Thinking About, Modeling, and Mastering Computation

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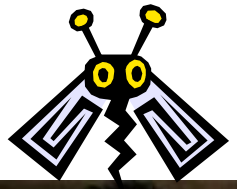
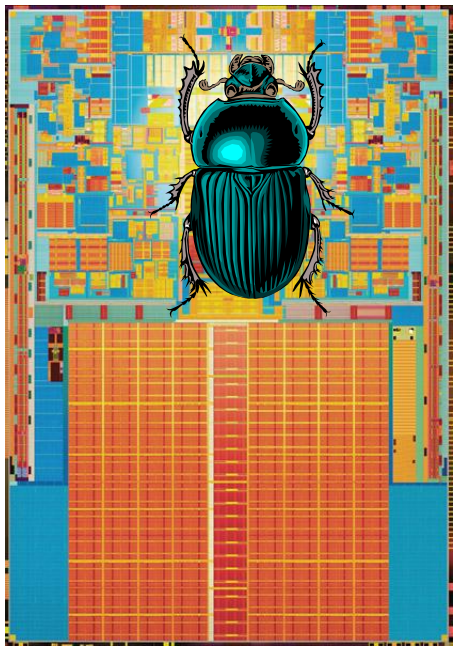


Computation models

Computing on computation



Intuitive

Rigorous

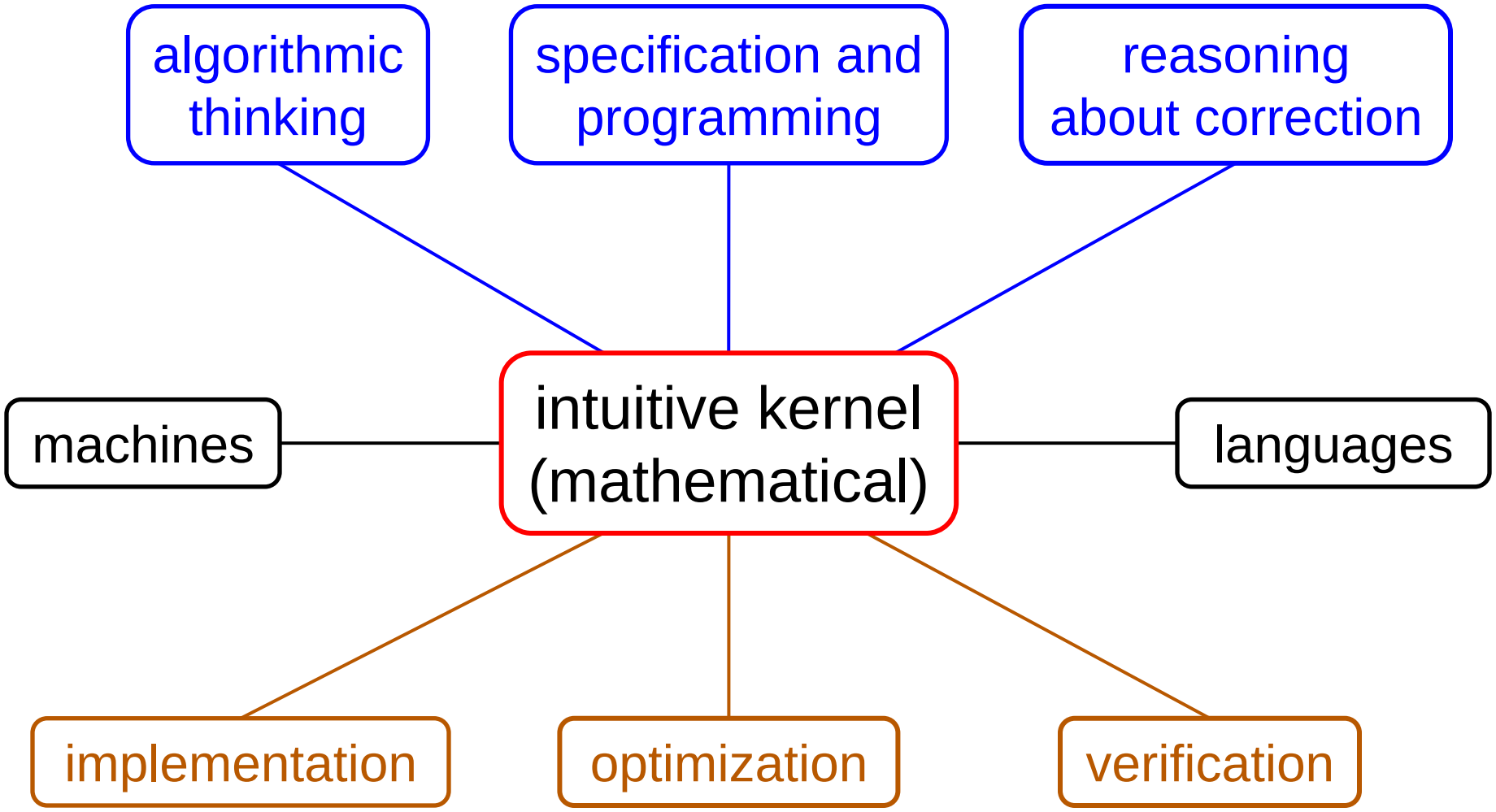
Slow

Superstupid

Superexact

Superfast

Anatomy of a Computation Model



The Eratosthenes Sieve

A number is prime iff it has no other divider than 1 and itself

2	3	~~4~~	5	~~6~~	7	~~8~~	9	~~10~~	11
~~12~~	13	~~14~~	15	~~16~~	17	~~18~~	19	~~20~~	21
~~22~~	23	~~24~~	25	~~26~~	27	~~28~~	29	~~30~~	31
~~32~~	33	~~34~~	35	~~36~~	37	~~38~~	39	~~40~~	41
~~42~~	43	~~44~~	45	~~46~~	47	~~48~~	49	~~50~~	51

