[restatement] I am interested in developing any given computational medium as a thinking partner in the same way that a guitar is developed as a singing partner. Notably, it is in game and browser engines - in particular, the *function callback*, - that the necessary feedback loop is established.

The feedback loop between a source of input (the human playing notes) and a source of output (the guitar producing sound) is fundamental to co-creativity in particular, and performance in general. Very few people can predict how any arbitrary combination of notes, stroke velocities, and so forth will actually sound, especially not in the brief time it takes to fret these notes and strum the guitar.

(Notably, the time it takes to fret the desired notes is nontrivial until some technical skill in playing the guitar is acquired through time-consuming repetition. If every computational medium has its own learning curve, then we are motivated to support *expedient means* with fewer degrees of design freedom, but which are less prone to failure of expression - meaning casual creation support tools.)

The feedback loop between a computational model (in your head) and a running model (in a computational notebook) is analogous. Sheet music becomes code snippets, and inspired advice

Most conceptual thought is organized as metaphor, as collections of shapes in

extraordinarily specific configuration. Fox Harrell describes phantasms as all those concepts which do not have embodied, perceptible referents. These may be essentially contested, but are nonetheless enacted. Creativity, or justice, are typical examples - we know them when we see them, but we necessarily struggle to define either.

(On this note, please substitute ‘conceptual thought’ with an idea that is sufficiently motivating, but not actually provocative. I’m using the lens of metaphors to avoid getting boxed prematurely into rational methods of truth-seeking.)

Certain metaphorical blends are simple, with few layers of phantasm involved. For instance, snake and spider silhouettes are associated with danger through a hard-wiring of the mammalian brain, although justifying ‘a serpent tongue’ to mean a liar is more complex.

Others are much more involved, such as Euler’s identity, which describes rotations in the plane in algebraic terms (as Lakoff and Nunez explain from first principles).

[figure: rotation by \pi radians on the unit circle]

$ e^{-i\pi} = -1 $

Certain complex metaphorical blends are self-replicating cultural organisms, spreading through daily experiences (e.g. femininity and masculinity), formal schooling (e.g. the calculus of differences), or shared play (e.g. house rules for a card game).

Media artifacts are vital to restating, testing, and making use of complex conceptual dependencies. Typically the media artifact is the tip of an iceberg, where the process that created it is the site of transformative learning. However, computational media artifacts can also organize the performance in which their reader is involved.

In the case of works like Parable of the Polygons [cite], a computational notebook can describe how racial prejudice works by playing out a simplified algorithm of preferential assortment. (Even more persuasive than playing with that notebook might be re-implementing the code yourself - but it is also fine to stay within the frame of the artifact, and engage with the specific computations which it affords.)

Media artifacts arise from a combination of internal reflective processes, and external cultural processes, where the latter behave like organisms that compete for survival (as human practices requiring both time and effort). A cultural organism cannot survive without both the material conditions producing desire, and medium(s) which suit its spread.

For instance, the act of smoking tobacco was a high-status signifier until it became affordable to most consumers. But how was it popularized? Popular films showed smoke captured on film, which is beautiful - at the same time, smoking breaks are a potential networking boon, if your professional colleagues share the habit. (I must think of Twitter similarly.) And we cannot neglect that the tobacco companies leveraged their growing power to

this end, using the rhetoric of advertising to ramp up desire.

The growth of the smoker demographic was halted, and ultimately reversed, by the fact that smoking is a public health hazard that promotes severe respiratory ailment. But this fact mattered now (and not before) because campaigns were waged against smoking, and regulations imposed upon it. Should we conclude from this, say, that smoking is easier than calculus? No, of course it's difficult to grow a plant and to make a cigarette and to find people who are also taking a smoking break. But the cultural weather of consumerism and cinematic glamor aligned for a few decades, and in hindsight it seems quite inevitable.

Other practices do not appear to benefit from these growth factors, and need to be encouraged by growing their internal ecosystems, through the construction of media artifacts. (For this reason, it is especially beneficial to encourage those skillful practices which lead to more artifacts being made.)

For instance, the development of standard libraries for deep learning (a parameter-free statistical technique) has enabled and been enabled by a surge in the demand for facilities to process big data (owing to a societal transition toward mass use of online shopping and social media), leading to the creation of 'data science' as a discipline whose stakeholders range from online advertisers to medical researchers to climate scientists to campaign specialists.

We now leave desire and historical contingency aside, to regard those mediums of cultural growth which are computational. This allows us to focus on features of computational media which suit them well to carrying phantasms, especially metaphors, even when built ‘from scratch’ (in JavaScript, Jupyter Notebook, or a more traditional game engine, e.g. a labyrinth scratched into dirt). These games are in some sense reproducible, although their readings are not.

In the realm of psychological science, there is growing interest in the cultivation of computational models, as a viable language of exchange for active theories. (It is interesting to see a greater emphasis put on programming than on mathematics, in the context of the sciences beyond physics.) Guest and Martin argue for the value of standardizing the representation of theory, creating grounds to fork data-based papers from model-based papers to strengthen the connection between application and theory, while allowing each to be validated in a suitable manner - by statistics or analysis, respectively.