**Bahria University, Islamabad Campus**

Department of Computer Science

Final Assessment

Class/Section: MS(DS/CS)-3A

**(Spring 2020 Semester)**

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| Course: | **Deep Learning** | Date Assigned: **July 3, 2020** |
| Course Code: | DSC 707 | Start Time: **15:30** |
| Faculty’s Name: | Dr. Imran Siddiqi | Submission Time: **23:30** |
| Max Marks: | 50 |  |

**INSTRUCTIONS:**

1. The assessment is an individual effort and is assumed to be completed with academic honesty.
2. **Plagiarism** (copying) is not tolerable and will be considered equivalent to cheating in a regular exam. Plagiarized content will be awarded **zero credit** without any debate.
3. Submissions will only be accepted **through LMS** and not through any other medium.
4. Use this file as an **answer sheet** and provide your solutions. Submit the solution as a **single PDF file**.
5. Clearly write your **Name and Enrolment No**. in the space provided below.
6. Both typed and handwritten submissions are acceptable.

|  |  |  |  |
| --- | --- | --- | --- |
| **Name:** |  | **Enrolment No.** |  |

|  |  |  |
| --- | --- | --- |
| **Question** | **Marks Obtained** | **Max. Marks** |
| **1** |  | **16** |
| **2** |  | **12** |
| **3** |  | **14** |
| **4** |  | **08** |
| **TOTAL** |  | **50** |

**Question # 1 (16 Marks)**

(5)

1. Take your enrolment number, for example 01-284192-003. Drop the prefix “01” and remove the separator ‘-‘ : 01-284192-003 🡪 284192003. Create a 3x3 filter by scanning the sequence from left to right and filling a 3x3 matrix row-wise:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *f* = | |  |  |  | | --- | --- | --- | | 2 | 8 | 4 | | 1 | 9 | 2 | | 0 | 0 | 3 | |

Consider the top left 2x2 part of the above filter and assume it to be a feature map. For the above filter, the feature map would be:

|  |  |
| --- | --- |
| 2 | 8 |
| 1 | 9 |

Apply **Transposed convolution** on the feature map with filter ‘f’ using stride = 2 and no padding.

Show the filter as well as the result of Transposed Convolution:

|  |
| --- |
|  |

**(8)**

1. Consider an input volume of dimension . Filters of size are applied on the input volume with NO PADDING and stride of 2. A total of such filters are applied. Compute the total number of multiplications as well as parameters for:

* Standard Convolution
* Depth-wise Separable Convolution

**Note: Your answer should only contain the given variables (*N, D, f & M*), No credit for assuming new variables or values for given variables.**

|  |  |
| --- | --- |
| **Total Multiplications:** | |
| Standard Convolution |  |
| Depth-wise Separable Convolution |  |
| **Total Parameters:** | |
| Standard Convolution |  |
| Depth-wise Separable Convolution |  |

**(3)**

1. Assume you apply transfer learning on pre-trained ConvNets to solve a classification problem. Pre-trained models are used as feature extractors with SVM classifier. Furthermore, in another set of experiments, they are fine-tuned on your dataset by continuing back propagation. The following results are reported on test data.

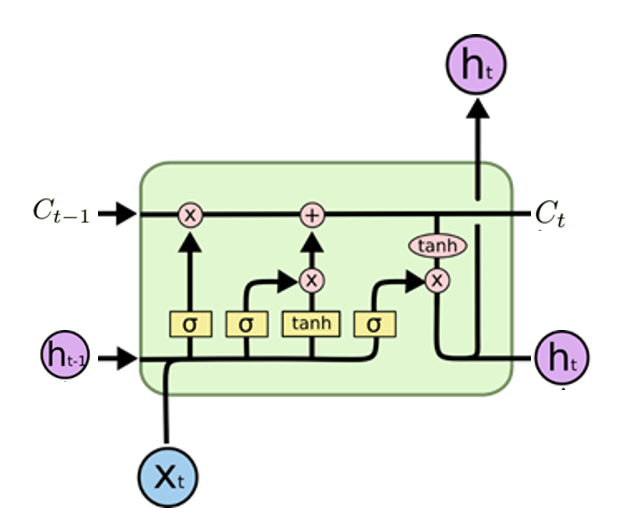
Analyze these results and write a brief discussion on the inferences you can make from the reported results.

