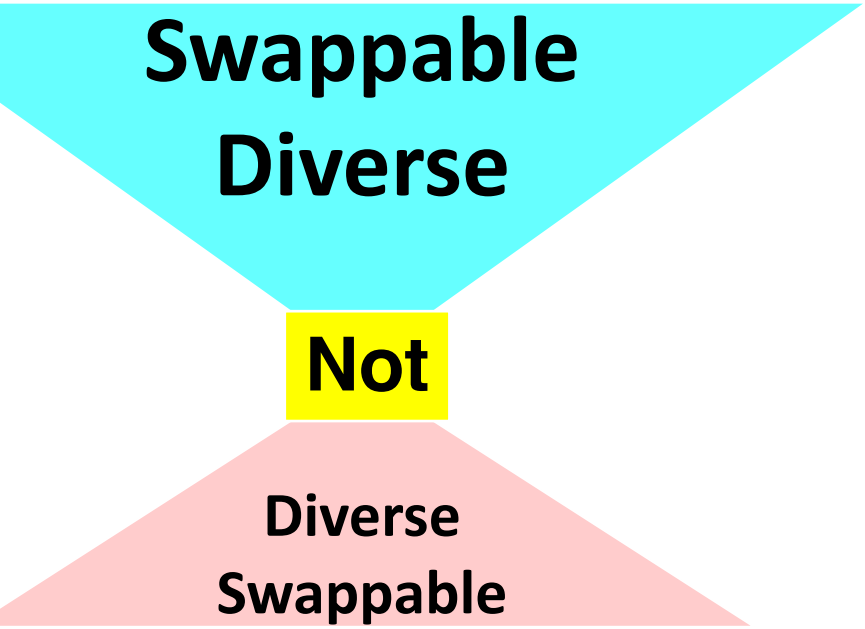
Diversity hourglass



Diversity hourglass

- Swappable
- Evolvable
- Virtual
- Fragility?

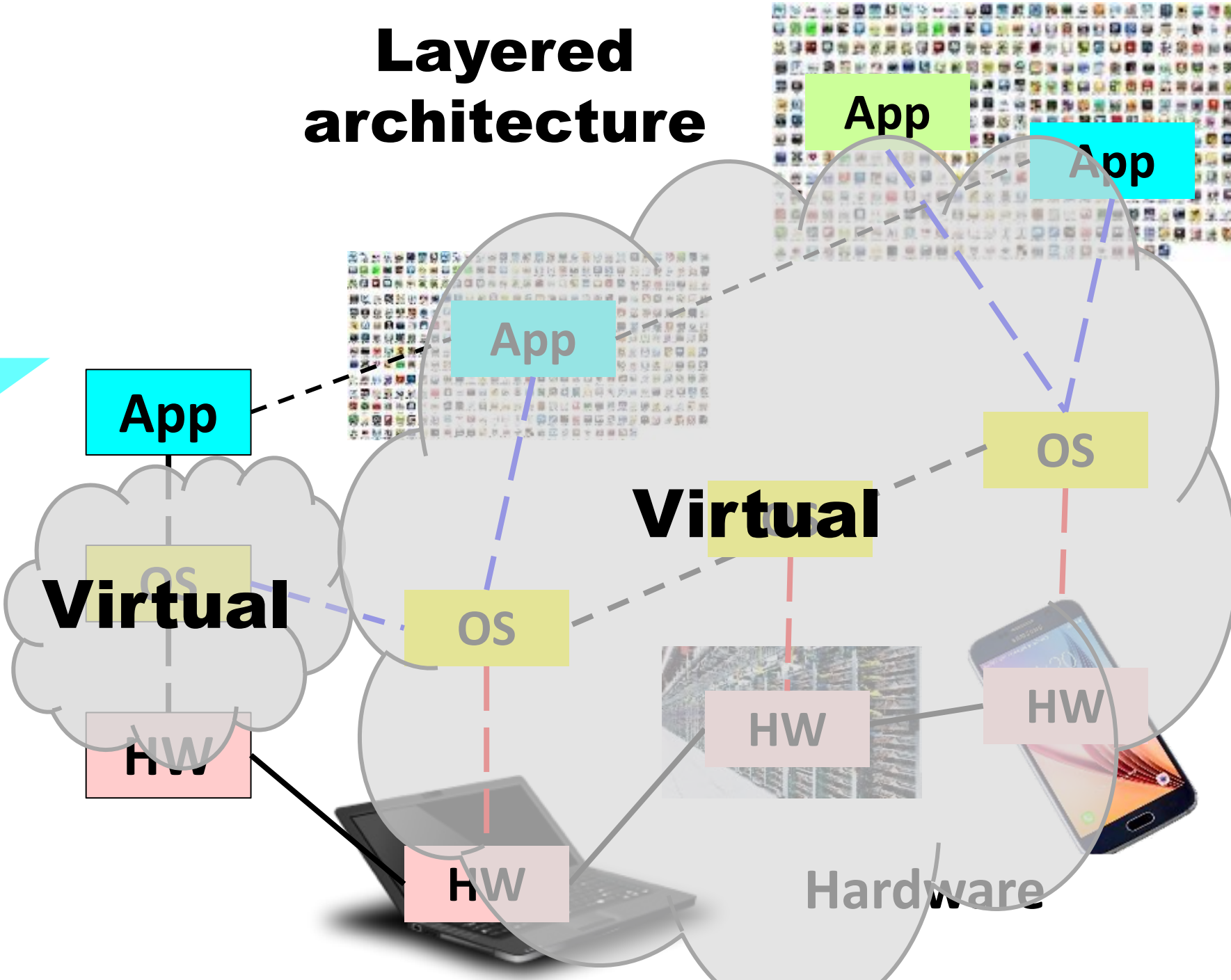
Layered architecture

Diversity hourglass

Swappable
Diverse

Not

Diverse
Swappable

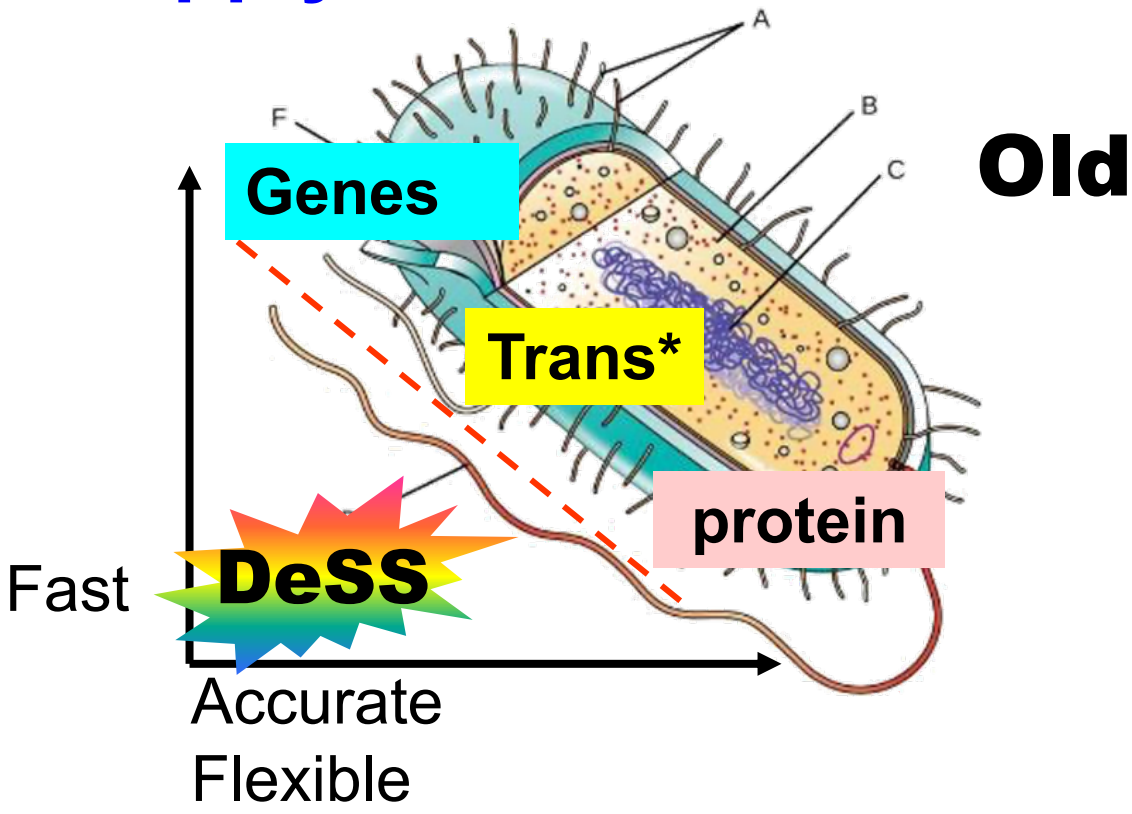


Layers
vs
Levels
Universal
Digital
Layers
Active
DSS
fast
efficient
flexible
robust
Most
accessible?
Clothing
Garment
Cloth
Thread
Fiber
Layers
Levels
Transport
Levels
Layers
Levels
Baking
Lego architecture
Laws?
large
thin
1 << # toys
Lego
Software
Hardware
Sense\Act
Legoware
Layers
Levels

