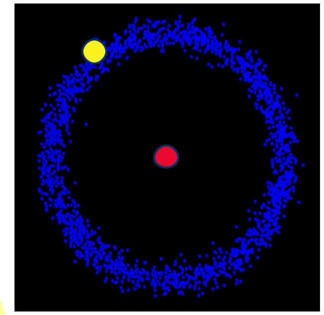
Presented at Quantum Mind II, Tucson, AZ



The Math Over Mind and Matter

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DJM Mar 2003

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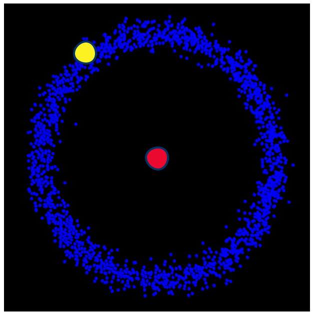
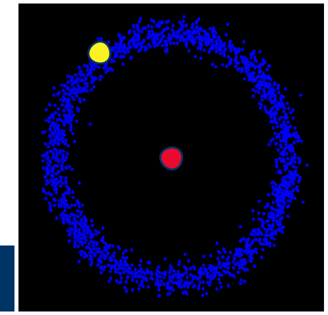
Math over Mind *and* Matter



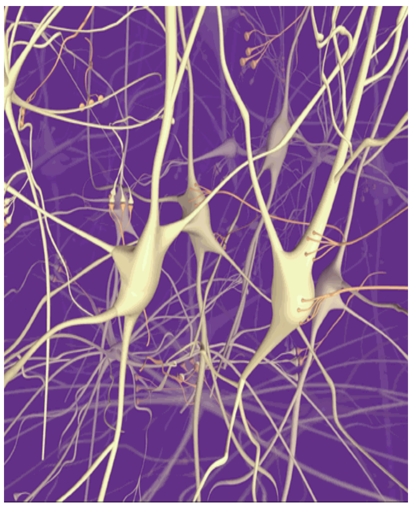
- Results from math field of probabilistic geometry
- Describes classical neuron behavior
  - Patented result from 30 years of work
  - Corob tokens, computation and language
- Describes quantum ensemble state behavior
  - Results of Air Force contract #F30602-02-C-0077
  - Quantum corob tokens, computation and language
- Corob perspective describes both!!

Data Tokens Survive

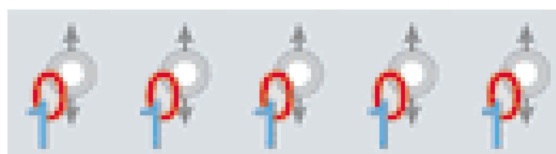


0 = min or not firing
1 = max firing *rate*

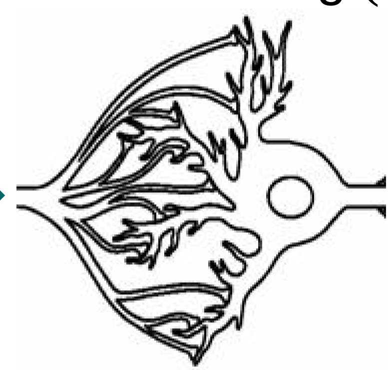
Classical Neurons $(0 \rightarrow 1)$



Quantum Spins $(0 \rightarrow 360^{\circ})$



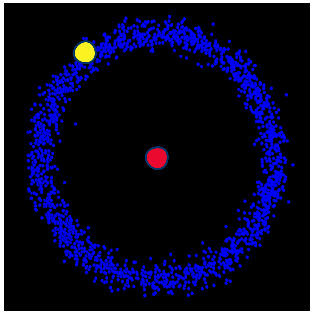
Classical firing $(0 \rightarrow 1)$



0
or
1

Classical → Quantum → Classical

The Math: Correlithm Objects



Corob: A point in a high dimensional space N>20

Neural Corob Models

- Humans are smart
- Mimic brain statistics

Quantum Universe

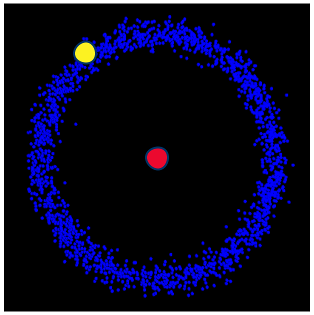
- Massive parallelism
- Mimic quantum statistics

Quantum Corobs

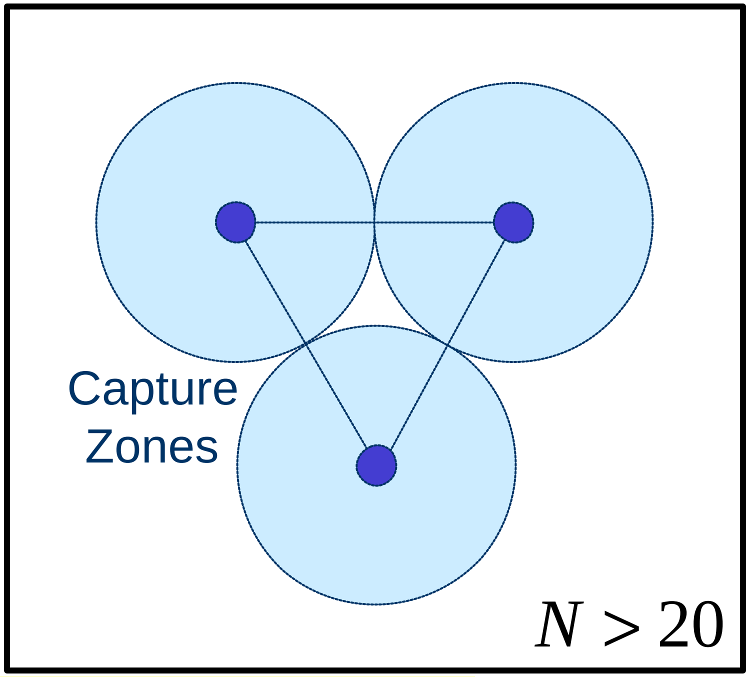
corob tokens mapped onto quantum states

Tokens from Randomness

for 3 tokens



3 random points in bounded space



- Soft data tokens emerge out of pure randomness (uniformly distributed)

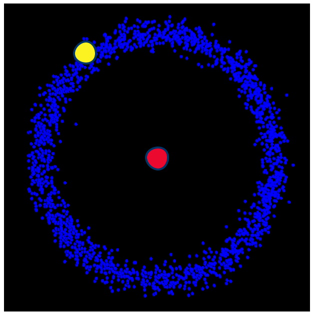
- All tokens are the same *standard* distance apart (with standard deviation)

$$for\ X = [x_1, \ldots, x_N]\ and\ Y = [y_1, \ldots, y_N]$$

$$dist(X,Y) = \sqrt{(x_1 - y_1)^2 + \ldots + (x_N - y_N)^2}$$

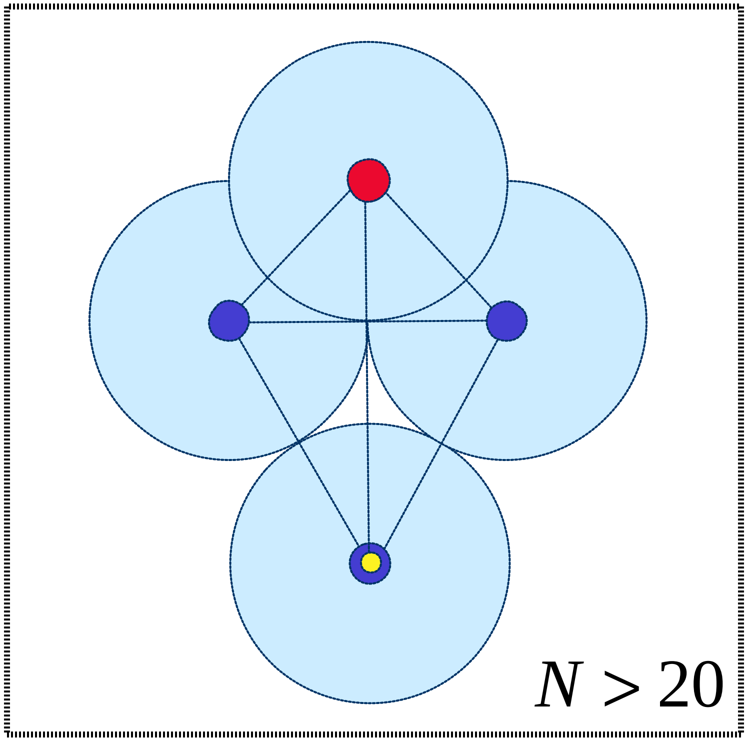
High Dimensional Tetrahedron

for 4 tokens



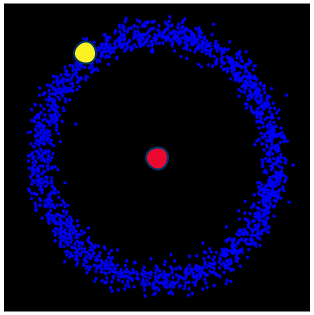
- Soft data tokens emerge out of pure randomness
- All tokens are the same standard distance apart
- Works for any number of corob soft tokens (N>20)

