**Introduction**

This document contains the very first formal analysis of a prompt that we believed to be a great step for GPT-3 for successfully generalizing to our problem, and extracting all the information we wanted.

**Structure of Prompt**

* Directions
  + Definition of biological strategy (first sentence)
  + Definition of the main elements of the strategy
  + Telling GPT-3 to include all the elements extracted in the strategy
* One-Shot Sample
  + Sample “Text” → Harbor Seal …
  + Sample “Output”
* Input
  + Input “Text” → {}
  + Output start → “Strategy:”
    - GPT-3 only needs the first part of the output (in fact, it may not even need this)

**Prompt**

A biological strategy is a characteristic, mechanism, or process that an organism or ecosystem exhibits to accomplish a particular function within a particular context.

The main elements of a biological strategy are:

- The organism or ecosystem

- The part of the organism

- Function (what it does or accomplishes)

- Mechanisms (how it does it)

- Context (environment, conditions, constraints, stressors)

Make sure your strategy is accurate, high-quality, written by an expert, and can be understood by a high school student.

Text: Harbor seal vibrissa morphology suppresses vortex-induced vibrations. Harbor seals (Phoca vitulina) often live in dark and turbid waters, where their mystacial vibrissae, or whiskers, play an important role in orientation. Besides detecting and discriminating objects by direct touch, harbor seals use their whiskers to analyze water movements, for example those generated by prey fish or by conspecifics. Even the weak water movements left behind by objects that have passed by earlier can be sensed and followed accurately (hydrodynamic trail following). While scanning the water for these hydrodynamic signals at a swimming speed in the order of meters per second, the seal keeps its long and flexible whiskers in an abducted position, largely perpendicular to the swimming direction. Remarkably, the whiskers of harbor seals possess a specialized undulated surface structure, the function of which was, up to now, unknown. Here, we show that this structure effectively changes the vortex street behind the whiskers and reduces the vibrations that would otherwise be induced by the shedding of vortices from the whiskers (vortex-induced vibrations). Using force measurements, flow measurements and numerical simulations, we find that the dynamic forces on harbor seal whiskers are, by at least an order of magnitude, lower than those on sea lion (Zalophus californianus) whiskers, which do not share the undulated structure. The results are discussed in the light of pinniped sensory biology and potential biomimetic applications.

Strategy: A harbor seal’s whiskers possess an undulated surface structure that reduces vortex-induced vibrations while moving through the water

Organism: harbor seal

Part of: whiskers

Function: reduces vortex-induced vibrations

Mechanisms: undulated surface structure

Context: moving through water

Text: {}

Strategy:

**Structure of Content**

* Each entry has
  + Paper Id
  + Summary generated from GPT-3 Da Vinci
    - Biological Strategy
    - Organism
    - Part of
    - Function
    - Mechanisms
    - Context
  + My notes and analysis