Genes
Networked
Swappable
Diverse
Supply chains

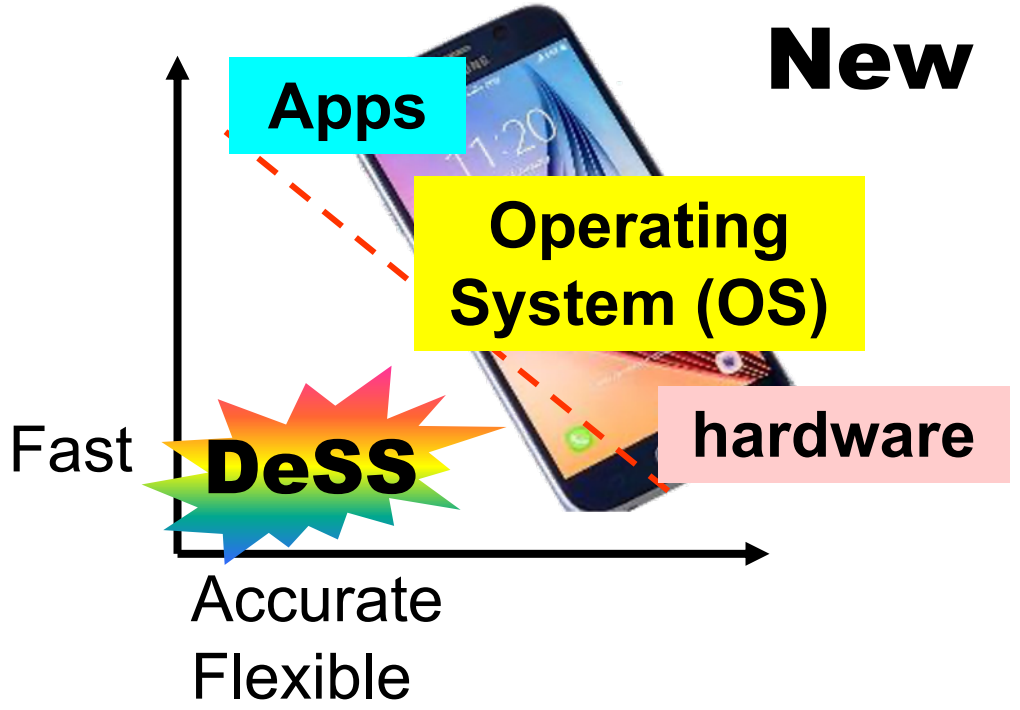
Diversity Enabled Sweet Spot

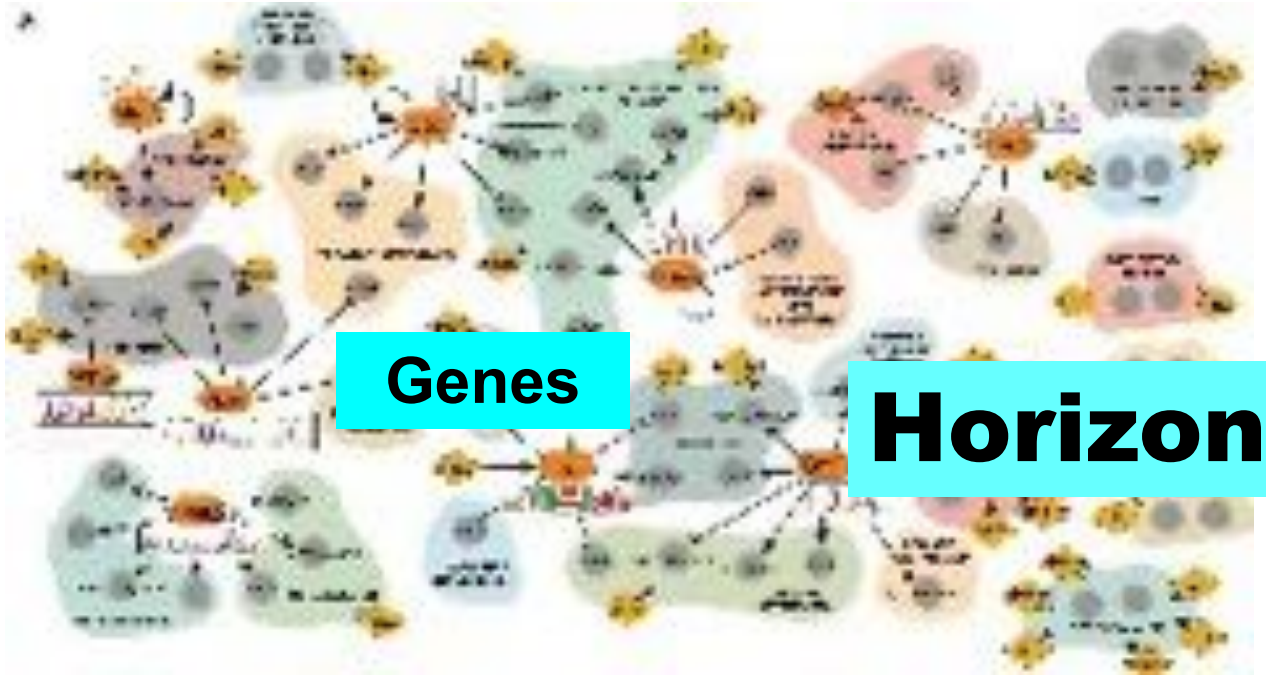
Apps
Networked
Swappable
Diverse



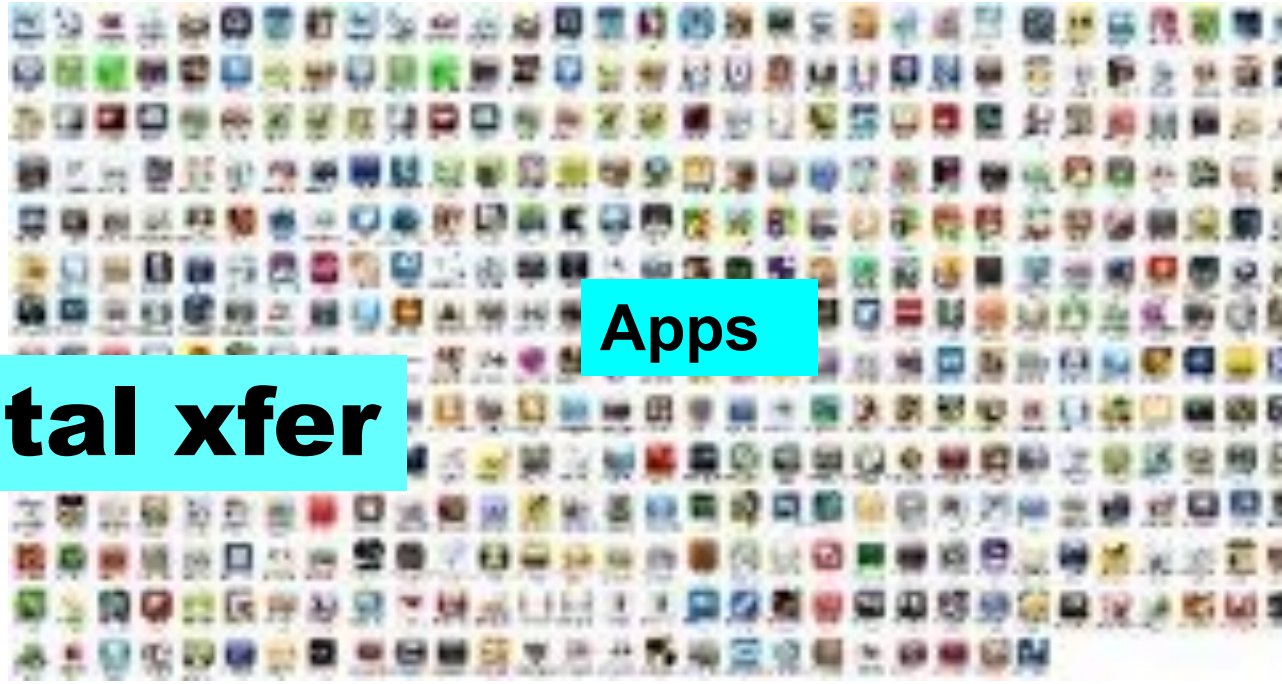
Old

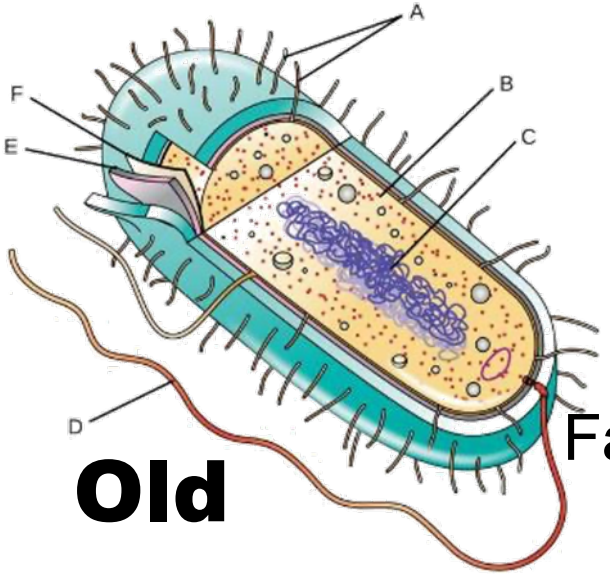
New



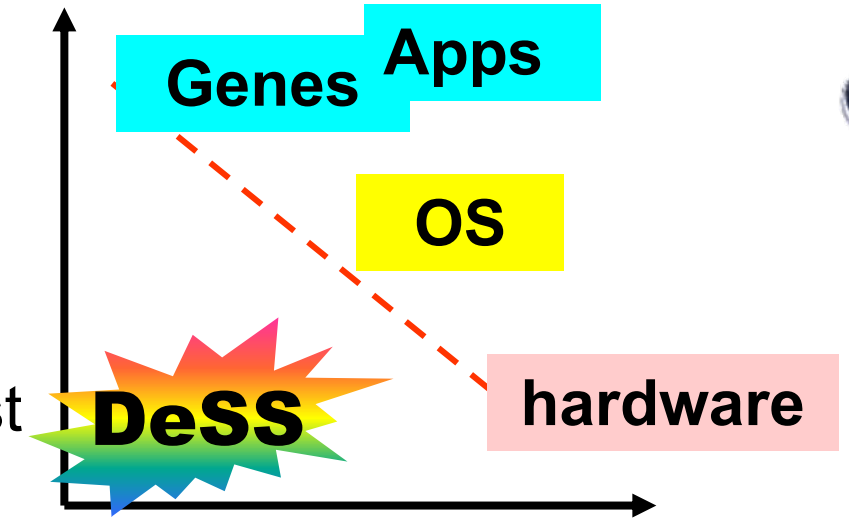


Horizontal xfer





Old



New

law

layer

level

architecture

DeSS

fragility

zombies

evolvability

Horizontal xfer

EBO

efficiency

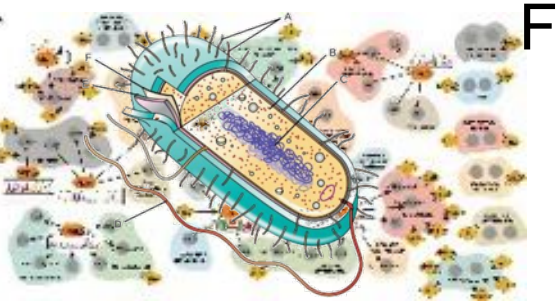
Memes

Genes

Apps

OS

hardware



Fast