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32	~~33~~	34	35	36	37	38	~~39~~	40	41
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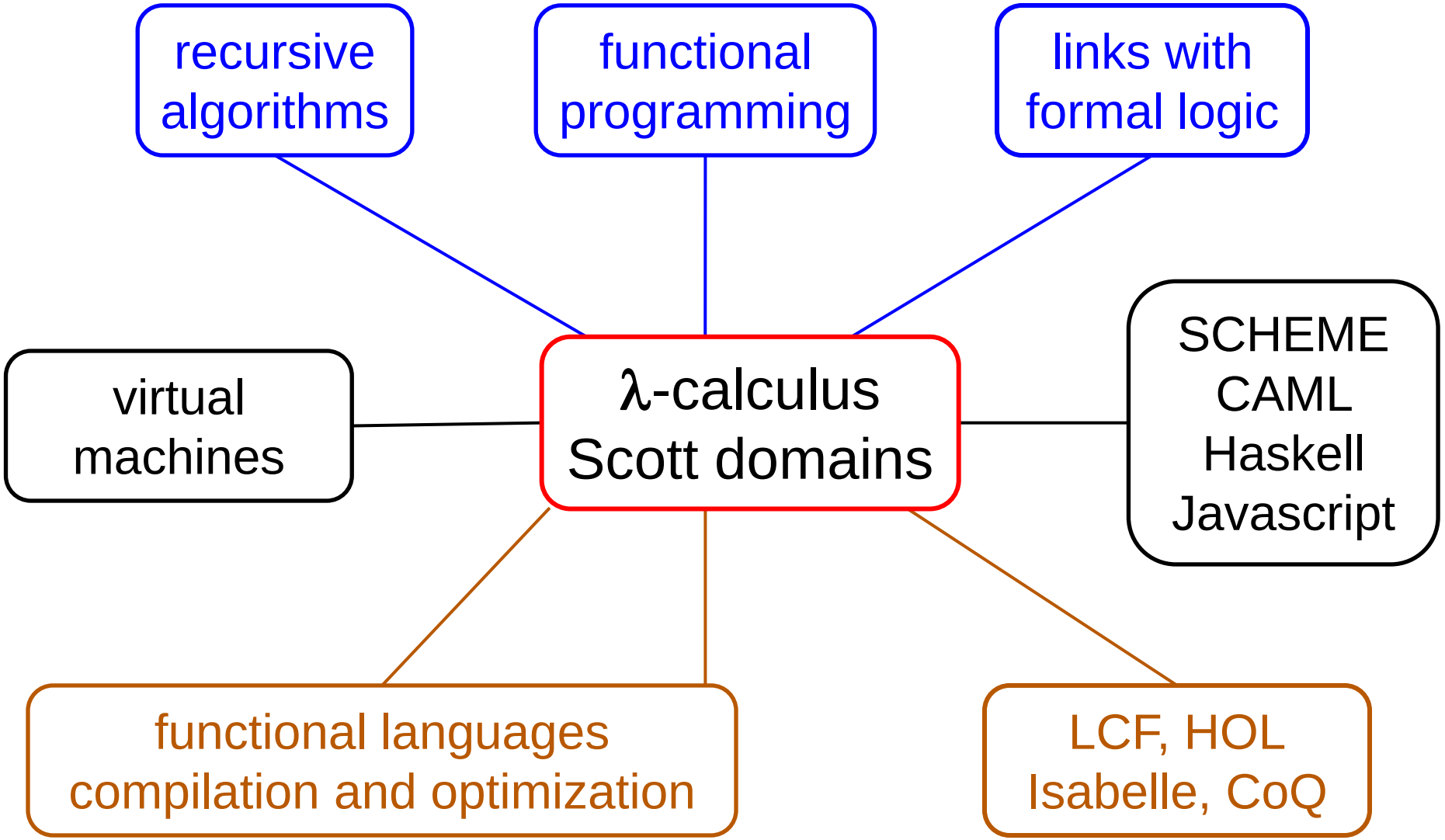
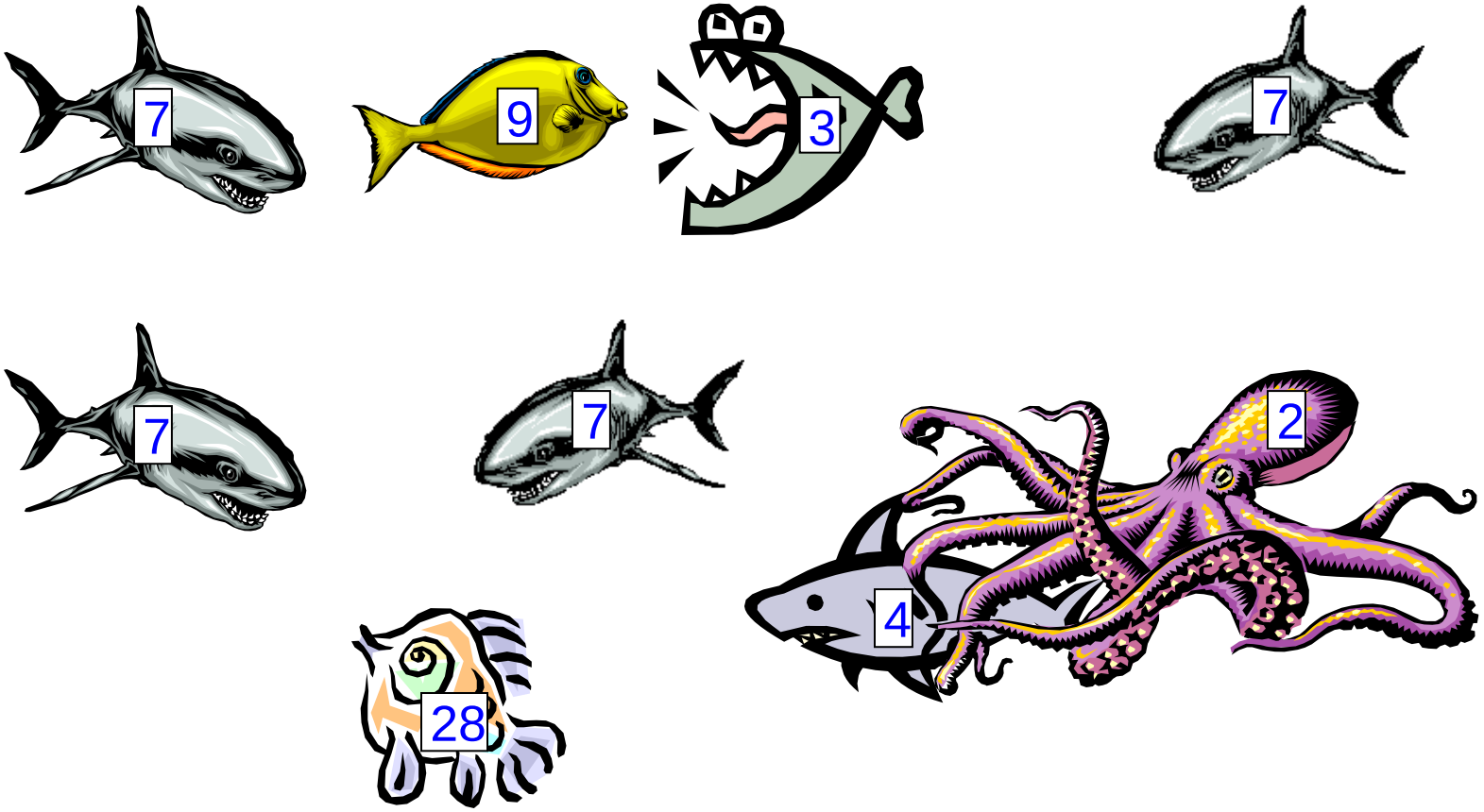
Brain attention is sequential !

