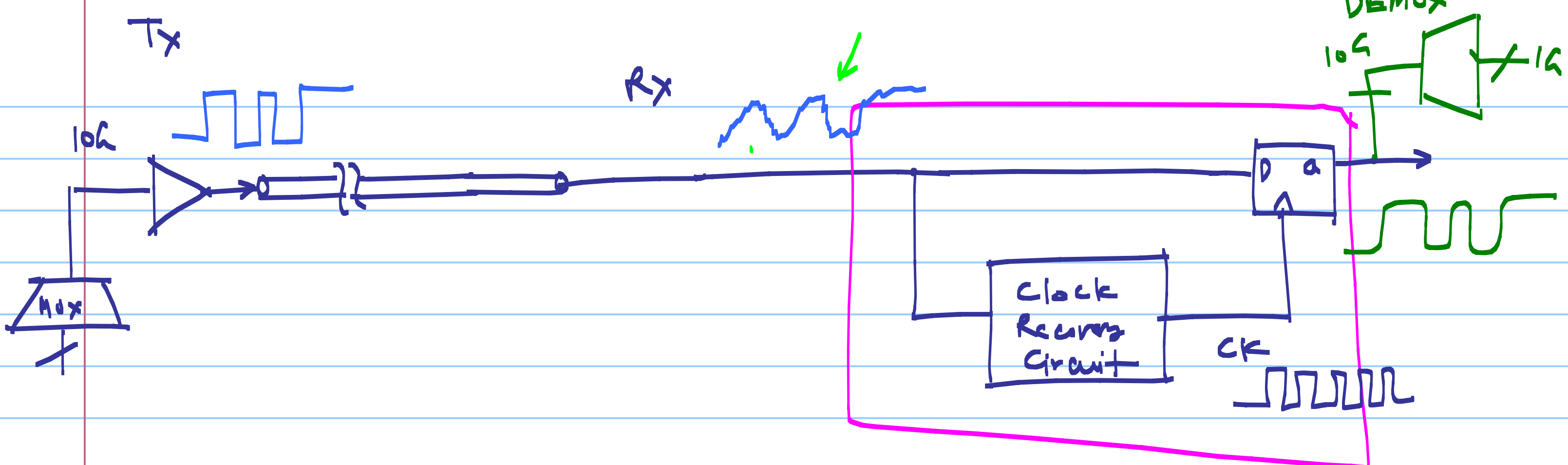
Backplane



"Serial Links"



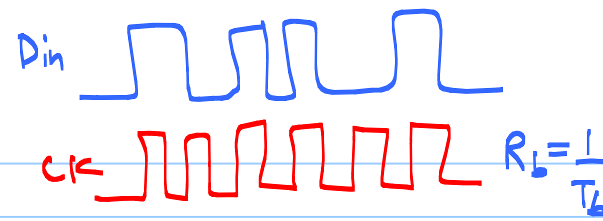
* Rx data from a serial interface is asynchronous & noisy



Clock and data recovery circuit (CDR)

→ CDR removes the timing errors & clean up the data transitions

RocketIO



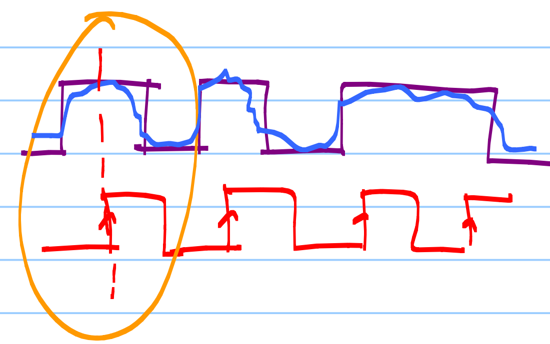
* The clock recovered from the random data, must satisfy

① frequency of the clock = data rate

Eg. 10 GHz clock → 10 Gb/s data

⇒ 100 ps

② for optimum sampling, the recovered clock must align with the center of the data