4 random points in bounded space



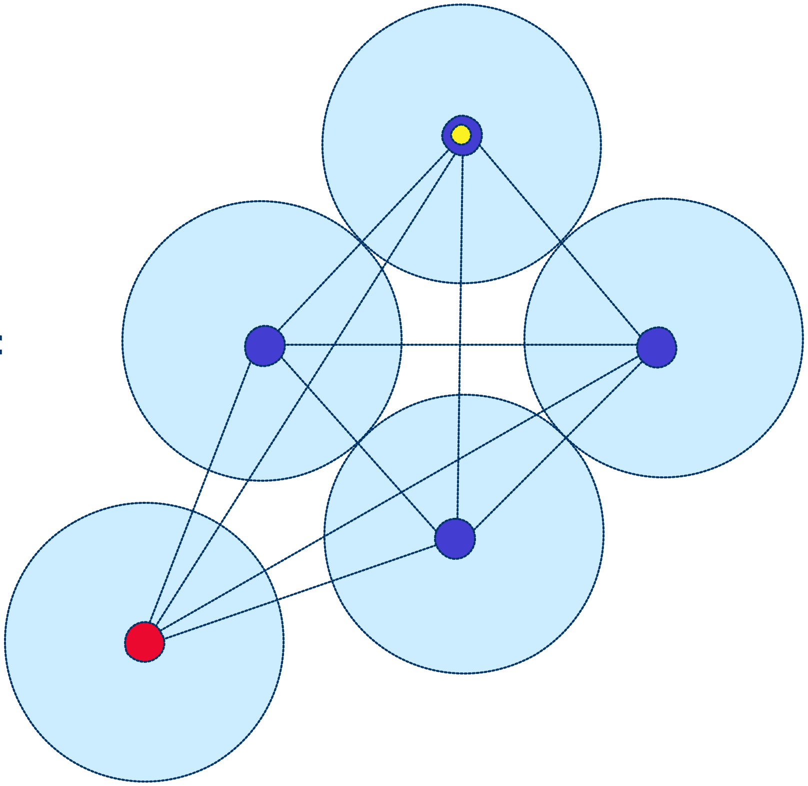
Corob Computing

for 5 tokens



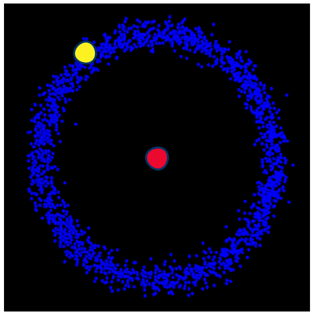
- Soft data tokens emerge out of pure randomness
- All tokens are the same standard distance apart
- Works for any number of corob soft tokens
- Tokens can uniquely represent *concepts* and the states of computation

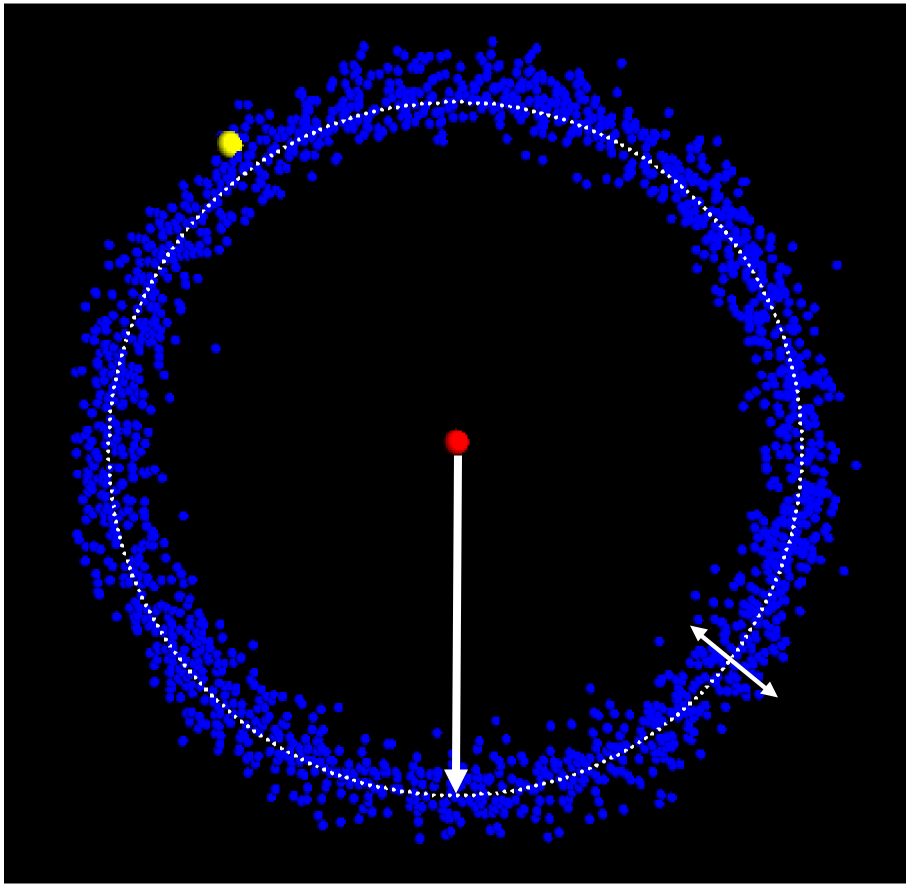
Forms an N-dim tetrahedron



Expected Standard Distance

for 2000 tokens



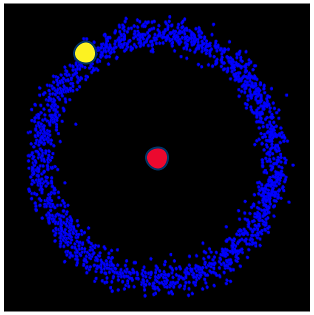


Every token is *equidistant* from all other tokens so forms an N-shell or an N-equihedron

