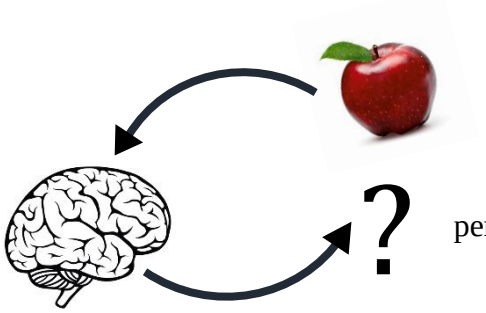
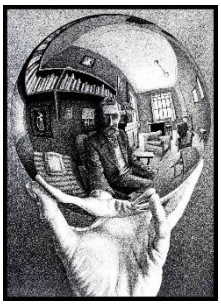
Information integration in approximate Bayesian inference

overview with Marr's levels of analysis

computational goal



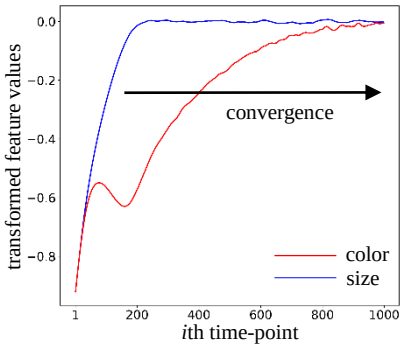
perception



consciousness

inference of the apple's size and color

algorithm



Perception is ***approximate Bayesian inference***: at each point in time, the brain makes a "best guess" of size and color given the sensory data y by maximizing

$$P(c, s|y) = \frac{P(c, s|y)\, P(c, s)}{P(y)}$$

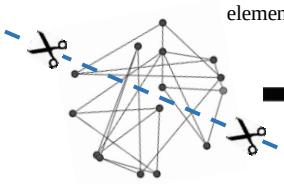
...and does so until these guesses converge.

? black box

representations and **algorithms** enabling consciousness

Representations and algorithms **are such that** information is ***integrated***: a conscious system generates more information as a whole than the sum of a bipartition.

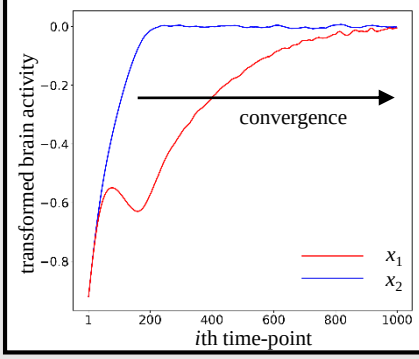
system of interconnected elements with bipartition



integrated information

brain activity during approximate Bayesian inference

implementation



Evolution of feature values corresponds to brain activity as measured in (groups of) neurons x_1, x_2 over time.

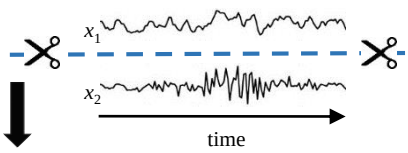
deriving evolution of x_1, x_2 with ***black box variational inference***

? black box

neuronal implementation of representations and algorithms

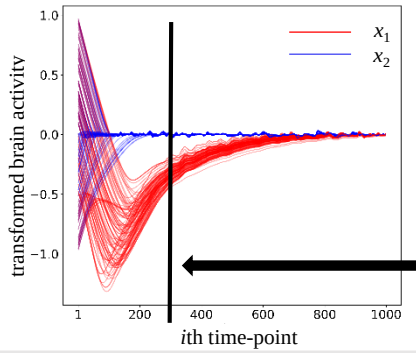
Neuronal implementation of representations and algorithms **are such that** information is ***integrated***.

measured activity in a system of interconnected (groups of) neurons x_1, x_2



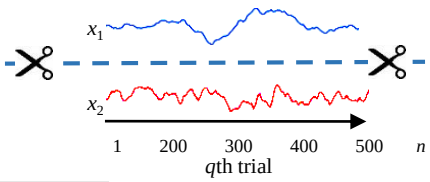
integrated information (calculated via e. g. ϕ-*empirical*)

how we bring variational inference and integrated information together

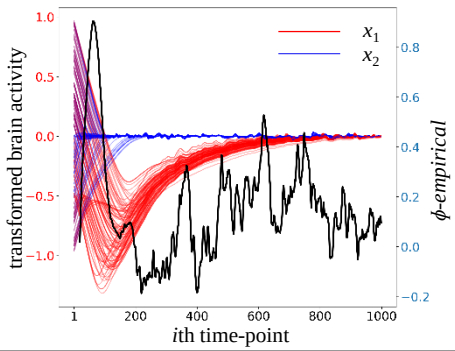


1. Repeat the inferential process and get many "trials" of approximate Bayesian inference,

2. extract values from trials $q = 1 \ldots n$ at time-point i (the indicated "slice") in the inferential process,



3. treat them as a time-series and calculate ϕ-*empirical*,



4. do that for each time-point i.

We thereby obtain the dynamics of integrated information during approximate Bayesian inference.

Or the dynamics of conscious level during perceptual inference.