A: Natural Language samples used in the first study before the new process

1. How does an Elephant Turbinate save water loss? (asknature.org)

   Respiration can be a significant cause of water loss. Elephants have a particularly effective so-called temporal counter-current exchange mechanism in their nasal passages that minimizes the amount of water lost from the respiratory system. The nasal turbinates are important structural and functional components of this mechanism. This is a series of bony, shelf-like structures in the nasal passageway covered with a well-vascularized layer of moist tissue and mucus. As, inhaled air is warmed and moistened, it evaporates mucus present on the turbinates in nasal passage, leading to the cooling of passages. When elephant exhales, warm, water-saturated air from the lungs passes across the cooled nasal turbinate surfaces and water condenses out of it, staying within the nasal passages rather than being lost to the outside air. In this way, elephants recover water from exhaled air.

2. How does a Bombardier Beetle fend predator? (MIT News, Wikipedia, ….)

   The bombardier beetle is known for its ability to spray a high-pressure jet of a boiling irritant to fend off predators. This rapid-fire process is called pulse combustion, a term typically associated with jet engines, furnaces, and paint sprayers. Tom Eisner of Cornell University demonstrated that the beetle accomplishes this feat by combining hydrogen peroxide, hydroquinone and two catalysts in a tiny combustion chamber in its abdomen. The resulting chemical reaction produces a 100° C (212 °F) jet of benzoquinone and steam. Once a critical pressure is reached, the chamber's exit valve opens and boiling toxic liquid and steam blasts in the direction of the danger.

3. How does a Thermal Wheel work? (Wikipedia)

   A thermal wheel consists of a circular honeycomb matrix of heat-absorbing material, which is slowly rotated within the supply and exhaust air streams of an air handling system. As the thermal wheel rotates heat is picked up from the exhaust air stream due to convection in one half of the rotation, and given up to the fresh air stream in the other half of the rotation. Thus waste heat energy from the exhaust air stream is transferred to the matrix material and then from the matrix material to the fresh air stream, raising the temperature of the supply air stream by an amount proportional to the temperature differential between air streams, or 'thermal gradient', and depending upon the efficiency of the device. The heat exchange matrix is normally manufactured in aluminum, which has good heat transfer properties. The heat exchanger is rotated by a small electric motor and belt drive system.

4. How does an Electric Horn work? (Autocurious.com)

   The main component of the horn is the diaphragm. It is a thin metallic circular sheet or membrane which vibrates to produce sound. It lies at the front of the horn assembly and is connected to a plunger. The plunger faces towards the electromagnet. The electromagnet lies at the rear end of the horn assembly. The current is supplied to one end of an electromagnet from the positive terminal of the battery and its other end is earthed to the frame body through the contact plate arrangement. The frame body is connected to the negative terminal of the battery and hence is called earth. Hence, connecting the second

terminal of the horn to the frame completes the current flow circuit. The two contact plates which contain two small points of contact are connected to each other in the default state. A contact braking disk is fitted on the plunger and it lies in between the contact plates, as shown in the figure. As soon as we press the horn switch, the current starts flowing in the electromagnet through the contact points. This magnetizes the electromagnet which attracts the plunger towards it. The plunger pulls the diaphragm with it and hence the diaphragm moves inside. As the plunger is pulled inside, the contact breaker disc pushes the contact plates apart and hence the current supply to the electromagnet stops. In absence of magnetic attraction, the diaphragm springs back to its original position. This pulls the plunger and the disc to their original position and the contact between the contact points is restored. So the current once again starts flowing through the electromagnet and the whole process is repeated again and again. During all this, the diaphragm continues it's to and fro motion. This induced vibrations in it, which produces the sound of a definite frequency. As soon as we release the horn switch, the current flow to electromagnet stops and hence the horn sound stops.

B: Natural Language samples used in the second study with the new process

1. How does an Electric Battery work? (howstuffworks.com)

   When a load completes the circuit between the two terminals, the battery produces electricity. Electricity is produced through a series of electrochemical reactions between the anode, cathode and electrolyte. The anode experiences an oxidation reaction. The reaction in the anode creates electrons. At the same time, the cathode goes through a reduction reaction. The reaction in the cathode absorbs them. The net product is electricity.