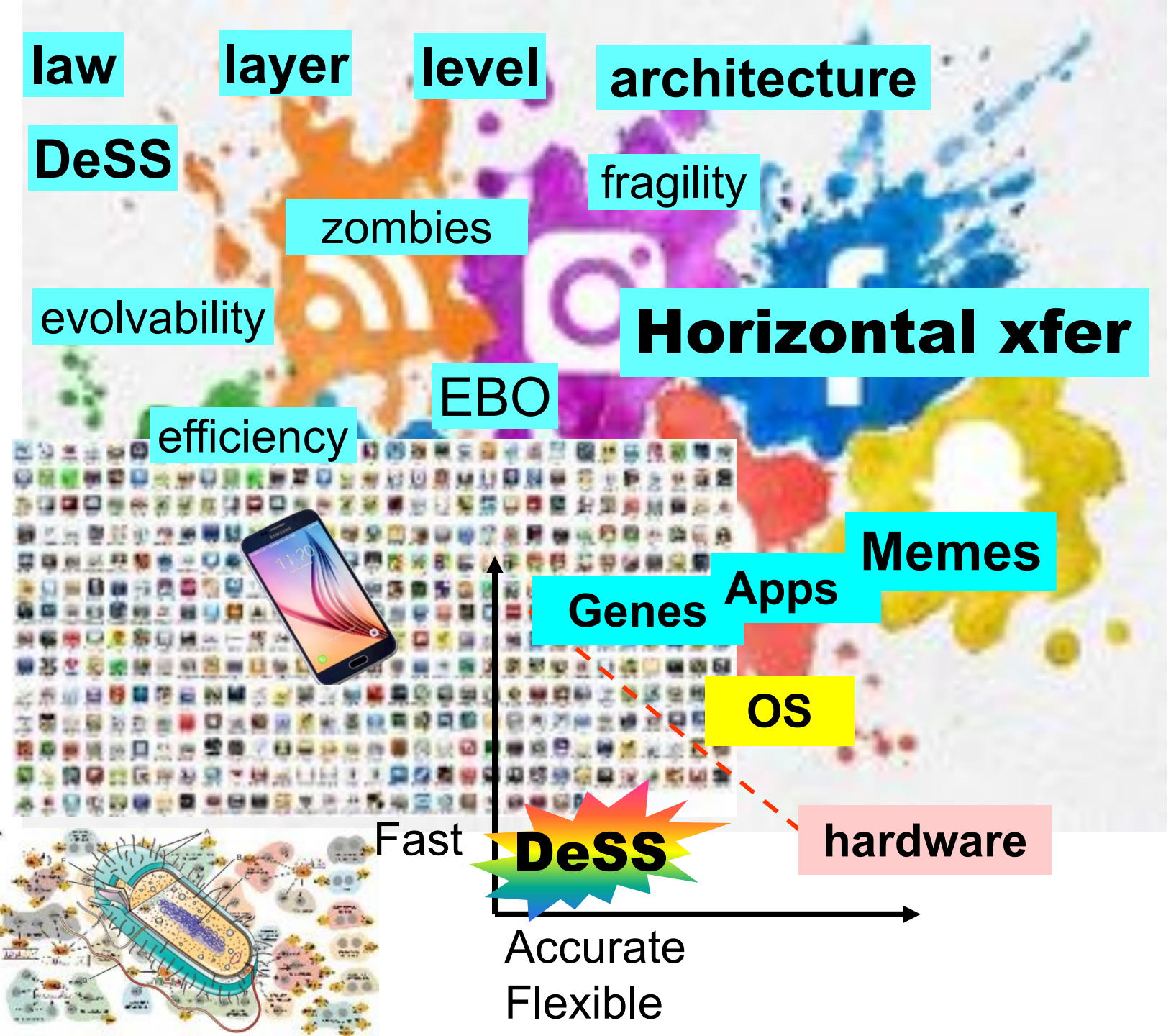
DeSS

Accurate

Flexible

Layered architecture

- Bacteria
- Computing
- **Language**



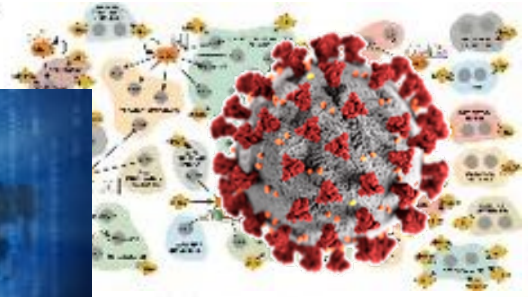
Shared OS enable:

- Evolvability, flexibility

- **Horizontal gene transfer**
- Sexual recombination
- Selective breeding
- Genetic engineering

- **Apps software**
- Internet, cloud, IOT

- **Language**
- Culture, commerce
- Education
- Technology, science
- Entertainment



Diverse Swap

Not

Diverse

Apps

Memes

Genes

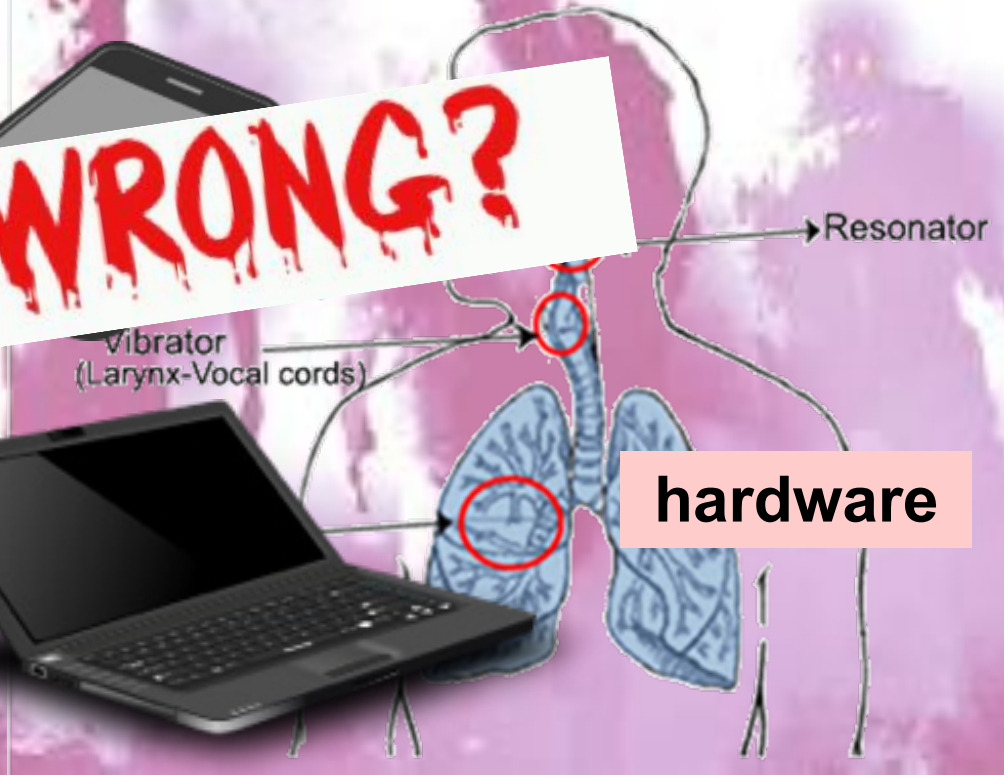
WHAT CAN GO WRONG?