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**Question # 2 (12 Marks)**

**(6+2)**

1. Consider the general architecture of an LSTM cell as follows.



The parameters of LSTM are summarized in the following.

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

1. Feed the input vector provided in Annex-A (at the end of question paper) to the LSTM and compute the cell state and hidden state. A separate input sequence has been specified for each of the students and the same sequence is to be employed.

**Note**: Use precision of two places after decimal and fill you answers in the following table:

|  |  |  |
| --- | --- | --- |
| Forget gate output: |  |  |
| Input gate output: |  |  |
| Candidate cell state: |  |  |
| Updated cell state: |  |  |
| Output gate: |  |  |
| Updated hidden sate: |  |  |

1. Assume the LSTM (above) is employed to predict the rating of a review on a scale of 1 to 5. State the total number of parameters in this model.

|  |  |
| --- | --- |
| Total Number of Parameters: |  |

**(4)**

1. Normalize the matrix ‘f’ in Question # 1 by dividing each value in the matrix by the sum of all values in that column. (An example is shown below)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | | 2 | 8 | 4 | | 1 | 9 | 2 | | 0 | 0 | 3 | |  | |  |  |  | | --- | --- | --- | | 2/3 | 8/17 | 4/9 | | 1/3 | 9/17 | 2/9 | | 0/3 | 0/17 | 3/9 | |

Use the normalized values to fill the following 3x3 table

|  |  |  |  |
| --- | --- | --- | --- |
|  | **T=0** | **T=1** | **T=2** |
| **“B”** |  |  |  |
| **“Y”** |  |  |  |
| **“-”** |  |  |  |

Now, consider this 3x3 table as the network output for a handwriting recognition task with CTC loss. There are three time-steps and the vocabulary is V= {“B”, “Y”, “-”} where “-” represents the pseudo character. Compute CTC loss from the network output if the ground truth transcription was “BY”.

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**Question # 3 (14 Marks)**

**(7)**

1. Consider a simple (single-layer) recurrent neural network that is trained to accept a sequence of words and predict the next word. The vocabulary has four words in total that are one-hot encoded.

*V = {“exam”, “is”, “easy”, “tough”}*

|  |  |
| --- | --- |
| *exam:* | [1 0 0 0] |
| *is:* | [0 1 0 0] |
| *tough:* | [0 0 1 0] |
| *easy:* | [0 0 0 1] |

The parameters of the RNN are listed in the following.

|  |  |  |
| --- | --- | --- |
|  |  |  |

Assume the network is fed with two words: “exam is \_\_\_\_\_\_\_\_\_”. Predict the third word using the given RNN. Show the key steps which lead you to the final solution.

Solution:

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**(4)**

1. In the context of object detection, assume an image of size 256 x 256 is fed to a CNN. The CNN has five convolutional and five pooling layers. Convolution is always done with padding and stride of 1 using a filter of size 5x5. All pooling layers employ max pooling with filter size of 2x2 and stride of 2.

Selective search produces a region proposal of size 64x 128 at location (96, 96) in the image. Project the region proposal on the feature map and state the location and size of the projected proposal.

|  |  |
| --- | --- |
| Location of Projected Proposal: |  |
| Size of Projected Proposal: |  |

**(3)**

1. List key differences between YOLO and Fast R-CNN for object detection. Only crisp differences and not details of these algorithms are required.

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**Question # 4 (8 Marks)**

**(5)**

1. Design and list the algorithmic steps that allow employing an auto-encoder to fill the missing parts in an image (scene completion). The listed steps are expected to be independent of any implementation platform.

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**(3)**

1. The recent dominance of deep learning based solution is forcing many researchers to employ such solutions for relatively simple problems which could easily be solved using traditional techniques. Provide your (scientific) views on this tendency with arguments in favor of or against this trend.

