

# nn-nb

September 23, 2015

```
In [1]: %load_ext tikzmagic
        %matplotlib inline

In [98]: import os
         import subprocess
         import sys
         from collections import namedtuple

         import numpy as np
         import matplotlib as mpl
         import matplotlib.pyplot as plt
         from mpl_toolkits.mplot3d import Axes3D
         from colormaps import viridis # DEATH TO JET!

         # Pylearn 2 Imports
         from pylearn2.config import yaml_parse
         from pylearn2.utils import serial

         # Add my Python utils to the path
         sys.path.append(os.path.join('.', 'Sean', 'py_utils'))

         # Some imports from local files
         from compare_output import compare_guesses, compare_output
         from pgm import read_pgm, write_pgm
         from raw import read_raw
```

## 1 Neural Network Image Processing with Pylearn2 for the JPL Space Design Competition

### 1.1 or: How I Learned to Stop Worrying and Love the Net



Figure 1:

<https://wiki.cites.illinois.edu/wiki/display/jplteam>

April, 2015, the aerospace department hosted a competition put on in conjunction with the NASA Jet Propulsion Laboratory which asked students to build an algorithm to identify safe landing zones on a series of hypothetical planetary surfaces given a limited set of overhead images and terrain data. While this sort of task is very important for NASA, nearly identical classification tasks can easily be constructed for other industrial applications, such as landing drones (think Amazon drone delivery).

Because this is a classification problem with a large component being image processing, we figured machine learning would be very well suited. We have in this problem a clear set of geometric constraints, and at the outset, we were unsure if we could construct an algorithm that would be able to handle all of the different constraints.

```
In [3]: # Define the locations of input things
train_dir = os.path.join(".", "training data", "terrainS{slope}C{crater}R{roughness}_100")
pgm_file = os.path.join(train_dir, "terrainS{slope}C{crater}R{roughness}_100.pgm")
raw_file = os.path.join(train_dir, "terrainS{slope}C{crater}R{roughness}_100_500by500_dem.raw")
soln_file = os.path.join(train_dir, "terrainS{slope}C{crater}R{roughness}_100.invHazard.pgm")

# Define the locations of output things
output_dir = os.path.join(".", "Sean", "nn_files_S{slope}C{crater}R{roughness}")
output_pgm = os.path.join(output_dir, "out_preprocessing_S{slope}C{crater}R{roughness}.pgm")
output_png = os.path.join(output_dir, "out_preprocessing_S{slope}C{crater}R{roughness}.png")
output_nn_safe = os.path.join(output_dir, "nn_outS{slope}C{crater}R{roughness}_safe.raw")
output_nn_unsafe = os.path.join(output_dir, "nn_outS{slope}C{crater}R{roughness}_unsafe.raw")

difficulty = namedtuple("Difficulty", ["slope", "crater", "roughness"])
difs = list(map(lambda x: difficulty(*x), [(0, 0, 10), (4, 0, 10), (4, 4, 10), (4, 4, 20)]))
```

## 2 Problem

### Can we use neural networks to identify “safe” landing sites on a planetary surface?

For each potential landing site (100 m x 100 m), we are given two sets of data:

1. The terrain height, with a resolution of 0.2 m (500x500 pixels), as a raw file of 32-bit floats
2. An overhead image of the landing site, with the sun from the east at 30° above the horizon, with a resolution of 0.1 m (1000x1000 pixels), as a pgm image file of 8-bit integers

In this scenario, this data would correspond to a coarse satellite imaging of the surface and a snapshot taken by the rover during the descent, respectively. Because of the relatively low sampling density, brute forcing the problem from the height data alone is not sufficient, we need some intelligent data processing scheme.

From these two sets of data, we must construct a corresponding 1000x1000 pixel map of acceptable landing locations.

### 2.1 Geometric Constraints

The rover that we must consider is one with the following dimensions:

For a given location to be considered safe, the rover must be able to land safely in all rotational configurations about its center.

There are two key constraints that disqualify a potential landing zone:

#### 2.1.1 Slope hazards

If the landing spot of the rover is at too great a slope, the rover runs the risk of toppling over. The maximum allowed tilt from vertical is 10°.