hardware

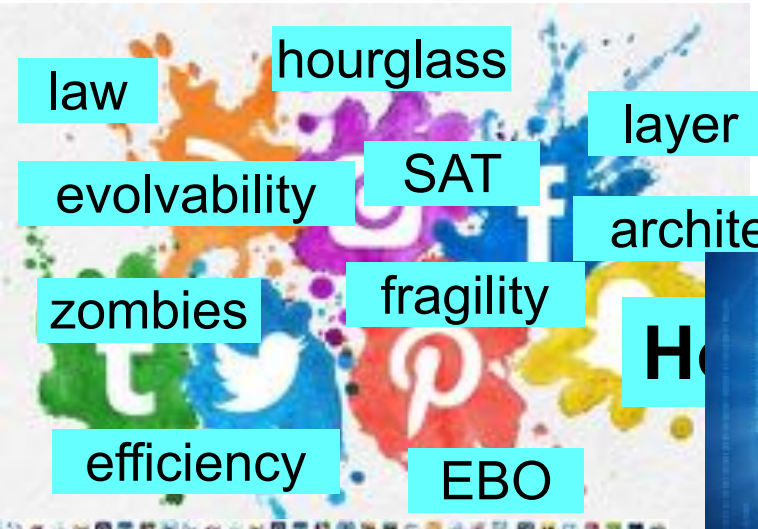
DeSS

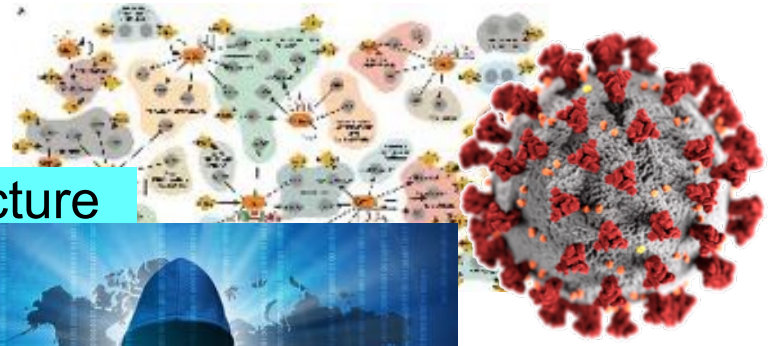
Accurate

Flexible



hardware





Diverse Swap

Virus

Not Diverse

Exploit "OS" universality

DeSS

Apps

Memes

Genes

Virus

OS

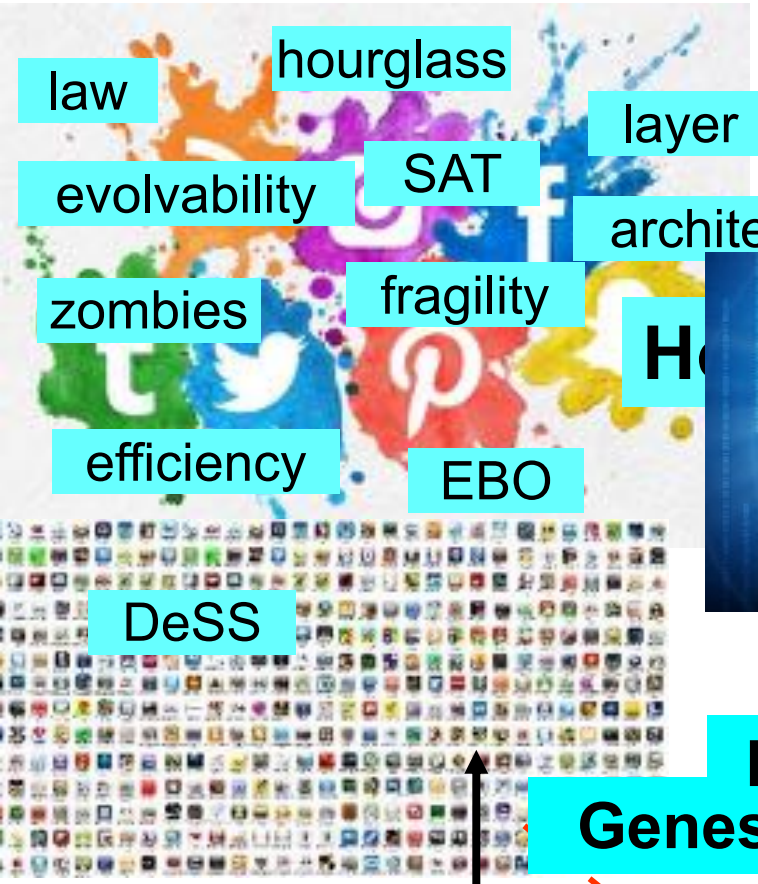
hardware

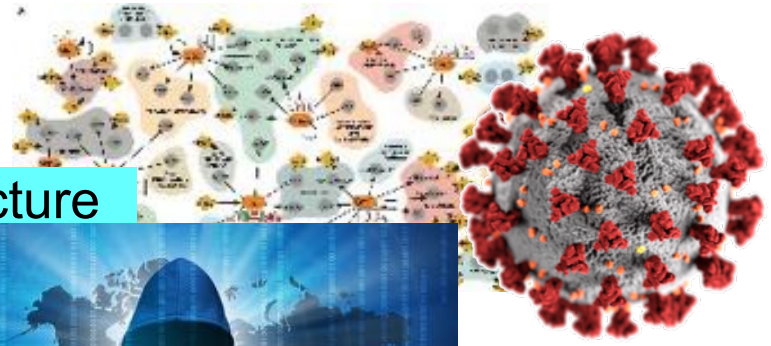
Fast

DeSS

Accurate

Flexible





Diverse Swap

Virus

Not

Diverse

Exploit "OS" universality

Virus

Apps

Memes

Genes

OS

hardware

DeSS

Fast

Accurate

Flexible

- **Bad genes, memes, malware**
- Evolution, not intelligent design
- Our most important architectures have other extreme fragilities
- We need a deep theory of architecture

Inequalities

Race, Sex
Wealth, Health
Education
Law, Taxes
Politics
Environment
....

SHARE HOLDER

$

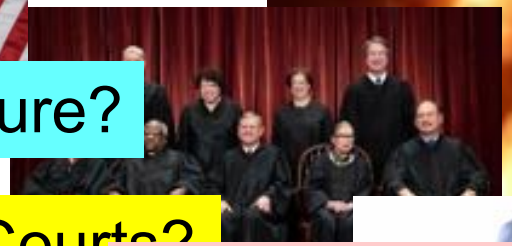
Corporation

Supplier

Customer

Employee

Legislature?



Courts?

Police
"Corrections"

Fast

Accurate
Flexible

Bad examples?

***Values* need a layered architecture to implement**

Systems using layer/parallel architectures need *values* to be scalable and robust

New theory of social architecture with great animal models (elephants, bonobos, orcas)

Architectures: Good, Bad, Ugly, Hijacked,...

Generative
Modular
Compos

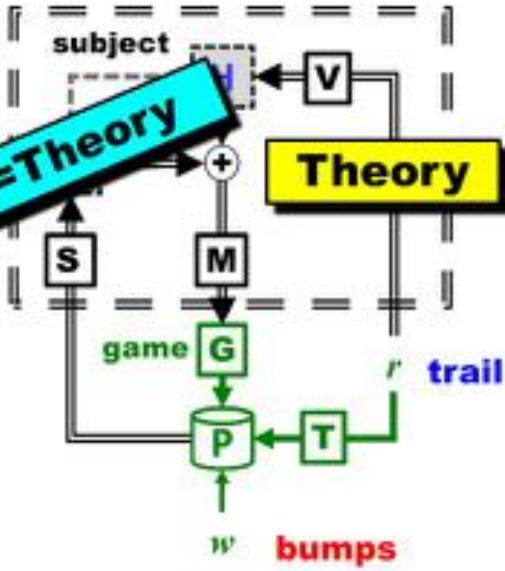
Digital transformation

Apps
Memes
Genes
OS

Fast DeSS Accurate

Shared OS enable:
- Evolvability
- Horizontal gene tra
- Sexual recombinat

Data=Theory

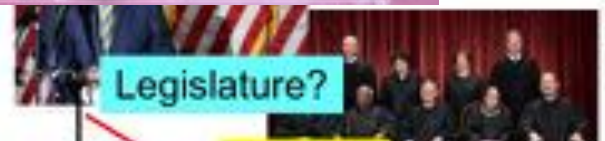


Slow Trail
Layers
Bumps
Inaccurate
Rigid
Localized, distributed
Unconscious
Automatic
Unstable real dynamics

ency
zed

Architecture of fragility

Systemic racism

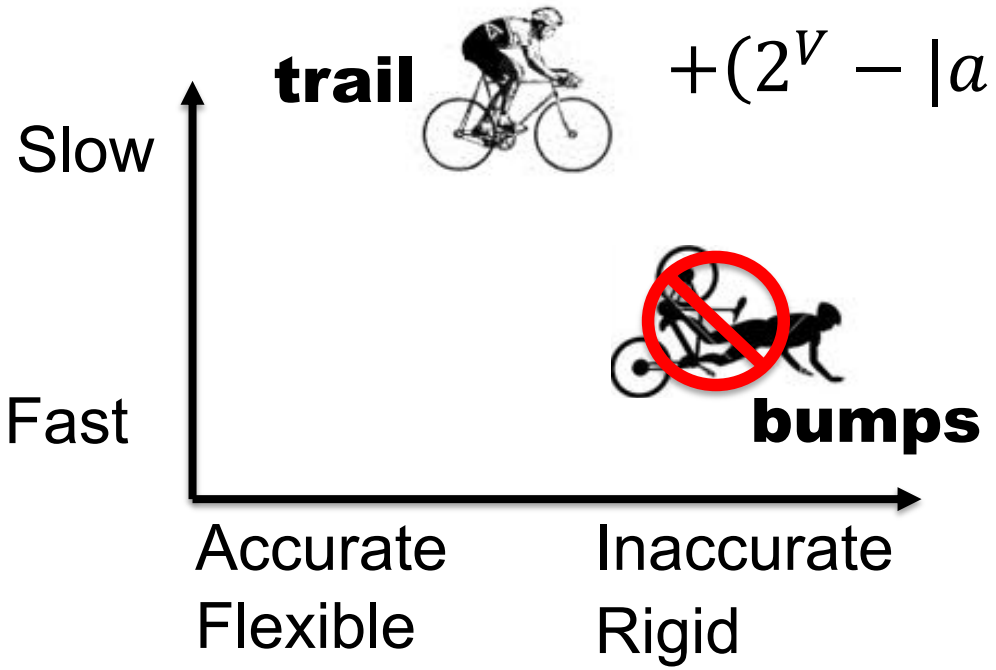


Courts?
Police "Corrections"
Fast DeSS Accurate Flexible

Diversity-enabled sweet spots in layered architectures and speed-accuracy trade-offs in sensorimotor control

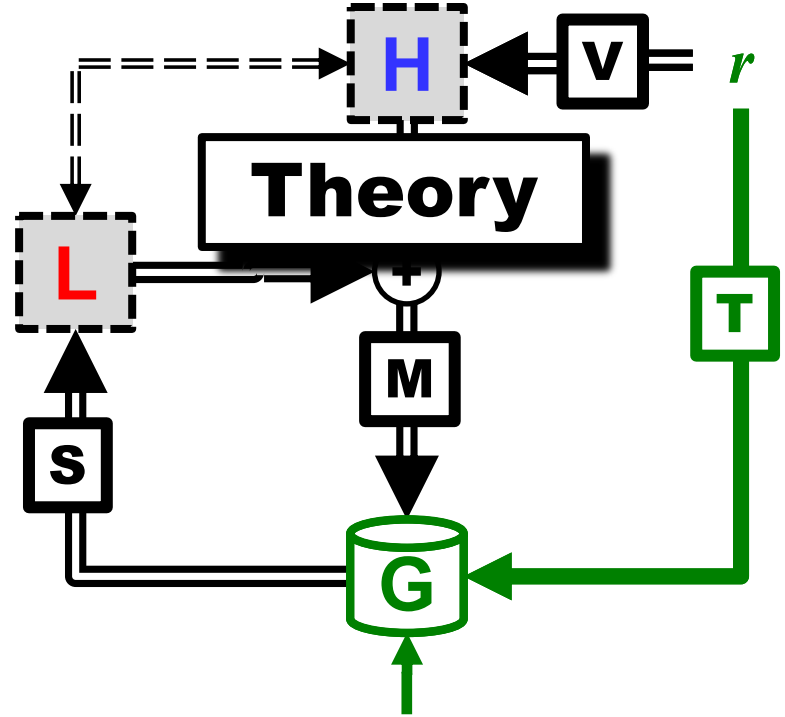
Yorie Nakahira, Quanying Liu, Terrence J. Sejnowski, and John C. Doyle