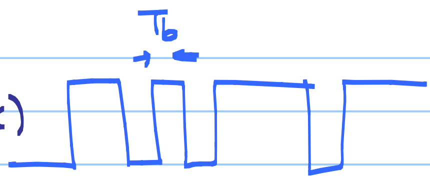


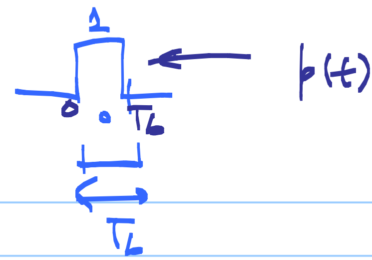
③ Should exhibit small jitter

↳ contributes jitter in the recovered data

* Random NRZ data

$x(t)$

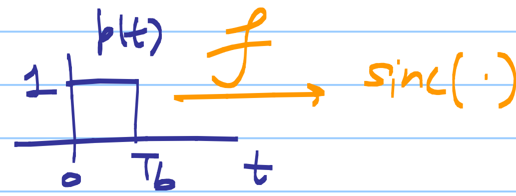




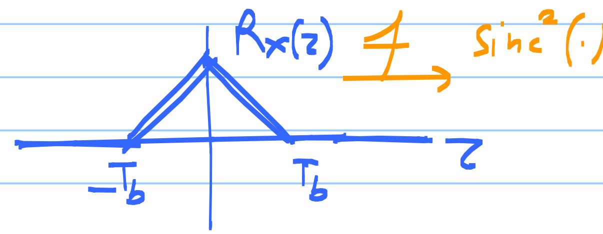
data rate $= R_b = \frac{1}{T_b}$

$b_k = \{0, 1, 1, 0 \ldots$

$$x(t) = \sum_k b_k \cdot p(t - kT_b)$$



Autocorrelation: $R_x(\tau) = \begin{cases} 1 - \frac{|\tau|}{T_b}, & |\tau| < T_b \\ 0, & |\tau| \geq T_b \end{cases}$



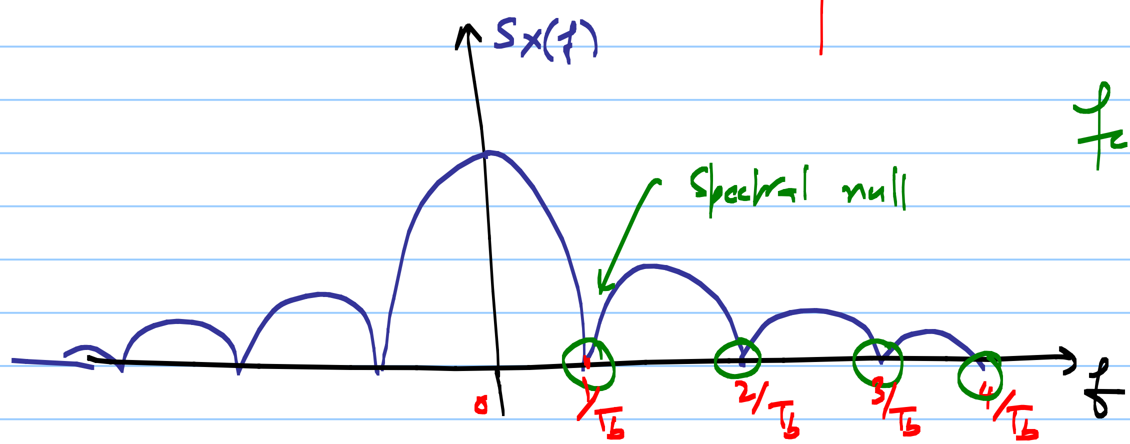
Random process ⇒ PSD $\quad S_x(f) \overset{\mathcal{F}}{\longleftarrow} R_x(\tau)$

for NRZ random data:

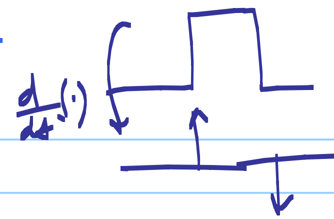
$$S_x(f) = \frac{1}{T_b} \cdot |P(f)|^2 = \frac{1}{T_b}\left[T_b \frac{\sin(\pi f T_b)}{(\pi f T_b)}\right]^2, \qquad \text{sinc}(x) = \frac{\sin(\pi x)}{\pi x}$$

