Science Monstrosity II: Science of the Lambs

Ray Luo, Raj Dhuwalia, and Lev Trubov

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Tossups

1. Stanislaw Ulam called him a "true eccentric," and he had a remarkable ability to fall asleep during someone's lecture, snoring loudly, then suddenly wake up and ask a relevant question. Hardy introduced him to Lebesque integrals, and Russell introduced him to Brownian motion; in the 1920s, he combined the two and developed many underlying principles of stochastic analysis. He applied statistical theory to the anti-aircraft fire problem in World War II, possibly leading to his consideration of communication and regulatory feedback in human beings, the subject of his most famous works. FTP, name this author of The Human Use of Human Beings and Cybernetics.
    Answer: Norbert **Wiener**

2. In mammals, it is accompanied by compaction, or formation of cadherins that enable maximum surface contact. In arthropods, it is superficial, while radial, spiral, and rotational patterns are types of the holoblastic variety differentiated by orientation of mitotic spindles. In fish, reptiles, and birds, this process is meroblastic, or incomplete, due to the prescence of yolk. Forming a morula that later undergoes blastulation to form a blastocoel cavity and a blastula, FTP, name this first stage of development after fertilization, a series of cell divisions.
    Answer: **cleavage** (prompt on blastula and blastulation before they are mentioned)

3. To make the second term positive, by convention the ratio is written with the more negative species above. Write out the definition of the dissociation constant. Solve for hydrogen ion concentration and take the logarithm of both sides. When acid concentration equals conjugate base concentration at the half-equivalence point, it reduces to pH is equal to pKa. This is, FTP, what equation stating that the pH of a buffer is equal to the pKa plus the logarithm of base over acid concentrations?
    Answer: **Henderson-Hasselbalch** equation (note that it is -balch, not -bach)

4. In 1966, the British Government produced a study known as the Jost Report, which announced that 4% of the nation's GNP and 30% of energy production was lost due to this, prompting establishment of centers for tribology. Superlubricity, a total absence of it, can occur between crystals in dry, incommensurate contact, and has been observed in graphite surfaces out of registry with each other. It does not depend on the speed, or on area of contact, but, as it is not a conservative force, it does depend on the path traveled. FTP, name this force, equal to its namesake coefficient times the normal force between the two surfaces, and which has static, dynamic, and rolling varieties.
    Answer: **friction**

5. Satisfying it is a necessary but not sufficient condition for a language to be regular, and its proof is based on the acceptance of a regular language by a deterministic, finite automaton. Another part of the proof uses the Pigeon Hole Principle to show that some state must be revisited. Hence any input of length

greater than or equal to n can be subdivided as xyz with length of xy less than or equal to n, length of y greater than or equal to 1, and quantity xy raised to the k times z in regular language L for all natural numbers k. Slightly more complicated when stated for context free languages, FTP, name this famous lemma used to push strings along.

Answer: **Pumping** lemma

6. Its highest mountain range is named after James Clerk Maxwell and is taller than Mt. Everest. Originally, Greeks had two names for it, Hesperus when it was seen in the evening in the west, and Phosphorus when it was seen in the morning in the east, until Pythagoras recognized it was the same object. Ray Bradbury was very, very wrong when he wrote in The Illustrated Man that this planet was almost completely covered with an ocean, and that it has been raining there for millions of years. Called Jin xing by the Chinese, Dil-bat by the Babylonians, and Chak by the Maya, this is, FTP, what planet, second from the sun, named after the Roman goddess of love?

Answer: **Venus**

7. The gravitational constant expressed in basic units of astronomical unit for length, the mean solar day for time, and solar mass for mass; the year length derived from Kepler's second law for a particle of negligible mass orbiting the sun at 1 AU; a complex number whose both real and imaginary parts are integers; a type of electromagnetic accelerator frequently used as a weapon in science fiction; a method for calculating the inverse of a square matrix; and a law stating the relationship between the electric flux through a closed surface and the enclosed charge are all namesakes, FTP, of which German mathematician, who, according to legend, when he was in elementary school, astonished his teacher when he discovered a quick way to add all the numbers from 1 to 100?