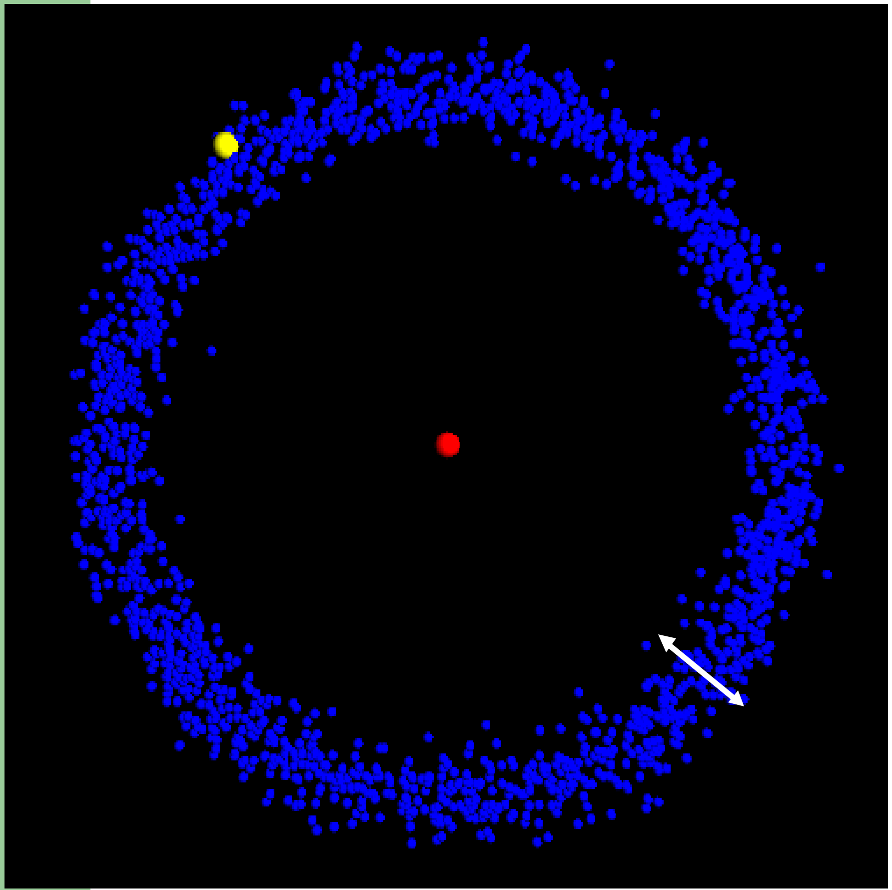
$$\text{standard distance} = \sqrt{N/6}$$

$$\text{standard deviation} = \sqrt{7/120}$$

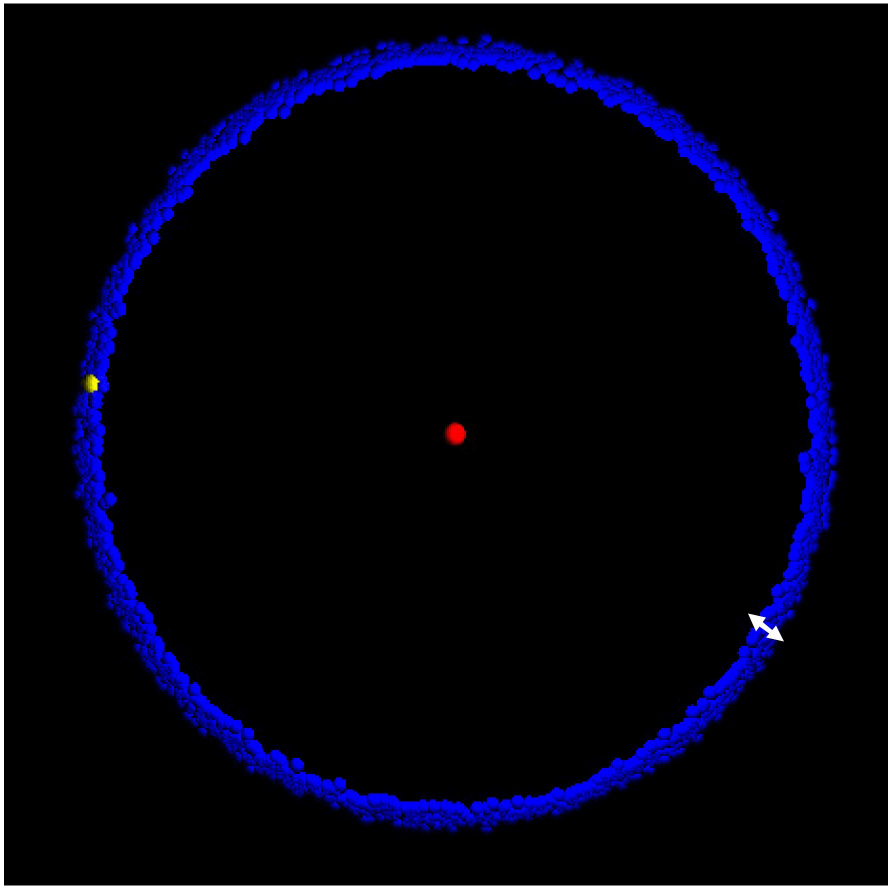
Constant-like expected values



For N=96, Standard distance = 4

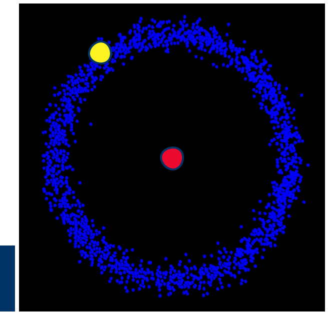


For N=2400, Standard distance = 20

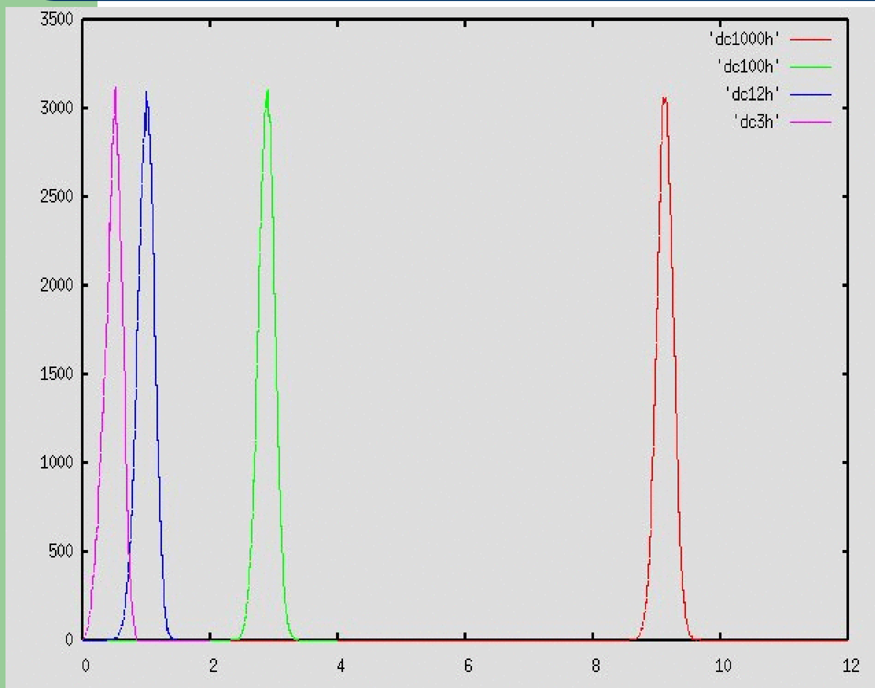


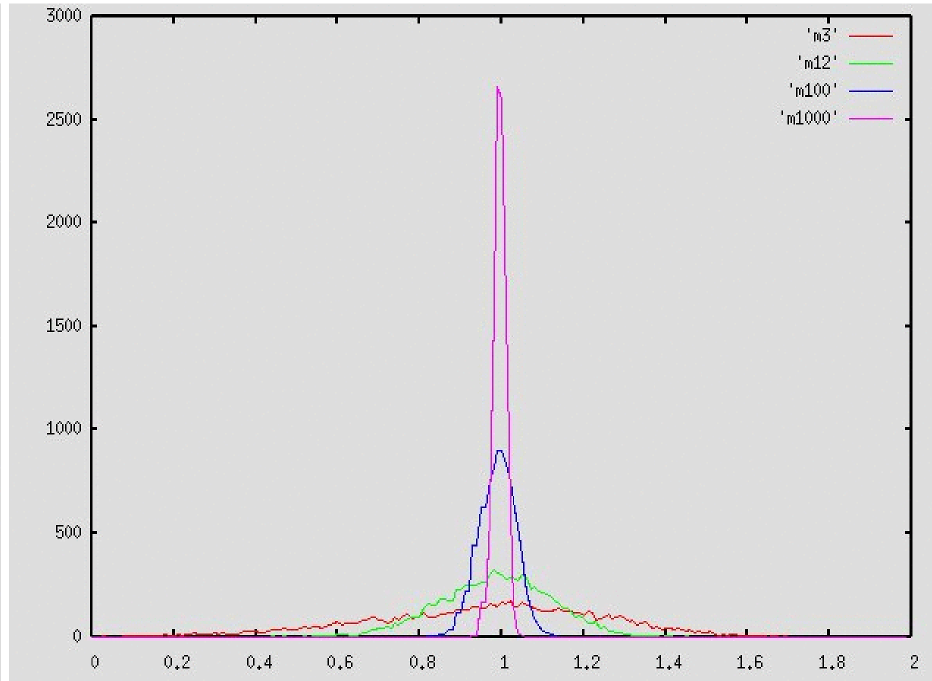
$$\text{standard distance} = \sqrt{N/6}$$