PNAS 2021



Layers

$$\delta\left(\begin{array}{c}\sum_{i=1}^{T}|a^{i-1}|+\\ |a^T|\left(2^{\lambda T}-|a|\right)^{-1}\end{array}\right)$$



Universal Architecture

$(2^V - |a|)^{-1}$

Slow

System

Layers

s

$+\delta\left(\sum_{i=1}^{T}|a^{i-1}| + |a^T|(2^{\lambda T} - |a|)^{-1}\right)$

Sweet Spot

Accurate

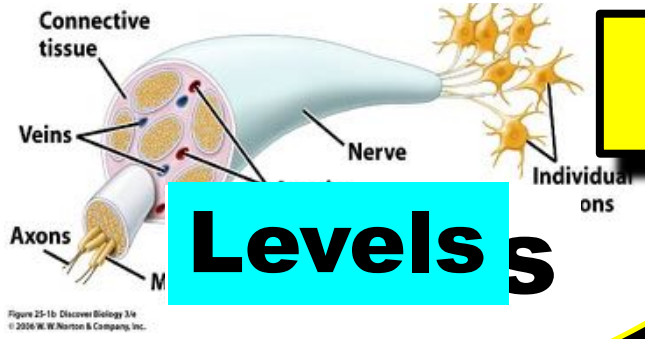
Flexible

Rigid

Laws

s

Nerves



Levels

s

Slow

Optic

Architect

$R = \lambda_\alpha T$

Vestibular

Fast

Diversity

Accurate

Inaccurate

L