$$= T_b \cdot \text{sinc}^2(f T_b)$$

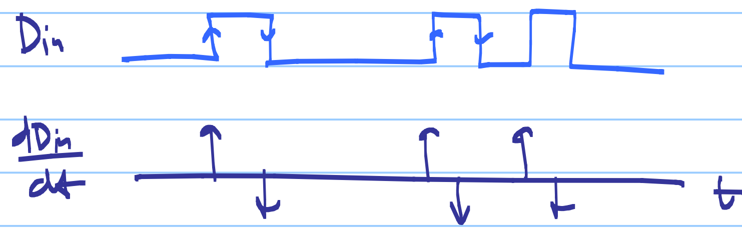
$$f_{ck} = \frac{1}{T_b}$$

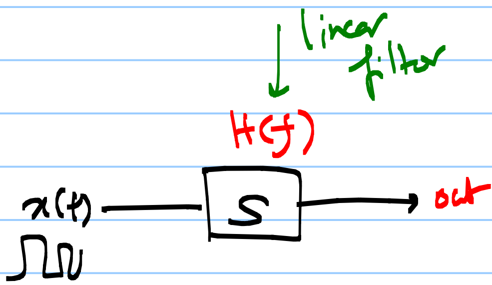


* No direct information for clock extraction



* Edge-detection

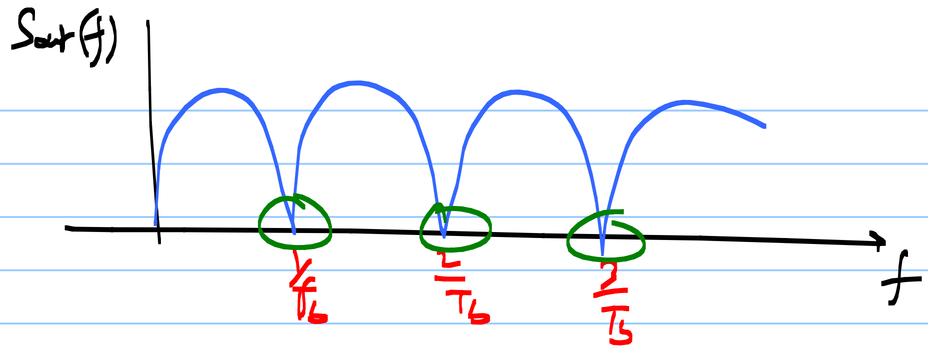




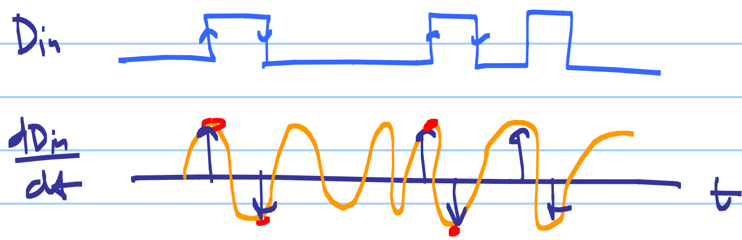
$$S_{out}(f) = S_{in}(f) \cdot |H(f)|^2$$