Constant Standard Deviation



for N=3,12,100,1000

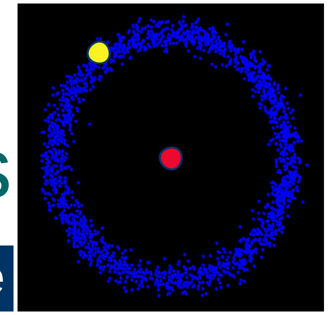




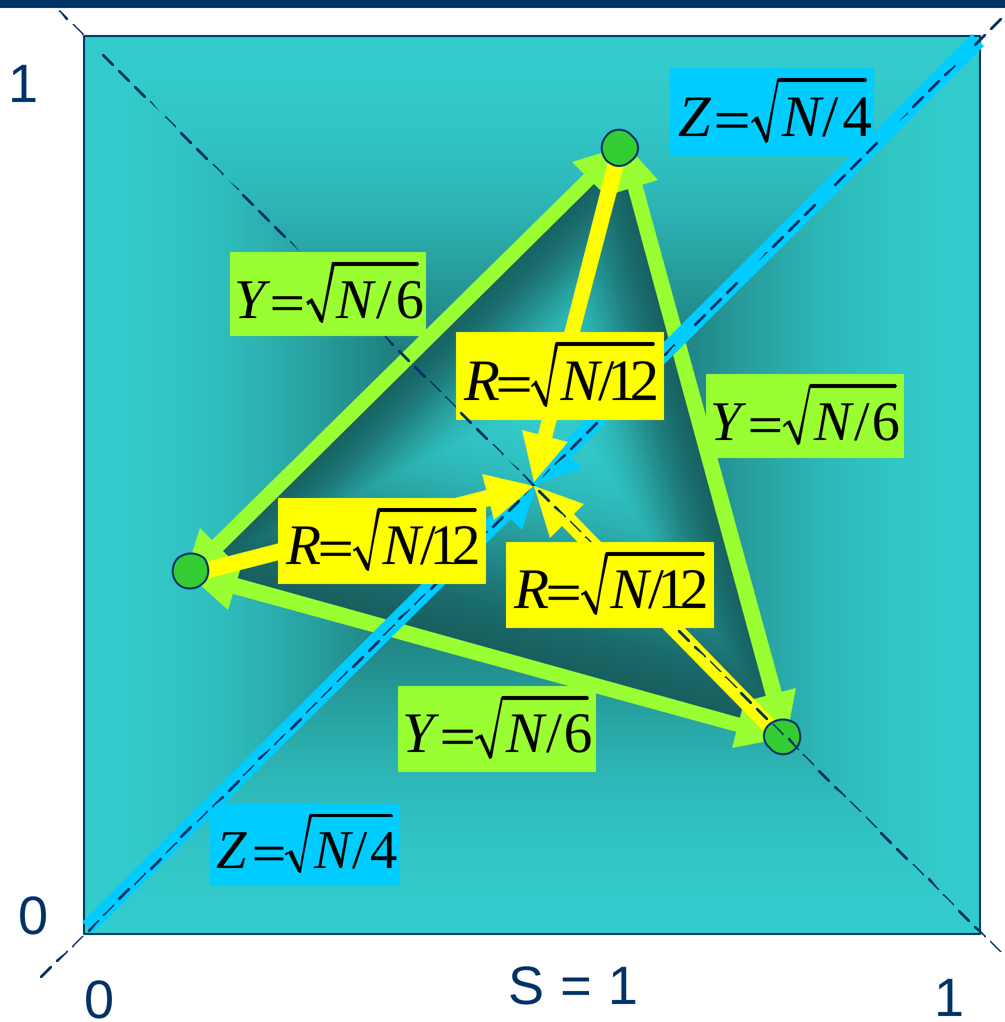
Standard Deviation	Confidence Interval
±1	0.6826895
±2	0.9544997
±3	0.9973002
±4	0.9999366
±5	0.9999994

Best if N>35 because standard distance is 10 times standard deviation

Standard Distance & Standard Radius



for unit N_R-cube



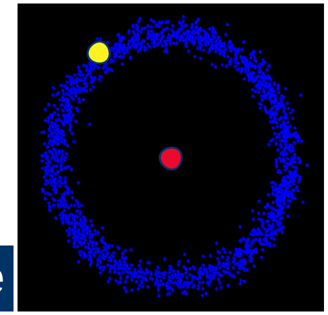
Exact Measures

$$M = \sqrt{N} = Z + Z$$
$$Z = M / 2 = \sqrt{N / 4}$$

Probabilistic Measures

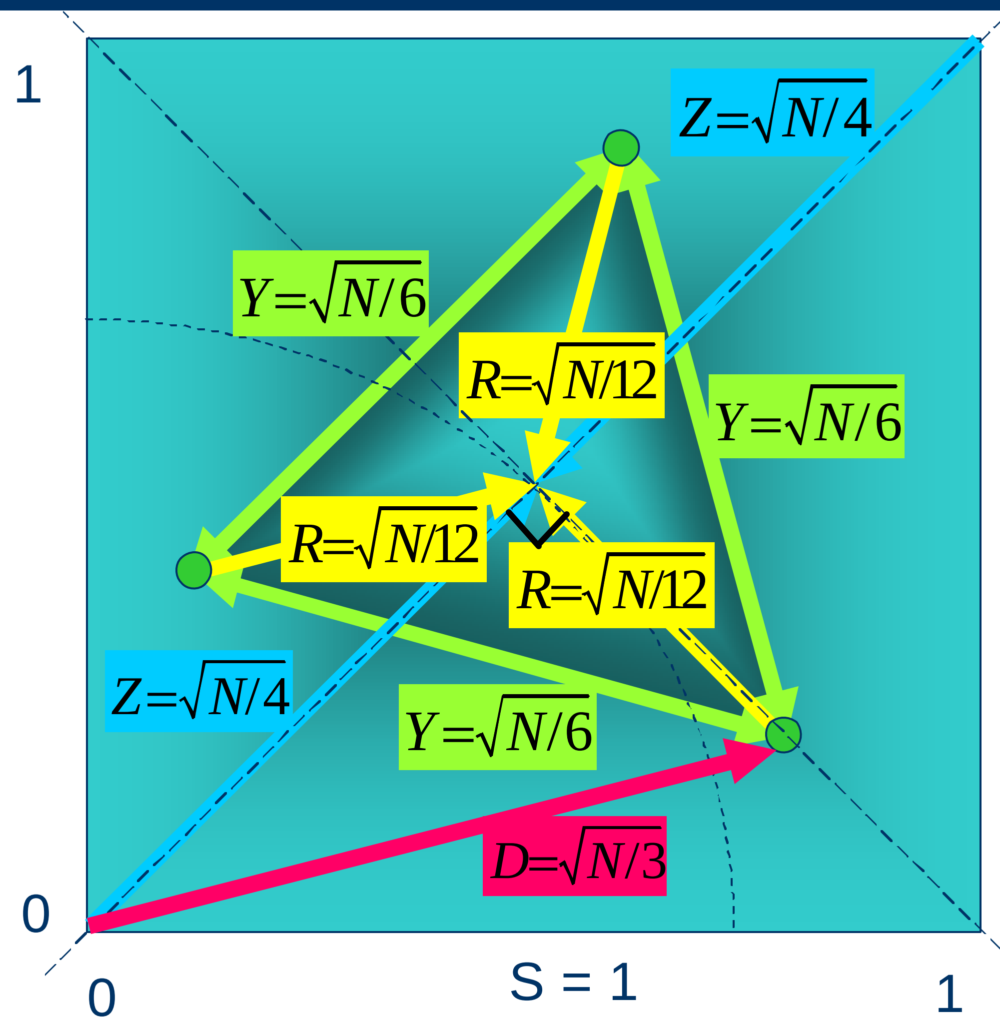
$$R \cong \sqrt{N / 12}$$
$$Y \cong \sqrt{N / 6}$$