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**Anx-A (Question 2)**

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| **SNo.** | **Enrollment No.** | **Name** | **Input vector for LSTM** |
| 1 | 01-242182-001 | ALI AHSAN | [0.1 0.2 0.3] |
| 2 | 01-242182-004 | MUHAMMAD HAMZA | [0.1 0.3 0.2] |
| 3 | 01-242182-005 | MUHAMMAD IRFAN | [0.3 0.2 0.1] |
| 4 | 01-242182-008 | RAFI ULLAH KHAN | [0.1 0.2 0.1] |
| 5 | 01-243191-002 | ABDUL MAJID | [0.1 0.3 0.1] |
| 6 | 01-243191-008 | MUHAMMAD IBRAHIM KHALIL | [0.2 0.1 0.2] |
| 7 | 01-243191-012 | SIDRA NASIR | [0.2 0.3 0.2] |
| 8 | 01-243191-019 | SYED WAJAHAT ALI SHAH | [0.3 0.1 0.1] |
| 9 | 01-243191-021 | WAQAS NAWAZ | [0.3 0.2 0.3] |
| 10 | 01-249182-004 | HUSSAIN WAHEED AKHTAR | [0.1 0.1 0.2] |
| 11 | 01-249182-006 | IKRAM ULLAH KHAN | [0.1 0.1 0.3] |
| 12 | 01-249182-012 | MUHAMMAD ROHAN ALI | [0.2 0.2 0.1] |
| 13 | 01-249182-017 | NAJAM KHAN | [0.2 0.2 0.3] |
| 14 | 01-249182-018 | QASIM MEHMOOD | [0.3 0.3 0.1] |
| 15 | 01-249182-025 | UZAIR TAYYAB RAI | [0.3 0.3 0.2] |
| 16 | 01-249182-028 | HUSSAIN TARIQ | [0.4 0.5 0.6] |
| 17 | 01-249182-029 | YAHYA ALI SHARIF | [0.5 0.4 0.6] |
| 18 | 01-249191-001 | BILAL UR RAHMAN | [0.6 0.5 0.4] |
| 19 | 01-249191-002 | HAIDER ALI | [0.4 0.5 0.4] |
| 20 | 01-249191-003 | IRFAN RASHID | [0.4 0.6 0.4] |
| 21 | 01-249191-004 | KINZA TAMEEZ | [0.5 0.4 0.5] |
| 22 | 01-249191-006 | MUHAMMAD BILAL | [0.5 0.6 0.5] |
| 23 | 01-249191-007 | MUHAMMAD UMAR SAFEER | [0.6 0.4 0.6] |
| 24 | 01-249191-008 | NOOR UL HAQ | [0.6 0.5 0.6] |
| 25 | 01-249191-009 | SAAD HABIB | [0.4 0.4 0.5] |
| 26 | 01-249191-010 | SARFRAZ AHMAD | [0.4 0.4 0.6] |
| 27 | 01-249191-011 | SUNBUL AYUB | [0.5 0.5 0.4] |
| 28 | 01-249191-012 | UM KALSOOM | [0.5 0.5 0.6] |
| 29 | 01-249191-013 | WAQAR KALEEM KHAN | [0.6 0.6 0.4] |
| 30 | 01-249191-014 | ALI IMRAN | [0.6 0.6 0.5] |
| 31 | 01-249191-015 | ATIF FAROOQ | [0.1 0.2 0.4] |
| 32 | 01-249191-016 | HAFIZ MUHAMMAD QADIR | [0.4 0.2 0.1] |
| 33 | 01-249191-017 | MUHAMMAD ASHAR QADIR | [0.2 0.4 0.1] |
| 34 | 01-249191-018 | SEHRISH GUL | [0.1 0.2 0.5] |
| 35 | 01-249191-020 | BASIT ALI | [0.2 0.1 0.5] |
| 36 | 01-249191-021 | MUHAMMAD AHMED | [0.5 0.2 0.1] |
| 37 | 01-249191-022 | MUHAMMAD ROOSHAN JAVED | [0.5 0.1 0.2] |
| 38 | 01-249191-024 | USAMA BIN BILAL | [0.5 0.2 0.4] |
| 39 | 01-284192-001 | JUNAID ALI KHAN | [0.6 0.4 0.8] |
| 40 | 01-281192-001 | ADNAN YAQOOB SALIK | [0.8 0.4 0.6] |

**Bon Courage ☺**