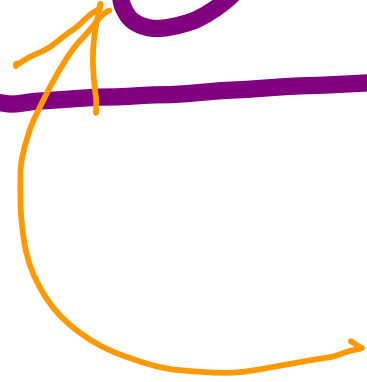
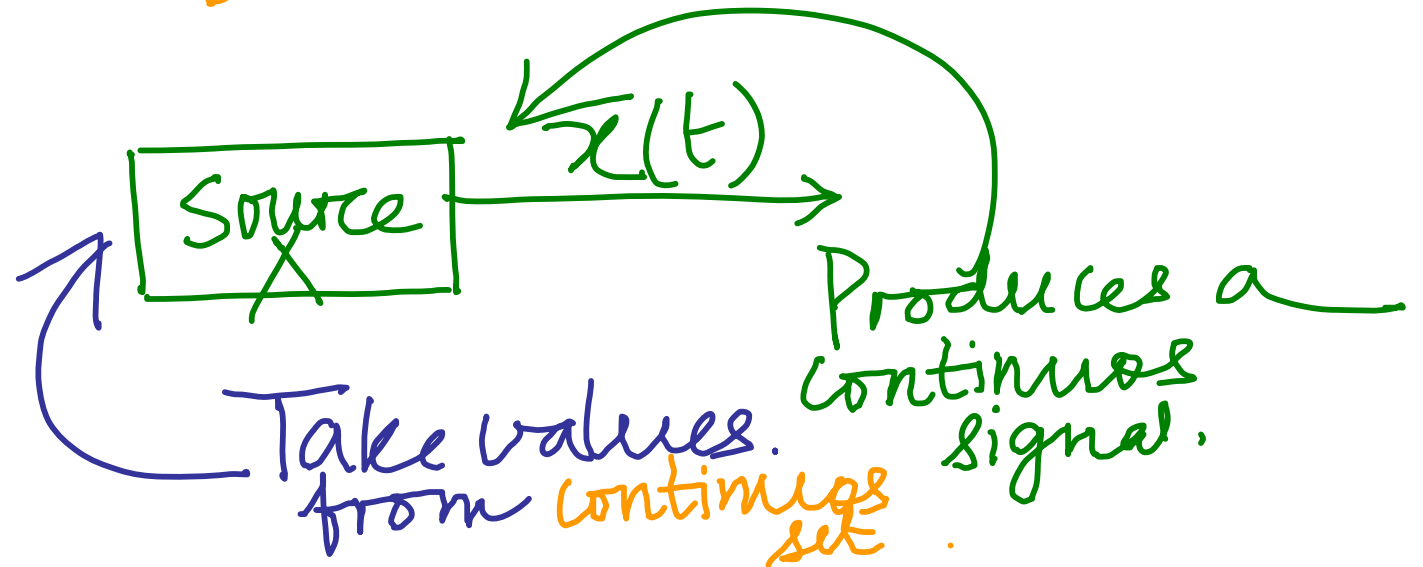




DIFFERENTIAL ENTROPY



So far we have seen sources with Discrete Alphabet.