Answer: Carl Friedrich **Gauss**

8. While returning from England in the 1920s, he proved that the ocean's color does not come from reflecting the sky. The resonance spectroscopy named for him is very sensitive to modes with high Franck-Condon factors, and the time-resolved form can study photoisomerizations with sub-picosecond resolution. His namesake effect produces very weak spectral lines, arising from inelastic collisions of photons with atomic or molecular vibrations, leading to the Stokes and anti-Stokes lines. FTP, name this Indian physicist who won the 1930 Nobel Prize for Physics.

Answer: Chandrasekhara Vendata **Raman**

9. One case of this phenomenon is the relationship of Danaus plexippus and Limenitis archippus, and its namesake rings can include hundreds of species. Another case is the relationship among social wasps, solitary digger wasps, and caterpillars of the cinnabar moth. In the 1990s, the viceroy and monarch case was found to be this form of adaptation, since both butterflies are in fact poisonous, and its obvious advantage is that a predator only needs to encounter one member to learn about the entire complex. FTP, name this form of mimicry in which two or more unpalatable species are protected by their mutual resemblance.

Answer: **Mullerian** mimicry

10. Its value per CH2 group is found by subtracting the experimental heat of combustion from the expected heat of combustion for a straight-chain analog and dividing by the number of carbon atoms. The result of tetrahedral carbon bond angles and torsional steric hinderance, it has a value of 0 for n equals 14 and 6. It causes the puckering conformations of envelope and half chair in cyclopentane and the nonplanar flip in cyclobutane. With a value of 0 for cycloxehane, FTP, name this property of cyclic alkanes, the sum of bond-angle strain and eclipsing strain.

Answer: **ring strain**

11. Becker syndrome is a milder form of this disease, whose symptoms include spinal deformity and respiratory weakness. Caused by various mutations like deletions and point mutations at intron splice sites, most patients are wheel-chair bound as teens and die by their 20s. A large protein that links actin filaments together and tethers this network to the membrane glycoprotein complex is rendered defective for muscle contractions. FTP name this X-linked disorder caused by defect of dystrophin, a type of muscular dystrophy.
    Answer: **Duchenne muscular dystrophy** (or **DMD**)

12. Georg Mohr demonstrated that only one of the pieces of equipment for this process is necessary. It can be done with a regular heptadecagon, pentagon, and triangle, but not with a nonagon or heptagon. In general, it can be done with any regular polygon whose number of sides' odd factors are distinct Fermat primes. The three most famous problems involving this are impossible: the quadrature of a circle because it involves creating a transcendental ratio and doubling a cube and trisecting an angle because they involve solving cubic equations. FTP, name this process, used to solve geometric problems only by drawing straight lines and arcs of circles.
    Answer: **ruler and compass construction** (accept equivalents)

13. When written in full tensor form, its three eigenvalues determine whether an object will tumble. Its area variety is used to determine bending stress of a beam, and is expressed in units of length to the fourth power. If the axis is horizontal and passes through the centroid, it equals pi times r to the fourth over 4 for a circle and a to the fourth over 12 for a square, where a is the length of a side. The more common mass variety is found by integrating the product of distance from the axis and density over the entire 3-D space, resulting in a quantity expressed in units of mass times the units of length squared. Equal to 2 times M times R squared over 5 for a solid sphere, 2 times M times R squared over 3 for a hollow sphere, and M times R squared for a cylindrical ring, this is, FTP, what rotational analog of mass?
    Answer: **moment of inertia**

14. Despite its name, Kepler and Halley described the same problem centuries before the man whose name it bears. Numerous unsuccessful explanations have been proposed, including one by Edgar Allan Poe, who correctly claimed that each star shines a finite amount of time-but the problem stands if new stars are constantly forming. The issue was finally resolved by the Big Bang theory, which doesn't have the problem because the universe is finite, and the distant stars are receding, diminishing in brightness. FTP, name this astronomical problem that states that in an infinite universe, the night sky should blaze with light from an infinite number of stars.
    Answer: **Olbers'** paradox