$$S_y(f) = |j2\pi f|^2 \cdot T_b \cdot \frac{\sin^2(\pi f T_b)}{(\pi f T_b)^2}$$

$$= \left(\frac{2\sin(\pi f T_b)}{T_b}\right)^2$$



$S_{out}(f)$
$1/T_b$
$2/T_b$
$3/T_b$
f

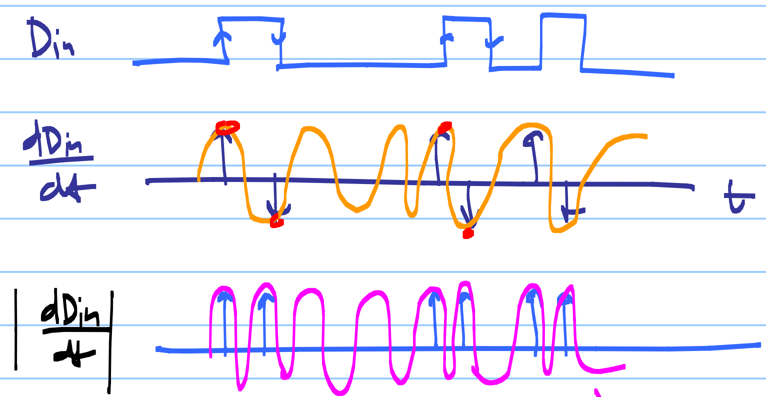


$f_b = \frac{1}{T_b}$

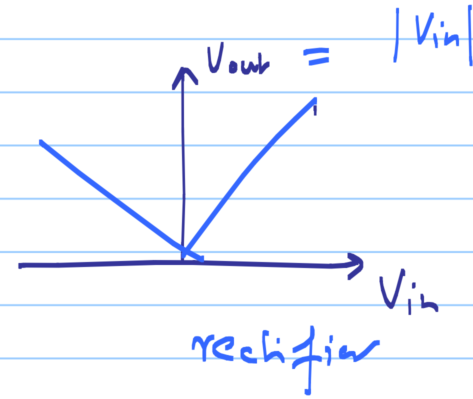
* Equal transitions of 1's & 0's

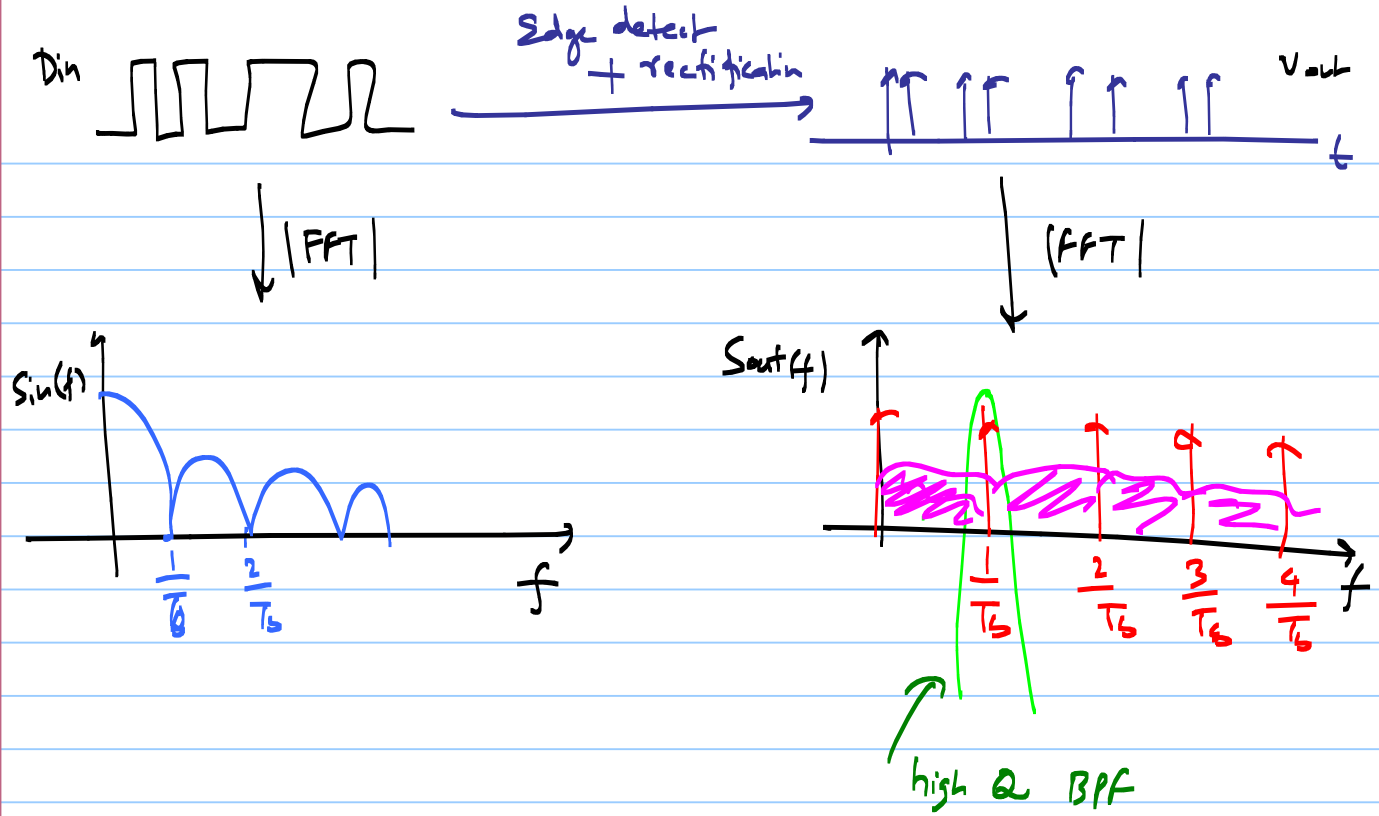
Correlation $\Rightarrow$ $\displaystyle\int_{-\infty}^{\infty} \frac{dD_{in}}{dt} \cdot \cos\left(\frac{2\pi t}{T_b} + \theta_b\right) \cdot dt = 0$

