

BS BIOLOGICAL SCIENCES

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BIF602- Bioinformatics Computing II

File/Short-Notes For Midterm

By

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☎ **0330-8553704**

📎 ***File/Short-Notes For Midterm:***

Q1: What is Natural Computing?

Answer:

Natural Computing investigates models and computational techniques inspired by nature. Attempts to understand the world around us in terms of information processing. Interdisciplinary field that connects computer sciences with natural

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sciences. The main idea of natural computing is that information processing is a natural process for us.

Q2: What are the three types of approaches of Natural Computing?

Answer:

Three types of approaches:

computing inspired by nature

Simulation and emulation of natural phenomenon in computers

Computing with natural materials

Q3: What is computing inspired by nature?

Answer:

Computing inspired by nature includes:

i. Nature as Inspiration

ii. Nature as Implementation Substrate

iii. Nature as Computation

Q4: What are the techniques included under “Nature as Inspiration”?

Answer:

Nature as Inspiration:

- *Cellular Automata*
- *Neural Computation*
- *Evolutionary Computation*
- *Swarm Intelligence*
- *Immuno-computing*
- *Artificial Life*
- *Membrane Computing*

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Q5: What artifacts were developed by taking inspiration from nature?

Answer:

Artifacts such as chemicals used for pharmaceuticals, infrared imaging systems, airplanes, submarines etc. were all developed by taking inspiration from nature from animals (bats etc.) to chemical substances.

Q6: What are some natural phenomenon and processes involving natural means?

Answer:

Some natural phenomenon and processes involving natural means:

- *Clustering of dead bodies in ant colonies*
- *Bird flocking*
- *Manipulating DNA strands*

Q7: What is the basic mechanism behind this type of clustering or grouping phenomenon?

Answer:

The basic mechanism behind this type of clustering or grouping phenomenon is an attraction between dead items mediated by the ants.

Q8: How do small clusters of items grow?

Answer:

Small clusters of items grow by attracting more workers to deposit more dead bodies.

Q9: How can this grouping phenomenon be modeled?

Answer:

This grouping phenomenon can be modeled using two simple rules:

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1. Pick up rule
2. Dropping rule

Q10: What is most natural to assume when we see birds flocking in the sky?

Answer:

When we see birds flocking in the sky it is most natural to assume that the birds follow a leader the one in front of the flock.

Q11: What are the branches of NC?

Answer:

Branches of NC:

1. Computing inspired by nature
2. The simulation and emulation of nature in computers
3. Computing with natural materials

Q12: What is “Computing inspired by nature”?

Answer:

Nature has greatly enriched computing been very successful in solving complex problems. There is an urge for survival in living organisms.

Q13: What is “The simulation and emulation of nature in computers”?

Answer:

It provides new tools for the synthesis and study of natural phenomena that can be used to test biological theories usually not possible of testing via the traditional and experimental techniques. It is in most cases a synthetic approach aimed at synthesizing natural phenomena or known patterns and behaviors.

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Q14: What are the main approaches to the simulation and emulation of nature in computers?

Answer:

There are two main approaches to the simulation and emulation of nature in computers:

- 1. Artificial life*
- 2. Fractal geometry of nature*

Q15: What is “Computing with natural materials”?

Answer:

It is concerned with new computing methods based on other natural material than silicon.

Q16: What do these methods result in?

Answer:

These methods result in a non-standard computation that overcome some of the limitations of standard sequential John von Neumann computers.

Q17: What motivates researchers to design new computers?

Answer:

Motivated by the need to identify alternative media for computing researchers are now trying to design new computers based on molecules such as membranes DNA and RNA or quantum theory.

Q18: What is the neuronal model also known as?

Answer:

This neuronal model also known as artificial neuron gave rise to a field of investigation of its own, the so-called artificial neural networks.

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Q19: What is the computing approach motivated by biology that arose in mid 1960s?

Answer:

Another computing approach motivated by biology arose in mid 1960s gave rise to the field of evolutionary computing which uses ideas from evolutionary biology to develop evolutionary algorithms for search and optimization.

Q20: What are the main types of Evolutionary Algorithms (EAs)?

Answer:

Main types of EAs:

- 1.Genetic Algorithms*
- 2.Evolution strategies*
- 3.Evolutionary programming*
- 4.Genetic programming*
- 5.Classifier systems*

Q21: What is Swarm Intelligence?

Answer:

The term swarm intelligence was coined in the late 1980s to refer to cellular robotic system in which a collection of simple agents in an environment interact based on local rules. Now days the term is being used to describe any attempt to design algorithms or problem solving devices inspired by the collective behavior of social organisms, from insect colonies to human societies.