Space Center is [.5 .5 …]



Distance from Corner to Random Point

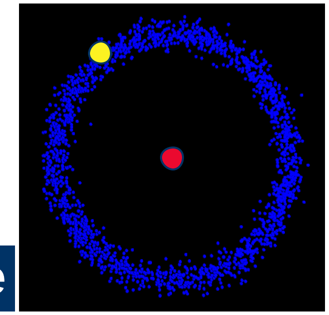
for unit N_R-cube



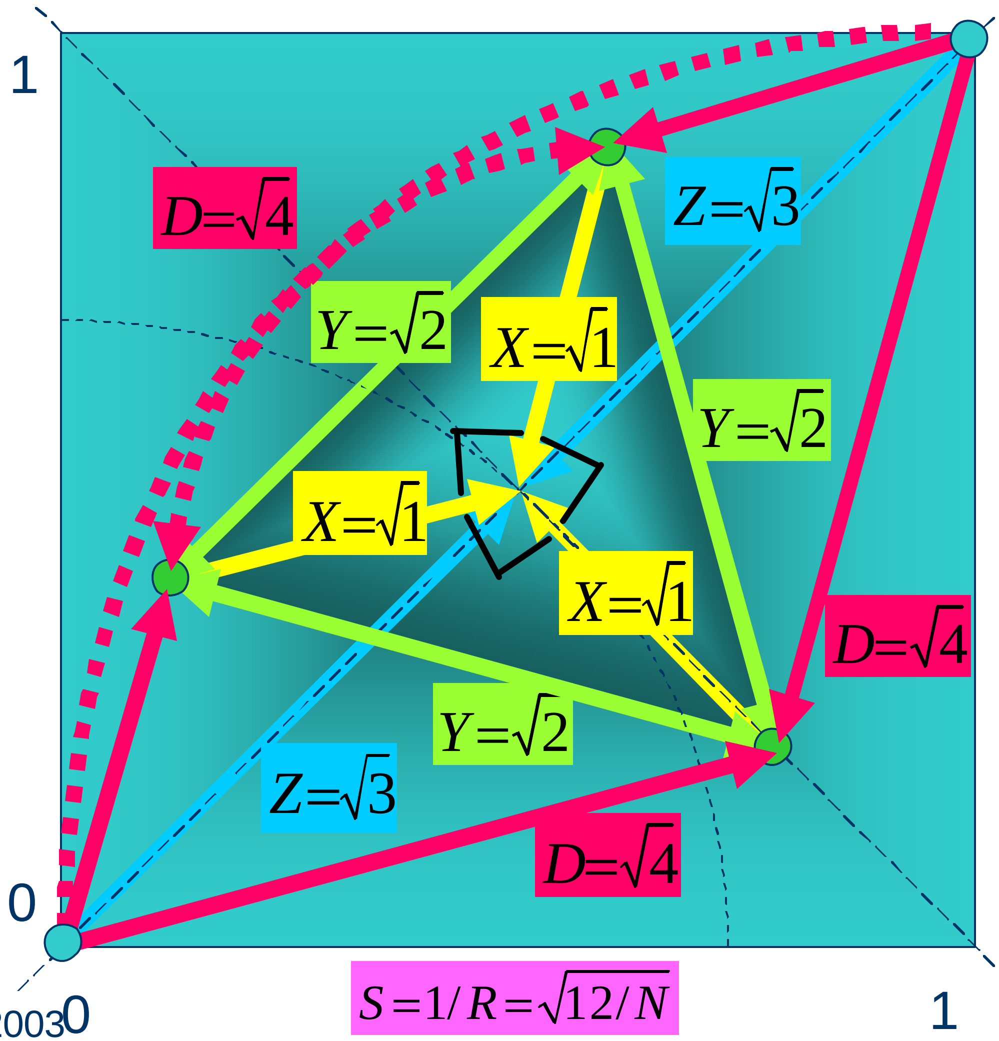
Distance from random corner to a random point is D=2R so call it the diameter D.

Notice equalities:
$Z^2 + R^2 = D^2$ and
$Z^2 + Z^2 = K^2$ where
$K \cong \sqrt{N/2}$ is the Kanerva distance of random corners

