

Philosophy and Science
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‘Most of us don't worry about these questions most of the time. But almost all of us must sometimes wonder: Why are we here? Where do we come from? Traditionally, these are questions for philosophy, but philosophy is dead,’ he said. ‘Philosophers have not kept up with modern developments in science. Particularly physics’. - Stephen Hawking.

‘My concern here is that the philosophers believe they are actually asking deep questions about nature. And to the scientist it's, what are you doing? Why are you concerning yourself with the meaning of meaning?’ - Neil deGrasse Tyson.

1. Picture theory

‘We make to ourselves pictures of facts.

The picture presents the facts in logical space, the existence and non-existence of atomic facts.

The picture is a model of reality.’ – Wittgenstein. *Tractatus Logico-Philosophicus*. 2.1-2.12.

Activity: In each of these sentences, how are they making a picture of the world? What are the individual parts of the picture? Are the parts of the picture combining in space, time, logic, causality or some other method? Are there some sentences where the picture theory fails?

Science sentences:

Quorum sensing systems allow bacterial cells to assess cell density and to collectively generate an output response once a threshold concentration of the signal molecule is reached.

We profiled the bacterial composition of the preterm infant gut with metagenomic shotgun sequencing using unique clade-specific marker genes.

C. elegans strains were maintained on NGM agar plates seeded with OP50 *Escherichia coli* according to standard protocols [68].

We interpret these niche shapes in light of a conceptual model comprising five basic niche shapes.

Here we report evidence that three-quarters of the human genome is capable of being transcribed, as well as observations about the range and levels of expression, localization, processing fates, regulatory regions and modifications of almost all currently annotated and thousands of previously unannotated RNAs.

Medicago sativa (alfalfa) form intracellular associations with rhizobial bacteria such as *Sinorhizobium meliloti*. *S. meliloti* resides within specialized root structures called nodules, where it fixes atmospheric nitrogen and significantly contributes to plant growth under nitrogen-limiting conditions.

2. Family resemblances

‘Consider for example the proceedings that we call "games". I mean board-games, card-games, ball-games, Olympic games, and so on. What is common to them all?—Don't say: "There must be something common, or they would not be called 'games' "—but look and see whether there is anything common to all.—For if you look at them you will not see something that is common to all, but similarities, relationships, and a whole series of them at that. To repeat: don't think, but look!—Look for example at board-games, with their multifarious relationships. Now pass to card-games; here you find many correspondences with the first group, but many common features drop out, and others appear. When we pass next to ballgames, much that is common is retained, but much is lost.—Are they all 'amusing'? Compare chess with noughts and crosses. Or is there always winning and losing, or competition between players? Think of patience. In ball games there is winning and losing; but when a child throws his ball at the wall and catches it again, this feature has disappeared. Look at the parts played by skill and luck; and at the difference between skill in chess and skill in tennis. Think now of games like ring-a-ring-a-roses; here is the element of amusement, but how many other characteristic features have disappeared! And we can go through the many, many other groups of games in the same way; can see how similarities crop up and disappear.’ – Wittgenstein. *Philosophical Investigations* #66.

Definition of a gene #1 - Heritable basis of a phenotype.

Definition of a gene #2 - One gene, one enzyme or one gene, one polypeptide.

Definition of a gene #3 - Transcribed region of the genome.

Activity: Each of these sentences concern a gene, but none of the papers explicitly define what a gene is. Would having an explicit definition make them easier to understand? How different are the implicit definitions in each sentence and to what extent do they complement one another? How would taking one definition versus another change the understanding of each of these sentences?

Science sentences:

We used the well annotated genome of the genetic model system *Drosophila melanogaster* and genome sequences of related species to carry out a whole-genome search for new *D. melanogaster* genes that are derived from noncoding DNA. Here, we describe five such genes, four of which are X-linked.

Amplicon sequencing of taxonomic marker genes such as the 16S rRNA gene in bacteria, the ITS region in fungi, and the 18S rRNA gene in eukaryotes provides a census of a community.

Mixed stage embryos (MxE) have robust zygotic transcription of genes involved in tissue differentiation and morphogenesis, and most have fully implemented dosage compensation.

To implicate genes involved in Rac signaling, RNA interference (RNAi) was used to perturb gene functions, and the corresponding cellular phenotypes were analyzed for changes.

In this paper, we introduced a novel Generalized Hidden Markov Model for gene prediction that integrates intrinsic and extrinsic information in one single probabilistic model

We have identified a large number of gene sets and pathways that are enriched for associations with height.

3. Language games

‘The language is meant to serve for communication between a builder A and an assistant B. A is building with building stones: there are blocks, pillars, slabs and beams. B has to pass the stones, and that in the order in which A needs them. For this purpose they use a language consisting of the words "block", "pillar", "slab", "beam". A calls them out;—B brings the stone which he has learnt to bring at such-and-such a call. Conceive this as a complete primitive language.’ - *Wittgenstein. Philosophical Investigations #2.*

‘Think of the tools in a tool-box: there is a hammer, pliers, a saw, a screw-driver, a rule, a glue-pot, glue, nails and screws.—The functions of words are as diverse as the functions of these objects.’ - *Wittgenstein. Philosophical Investigations #11.*

‘For a large class of cases—though not for all—in which we employ the word "meaning" it can be defined thus: the meaning of a word is its use in the language.’ - *Wittgenstein. Philosophical Investigations #43.*

Activity: What is each of these sentences trying to do, or to restate, what is the function of the word in bold/italics? If the word in bold/italics was a tool, what kind of tool is it and what is the use of that tool? What is the language game being played with each of these sentences and what are the rules of that language game?

Science sentences:

This finding *suggests* that the dominant *Drosophila* symbionts remain associated with their host because of repeated reintroduction rather than internal growth.

This is *consistent* with the sharp increase in the abundance of this genus in saccharin-consuming mice observed in the 16S rRNA analysis.

Furthermore, a similar and *statistically significant* ($P < 1.6 * 10^{-4}$) relationship was found when the S excretion values for this collection period were first corrected to unit body mass.

In this instance, the larger of each pair of correlations related to operating expense is *nearly significant* ($P < .08$).

In addition, three recent studies using EST data (13, 14) and tiling-microarray data from chromosome (15) indicated that retrocopy transcription may be widespread, *although these surveys were limited*, and potential functional implications were not addressed.

Further research will be needed to understand how these requirements are fulfilled in the many natural examples of interspecific cooperation.

The trends illustrated here were all of *large effect* (fold-change > 2) and statistically significant following FDR correction (Methods).