Q22: What is AIS?

Answer:

Artificial immune system (AIS) or immune-computing borrow ideas from the immune system and its corresponding models to design computational system for solving complex problems.

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Q23: When did AIS emerge and what are its application areas?

Answer:

This is also a young field of research that emerged around the mid 1980's. Its application areas range from biology to robotics.

Q24: What is the goal of the simulation and emulation of nature in computers?

Answer:

It is in most cases a synthetic approach aimed at synthesizing natural phenomena or known patterns and behaviors.

Q25: What are the two main approaches to the simulation and emulation of nature in computers?

Answer:

There are two main approaches to the simulation and emulation of nature in computers:

- 1. Artificial life*
- 2. Fractal geometry of nature*

Q26: What has recent advances in computer graphics made possible?

Answer:

Recent advances in computer graphics have made it possible to visualize mathematical models of natural structures and processes with unprecedented realism.

Q27: What are Fractals?

Answer:

Fractals are rough or fragmented geometric shapes that can be subdivided into parts each of which is exactly or statistically a reduced-size copy of the whole.

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Q28: What is Fractal Geometry?

Answer:

It is the geometry of nature with all its irregular, fragmented and complex structures. Nature provides many examples of fractals, e.g. ferns, coastlines, mountains, trees, organisms, our organs etc. Their applications include:

- 1. landscape design*
- 2. study of growth*
- 3. development*
- 4. analysis of natural processes*

Q29: What is Artificial Life?

Answer:

A Life is devoted to a new discipline that investigates the scientific, engineering, philosophical and social issues involved in our rapidly increasing technological ability to synthesize life-like behaviors from scratch in computers, machines, molecules and other alternative media.

Q30: What are the major goals of Artificial Life?

Answer:

A Life has its major goals:

- 1. to increase the understanding of nature (life-as-it-is)*
- 2. enhance our insight into artificial models and possibly new forms of life (life-as-it-could-be)*
- 3. to develop new technologies, sophisticated robots, educational systems, graphics*

Q31: What is Computing with natural materials?

Answer:

It is concerned with new computing methods based on natural material other than silicon.

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These methods result in a non-standard computation that overcome some of the limitations of standard, sequential John von Neumann computers.

Q33: What motivates researchers to design new computers?

Answer:

Motivated by the need to identify alternative media for computing, researchers are now trying to design new computers based on molecules (DNA and RNA), membranes, or quantum theory.

Q34: What is DNA Computing?

Answer:

Proposed by Leonard Adleman utilizing the property of DNA for massively parallel computation. With an appropriate setup and enough DNA, one can potentially solve huge problems by parallel search. Can be much faster than utilizing a conventional computer.

Q35: What is Quantum Computing?

Answer:

A quantum computer is a machine that performs calculations based on the laws of quantum mechanics, which is the behavior of particles at the sub-atomic level.

Q36: Why are natural approaches appealing?

Answer:

All natural approaches are very appealing to us mainly for computational reasons. They also may help us study and understand the world we inhabit, and even to create new forms of life and new computing paradigms.

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Q37: What is Modeling?

Answer:

Modeling is an integral part of many scientific disciplines and lies behind great human achievements and developments. Most often the more complex a system the more simplifications are embodied in its models. Trappenberg defined “models (as) abstractions of real world systems or implications of a hypothesis in order to investigate particular questions or to demonstrate particular features of a system or a hypothesis.” The critical steps in constructing a model are the selection of salient features and laws governing the behavior of the phenomena under investigation.

Q38: Why do we need Feature Selection?

Answer:

- 1. To improve performance (in terms of speed, predictive power, simplicity of the model).*
- 2. To visualize the data for model selection.*
- 3. To reduce dimensionality and remove noise.*

Feature Selection is a process that chooses an optimal subset of features according to a certain criterion.

Q39: What is a Metaphor?

Answer:

The word metaphor comes from the Greek for “transference”. It corresponds to the use of language that assigns one thing to designate another in order to characterize the latter in terms of the former. Metaphors of the form X is a Y can be understood as X is like Y . e.g. to name a computational tool developed with inspiration from human brain an “artificial neural network” or a “neurocomputing device” corresponds to attributing properties of the human brain to the artificial neural network or neurocomputing device.

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Q40: What is the first step toward developing a NC system?

Answer:

In most cases the first step toward developing a NC system is to look at nature or theoretical models of natural phenomena in order to have some insights into how nature works and how it behaves.

Q41: What is an Agent?