2. How does a Solar Water Heater work? (howstuffworks.com)

   At its core, a solar water heater does one thing: It uses sunlight to warm water. The main components of a solar water heater are a solar collector and a storage tank. The solar collector turns the sun's radiation into heat. A storage tank holds the water. The solar water heaters are of two types, passive and active. An active heater uses electrical pumps and controls to move water around the system. A passive heater uses nothing but forces of nature.

3. How does Mechanical Lock work? (explainthatstuff.com)

   A mechanical lock is a device that keeps valuables safe or restricts access to something that needs protection. Most mechanical locks are fitted to things like doors and cupboards and have two physically separate parts. One part is fitted to the frame (the static part of the door) and is essentially a sturdy, metal reinforcement for a hole cut into the door itself. The other part of the lock fits into a rectangular hole in the door (known as a mortise) and consists of a metal mechanism that moves a heavy bolt into or out from the reinforced hole. The bolt slides from side to side when you turn a key clockwise or anticlockwise, so it has to be operated by a mechanism that can convert rotary motion (the turning key) into reciprocating motion (the sliding bolt). The other essential part of a lock's mechanism is a set of fixed or moving metal pieces (wards or tumblers) that engage with slots cut into the key, ensuring only one key can rotate, turn the cam, slide the bolt, and open the door.

4. Fish visualize near-infrared wavelengths of light (asknature.org)

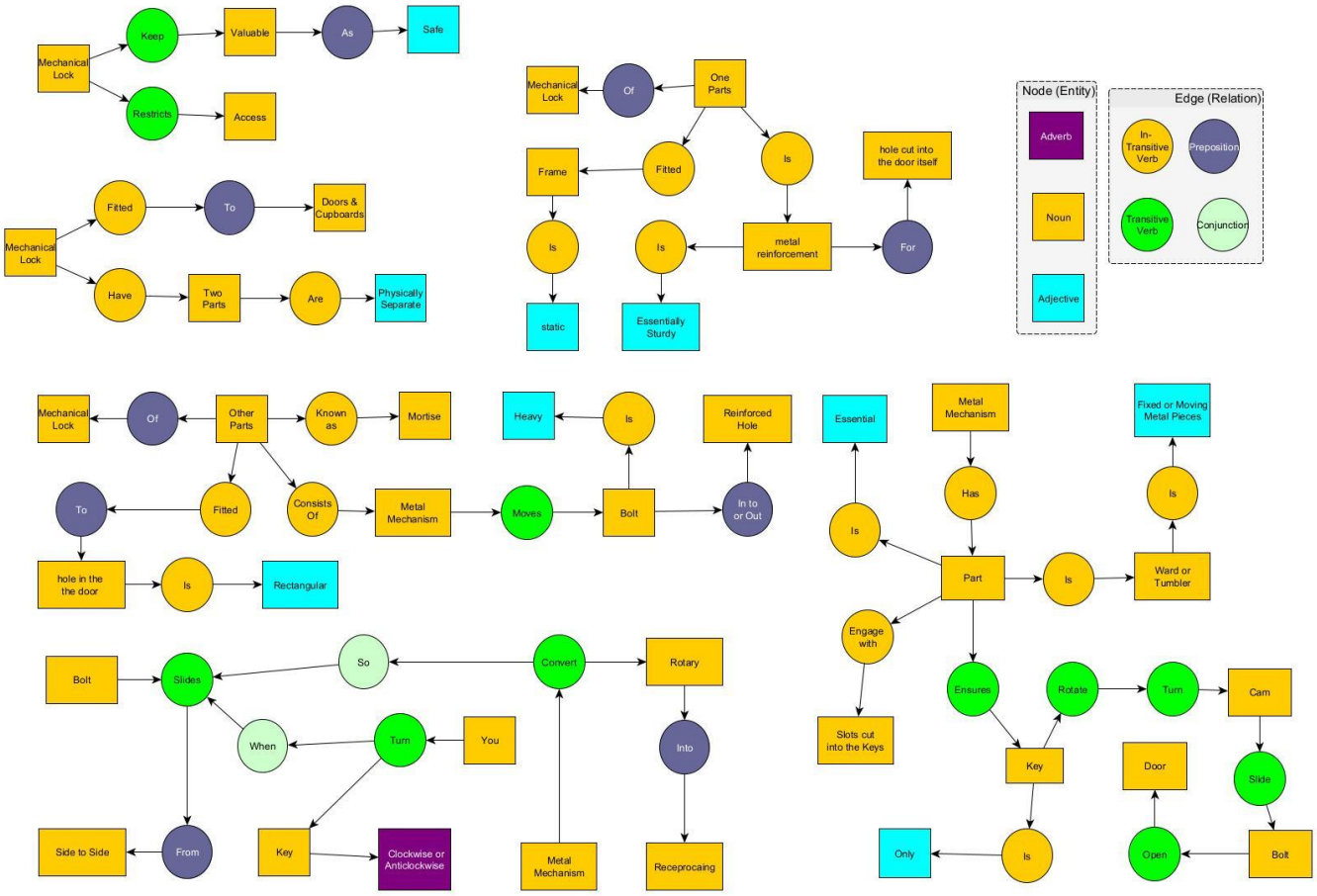
   Several types of freshwater fish are known to see near-infrared light. To understand how fish see such long wavelengths of light, we need to understand about the process called ‘phototransduction’ that enables humans, fish, and other vertebrates to see. In this process, light passes into the pupil, focuses across the eye’s lens, and strikes the retina, which contains hundreds of millions of photoreceptor cells. These cells convert information to electric signals that the brain can interpret. Photoreceptor cells come in two different shapes, each with a distinct role in vision. Rod-shaped photoreceptors help with light contrast and allow us to see at lower light levels. Walking through a dark room, rod receptors help you navigate even if you can’t distinguish colors. At higher brightness levels, three types of cone-shaped photoreceptors—red, green, and blue— help us see colors because they’re sensitive to different wavelengths of light. Vitamin A, which comes in two forms namely A1 and A2, is part of the protein complexes that make up the rod and cone cells. Some fish can see longer wavelengths of light because they have an enzyme that converts vitamin A1 to vitamin A2. Vitamin A2 appears to shift the sensitivity of red cone cells to longer wavelengths, allowing fish that have this particular enzyme to see near-infrared light.