**Content**

* W2103410568
  + "title": "Building a home from foam\u2014t\u00fangara frog foam nest architecture and three-phase construction process", "abstract": "frogs that build foam nests floating on water face the problems of over-dispersion of the secretions used and eggs being dangerously exposed at the foam : air interface. nest construction behaviour of tungara frogs, engystomops pustulosus, has features that may circumvent these problems. pairs build nests in periodic bursts of foam production and egg deposition, three discrete phases being discernible. the first is characterized by a bubble raft without egg deposition and an approximately linear increase in duration of mixing events with time. this phase may reduce initial over-dispersion of foam precursor materials until a critical concentration is achieved. the main building phase is marked by mixing events and start-to-start intervals being nearly constant in duration. during the final phase, mixing events do not change in duration but intervals between them increase in an exponential-like fashion. pairs joining a colonial nesting abbreviate their initial phase, presumably by exploiting a pioneer pair's bubble raft, thereby reducing energy and material expenditure, and time exposed to predators. finally, eggs are deposited only in the centre of nests with a continuously produced, approximately 1 cm deep egg-free cortex that protectively encloses hatched larvae in stranded nests.”
  + Túngara frogs build nests in periodic bursts of foam production and egg deposition, three discrete phases being discernible.
    - Organism: Túngara frog
    - Part of: nest
    - Function: protect eggs → protectively encloses hatched larvae
    - Mechanisms: three-phase construction process
    - Context: on water → periodic bursts of foam production on water
  + Notes:
    - The biological strategy is generated by using the information from the title as the organism, and the claim of the paper for the rest of the strategy.
    - The organism is correct.
    - The Part of the organism portion is questionable because the nest is not a part of the frog. But after reading the abstract, it does not specifically mention a part of the frog.
    - The function is correct, the model picked it up from a different part of the abstract. But, it is not present in the biological strategy generated.
    - The context is not correct. The corrected context is displayed above.
    - The Mechanism is correct, and it is loosely mentioned in the biological strategy. The important thing to notes that the mechanism is actually very large because it has three steps and spans most of the abstract. So, actually what is captured as the mechanism is a summary of the actual 3 step mechanism
    - Better Summary:
      * Túngara frogs protectively enclose hatched larvae by building nests in periodic bursts of foam production and egg deposition on water.
        + Organism: Túngara frog
        + Part of: nest
        + Function: protectively encloses hatched larvae
        + Mechanisms: building nests
        + Context: periodic bursts of foam production on water
* W2138292607
  + “title”: A nocturnal mammal, the greater mouse-eared bat, calibrates a magnetic compass by the sun", "abstract": "recent evidence suggests that bats can detect the geomagnetic field, but the way in which this is used by them for navigation to a home roost remains unresolved. the geomagnetic field may be used by animals both to indicate direction and to locate position. in birds, directional information appears to be derived from an interaction of the magnetic field with either the sun or the stars, with some evidence suggesting that sunset/sunrise provides the primary directional reference by which a magnetic compass is calibrated daily. we demonstrate that homing greater mouse-eared bats (myotis myotis) calibrate a magnetic compass with sunset cues by testing their homing response after exposure to an altered magnetic field at and after sunset. magnetic manipulation at sunset resulted in a counterclockwise shift in orientation compared with controls, consistent with sunset calibration of the magnetic field, whereas magnetic manipulation after sunset resulted in no change in orientation. unlike in birds, however, the pattern of polarization was not necessary for the calibration. for animals that occupy ecological niches where the sunset is rarely observed, this is a surprising finding. yet it may indicate the primacy of the sun as an absolute geographical reference not only for birds but also within other vertebrate taxa.”
  + The greater mouse-eared bat calibrates a magnetic compass by the sun
    - Organism: greater mouse-eared bat
    - Part of: magnetic compass
    - Function: calibrates magnetic compass
    - Mechanisms: exposure to altered magnetic field → testing their homing response after exposure to an altered magnetic field
    - Context: at and after sunset
  + Notes:
    - The summary generated is heavily based off the title.
    - Overall, the biological strategy is actually correct in a sense, but it is missing the mechanism.
    - The mechanism and context seems mostly correct, I put an arrow next to the mechanism to what possibly might be better.
    - It feels like the red text portion should be the summary, obviously disregarding information like “we demonstrate”.
    - Better Summary:
      * Greater mouse-eared bats (myotis myotis) calibrate a magnetic compass with sunset cues by testing their homing response after exposure to an altered magnetic field at and after sunset.
        + Organism: greater mouse-eared bat
        + Part of: magnetic compass
        + Function: calibrates magnetic compass
        + Mechanisms: testing their homing response after exposure to an altered magnetic field
        + Context: at and after sunset
* W2005539166