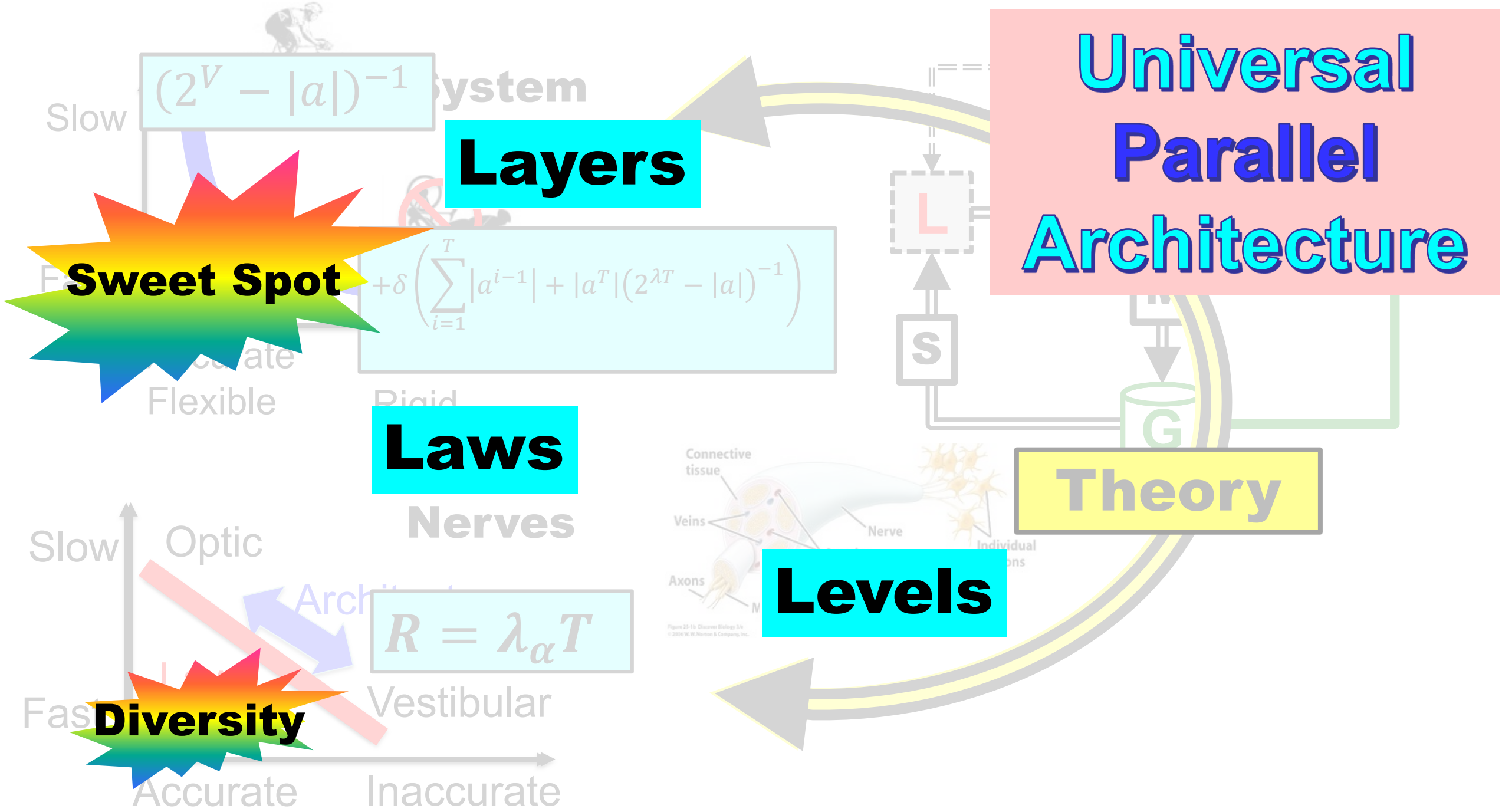
S

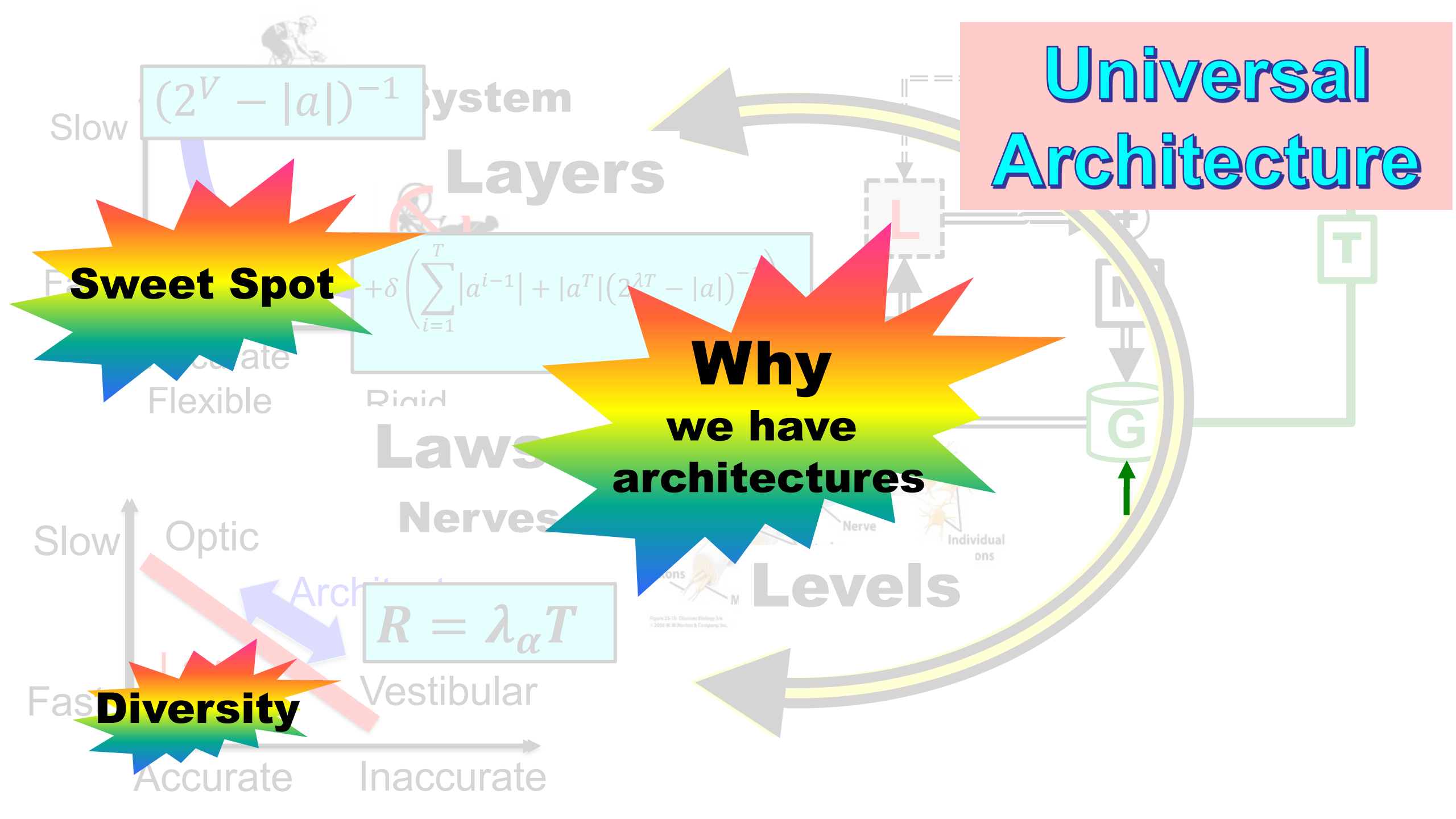
N

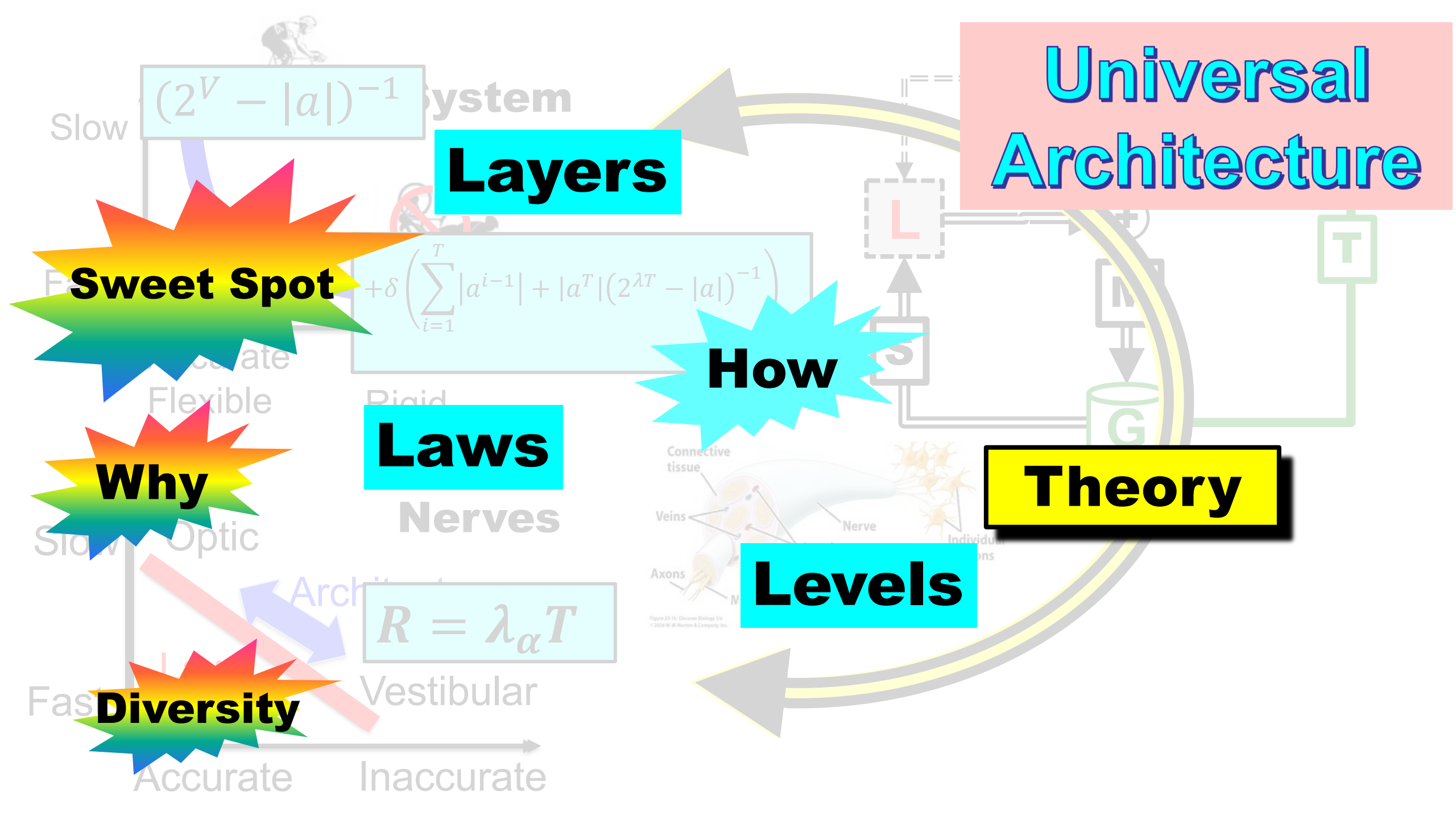
G

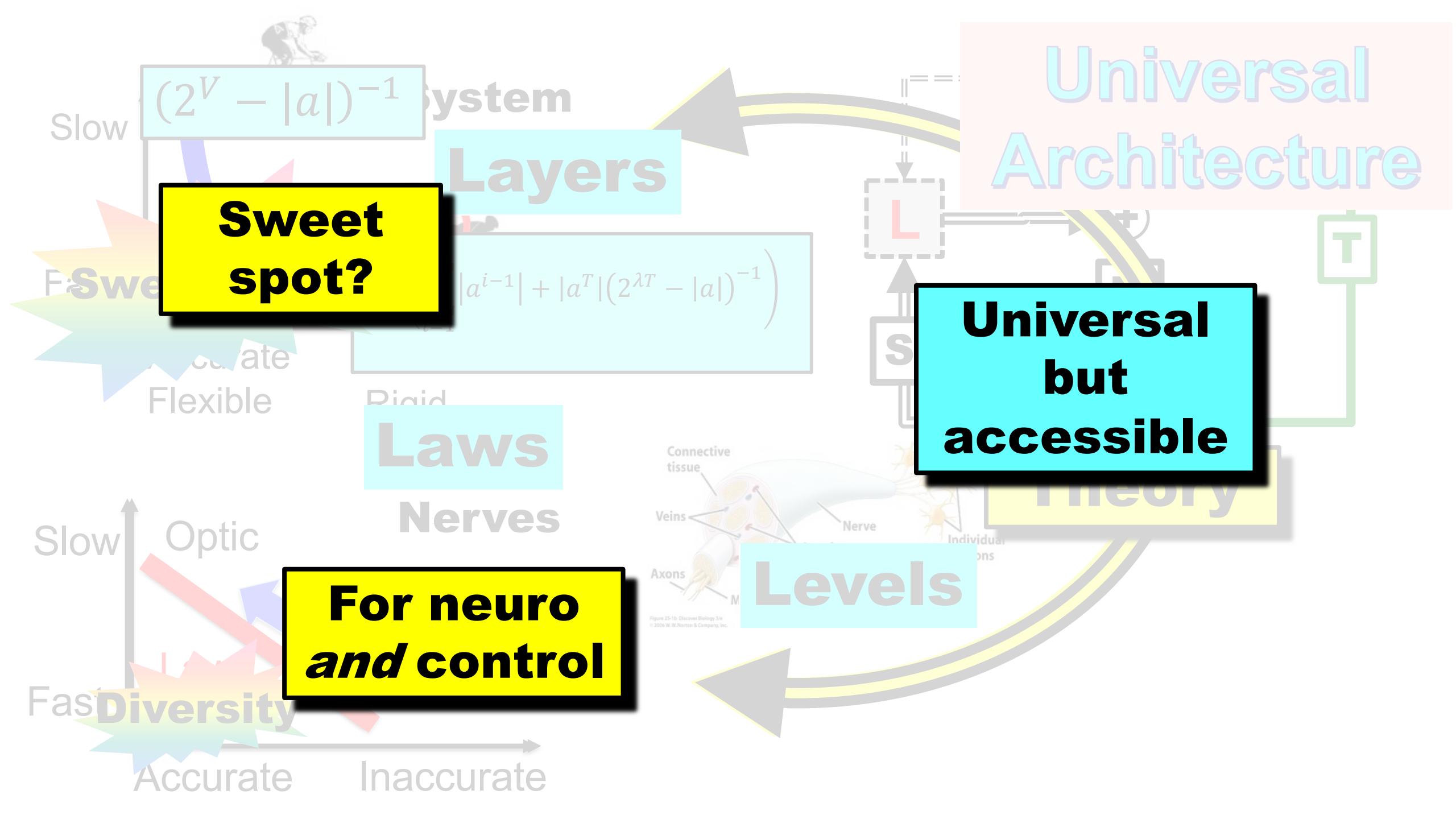
T

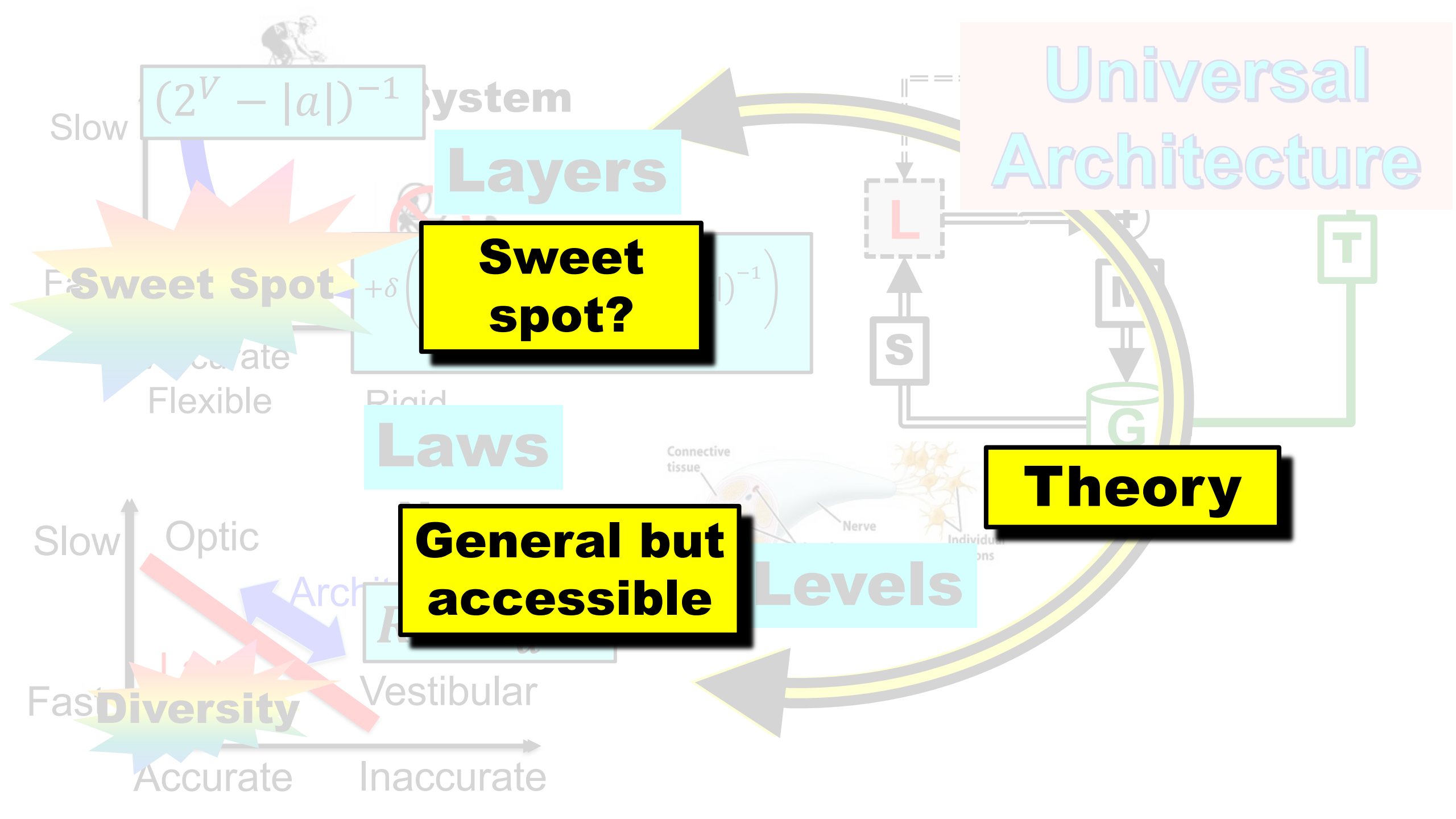
Theory


Universal Parallel Architecture
Layers
Sweet Spot
Laws
Theory
Levels
Diversity
$(2^V - |a|)^{-1}$
$+\delta\left(\sum_{i=1}^{T}|a^{i-1}| + |a^T|(2^{\lambda T} - |a|)^{-1}\right)$
$R = \lambda_\alpha T$
Slow
Flexible
Nerves
Optic
Vestibular
Accurate
Inaccurate
Connective tissue
Veins
Nerve
Axons
Individual
L
S
G