15. Its pleasurable effect was discovered in Johns Hopkins by Ira Remsen in 1879, and the verion of this chemical that is sold for human consumption is actually its sodium salt with chemical formula is C7 H4 N NaO3 S*2H2O. It may be synthesized from toluene, as Remsen originally did, or from phthalic anhydride or phthalic acid, and if the attached hydrogen is replaced with a methyl group, it no longer tastes sweet. Warning labels were placed on this chemical when experiments in the 1970s found a connection with bladder tumor in rats, and it is 300 times sweeter than sugar. FTP, what is this synthetic organic compound that may cause cancer by promoting accelerated cell division?
    Answer: **saccharin**

16. This term is sometimes applied to experiment testing Bell's inequalities if the measurement efficiency is low. It is a type of false generalization and one way to avoid it is to use stratification and time-lapse techniques. It is a problem that plagues many telephone polls, and makes it impossible to conduct a scientific poll online. A subtype of it is the spotlight fallacy, making conclusions based on the subset that gets the most attention, such as using 9/11 to draw conclusions about Islam. FTP, name this statistical problem

encountered when the part actually studied does not represent the whole, usually because it is self-selected or selected due to prejudice.

Answer: **biased sample** or **unrepresentative sample**

17. The discovery of these enzymes began with studies of ıTetrahymena thermophila and its intron-catalyzed splicing system. Among their varieties are the hammerhead and hairpin types and most of them can be engineered to cleave RNA ıin trans. Their secondary structure can be deduced from the primary sequence by analyzing the base pairing and free energy reduction during the folding. They were discovered by Thomas Cech of the University of Colorado, Boulder, who showed that RNA is autocatalytic, which led to speculation that life began with RNA as both genetic material and catalyst. Also including viroids and ribosomes, FTP, name this type of enzyme made of only RNA.

Answer: **ribozyme**

18. A possible trigger of it was symmetry breaking associated with the strong force, and the WMAP's finding of one-degree fluctuations in the background radiation is supporting evidence for this theory. One conclusion that can be derived from it is that there exist regions of the universe that we have not seen and which look different from the ones we know of because they fell out of thermal contact with the known regions. Applying it allows the development of models that both generate the intergalactic voids and allow for enough dark matter to ensure star rotation, and it addresses both the isotropy problem and the flatness problem, explaining the uniformity of the background radiation as a consequence of rapid expansion after the Big Bang. Proposed by Alan Guth, FTP, identify this hypothesis which contends that the early universe quickly expanded by a factor of about 10 to the 20th.

Answer: **inflation** or **inflationary hypothesis**

19. Thucydides recorded one in the first year of the Peloponnesian war, which allowed us to precisely date that year to be 431 B.C. They occur because the Moon's orbit around the Earth and the Earth's orbit around the Sun are not circular, but elliptic, and thus at different times, the lunar and solar disks have different sizes. As the Moon receded from Earth at about 3.5 centimeters per year, they have become more common, and this trend will continue. FTP, name this type of solar eclipse, in which, while the centers of the solar and lunar disks are aligned, the lunar disk is smaller than the solar, resulting in a narrow ring of the photosphere around the dark lunar disk?

Answer: **annular** eclipse

20. This compound with formula C10 H13 N5 O4 consists of two heterocyclic rings: a pyrimidine with two carbonyl groups, and a furan with a distinctive side chain of 3 nitrogens. Unlike dTTP, its triphosphate doesn't have a 3-prime hydroxyl group, which is how it interferes with reverse transcriptase. In 1997, it was found to undergo a structural change which reduces its effectiveness, but the related drug d4T does not have this problem. Often taken with a "cocktail" of drugs, it is also marketed as Retrovir or Zidovudine. FTP, name this drug with scientific name azidothymidine, used since 1985 to fight HIV and AIDS?