Normalized Distances Summary



for unit N_R-cube



$S=1/R=\sqrt{12/N}$

$R=\sqrt{N/12}$

$X=\sqrt{N/12}/R=\sqrt{1}$

$Y=\sqrt{N/6}/R=\sqrt{2}$

$Z=\sqrt{N/4}/R=\sqrt{3}$

$D=\sqrt{N/3}/R=\sqrt{4}$

$K=\sqrt{N/2}/R=\sqrt{6}$

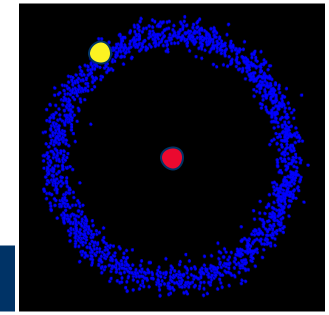
$M=\sqrt{N}/R=\sqrt{12}$

$C=\sqrt{N/4}/R=\sqrt{3}$

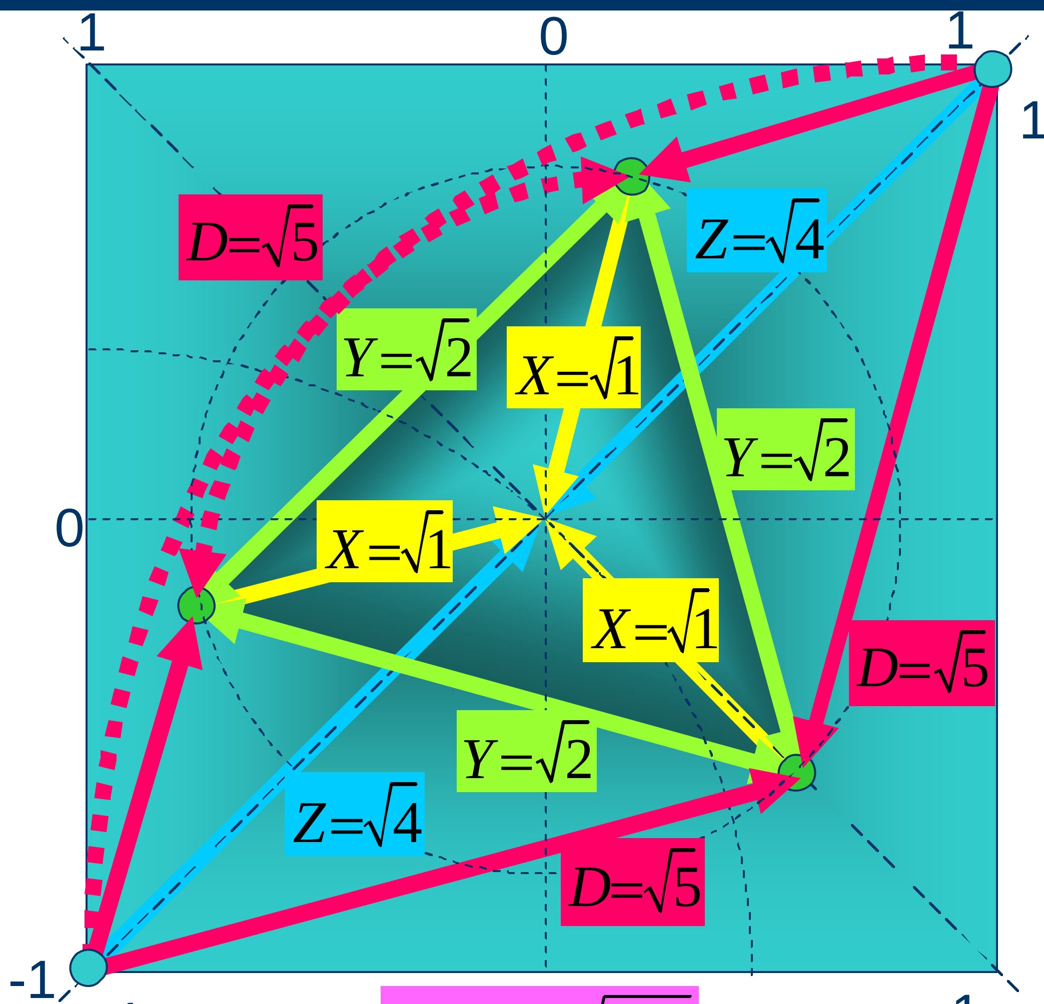
$Stdev_Y=\sqrt{7/120}/R=\sqrt{7/10N}$

$Stdev_R=\sqrt{1/60}/R=\sqrt{1/5N}$

Normalized Random Phase Qubits



for array of qubits N_q



$S = 2/R = \sqrt{2/N}$

$R = \sqrt{N}$

$X = \sqrt{N}/R = \sqrt{1}$

$Y = \sqrt{2N}/R = \sqrt{2}$

$Z = \sqrt{4N}/R = \sqrt{4}$

$D = \sqrt{5N}/R = \sqrt{5}$

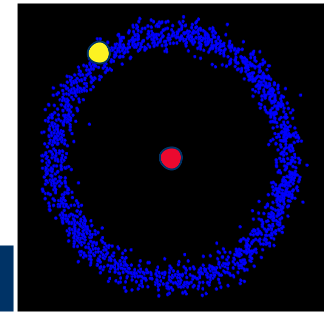
$K = \sqrt{8N}/R = \sqrt{8}$

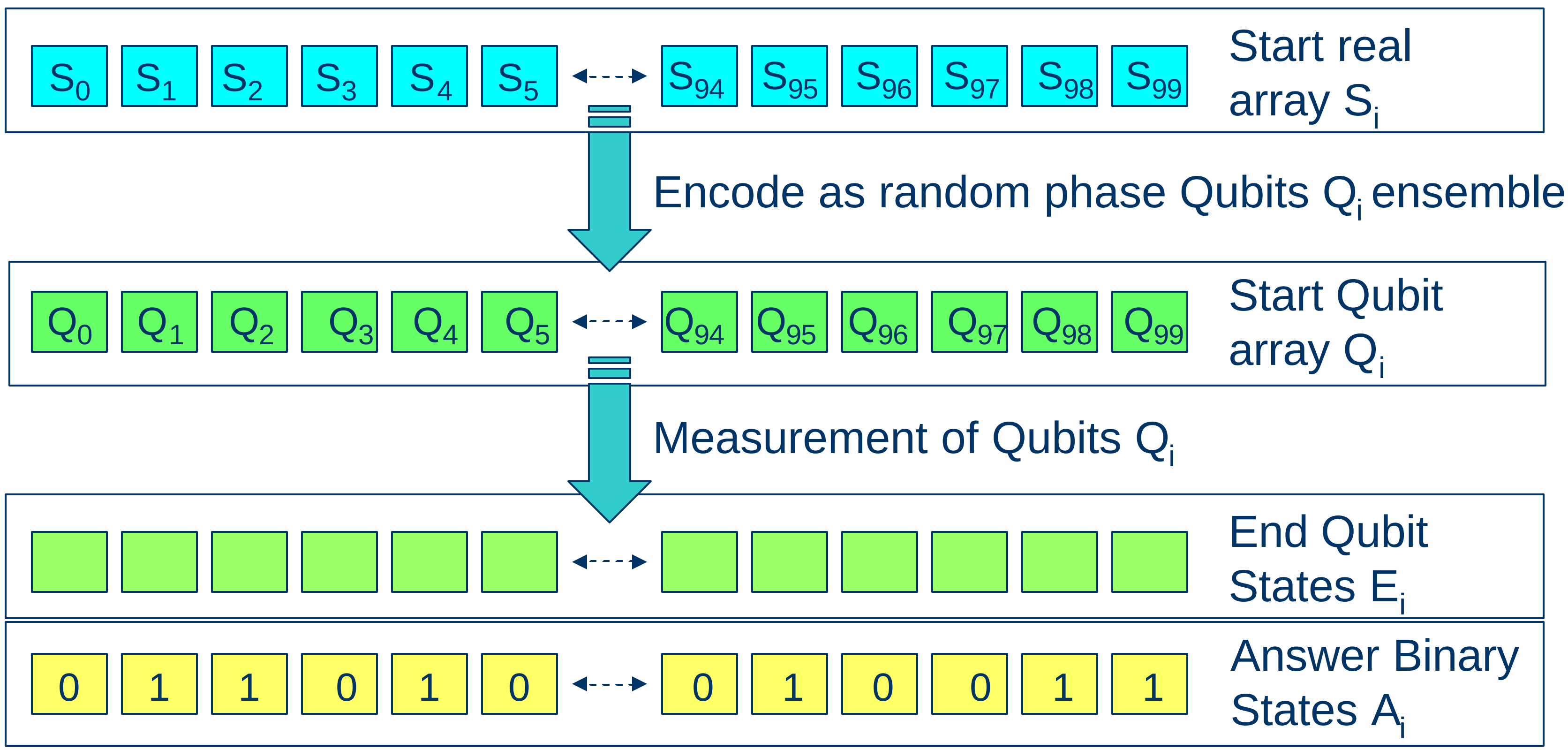
$M = \sqrt{16N}/R = \sqrt{16}$

$C = \sqrt{4N}/R = \sqrt{4} = 2$

$D^2 = \sqrt{4}^2 + \sqrt{1}^2 = \sqrt{5}^2$

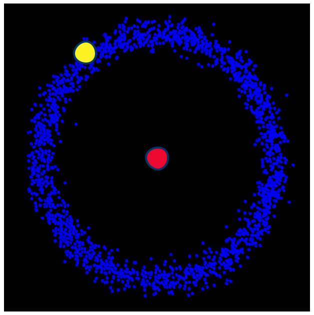
Quantum Corob Encoding

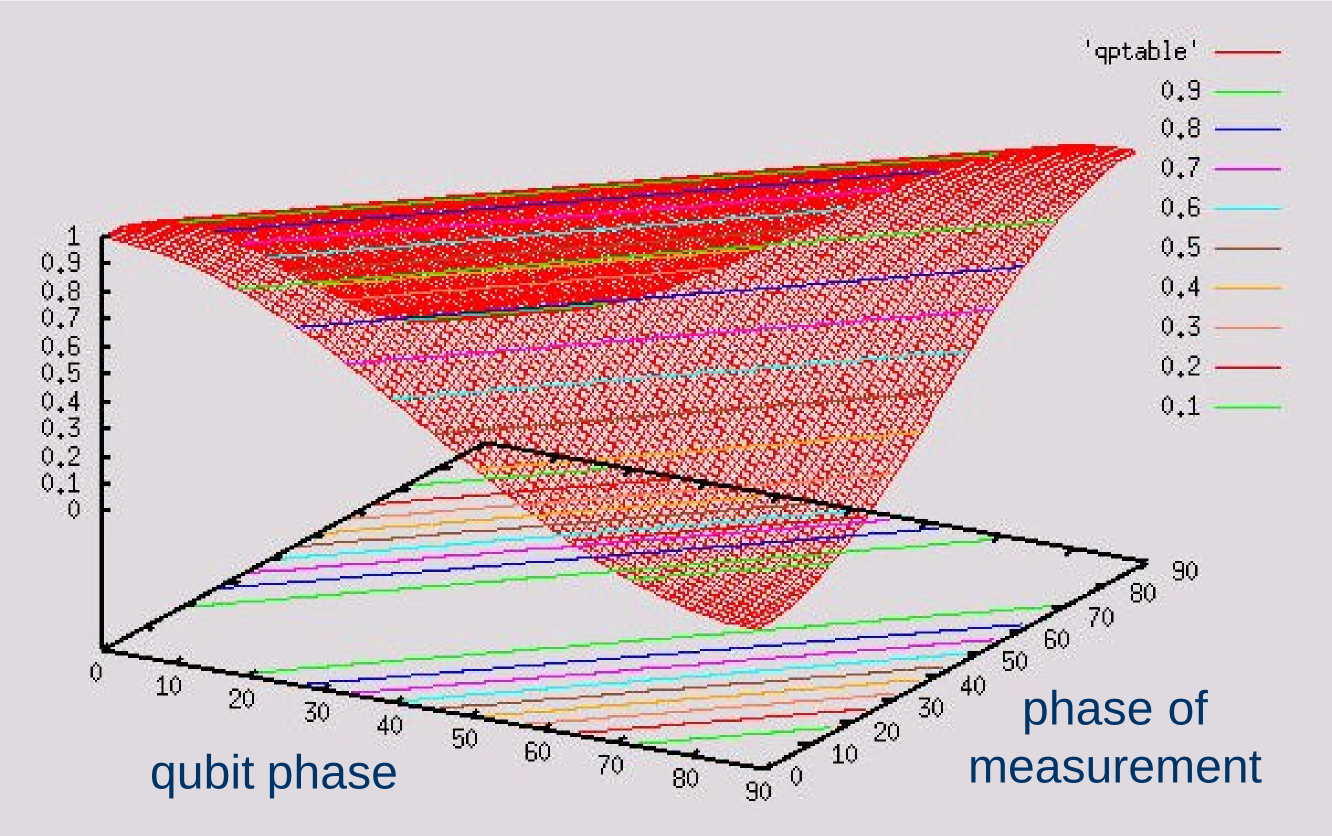




Quantum Corob Measurement Process!!