Answer:

Agent is taken from the Latin word agere, means to do. An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators. An agent is a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet its design objectives. The terms Individuals, entities and agents are sometimes used interchangeably with no distinctions in the literature. Agents can be of many types including, biological, physical or virtual.

Q42: What are the properties of agents?

Answer:

- 1. Autonomy: agents operate without direct intervention from the user, and have some sort of control over their actions.*
- 2. Pro-activeness: agents not only react in response to the environment but also exhibit goal-directed behavior.*
- 3. Reactivity: agents perceive their environment and respond to changes.*
- 4. Social ability: agents can interact with other agents.*

Q43: What is Parallelism and Distributivity in nature?

Answer:

In the natural world parallel processing is evident in insect societies brain processing and so forth. A colony of ants has individuals assigned to various tasks such as harvesting food, cleaning the nest and caring for the queen. Termites, bees

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and wasps also perform similar tasks in a distributed way there are individuals allocated for different tasks. In parallel computing, all processors may have access to a shared memory to exchange information between processors. In distributed computing each processor has its own private memory (distributed memory). Information is exchanged by passing messages between the processors.

Q44: What is Interactivity in natural systems?

Answer:

A remarkable feature of natural systems that individual agents are capable of interacting with one another or the environment. Individual organisms interact with one another in variety of forms: reproductively, symbiotically, competitively etc. In computer science interactive computing refers to software which accepts input from humans as it runs.

Q45: What is Connectivity in natural computing?

Answer:

Connectionist systems employ a type of representation whereby information is encoded throughout the nodes and connections of the network of basic elements also called units. The connections establish specific pathways of interaction between units two units can only interact if they have a connection linking them. Networks are successful examples of parallel-distributed processors for instance neural networks and immune networks.

Q46: What is Stigmergy?

Answer:

Stigmergy is a consensus social network mechanism of indirect coordination through the environment between agents or actions. The principle is that the trace left in the environment by an action stimulates the performance of a next action. Stigmergy is a form of self-organization social network.

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Q47: What is Adaptation?

Answer:

Organisms face a succession of environmental challenges as they grow and show adaptive plasticity as traits develop in response to the imposed conditions. This gives them resilience to varying environments. An adaptation can be structural meaning it is a physical part of the organism. An adaptation can also be behavioral affecting the way an organism acts.

Q48: What is Evolution?

Answer:

Evolution means the slow gradual change in a population of organisms over time. Evolution includes all of the changes in the characteristics and diversity of life that occur throughout time. Evolution can occur on both large and small scales.

Q49: What is Feedback?

Answer:

Feedback occurs when the response to a stimulus has an effect of some kind on the original stimulus. It can be understood as the return of a portion of the output of a process or system to the input especially when used to maintain performance or to control a system or a process.

The main types of feedback are **negative feedback** and **positive feedback**. These mechanisms differ in how the output affects the system:

Negative Feedback: Counteracts changes in a system to maintain stability.

Positive Feedback: Amplifies changes in a system driving it further in the same direction

Q50: What is Self-organization?

Answer:

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Self-organization refers to a broad range of pattern-formation processes in both physical and biological systems such as sand grains assembling into rippled dunes, cells making up highly structured tissues, fishes joining together in schools and so forth. A pattern corresponds to a particular, organized arrangement of objects in space or time.

Q51: What is Emergence?

Answer:

Emergence is a phenomenon whereby larger entities arise through interactions among smaller or simpler entities such that the larger entities exhibit properties not exhibited by the smaller/simpler entities.

Q52: What is Reductionism?

Answer:

Reductionism refers to several related philosophical ideas regarding the associations between phenomena which can be described in terms of other phenomena the latter of which are considered in some manner simpler or more fundamental. Reductionism attempts explanation of entire systems in terms of their individual, constituent parts and their interactions.

Q53: What are Bottom-up vs Top-down approaches?

Answer:

A top-down approach, also known as stepwise design is essentially the breaking down of a system to gain insight into its compositional sub-systems in a reverse engineering fashion. A bottom-up approach is the piecing together of systems to give rise to more complex systems thus making the original systems sub-systems of the emergent system

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Q54: What is determinism?

Answer

Determinism is a belief that a determinate set of conditions can only produce one possible outcome given fixed laws of nature.

Q55: What does universal causation mean?

Answer

Universal causation means that every event everything that happens or occurs has a cause.

Q56: How do fatalists view determinism?

Answer

Fatalists claim that there is nothing that we can do to affect our lives in any significant way. For example one cannot in any way affect whether he or she is going to have a fatal accident tomorrow.

Q57: How do determinists differ from fatalists?