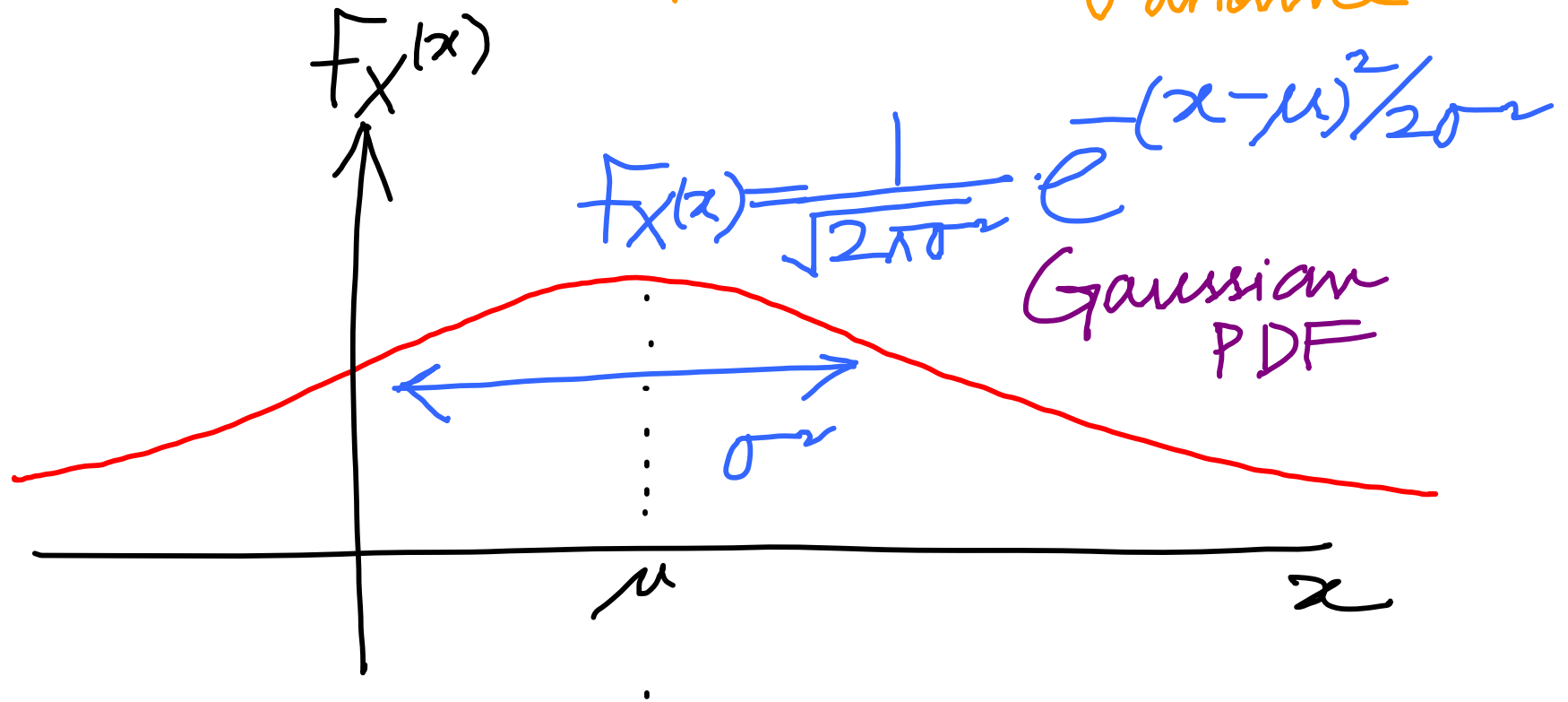
output belongs to a
continuous set of values.

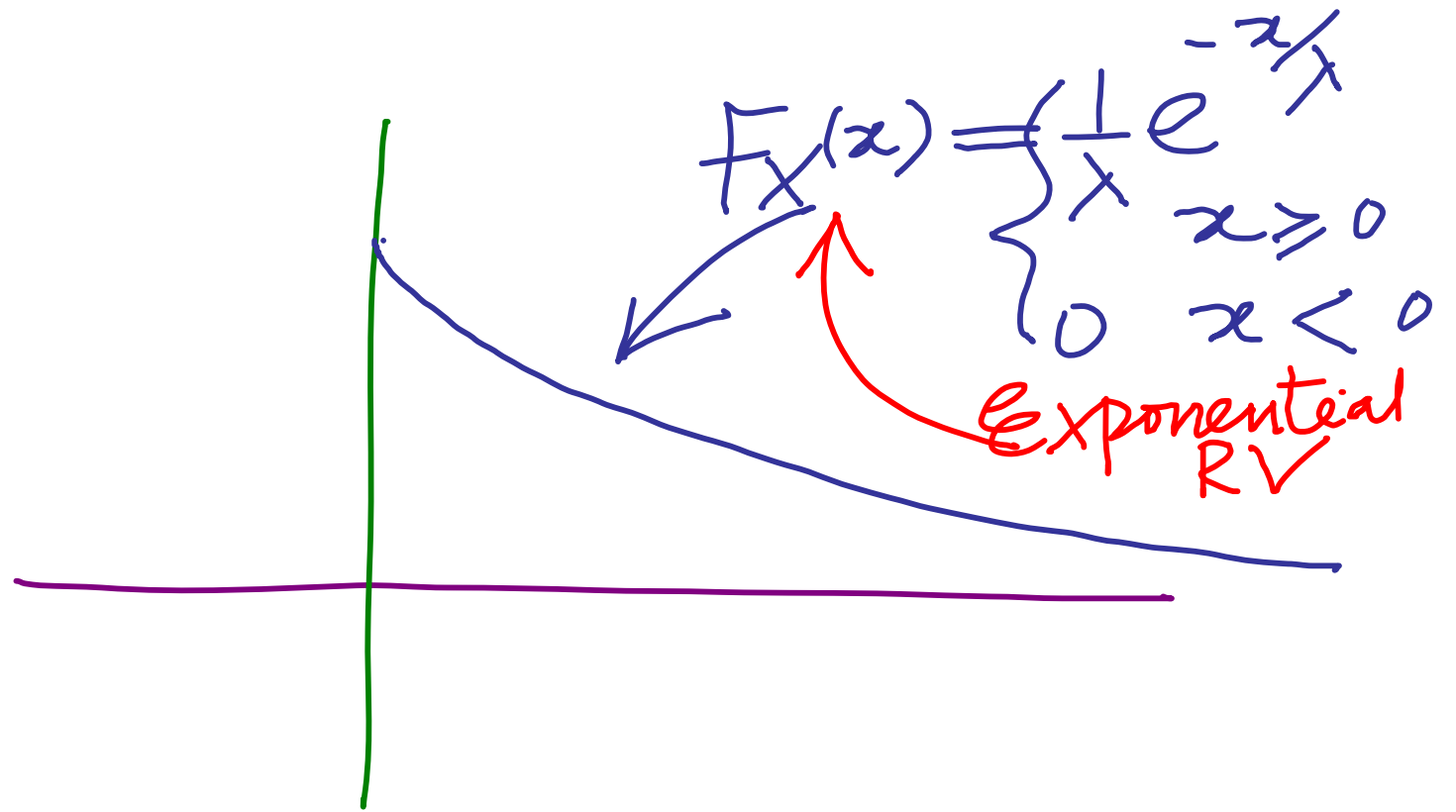
output distribution
is characterized by
a probability density
function.