The functional programming model



The Darwin Sieve: p, kp → p



Asynchronous parallelism
CHAM = Chemical Abstract Machine

Sieve comparizon

2	3	4	5	6	7	8	9	10	11
12	13	14	15	16	17	18	19	20	21
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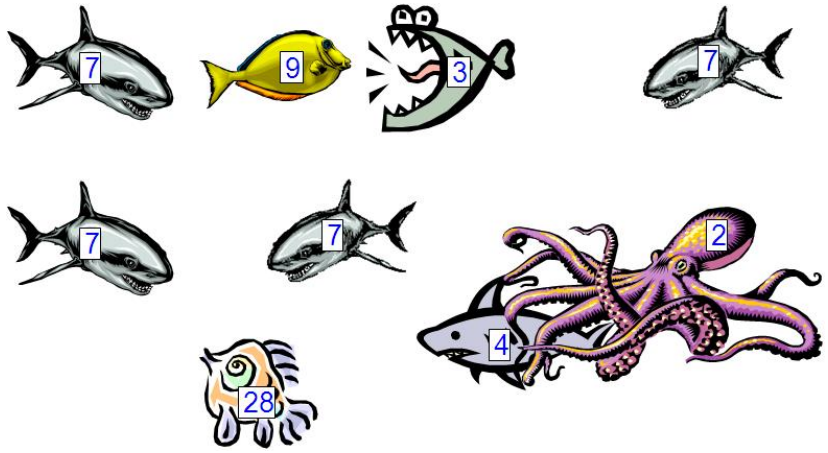


sequentiality
complex causality
deterministic behavior
deterministic result
trivial termination
limited to finite set

massive parallelism
minimal causality
non-deterministic behavior
deterministic result
probabilistic termination
goes infinite

Deadlock)

Starvation

Synchronous and vibratory parallelisms

Synchronous

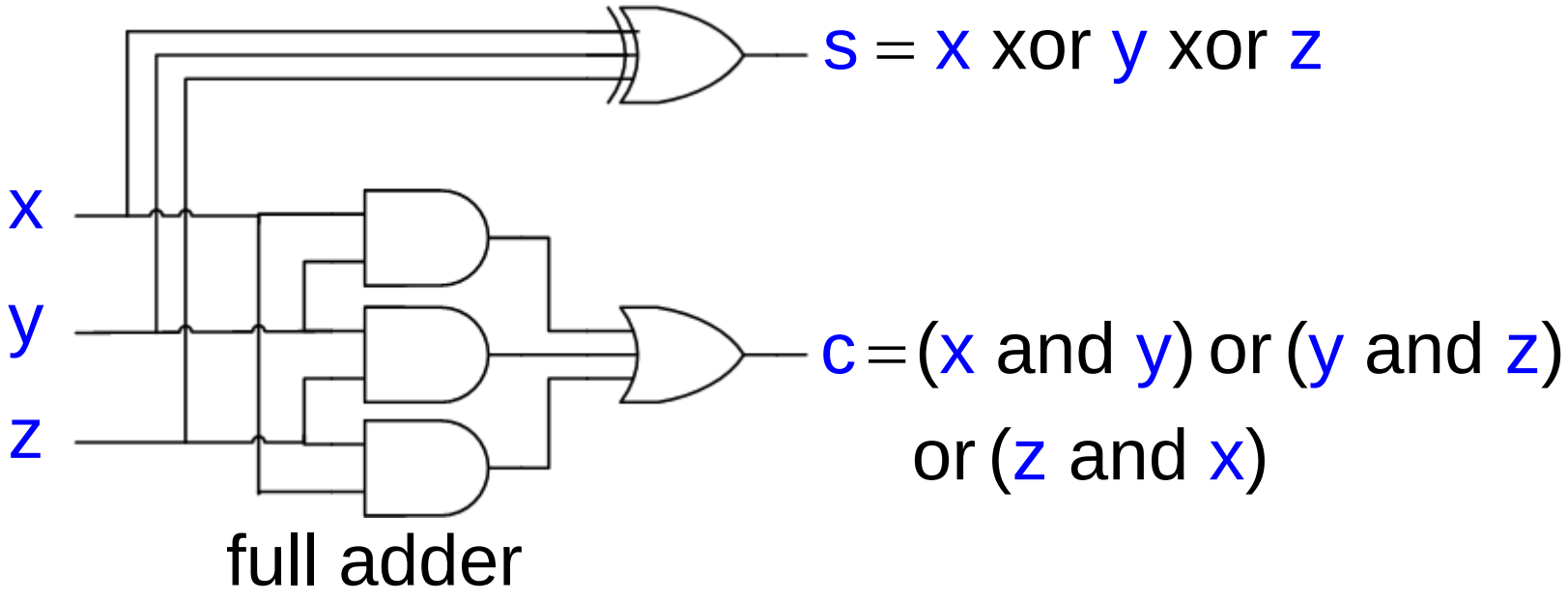
Conceptual zero-delay communication (spectators)