Answer: **AZT** (accept early **azidothymidine** or **azidodideoxythymidine** or **Retrovir** or **Zidovudine**)

Bonuses

1. Stuff about a type of chemical reaction, FTP each:
[10 points] This reaction with an alphanumeric name is a concerted displacement of one nucleophile by another on an sp3 carbon. One example is hydroxide reacting with iodomethane.
    Answer: **SN2**
[10 points] SN2 reactions often produce this type of inversion about the chiral carbon named for a German guy.
    Answer: **Walden** inversion
[10 points]This is a concerted reaction where a base abstracts a proton at the same time that the leaving group is leaving. It usually produces a double bond.
    Answer: **E2** (prompt on "elimination")

2. Answer some questions about a mathematical technique FTSNOPE:
[10 points] For a cheap 5 points, what type of series, named for a decomposing French guy, is an expansion of a function in sines and cosines?
    Answer: **Fourier** series
[15 points] What waveform is represented by the expression f(x) equals sin x, minus sin 2x over 2, plus sin 3x over 3, minus sin 4x over 4, et cetera?
    Answer: **sawtooth** (accept things which sound equivalent, but don't accept "triangle")
[10 points] What waveform is represented by the expression f(x) equals sin x, plus sin 3x over 3, plus sin 5x over 5, et cetera?
    Answer: **square** wave

3. Name the types of radioactive decay, FTSNOPE:
[5 points] This is the first form of decay that was observed, as radium changed into radon. It results with the emission of a helium-4 nucleus from the parent nucleus.
    Answer: **alpha** decay
[5 points] This type of decay makes breeder reactors possible, allowing U-238 to capture a neutron, and, undergoing such decay twice, to turn to Pu-239. It also produces an electron and an antineutrino.
    Answer: **beta-minus decay** or **electron emission**
[10 points] This can be seen as beta-minus decay in reverse: an electron and a proton produce a neutron and a neutrino. It is usually of K variety, although under rare circumstances, L variety occurs.
    Answer: **electron capture**
[10 points] It can occur only in heavy elements, but even there it only accounts for a small percentage of decayed nuclei. In this decay, the heavy nucleus splits into two smaller nuclei, of roughly equal size.
    Answer: **spontaneous fission**

4. Answer the following about the circulatory system of the brain FTPE.
[10 points] These arteries ascend the left the right sides of the neck and enters the skull, branching into anterior and middle cerebral arteries, which supply blood to the cerebral hemispheres.
    Answer: **carotid** arteries
[10 points] This artery of the brain are formed by the vertebral arteries after they enter the base of the skull. It supplies blood to the brainstem and posterior portions of the cerebral hemisphere.
    Answer: **basilar** artery
[10 points] At the base of the brain, the carotid and basilar arteries join to form this structure. It provides needed backup in case any of the main arteries to the brain should be blocked or damaged.
    Answer: **circle of Willis**

5. Name the planet from a lesser-known moon, for 10 points, or 5 if you need an easier moon.

[10 points] Pasiphae
[5 points] Almathea
    Answer: **Jupiter**
[10 points] Larissa
[5 points] Nereid
    Answer: **Neptune**
[10 points] Ymir
[5 points] Rhea
    Answer: **Saturn**

6. Identify these basic properties of inference algorithms for logical reasoning systems, FTPE.
[10 points] This describes an algorithm that derives only sentences that are entailed by the knowledge base.
    Answer: **sound**ness
[10 points] This describes an algorithm that can derive any sentence that is entailed by the knowledge base.
    Answer: **complete**ness
[10 points] This describes an algorithm that is sound, but may not terminate with the right answer when the query is not entailed by the knowledge base.
    Answer: **semidecidable** (accept **undecidable** although this is not strictly true)