C: Example of a Knowledge graph used in this work

Sample text: How does a mechanical lock work

> "A mechanical lock is a device that keeps valuables safe or restricts access to something that needs protection. Most mechanical locks are fitted to things like doors and cupboards and have two physically separate parts. One part is fitted to the frame (the static part of the door) and is essentially a sturdy, metal reinforcement for a hole cut into the door itself. The other part of the lock fits into a rectangular hole in the door (known as a mortise) and consists of a metal mechanism that moves a heavy bolt into or out from the reinforced hole. The bolt slides from side to side when you turn a key clockwise or anticlockwise, so it has to be operated by a mechanism that can convert rotary motion (the turning key) into reciprocating motion (the sliding bolt). The other essential part of a lock's mechanism is a set of fixed or moving metal pieces (wards or tumblers) that engage with slots cut into the key, ensuring only one key can rotate, turn the cam, slide the bolt, and open the door."

The knowledge graph representation for each sentence in the paragraph is given below:



D: Example of categories that coders used to encode words

Words/Clause identified by testers with SAPPhIRE label for the sample text on Mechanical Lock

Parts:

Word(s)	Tester 1	Tester 2	Tester 3	Tester 4
"metal pieces" (wards, tumblers)	X	X	X	X
bolt	X	X	X	X
cam	X	X		X
cupboards	X	X	X	X
door	X	X	X	X
frame	X	X	X	X
hole	X		X	X
key	X		X	X
mechanical lock	X	X	X	X
mechanism	X	X	X	X
metal reinforcement			X	X
mortise	X	X		X
slots			X	X

oRgangs:

Word(s)	Tester 1	Tester 2	Tester 3	Tester 4
Essential … Ensuring	X	X	X	X
essentially sturdy	X		X	X
heavy	X		X	
physically separate				X
rectangular	X		X	X
reinforced				X
set of fixed and moving metal pieces			X	
static				X
when … so		X		X
Two physically separate			X	

Input:

Word(s)	Tester 1	Tester 2	Tester 3	Tester 4
Rotary Motion	X			
turn a key		X	X	X

State Change:

Word(s)	Tester 1	Tester 2	Tester 3	Tester 4
From side to side			X	
Rotary to Reciprocating		X	X	X

Action & Phenomenon:

Word(s)	Tester 1	Tester 2	Tester 3	Tester 4
keeps (valuables) safe	X	X	X	X
restricts (access)	X	X	X	X
Convert (rotary to reciprocating)	X	X		
moves heavy bolt	X	X	X	X
open the door	X	X		X
slide the bolt	X	X	X	X
Turn key	X	X	X	X
Turn (the cam)	X	X		X