Vibratory

Predictable delay propagation (acousticians)

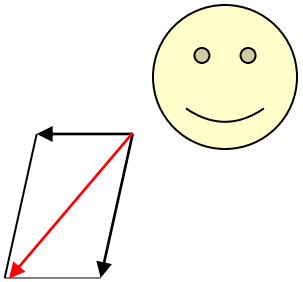
Implementation of Synchrony by Vibration

- Digital circuits



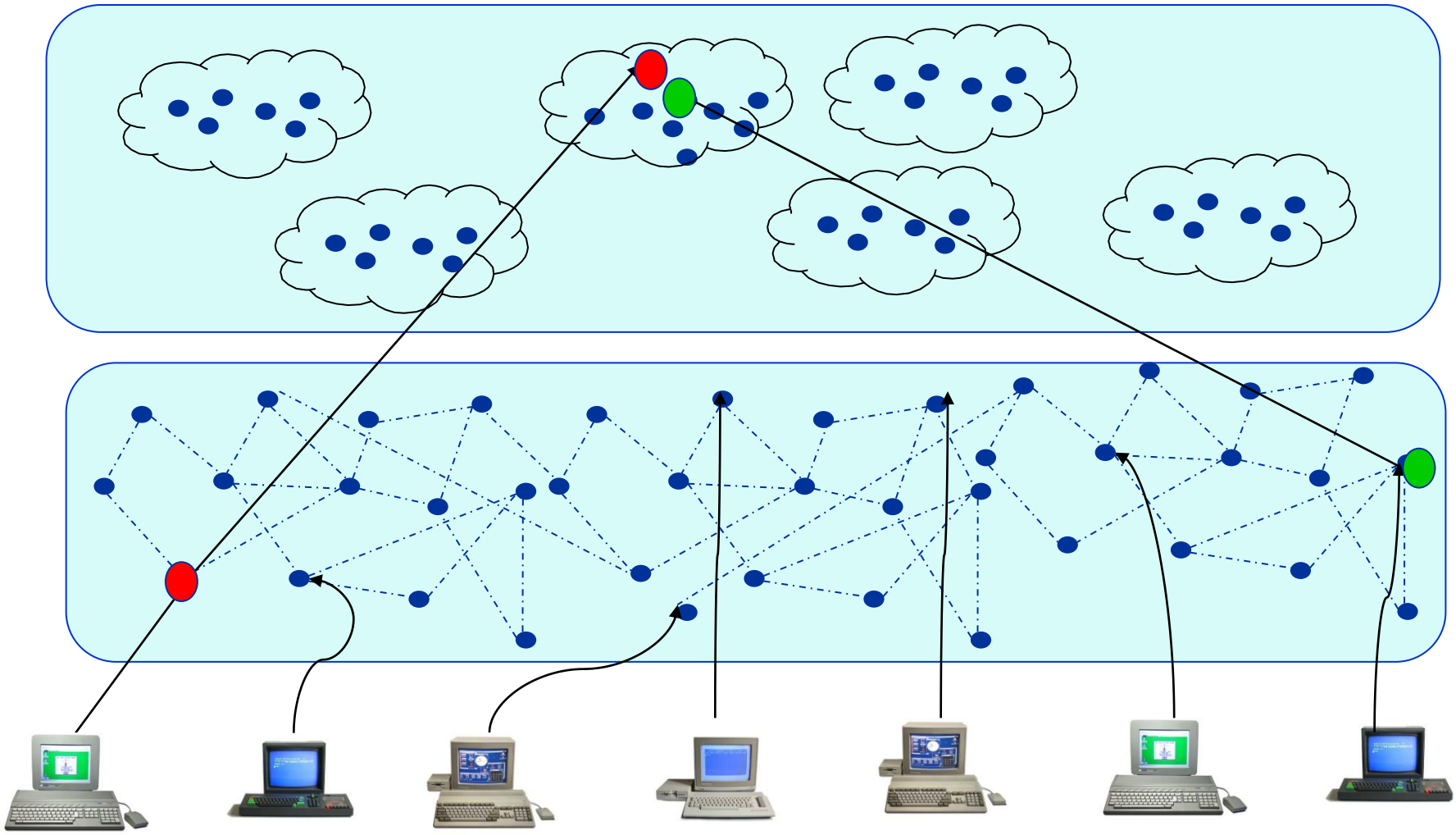
- Embedded control systems (airplanes, cars, etc.)