$f_X(x)$ ← output
PDF

$F_X(x)$ — Gaussian

$N(\mu, \sigma^2)$
Gaussian
mean
variance





DIFFERENTIAL ENTROPY

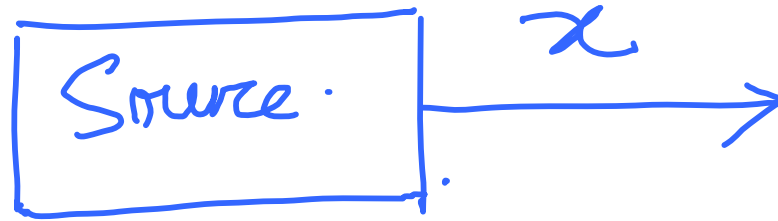
$$h(X) = \int_{-\infty}^{\infty} f_X(x) \log_2 \left(\frac{1}{f_X(x)} \right) dx$$

Differential Entropy
for a source with
output PDF $f_X(x)$.

Represented using h

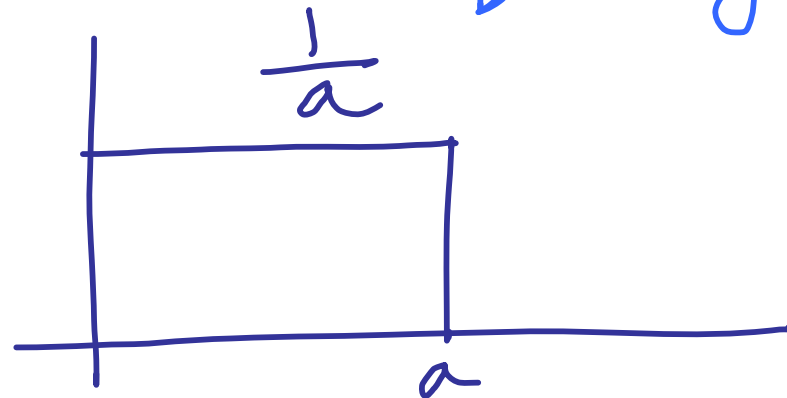
1. Probabilities
Replaced by PDF
2. Discrete sum
replaced by integral.

Example:



$$X \sim U[0, a]$$

Uniform Probability
Density Function



$$f_X(x) = \begin{cases} \frac{1}{a}, & 0 \leq x \leq a \\ 0, & \text{otherwise} \end{cases}$$

$$\begin{aligned} h(X) &= \int_0^a \frac{1}{a} \cdot \log_2 \cdot a \, dx \\ &= \frac{1}{a} (\log_2 a) \cdot \int_0^a \frac{dx}{a} \\ &= \frac{1}{a} \times a \times \log_2 a \end{aligned}$$

$$\boxed{h(X) = \log_2 a}$$

$$f_X(x) = U[0, a]$$

For $a < 1$, $\log_2 a < 0$

$\Rightarrow h(X)$ can be -ve

Therefore, unlike Entropy,
Differential Entropy can
be -ve.