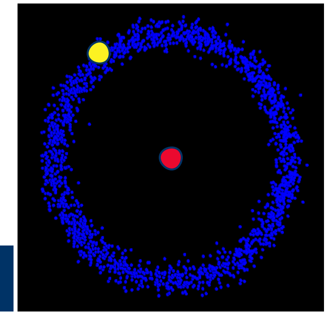
Qubit Projection

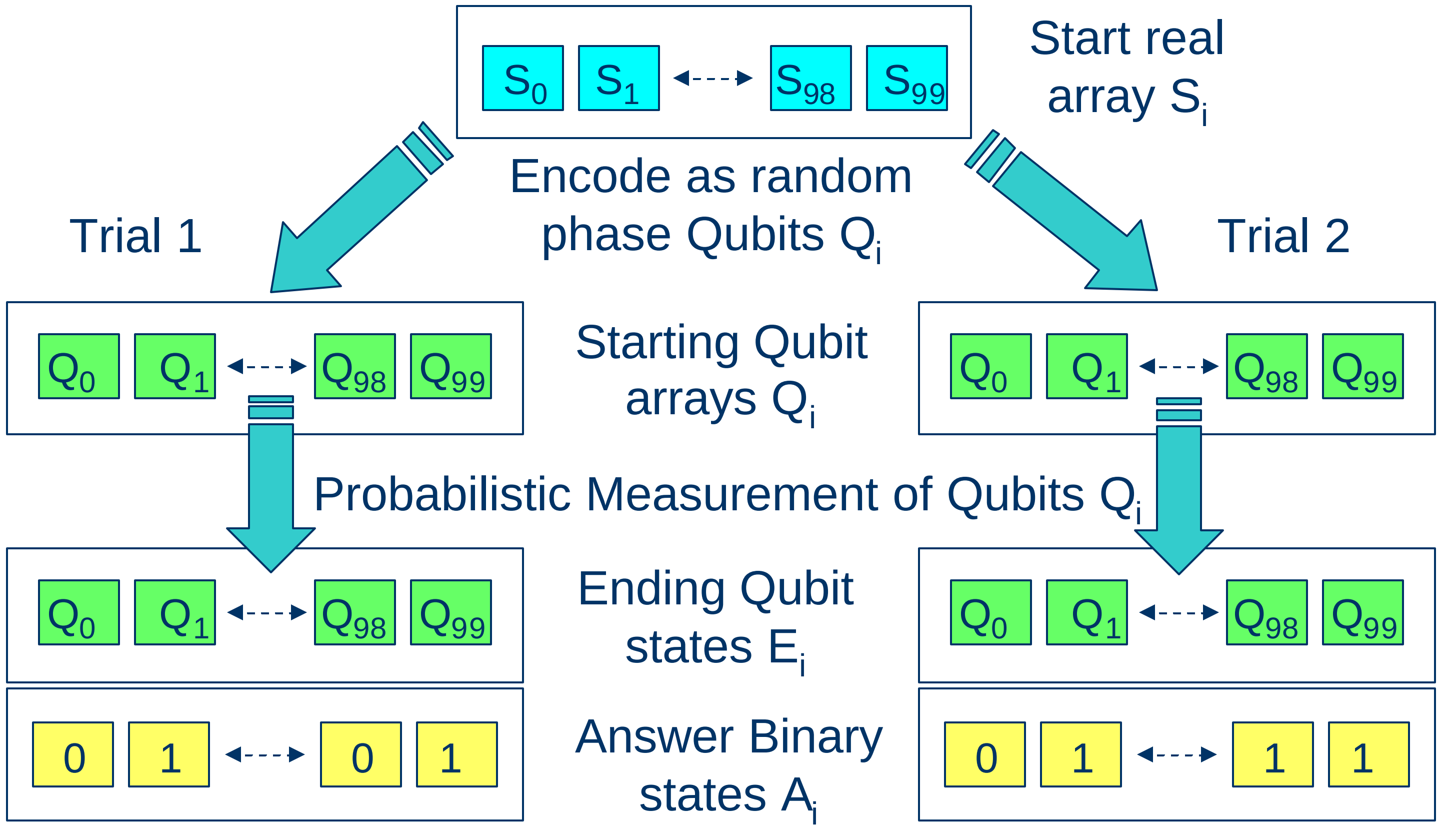




Probability plotted for qubit phase versus measurement phase

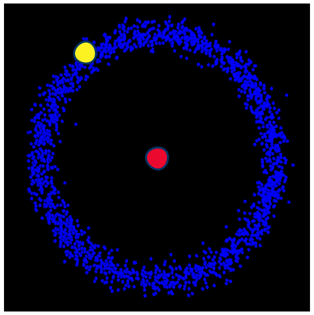
Corobs Survive Measurement

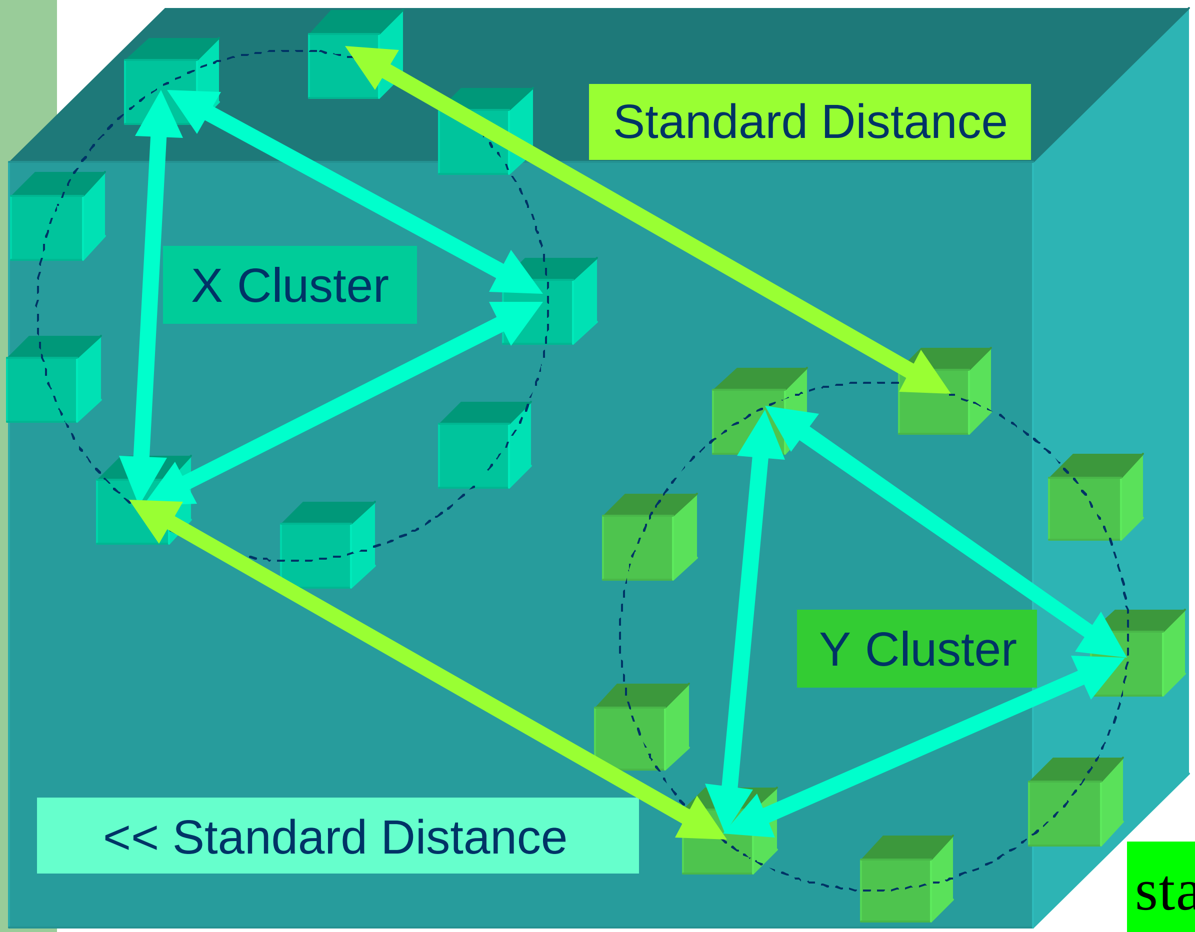




Answers are 75% same from multiple trials of same S_i!!

Quantum Corobs Survive Projection

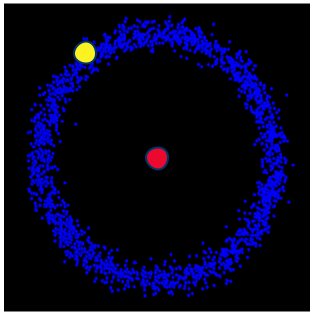


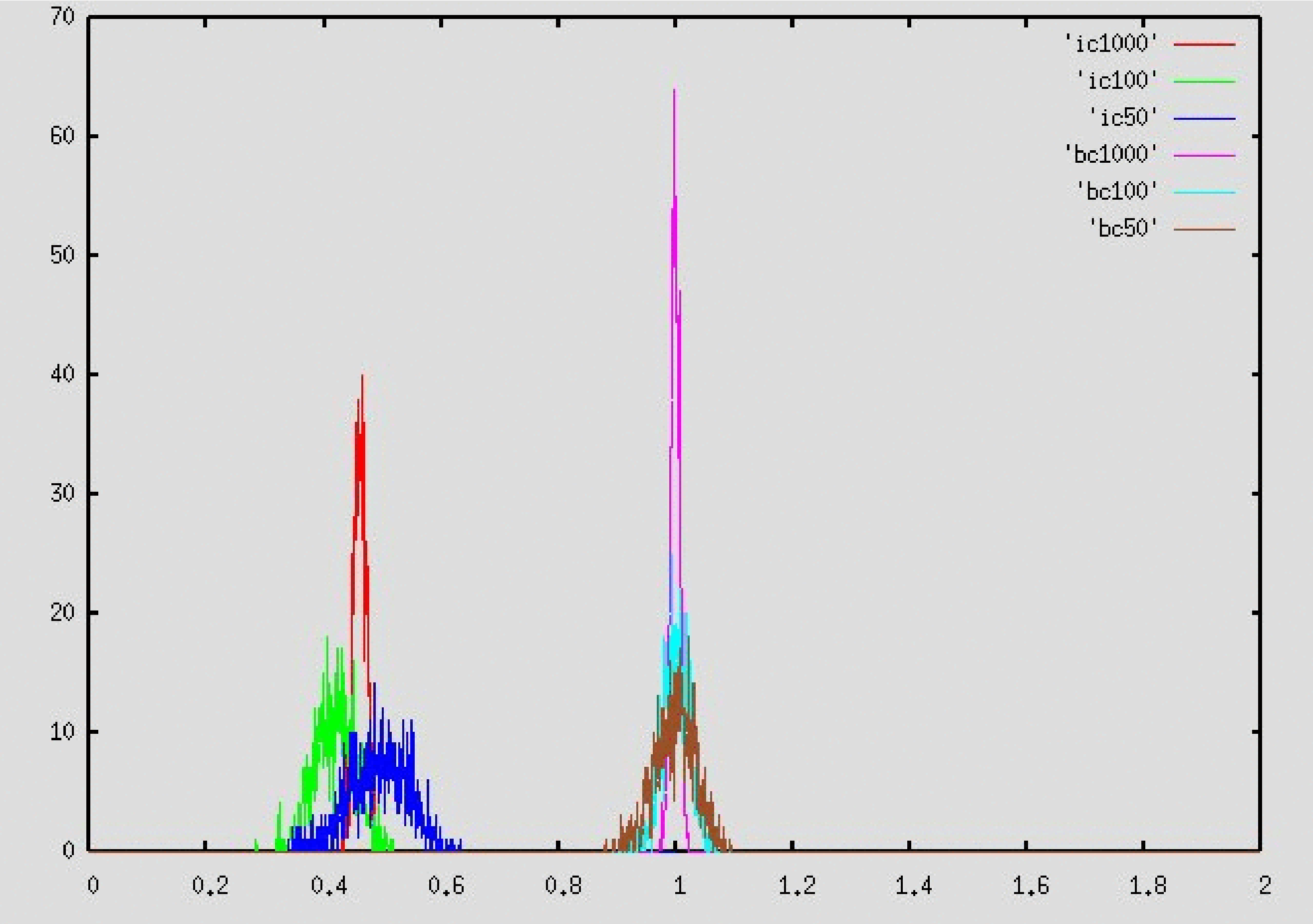


- Two random phase corobs X,Y
- Encode as arrays of qubit phases
- Measure qubits to form class. corob
- Repeat process or run concurrently
- All Xs will look like noisy versions of each other.