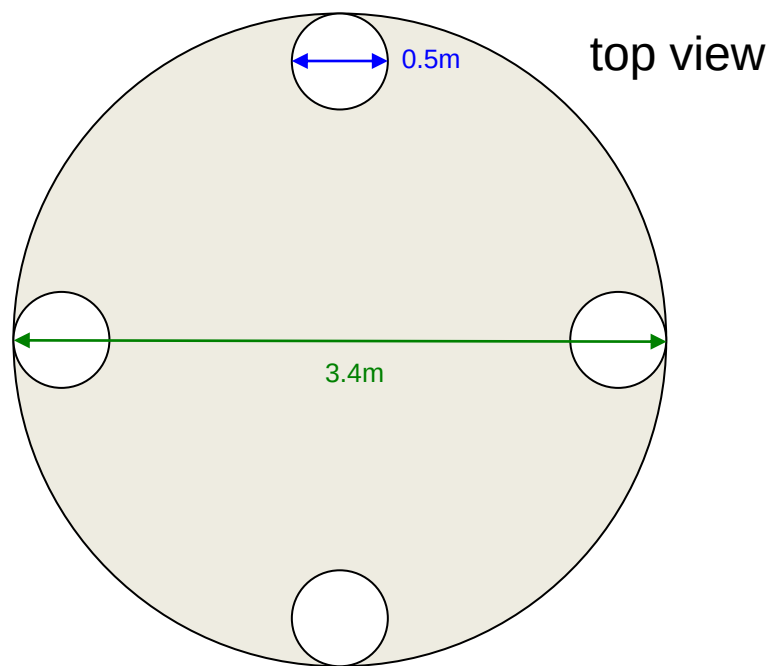
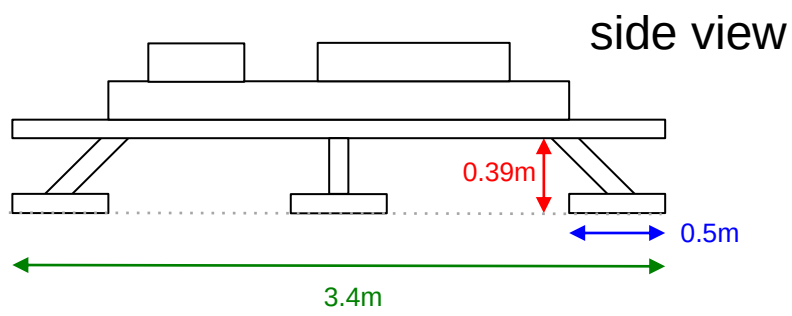


Figure 2:

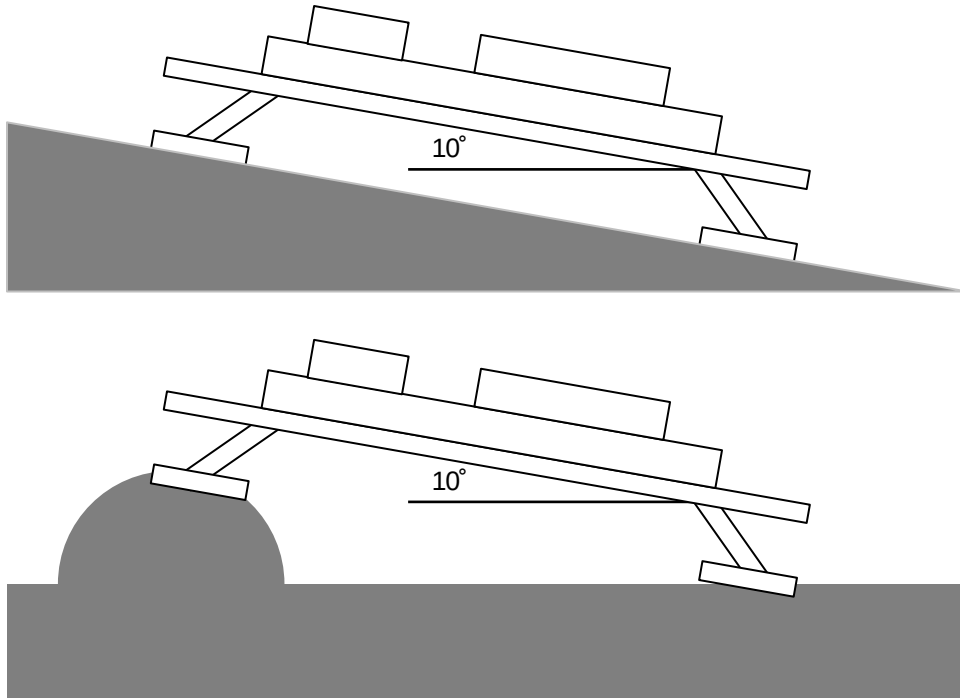


Figure 3:

### 2.1.2 Roughness hazards

There must be nothing below the rover that will make contact with the lower base of the rover, so there must be clearance over any rock or similar hazard.