Edge detect with rectification



→ non-zero correlation with $\cos\left(\frac{2\pi t}{T_b}+\theta\right)$

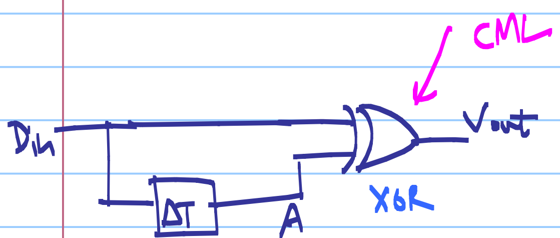


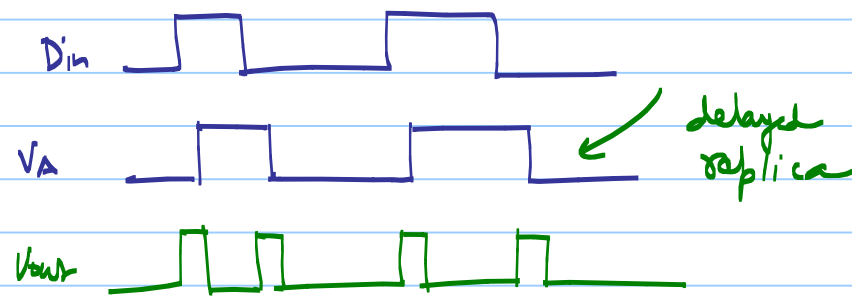


× PLL's are ubiquitous for clock recovery.

→ rectifier, $|x|$, x^2, x^4, . . . ← used in digital clock recovery.

Edge Detectors:

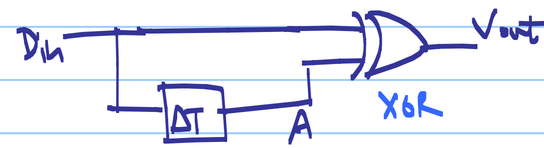


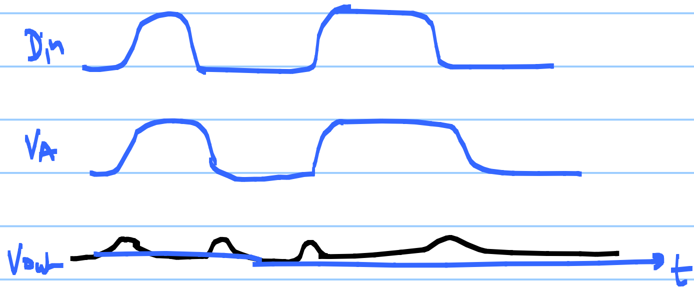


10Gb/s → $T_b = 100ps$

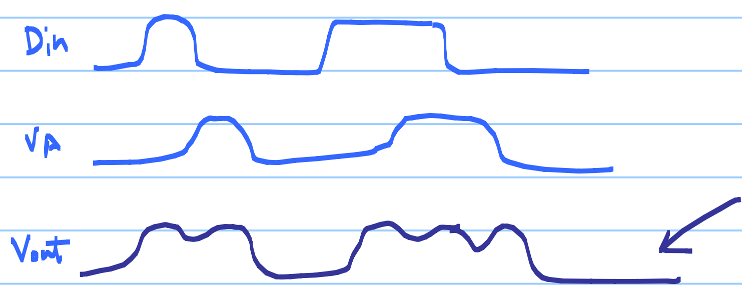
$t_{XOR} = 50\ ps$

① ΔT is not sufficiently large



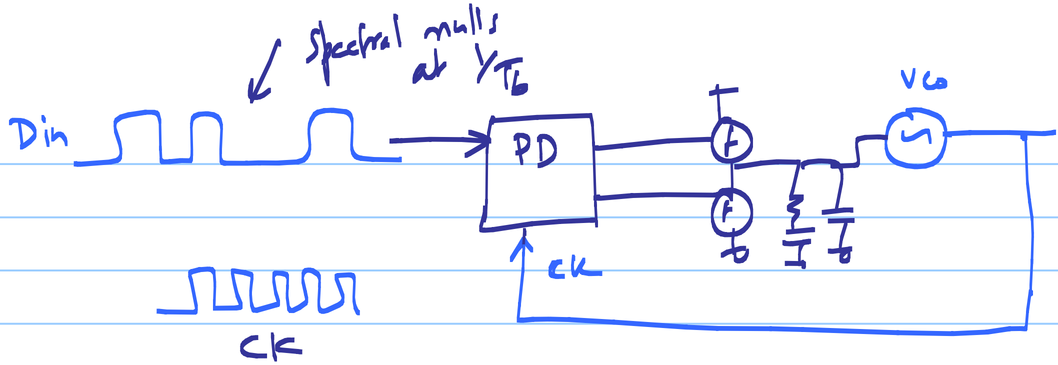


② $\Delta T \simeq T_b$



overlap b/w Din & VA is small

↳ No edge detection



* Since the spectrum of random data exhibits nulls at $\frac{m}{T_b}$, phase detectors used for periodic input fail completely in this case
  ↳ Can't use XOR, PFD from regular PLL's to compute phase difference

* Need different PDs for random data.