7. Answer the following about E-M radiation, FTPE.
[10 points] Because E-M radiation travels at finite speed, the modified wave equations are satisfied by the advanced potential and by this potential.
    Answer: **retarded potential**(s)
[10 points] The energy and total power radiated from an oscillating dipole are proportional to this power of the oscillation frequency.
    Answer: **fourth**
[10 points] For a moving point charge, this potential named for two guys has the CGS form phi equals e over the quantity R minus beta dot R, where R is the retarded position of the electron. It also includes a similar equation for A.
    Answer: **Lienard-Wiechert** potential(s)

8. Molecular cloning, FTSNOP.
[5 points] It must contain an orgin of replication, unique restriction sites, and means for selection, such as drug resistance. Give the general term for a DNA carrier directed at a host for cloning, such as phages and plasmids.
    Answer: **vector**
[15 points] This is a way of introducing DNA into cells by exposing cells to rapid pulses of high-voltage current, inducing temporary permeability to DNA in the surroundings.
    Answer: **electroporation**
[10 points] Michael Smith received a 1993 Nobel prize for this procedure of changing the DNA sequence at a particular site to create a specific mutation by altering the primer and cloning the mutated sequence.
    Answer: site directed **mutagenesis**

9. With formula 1,2,3-propanetriol, this viscous substance is obtained by alkaline hydrolysis of triglycerides. FTPE:
[10 points] Name this compound with 3 alcohol groups produced along with salts of fatty acids sold as soaps.
    Answer: **glycerol** (or **glycerine**)
[10 points] This process is known by this name, the production of soaps.
    Answer: **saponification**

[10 points] Treatment of glycerol with nitric acid gives this trinitrate ester, an explosive that exothermically decomposes to gases like nitrogen and water vapor.

Answer: **nitroglycerine**

10. Identify the following, FTPE.
[10 points] This dynamic programming algorithm, the most famous in Reinforcement Learning, keeps track of an action-value function in order to make decisions during exploration without explicit model representation.

Answer: **Q-learning**

[10 points] This small, inner membrane component of the electron transport chain, symbolized Q, accepts hydrogens donated by NADH-Q redutase, and forwards them to cytochrome reductase.

Answer: **ubiquinone**

[10 points] This mathematical concept is an extension of complex numbers, given by the form a + bi + cj + dk. It was first studied by Trinity College mathematician William Rowan Hamilton.

Answer: **quaternion**

11. Answer the following related questions, FTPE:
[10 points] Whether this exists or not may determine if, how, and when our universe will end. Name this substance, that may account for 90% of the mass of our universe, but for whose existence we only have circumstantial evidence.

Answer: **dark matter**

[10 points] The explanation for the missing mass problem may lie in exotic forms of ordinary matter, such as these dense chunks of transuranic elements with a cool acronym. Brown dwarfs are thought to be these.

Answer: **MA**ssive **C**ompact **H**alo **O**bjects

[10 points] These theoretical particles derive their name from the excuse scientists have for failing to detect them. Supposedly, they don't interact with normal matter by any force except gravity.

Answer: **W**eakly **I**nteracting **M**assive **P**articles

12. Identify the elements given their roles in a light bulb, FTPE.
[10 points] The filament is usually covered with atoms of this element, which sublime and condense onto the glass bulb wall at 3000 C.

Answer: **tungsten**

[10 points] The inert gas with atomic mass 39.95 usually occupies the inside of a light bulb.

Answer: **argon**

[10 points] This alternative to argon is a less efficient heat conductor, and thus makes the bulb last longer, though it is too expensive to use commercially. It has atomic mass 83.80.

Answer: **krypton**

13. Name these plant parts having to do with plant growth, FTPE.
[10 points] These slender, coiling structures support the plant as it climbs upward to gain access to sun light.

Answer: **tendrils**

[10 points] Important in the study of phototropism, this is a pointed leaf sheath in a monocot that protects the shoot before it emerges from the soil.

Answer: **coleoptile**

[10 points] This seed leaf stores reserves for the dicot seed and when it grows, is either carried to the surface above the hypocotyl or remain below surface and the epicotyl.