Answer

Determinists allow that human actions can make a difference. Scientific theories are capable of providing deterministic relations between the elements being investigated.

Q58: What is a characteristic of a deterministic system?

Answer

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The main characteristic of a deterministic system is predictability. A deterministic system can have its time evolution predicted precisely, and all events are inevitable consequences of antecedent sufficient causes.

Q59: What theoretical consequence arose from chaos theory regarding determinism?

Answer

Chaos theory led to the realization that there is a divorce between determinism and predictability meaning that a system may be deterministic but not fully predictable.

Q60: What types of phenomena are described by chaos theory?

Answer

Chaos theory deals with nonlinear phenomena that are effectively impossible to predict or control, such as changes in weather, cardiac arrhythmias, traffic flow patterns, epidemics, and the behavior of people in groups.

Q61: How does chaos theory differ from traditional notions of chaos?

Answer

Traditional chaos is thought of as unorganized, disorderly or random. Chaos theory however focuses on uncovering statistical regularities in processes that appear random.

Q62: What is the butterfly effect?

Answer

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The butterfly effect is a concept stating that small causes can have larger effects. Systems described as "chaotic" are extremely susceptible to changes in initial conditions.

Q63: How did chaos theory impact the understanding of natural phenomena?

Answer

Insights from chaos theory led to understanding patterns in the natural world such as the shapes of clouds, paths of lightning and coastlines.

Q63: What are fractals?

Answer

Fractals are never-ending, infinitely complex patterns that are self-similar across different scales. They are used to describe irregular, fragmented, jagged, or broken-up shapes found in nature, mathematics, and art.

Q64: Where are fractals found in nature?

Answer

Fractals are found in trees, leaves, snowflakes, clouds, landscapes, rivers, organs, molecules, genes, and even artistic patterns.

Q65: How is fractal geometry different from conventional geometry?

Answer

Fractal geometry deals with irregular patterns made of parts similar to the whole whereas conventional geometry concerns regular shapes, whole numbers, and lines.

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Q66: What is the purpose of physiological systems modeling?

Answer

The purpose is to understand how organs work, what happens in diseased organs how drugs affect organs and what constitutes healthy functioning for cells, organs, or the body.

Q67: What is a model?

Answer

A model is a simplified representation or abstraction of reality used for prediction, simulation, diagnostics, design, performance evaluation, and control system design.

Q68: How are models classified?

Answer

1. Models can be classified as:
2. Linear vs. Non-linear
3. Deterministic vs. Probabilistic (Stochastic)
4. Static vs. Dynamic
5. Discrete vs. Continuous
6. White box, black box, and gray box

Q69: What is abduction in modeling?

Answer

Abduction is the process of forming a personal hypothesis based on observed data as in spectators forming different descriptions of a TV drama. Each person creates a descriptive model of the system.

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Q70: What are the two most important classes of variables in modeling?

Answer

The input and the output of the system. Inputs are information or signals entering the system and can be manipulated outputs are the resulting signals or information from the system.

Q71: Does high precision imply high accuracy?

Answer

No. High precision does not imply high accuracy because precision does not compare to the true value.

Q72: How is a model tested?

Answer

A model is tested by acquiring additional data and simulating the model against this new data. Refinement continues until satisfactory accuracy is achieved using a quantitative goodness-of-fit criterion.

Q72: Who initiated sub-cellular and cellular modeling in 1952?

Answer

Alan Lloyd Hodgkin and Andrew Huxley who presented nonlinear ordinary differential equations approximating electrical characteristics of excitable cells.

Q73: Who presented the first cardiac Purkinje fiber model?

Answer

Denis Noble in 1960.

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Q74: What was the contribution of Alcmaeon of Croton?

Answer

He localized the brain as the center of understanding reality introduced channels connecting the brain to sensory organs and related health to balance.

Q75: What is the Physiome Project?

Answer

An internationally collaborative project initiated in 1993 to provide a public framework for computational physiology including databases of models at all spatial scales aiming to describe the functioning organism in normal and pathophysiological states.

Q76: What is physiome built upon?

Answer

Physiome is built upon the morphome, which describes the quantitative anatomical structure, chemical and biochemical composition, and material properties of an organism.

Q77: What is the purpose of the Physiome Project?

Answer

To define the physiome, provide a framework for modeling the human body using computational methods, integrate omics data, and support drug development and biosensor research.

Q78: What are prerequisites for the Physiome Project?

Answer

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Scientific, sociological, and political support, open-source information, free communication among investigators, and collaboration across institutions.

Q79: What are the stages of modeling a submodule?