Universal Architecture
Sweet Spot
Why
we have
architectures
Diversity
$(2^V - |a|)^{-1}$
$+\delta\left(\sum_{i=1}^{T}|a^{i-1}| + |a^T|(2^{\lambda T} - |a|)^{-1}\right)$
$R = \lambda_\alpha T$
Slow
Fast
Flexible
Rigid
Accurate
Inaccurate
Optic
Vestibular
Layers
Laws
Nerves
Levels
L
T
M
G
Nerve
Individual
ons


Universal Architecture
Layers
Sweet Spot
How
Laws
Why
Theory
Levels
Diversity
$(2^V - |a|)^{-1}$
$+\delta\left(\sum_{i=1}^{T}|a^{i-1}| + |a^T|(2^{\lambda T} - |a|)^{-1}\right)$
$R = \lambda_\alpha T$
Slow
Flexible
Rigid
Nerves
Optic
Vestibular
Accurate
Inaccurate
Connective tissue
Veins
Nerve
Axons
L
S
N
G
T


Universal Architecture
Layers
Laws
Nerves
Levels
Diversity
Sweet spot?
Universal but accessible
For neuro *and* control
Slow
Flexible
Rigid
Optic
Accurate
Inaccurate
Connective tissue
Veins
Nerve
Axons


Universal Architecture
Layers
Laws
Levels
Theory
Sweet spot?
General but accessible
Sweet Spot
Diversity
Slow
Fast
Accurate
Inaccurate
Flexible
Rigid
Optic
Vestibular
Connective tissue
Nerve
L
S
T
G