Answer: **cotyledon**

14. Give these terms from metallurgy of iron, FTPE:

[10 points] Used on pyrite and other ores, this pretreatment process involves heating an ore to a temperature below its melting point in the presence of air, so as to convert the ore into a better form for reduction.

Answer: **roasting**

[10 points] In a blast furnace, limestone is often added to draw out aluminum and silicon impurities from iron. The result is this mixture of calcium silicate and calcium aluminate which forms a layer at the bottom.

Answer: **slag**

[10 points] Also at the bottom is a layer of impure iron which is drawn out into bars. The iron contains up to 5% carbon and is known by this term.

Answer: **pig iron**

15. Answer some questions about certain astronomical objects, FTPE.

[10 points] They are typically young and contain hot, luminous stars. These astronomical features comprise stars born at the same time from a molecular cloud.

Answer: **open cluster**s (or **galactic cluster**s)

[10 points] This is the open cluster closest to us. Sirius is a former member of this cluster and the sun is on the outskirts of its namesake stream.

Answer: **Ursa Major**

[10 points] The most familiar open cluster in Taurus, this cluster also known as M45 and are also known as the Seven Sisters.

Answer: **Pleiades**

16. Identify these open-source programs often used in Web development, FTPE.

[10 points] This widely-used scripting language is an alternative to Microsoft's ASP. Currently, Zend is running a coding contest for version 5.

Answer: **PHP** (or **PHP Hypertext Preprocessor**)

[10 points] Currently running on over 27 million servers, this server program parses any file requested by a browser and displays the appropriate results. Its namesake foundation is currently running the Geronimo Project.

Answer: **Apache**

[10 points] This popular open-source database server is part of the LAMP group of programs, along with PHP and Apache. A query language designed for heavy loads, it allows many tables to be joined efficiently.

Answer: **MySQL** ("My sequel"; prompt on "SQL")

17. 30-20-10. Name the law of physics.

[30 points] It holds true for moving charges if it is assumed the electric and magnetic fields are a form of electromagnetic radiation and thus have momentum of their own.

[20 points] It has can be stated in a strong or a weak form, in the strong form all forces considered must act along the line connecting the two particles considered.

[10 points] The most common expression of it is "for every action there is an equal but opposite reaction".

Answer: **Newton's Third Law** or **Third Law of motion** (prompt on "Third Law", since there is a Third Law of thermodynamics and a Third Law of planetary motion)

18. Name the chemists who discovered the following laws, FTSNOPE.

[5 points] Law of conservation of mass, by heating mercury(II) oxide, producing mercury and oxygen gas.

Answer: Antoine **Lavoisier**

[5 points] Law of multiple proportions, as predicted by his atomic theory in the 1808 publication A New System of Chemical Philosophy.

Answer: John **Dalton**

[10 points] Law of definite proportions, i.e. that proportions of mass of elements composing a compound are

independent of mode of preparation, as opposed to Claude Berthollet.

Answer: Joseph **Proust**

[10 points] Law of combining volumes, i.e. that volumes of two reacting gases are in the ratio of simple integers, as is the ratios of product to reacting gases.

Answer: Joseph **Gay-Lussac**

19. Name the following from phylogenetic systematics, FTPE.

[10 points] This is an evolutionary branch defined by homologies, or a monophyletic group of common descendants. A main type of analysis in phylogenetics is named after it.

Answer: **clade**

[10 points] This is a shared derived characteristic, i.e. a homology common to all species on one branch below their common ancestor.

Answer: **synapomorphy**

[10 points] This is a set of species set apart from the group of species being studied because it is not as closely related to the study-group as the study-group members are to each other.

Answer: **outgroup**

20. As we all know, geologic time is divided into segments. FTSNOPE, name:

[5 points] The current epoch.

Answer: **Holocene**

[10 points] the current period.

Answer: **Quaternary**

[5 points] the current era.

Answer: **Cenozoic**

[10 points] the current eon.

Answer: **Phanerozoic**