  + "title": "Polarization sensitivity in two species of cuttlefish - Sepia plangon (Gray 1849) and Sepia mestus (Gray 1849) - demonstrated with polarized optomotor stimuli.", "abstract": "the existence of polarization sensitivity (ps), most likely resulting from the orthogonal arrangement of microvilli in photoreceptors, has been proposed in cephalopods for some time, although it has rarely been examined behaviourally. here, we tested the mourning cuttlefish, sepia plangon, and the reaper cuttlefish, sepia mestus, for polarization sensitivity using a large-field optomotor stimulus containing polarization contrast. polaroid filter drums with stripes producing alternating e-vectors were rotated around free-moving animals. polarized optomotor responses were displayed, and these responses were similar to those performed in response to a black-and-white, vertically-striped drum, whereas no responses were displayed to a plain polarizing control drum producing just a vertical e-vector. this indicates that the animals are able to see the contrast between adjacent stripes in the polarizing drum. to our knowledge, this is the first demonstration of functional polarization sensitivity in cuttlefish."
  + Cuttlefish are able to see the contrast between adjacent stripes in a polarizing drum.
    - Organism: Cuttlefish
    - Part of: eyes → microvilli in photoreceptors
    - Function: see contrast between adjacent stripes
    - Mechanisms: polarization sensitivity
    - Context: looking at a polarizing drum
  + Notes:
    - GPT uses the title to find the organism, and the second to last sentence for the rest of the information. More importantly, the second to last sentence is a claim, that probably will be supported in the paper.
    - Part of is correct. But, it does not mention “eyes” in the abstract, rather a part of the eye called the photoreceptor.
      * <https://www.allaboutvision.com/eye-care/eye-anatomy/photoreceptors/>
      * OR GPT creates “eyes” this because it sees the word “see” in the abstract.
    - The function is correct.
    - The Mechanism is correct.
    - The context is correct.
    - The organism is correct.
    - The red sentence is just a sentence that I feel is important.
* W2151557512
  + "title": "Identification and characterization of a multidomain hyperthermophilic cellulase from an archaeal enrichment.", "abstract": "archaea are microorganisms that use a wide range of carbon and energy sources. graham et al. describe an archaeal consortium that can grow at temperatures above 90 \u00b0c using crystalline cellulose as a carbon source, with potential applications in enzymatic degradation under extreme conditions."
  + A multidomain hyperthermophilic cellulase from an archaeal enrichment can grow at temperatures above 90 °c using crystalline cellulose as a carbon source.
    - Organism: archaeal consortium
    - Part of: cellulase
    - Function: can grow at high temperatures
    - Mechanisms: multidomain hyperthermophilic → using crystalline cellulose as a carbon source
    - Context: using crystalline cellulose as a carbon source → high temperatures or extreme conditions
  + Notes:
    - GPT uses the title information as well as the claim of the abstract/paper.
    - The biological strategy abstracted is correct.
    - Organism is correct. It could also be just be Archea.
    - Function is correct.
    - Mechanism is incorrect. It should be “using crystalline cellulose as a carbon source.”
    - Context is incorrect. It should be “high temperatures” from the function or “extreme conditions” from the last sentence.
* W2160542693
  + "title": “DIFFERENCES IN POLYSACCHARIDE STRUCTURE BETWEEN CALCIFIED AND UNCALCIFIED SEGMENTS IN THE CORALLINE CALLIARTHRON CHEILOSPORIOIDES (CORALLINALES, RHODOPHYTA) 1", "abstract": "the articulated coralline calliarthron cheilosporioides manza produces segmented fronds composed of calcified segments (intergenicula) separated by uncalcified joints (genicula), which allow fronds to bend and reorient under breaking waves in the wave-swept intertidal zone. genicula are formed when calcified cells decalcify and restructure to create flexible tissue. the present study has identified important differences in the main agaran disaccharidic repeating units [\u21923)-\u03b2-d-galp (1\u2192 4)-\u03b1-l-galp(1\u2192] synthesized by genicular and intergenicular segments. based on chemical and spectroscopical analyses, we report that genicular cells from c. cheilosporioides biosynthesize a highly methoxylated galactan at c-6 position with low levels of branching with xylose side stubs on c-6 of the [\u21923)-\u03b2-d-galp (1\u2192] units, whereas intergenicular segments produce xylogalactans with high levels of xylose and low levels of 6-o-methyl \u03b2-d-gal units. these data suggest that, during genicular development, xylosyl branched, 3-linked \u03b2-d-galp units present in the xylogalactan backbones from intergenicular walls are mostly replaced by 6-o-methyl-d-galactose units. we speculate that this structural shift is a consequence of a putative and specific methoxyl transferase that blocks the xylosylation on c-6 of the 3-linked \u03b2-d-galp units. changes in galactan substitutions may contribute to the distinct mechanical properties of genicula and may lend insight into the calcification process in coralline algae."
  + The main agaran disaccharidic repeating units [→3)-β-d-galp (1→ 4)-α-l-galp(1→] are different in genicular and intergenicular segments
    - Organism: Coralline calliarthron cheilosporioides
    - Part of: segments
    - Function: differentiates genicular and intergenicular segments
    - Mechanisms: different agaran disaccharidic repeating units
    - Context: segmented fronds composed of calcified segments (intergenicula) separated by uncalcified joints (genicula)
  + Notes:
    - The biological strategy generated is not correct.
    - I believe the highlighted red sentences at the beginning of the abstract should be the summary.
      * Organism: articulated coralline calliarthron cheilosporioides
      * Part of: segmented fronds
      * Function: allow fronds to bend and reorient
      * Mechanisms: calcified segments (intergenicula) separated by uncalcified joints (genicula)
      * Context: breaking waves in the wave-swept intertidal zone

Conclusion:

* Looking at only 5 samples, the results seem promising.
* The model is mostly using extractive text summarization.
* Although the output of GPT isn’t exactly what we are looking for, it does capture important information.
* We do not have the data or (possibly) computational resources to fine-tune GPT-3, but it looks like it will do a very good job of actually getting the biological strategy and components completely correct.