NEURAL COMPUTER
FINAL PROJECT

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Use Shagrir book The Nature of Physical Computing to formalize Computing as Modelling.

Sagrir proposes that computing is satisfied with modeling of the input-output type with some degree of morphism.

Assuming that computing is a process of the physical system that transforms (physical) input variables into output variables, the mirroring condition is as follows:

A physical system P is a computing system just in case:

(1) **Input-Output Mirroring**. The input-output function, g, of a given process in **P** preserves a certain relation, $\underline{\mathrm{R}}$, in a target domain **T**: there is a mapping from **P** to **T** that maps g to $\underline{\mathrm{R}}$, x to $\underline{\mathrm{x}}$, y to $\underline{\mathrm{y}}$, ..., such that $g(x) = y$ iff $\langle \underline{x}, \underline{y} \rangle \;\; \epsilon \; \underline{R}$. This means that g and $\underline{\mathrm{R}}$ share some formal relation **f**.

(2) **Implementing**. This process of **P**, whose input-output function is g, implements some formalism **S** whose input-output (abstract) function is **f**.

(3) **Representing**. The input variables x of **P** represent the entities $\underline{\mathrm{x}}$ of **T**, and the output variables y of **P** represent the entities $\underline{\mathrm{y}}$ of **T**.

The underlined italicized symbols (such as x and y) to signify properties of the target domain.

The paper Sadtler et. al. on Neural Manifolds cleverly establishes that neural activity is inherently constrained by properties of the physical network circuitry itself.

These constraints result in neural activity patterns that comprise a low-dimensional subspace — the manifold — within the larger possible high-dimensional neural space.

The authors relate this discovery to skill learning and adaptation

Important terms
metric tensor
Levi-Civita connection
Affine Connection
Covariant Derivative
Christoffel symbols Γ^i_{jk}