**Quiz** **Name:**

**CS276: Fall 2021** **Student Number:**

**Instructor: Jingyi Yu**

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Instructions:

Please answer the questions below. Show all your work. This is a close-book test. NO discussion/collaboration is allowed.

**Problem 1. CG (10 points)**

(a) Given the camera position $p = [1.0, 0.5, -2.0]$, viewing direction $v = [1.0,\ 0.5,\ 1.0]$, and the up direction $u = [0,\ 1,\ 0]$, determine the view transformation matrix $M$ which transforms 3D points onto camera coordinate system.

(b) Please briefly explain the difference between Ray Tracing and Rasterization.

**Problem 2. Deep learning (10 points)**

(a) You are designing a CNN classifier. For each layer, calculate the number of weights, number of biases and the size of the associated feature maps. The notation follows the convention:

- **CONV-K-N** denotes a convolutional layer with N filters, each them of size K×K, Padding and stride parameters are always 0 and 1 respectively.
- **POOL-K** indicates a K × K pooling layer with stride K and padding 0
- **FC-N** stands for a fully-connected layer with N neurons.

| Layer | Activation map dimensions |
|---|---|
| INPUT | 128 × 128 × 3 |
| CONV-9-32 | |
| POOL-2 | |
| CONV-5-64 | |
| POOL-2 | |
| CONV-5-64 | |
| POOL-2 | |
| FC-3 | |

(b) Why is it important to place non-linearities between the layers of neural networks?

**Problem 3. Optimizer (10 points)**

(c) The code below is meant to implement a single step of the training loop using the Adam optimizer, but some parts are missing. Finish the implementation of each line marked TODO. Recall the parameter update equations for Adam optimization:

$$V = \beta_1 V + (1 - \beta_1)\frac{\partial J}{\partial W}$$

$$S = \beta_2 S + (1 - \beta_2)\left(\frac{\partial J}{\partial W}\right)^2$$

$$V_{corr} = \frac{V}{1 - \beta_1^t}$$

$$S_{corr} = \frac{S}{1 - \beta_2^t}$$

$$W = W - \frac{\alpha}{\sqrt{S_{corr}} + \epsilon} V_{corr}$$

```
def optim_adam(weights_dict, gradients_dict, cache_dict, step):
    """
    v is VdW, s is SdW, v_corr is VcorrdW, s_corr is ScorrdW.
    """
    lr, beta1, beta2, eps = 1e-3, 0.9, 0.999, 1e-8
    for weight_name in weights_dict:
        w = weights_dict[weight_name]
        grad = gradients_dict[weight_name]
        v = cache_dict["v" + weight_name]
        s = cache_dict["s" + weight_name]

        # TODO: Exp weighted avg of grad
        v =

        # TODO: Exp weighted avg of grad^2
        s =

        # TODO: Bias correction. divide by (1 - beta1^step))
        v_corr =

        # TODO: Bias correction. divide by (1 - beta2^step))
        s_corr =

        # TODO: Update rule for Adam
        w =

        cache_dict["v" + weight_name] = v
        cache_dict["s" + weight_name] = s
        weights_dict[weight_name] = w
```

**Problem 4. CV (10 points)**

Prove geometrically that the projections of two parallel lines lying in some plane $\Psi$ appear to converge on a horizon line $h$ formed by the intersection of the image plane $\Pi$ with the plane parallel to $\Psi$ and passing through pinhole. (Draw a picture if it helps. Here we give you an example, of course you can draw your own.)