Reflex Layer

Fast
Inaccurate
Rigid
Localized
Unconscious
Automatic

trail

Unstable real dynamics

Tracking Layer

Slow
Accurate
Flexible
Centralized
Conscious
Deliberate

bumps

Stable virtual dynamics

Vision

trail

Slow

Fast

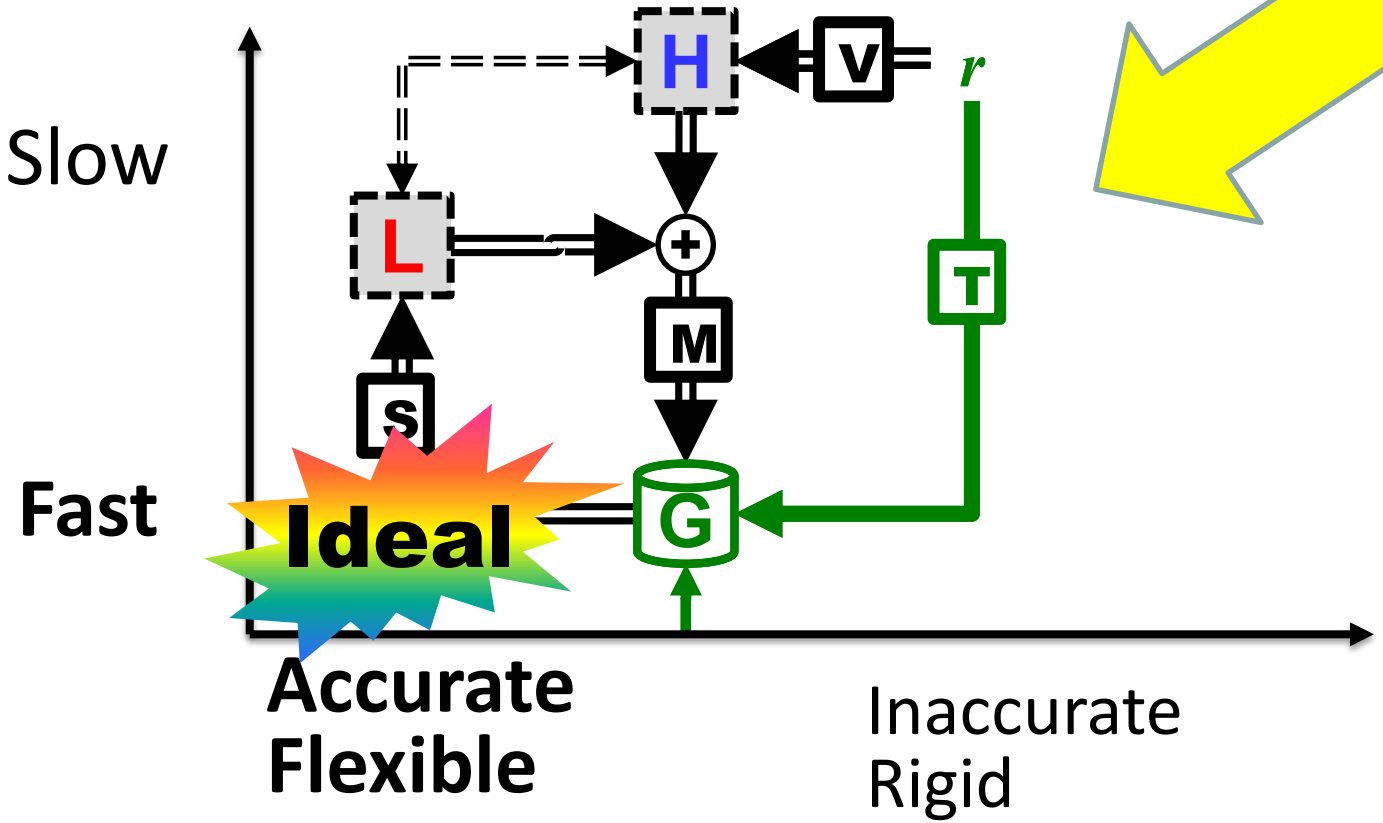
Ideal

Accurate
Flexible

Inaccurate
Rigid

bumps

trail


H
V
r
L
T
M
S
G
Ideal
Slow
Fast
Accurate
Flexible
Inaccurate
Rigid

bumps

trail

bumps

Slow

Fast

Tradeoff

Ideal

Accurate
Flexible

Inaccurate
Rigid

trail

Slow

Trail

Layers

Tradeoff

Fast

Ideal

Bumps

bumps

Accurate
Flexible

Inaccurate
Rigid

trail

Accurate

Slow

Trail

Layers

Tradeoff

Fast

Bumps

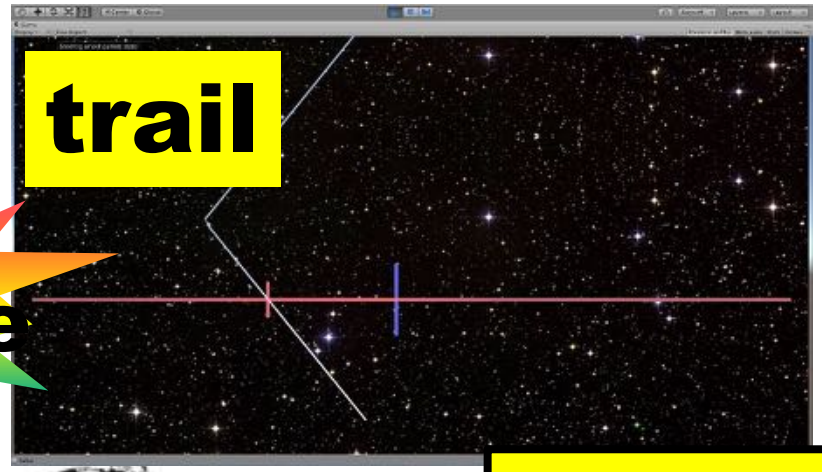
bumps

Ideal

Fast

Accurate
Flexible

Inaccurate
Rigid



trail

Accurate

Game

bumps

Fast

Slow

Trail

Layers

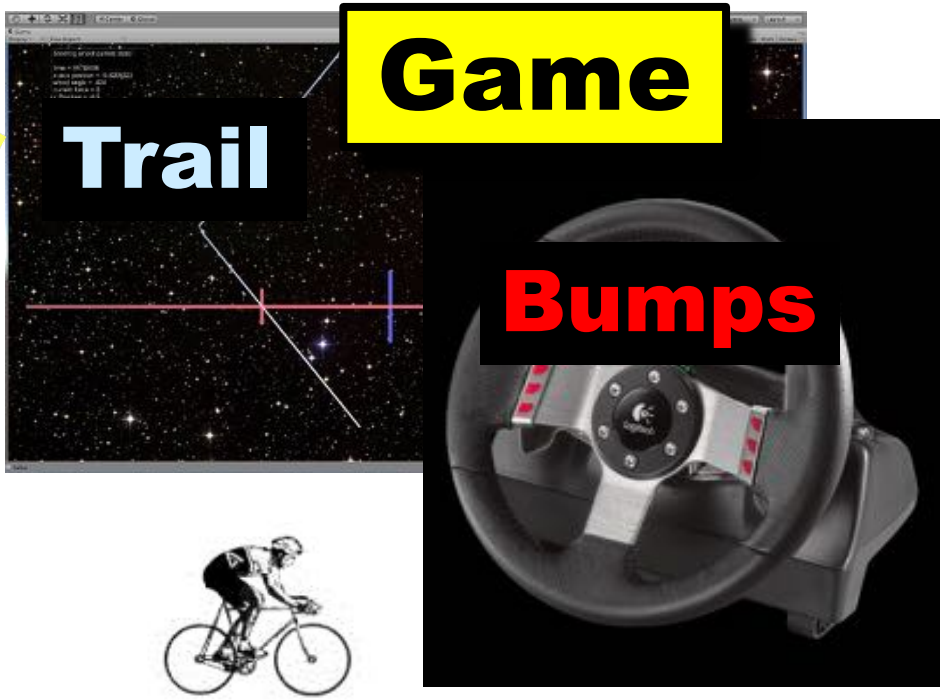
Tradeoff

Bumps

Ideal

Accurate
Flexible

Inaccurate
Rigid



Slow

Fast

Trail

Layers

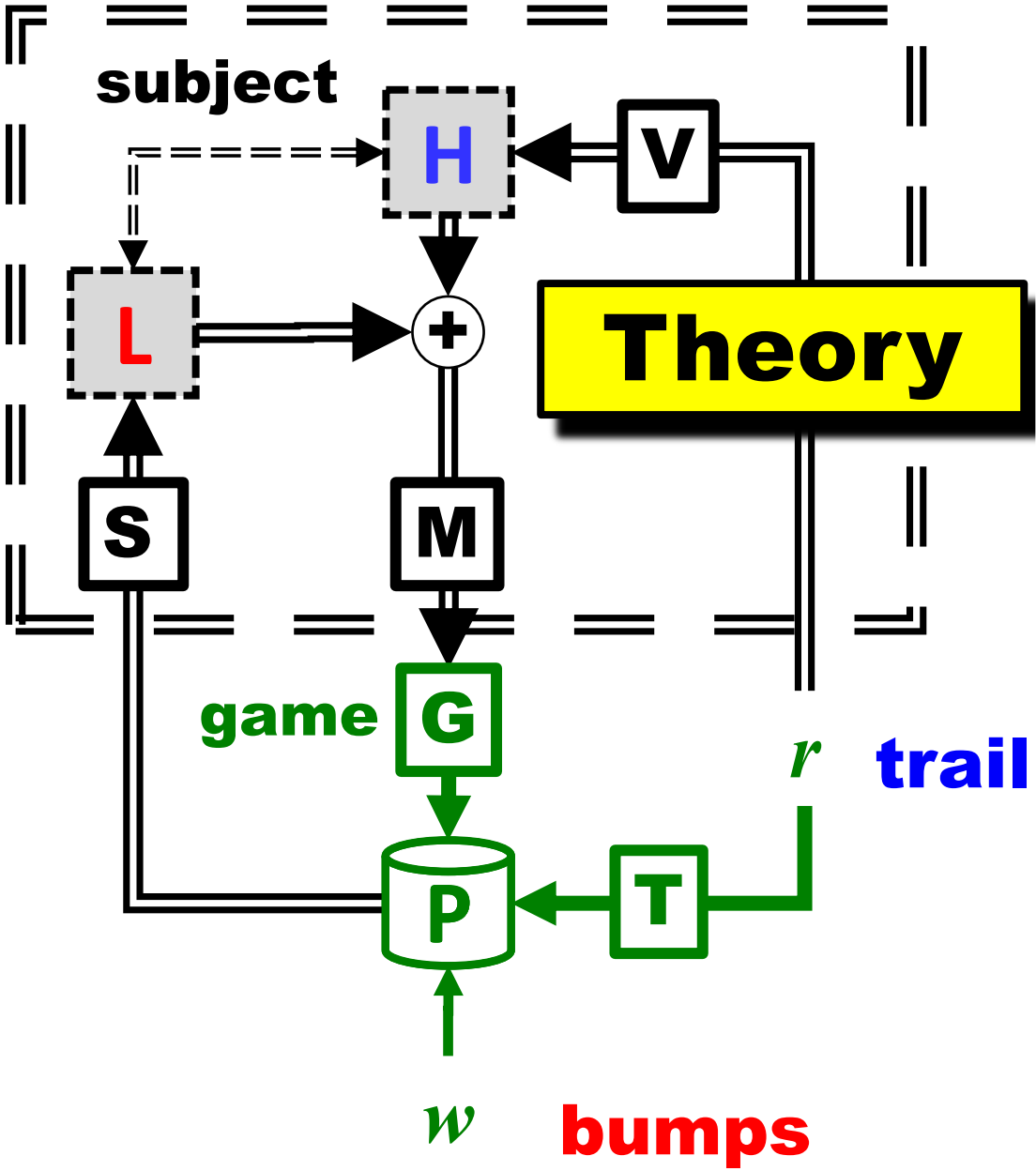
Tradeoff

Bumps

Ideal

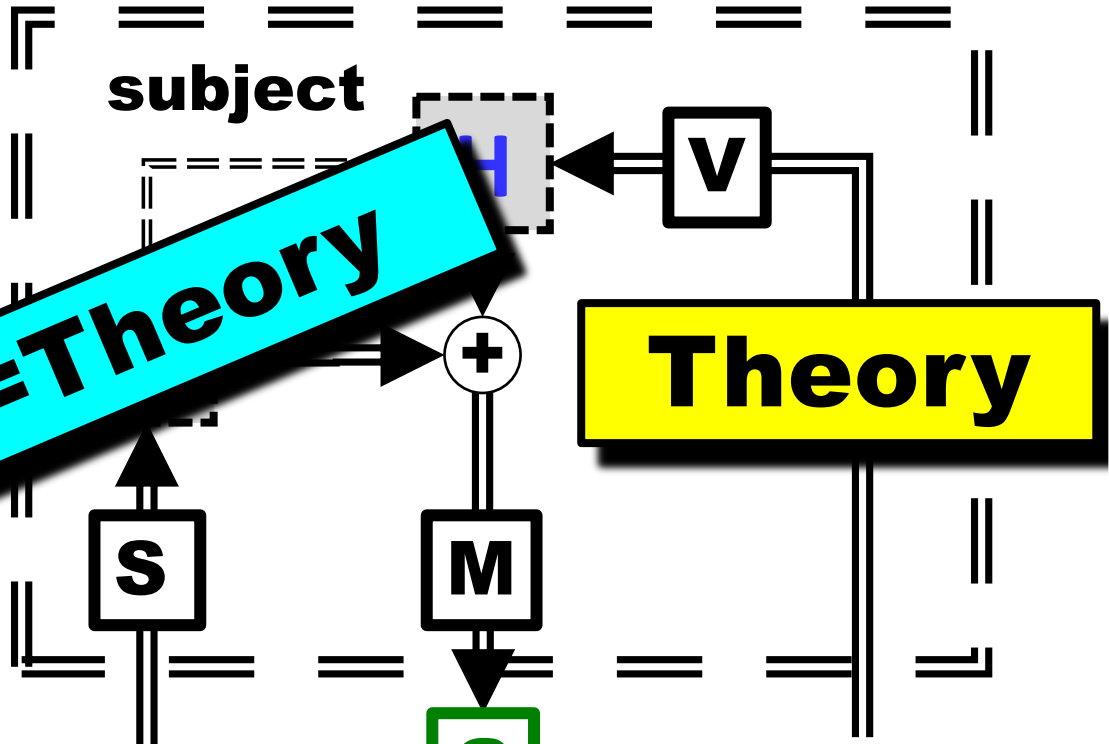
Accurate
Flexible
Centralized
Conscious
Deliberate
Stable virtual

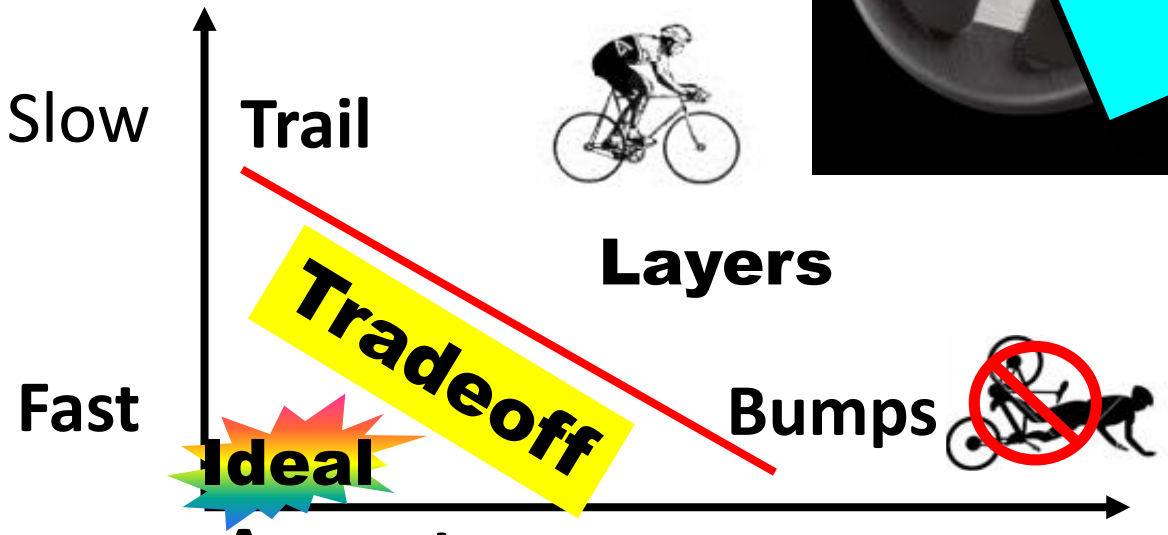
Inaccurate
Rigid
Localized, distributed
Unconscious
Automatic
Unstable real dynamics



Game

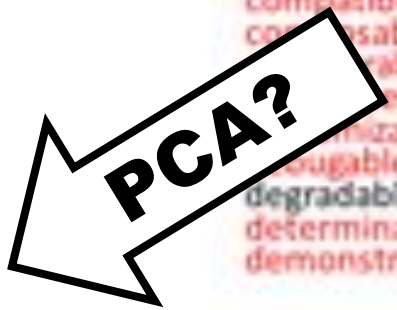
Data=Theory





Accurate	Inaccurate
Flexible	Rigid
Centralized	Localized, distributed
Conscious	Unconscious
Deliberate	Automatic
Stable virtual	Unstable real dynamics

Accurate Inaccurate
Flexible Rigid
Centralized Localized, distributed
Conscious Unconscious
Deliberate Automatic
Stable virtual Unstable real dynamics



PCA= “Principal Concept Analysis”???