Zero delay: Newtonian Mechanics



Concurrency + Determinism
Calculations are feasible

Diffuse parallelisms : networks, overlays

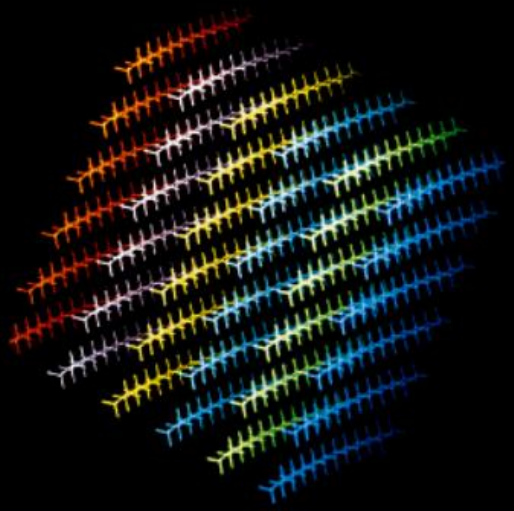


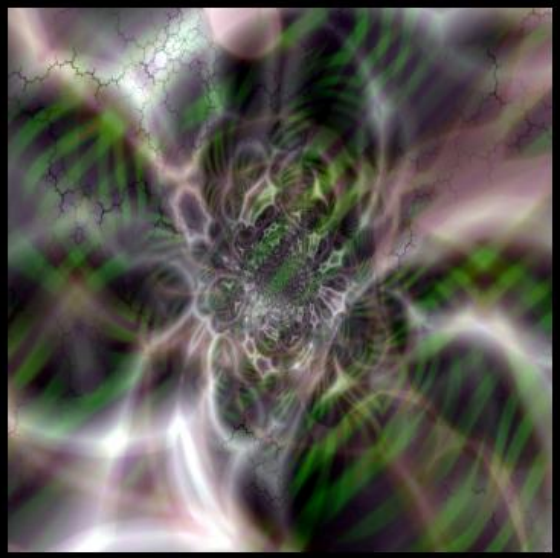
Computation in Visual Cortex

« crystal » « liquid » « smoke »

Visual input dimensionality

Low medium high

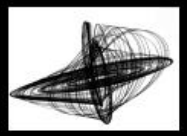




Rate coding
Low

(temporal precision)

Time coding
High



Conclusion

- Sequentiality is still very important
  - in our brain as well !
- There are several different kinds of parallelism
  - asynchronous, synchronous, vibratory, diffuse
  - each with a very wide range of applications
- Cooperation between different parallelisms is tricky
  - Globally Asynchronous Locally Synchronous Systems (GALS)
  - multiclock circuits
  - audio / video pipelines
  - large simulators
  - in our brain as well !