**Sample Final Questions**

1. **Simple - complex questions (to be answered in class):**

* What is the learning equation for unsupervised learning in an NN?
* What is the function of the Sparsity term in Deep Learning? How does it works?
* Can you relate reward and actions in an RL with BPN? If so how?
* What is Policy and Value in RL?
* Why do we need both Exploitation and Exploration in an RL? Will just Exploration work?
* What is the purpose of Pooling layer in DL?
* Why do we need FC layer in CNN?
* Why we cannot use Sigmoid function in DL; What is a good alternative to Sigmoid function.
* What is role of neighborhood function in SOM?

1. **Agents**

A.

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**Ans.**

**Agent:**

Anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators .

**Agent function :**

maps from percept histories to actions:

[*f*: P\* 🡪 A]

**Agent program** :

Program implementing or approximating an agent function.

**Rationality :**

A rational agent is one that acts so as to achieve the best outcome or,

when there is uncertainty, the best expected outcome.

**Autonomy:**

A property of agents that enables to handle unforeseen circumstances i.e. can compensate for partial or incorrect prior knowledge.

**Reflex agent :**

An agent that selects an action on the basis current percept, ignoring the rest of percept history.

**Model-based agent :**

An agent that uses a model for the world to represent how the world works. It uses the model to determine its actions.

**Goal- based agent :**

An agent that acts in order to achieve or maximize its

designated goals.

**Utility-based agent :**

Agent whose performance measure is given by a utility function.

**Learning agent :**

An agent that improves its performance over time through learning.

B. For each of the following agents, determine PEAS:

* Robot Soccer player
* Internet book-keeping agent

Ans.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Task** | **Measure Performance** | **Environment** | **Actuators** | **Sensors** |
| Robot soccer  player | Score, number of mistakes made, following the rule,.. | Ball, play ground, team  members,  competitors, | Legs, arms, head, speakers | Video camera,  Microphone, touch sensors, communication sensors |
| Internet  book-shopping  agent | Minimizing  cost, time,  information  about  interesting  books | The Internet,  Browsers, customer | Speakers, display, Add a new  order | Keyboard, Mouse, Microphone, Web pages,  buttons or  hyperlinks  clicked by  users |

C.

Consider an Agent that has to recognize the letters of the alphabet. Suppose the agent observe a binary image of 30 pixel x 30 pixel where each of the 900 points are either on or off. The action is to determine what letter an image represent.

1. How many states are there?
2. How many functions from the image state can form characters?
3. What is a practical way to represent features?

**To be done in the class.**

1. **Reinforcement Learning** –

* Need to do a good “search” using any search algorithms we have covered.
* How does the Agent learn so that the Reward is maximized over period of time (future discounting is needed)? [Can skip it]
* How would the Learning Unit learn?

B.

NN Architecture search using RNN (Recurrent Neural Net) Reinforcement Learning

1. **Just to raise your awareness and understanding**

The idea is that the structure and connectivity of a neural network can be described by a variable-length string. A neural network referred to as the controller is used to generate such a string. The child network that’s specified by the string is then trained on real data and results in an initial measure of accuracy on the validation set. This accuracy is then used to compute the policy gradient that updates the controller. As a result, architectures that have higher accuracies are given higher probabilities.



The controller predicts the filter height, filter width, and the stride height. The predictions are performed by a softmax classifier and then fed into the next time step as input. Once the controller completes the process of generating the architecture, a neural network with this architecture is built and trained.

Diagram

Description automatically generated

**\*\* Use some slides from Lecture 9**

* **Clearly RL is difficult – too many spaces to search, determining proper actions, relating / selecting actions to optimize rewards, discounting, Policy determination, Exploration, ….**
* **RL with Feature (SARSA – not covered) can help. Markov Chain Monte Carlo can also help (not covered). NLC and semantics (we covered briefly) can be very helpful!**
* **Knowledge-Based (KB) Agents ( Knowledge & Reasoning): an important part of Learning and making decisions. Dominated by Propositional Logic (very limited), Predicate Logic (limited) and Reasoning Under uncertainty. KB-Agent can help Exploration….Not Covered**

***NLC is essential here.***

1. **Unsupervised Learning**

* Lab solution

1. **Search / GA / Decision Tree**

**(in class) and also see below**

**GA – sample problem & solution:**

Consider to solve the following equation using GA (Genetic Algorithm):

a + 2b + 3c + 4d = 30. You are basically trying to find out the values for coefficients a, b, c and d using a search process. So, each chromosome has 4 numeric values for 4 coefficients. Assume a population size of 4. Assume values of the coefficients are between 0 and 30. You need to **show just 2 iterations** (thus you may not find a solution).

**Determine a good fitness function.** Selection is done by using the 2 top probabilities for the 2 parents that need to be mated for the next generation (so you would need to calculate appropriate probabilities). Then pick 2 population from 4 (after mating) using highest fitness values. From the new 4 population, select 2 parents for the 2nd iteration (using the criterion mentioned above) and complete the 2nd iteration. **Show all GA steps.**

**Ans.: Here the goal is to minimize f =** a + 2b + 3c + 4d – 30 (ideally to 0). The constraint is that a, b, c and d are between 0 and 30.

**1st Iteration -**

Initialization: Assume 4 chromosomes (population size of 4 as given) –

P1 - {1, 10, 20, 30}

P2 - {5, 6, 7, 21}

P3 - {10, 11, 21, 29}

P4 - {7, 8, 9, 10}

Fitness Function – Since we are trying to minimize f, a good fitness function will be 1/f so that the probability will be high i.e. fitness will be high etc.

Evaluation –

For P1 -> 1 + 2x10 + 3x 20 + 4x30 – 30 = 1 + 20 + 60 + 120 – 30 = 71 -> 1/f = .014

For P2 -> 5 + 6x10 + 7x 20 + 21x30 – 30 = 5 + 60 + 140 + 630 – 30 = 805 -> 1/f = .0012

For P3 -> 10 + 11x10 + 21x 20 + 29x30 – 30 = 10 + 110 + 420 + 870 – 30 = 1380 -> .000072

For P4 -> 7 + 8x10 + 9x 20 + 10x30 – 30 = 7 + 80 + 180 + 300 – 30 = 537-> 1/f = .0018

Probabilities – for P1: .014 / (.014 + .0012 + .00072 + .0018) = .014 / .0177 = 0.79.

Selection:

Clearly, the 2 highest probabilities will be with P1 and P4. So, we take P1 and P4 as the parents to mate (these are the fittest).

P1 - {1, 10, 20, 30} P4 - {7, 8, 9, 10}. Use 3rd position as Crossover point. Hence, we have,

P1’ – {1, 10, 9, 10} and P2’ – {7, 8, 20, 30}.

Mutation – randomly select position 4 for P1’ and position 2 for P2’

* {1, 10, 9, 20} and {7, 19, 20, 30}. We now need to calculate the fitness of all these 4 chromosomes and then select the 2 with the highest fitness values (call these Q1, Q2).

**2nd iteration:**

**Now we have 4 new population: P2, P3, Q1 and Q2.** Now repeat the same process again starting with calculating the fitness values to make selection for next parents.

1. **Deep Learning (in class)**

* What Deep Learning really does?
* How does it do it?
* Can Deep Learning do classification or Regression? Why or why not?

1. **Future Technologies – Intelligent Internet, Semantic Engine, ML for Unstructured data (Not covered)**