- All Ys will look like noisy versions of each other.

$$\text{standard distance} = \sqrt{N/8}$$

Token Distance Histograms

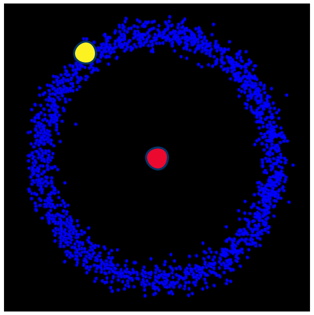




similar

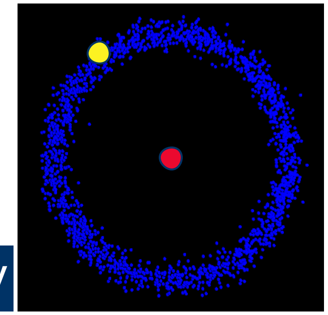
random

Math over Mind and Matter



- Corobs exist for *both* neural & quantum states
- Corob tokens merrily survive re-encoding
  - From neural to quantum state
  - From quantum to neural state (measurement)
- Same math works for both mind and matter
  - *Gray* Matter and
  - *Quantum* Mind
- Applicable to any Quantum Mind proposal!!
  - Thinking about high dimensional spaces is hard!

Think High Dimensional



Neural Topology | Quantum Topology