Answer

Schema of relationships, definitions of types and characteristics of relationships, quantitation of kinetics, mechanisms for relationships, and eventually quantitative mathematical models.

Q80: How are submodules linked?

Answer

Through inputs and outputs called “hooks” which transmit influences between submodules.

Q81: What is the Virtual Physiological Human (VPH)?

Answer

A computer-based simulation of human physiology, integrating knowledge of all body components to understand their interactions, predict health evolution, and enable individualised medicine.

Q82: What is the Cardiome Project?

Answer

A part of the Physiome Project aimed at developing an interactive model of the physiologically normal working heart integrating multiple data types from physiology, electrophysiology, metabolism and transport.

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Q83: At what levels can models be formulated?

Answer

Cellular, intercellular, tissue, organ and organism levels.

Q84: What is the difference between deterministic and stochastic models?

Answer

Deterministic models have exact relationships and predictability given initial conditions. Stochastic models include chance and can only predict outcomes in terms of probabilities.

Q85: What are parametric and non-parametric models?

Answer

Parametric models rely on physical laws and parameters to describe system behavior. Non-parametric models estimate system outputs from input-output data without assuming specific internal structures.

Q86: Provide an applied example distinguishing parameters and state variables.

Answer

Modeling heart rhythm during short-term exercise: food intake and time of day are fixed parameters. Modeling heart rhythm over an entire day would treat time of day and food absorption as state variables.

Q87: What is compartmental modeling?

Answer

Used for systems describing solute transfer across well-mixed compartments. Examples include blood distribution, cellular dynamics, temperature distribution, and pharmacokinetics.

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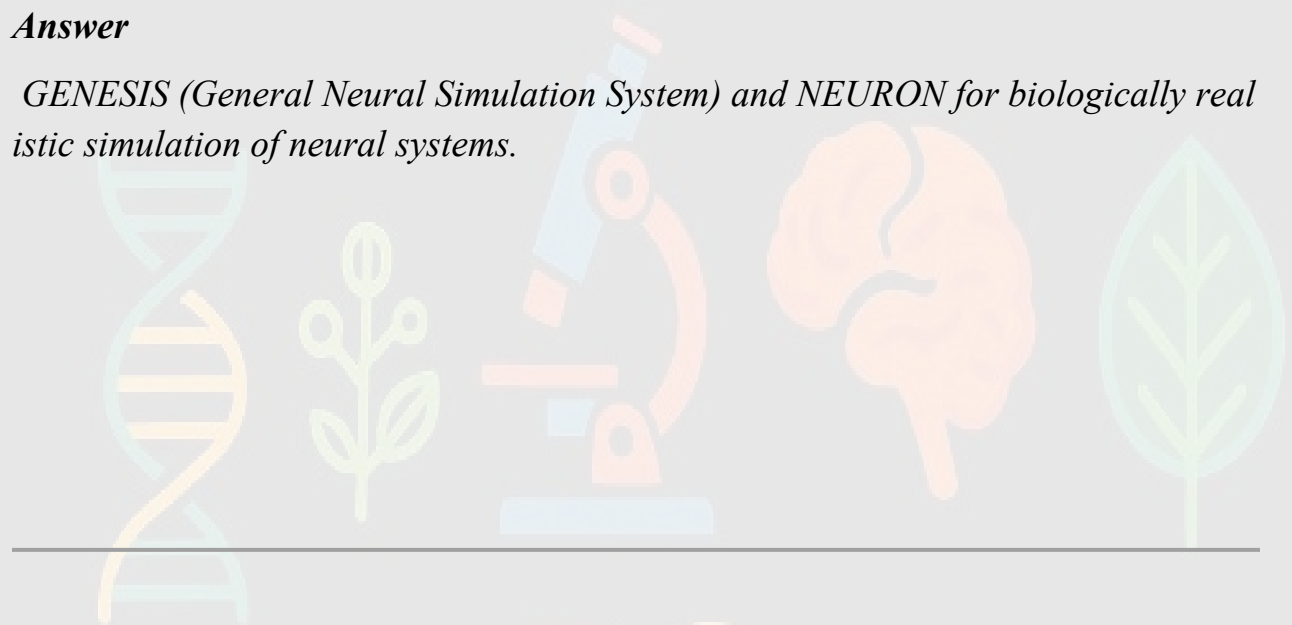
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Q88: What software supports neural system simulation?

Answer

GENESIS (General Neural Simulation System) and NEURON for biologically realistic simulation of neural systems.



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"Note: This is just one example of a solution. Try to come up with your own idea!"

Good Luck 😊

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