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Probabilistic sample(or random sample, sample):
One realizable phenomenon from the probabilistic problem you want to solve
Or one sampled case

Sample space Ω:
Set which contains all possible samples

Task of defining sample sapce:
Define which phenomenon is possible to occur
and which phenomenon is impossible to occur

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Sample space when you toss the coin
$\Omega = \{H, T\}$

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Some cases has set of entire real numbers as sample space
$\Omega = \mathbf{R}$

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Possible events: possible sub sets of sample space Ω

Sample space $\Omega = \{H, T\}$
Possible events: $\phi, \{H\}, \{T\}, \{H, T\}$

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Probability is function which takes all events
and which outputs number

$P(A) = 0.1$
P() is function P
A is event
0.1 is probability value

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Kolmogorov's axioms

1. $P(\text{all\_events}) \geq 0$
2. $P(\Omega) = 1$
3. If $A \cap B = \phi$, then $P(A \cup B) = P(A) + P(B)$

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Interpretion about probability value:
1. Frequentist
2. Baysian

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Information of "event A has high probability value",
"event B has medium probability value",
"event C has low probability value", ...
is called "probability distribution"

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Elementary event (or atomic event):
Elementary event has one number of sample

$P(\text{Diamond}) = 0.1$
$P(\text{Heart}) = 0.2$
$P(\text{Spade}) = 0.3$
$P(\text{Clover}) = 0.4$

Then, you can calculate probability value of all kinds of events,
which has 2 samples, 3 samples, etc
according to 3rd rule of Kolmogorov's axiom

$P(\text{Heart,Spade}) = 0.2 + 0.3 = 0.5$

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Probability mass function:
Probability mass function defines probability values
to each elementary event,
when there are only finite number of events

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$P(\{1\}) = 0.2$
$P()$ is probability function
$\{1\}$ is event which has one sample
0.2 is probability value for event $\{1\}$

$p(1) = 0.2$
$p()$ is probability mass function
1 is elementary event which has number 1
0.2 is probability value for elementary event 1

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$P(\{1, 2\}) = 0.2$
$P()$ is probability function
$\{1, 2\}$ is event which has 2 samples
0.2 is probability value for event $\{1, 2\}$

$p(1,2)$ can be defined

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Simple interval event A: $A = \{a \leq x < b\}$

$A = \{a \leq x < b\} \quad \rightarrow \quad P(A) = P(\{a \leq x < b\}) = P(a,b)$

$P(B) = P(\{-2 \leq x < 1\}) + P(\{2 \leq x < 3\}) = P(-2,1) + P(2,3)$

$P(B) = P(\{-2 \leq x < 3\}) - P(\{1 \leq x < 2\}) = P(-2,3) - P(1,2)$

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Cumulative distribution function:
From above, you used 2 numbers to define "interval" or "simple interval event A"

To use only one number, you can use negative infinity

$S_{-1} = \{-\infty \leq X < -1\}$
$S_0 = \{-\infty \leq X < 0\}$
$S_1 = \{-\infty \leq X < 1\}$
$S_2 = \{-\infty \leq X < 2\}$
$\vdots$
$S_x = \{-\infty \leq X < x\}$

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In interval $\{a \leq x < b\}$
simple intervale probability $P(a,b) = P(-\infty, b) - P(-\infty, a)$

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Probability density function:
derivative of Cumulative distribution function

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Probability distribution function:
Probability mass function
Cumulative distribution function
Probability density function

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