## 3 Provided Information

→ 4 Training sets of varying difficulty

Easiest landing site only has roughness hazards (rocks), then slopes, craters, and additional roughness are added in succession for each of the three subsequent data sets. For each data set, the height and image data, as noted above, are provided, in addition to the correct solution.

The algorithm is judged on its ability to solve not only the provided sets of data, but another batch of 4 data sets on the day of the competition.

### 3.1 Height Data

```
In [5]: vmax = max(np.max(read_raw(raw_file.format(**scr._asdict()), 500, 500)) for scr in diffs)
        vmin = min(np.min(read_raw(raw_file.format(**scr._asdict()), 500, 500)) for scr in diffs)

In [9]: fig, axs = plt.subplots(1, 4, sharex=True, sharey=True)
        fig.set_size_inches(12, 2.9)

        x = np.linspace(0, 100, 500)
        X, Y = np.meshgrid(x, x)

        for i, scr in enumerate(diffs):
            # Here's the data we'll plot
```

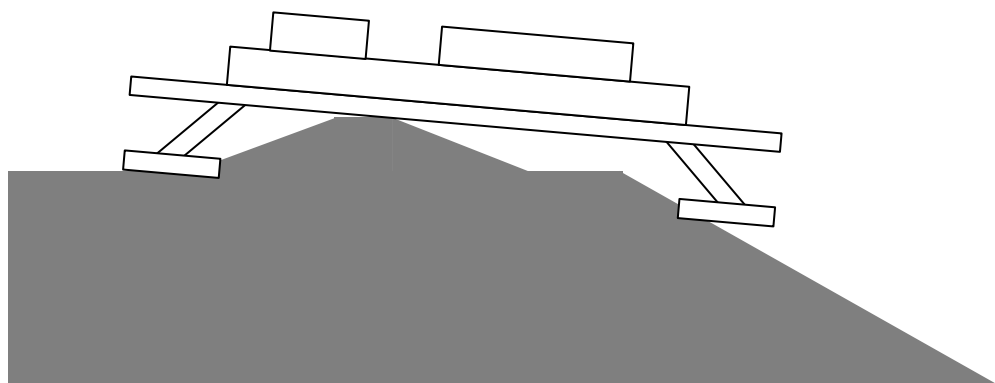
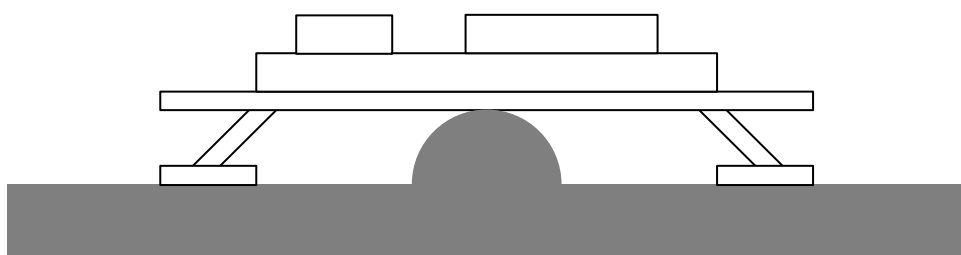
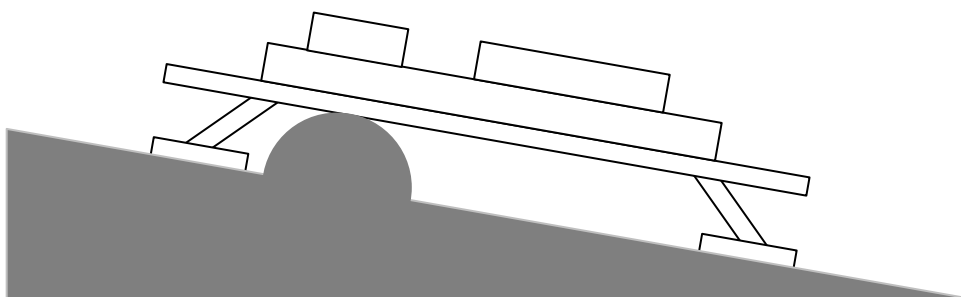
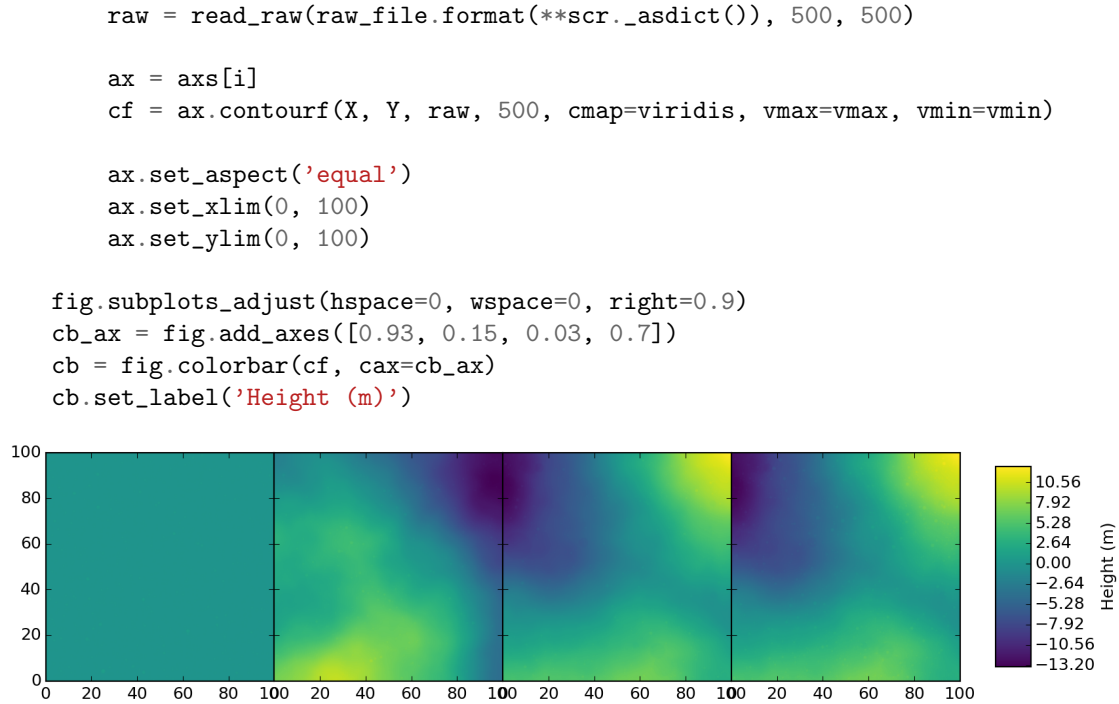


Figure 4:



```

In [6]: fig = plt.figure()
fig.set_size_inches(14, 3.5)

x = np.linspace(0, 100, 500)
X, Y = np.meshgrid(x, x)

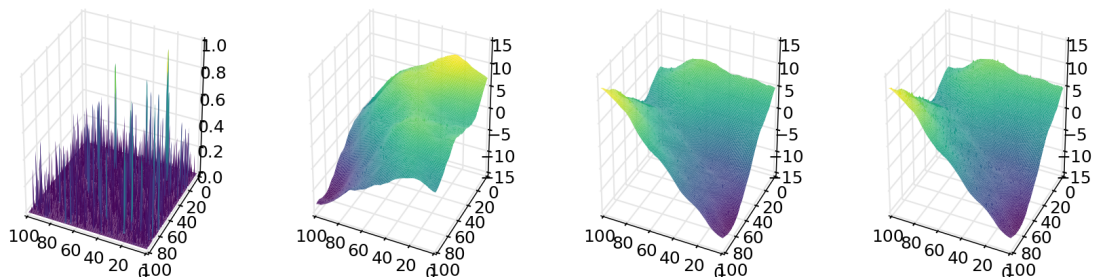
for i, scr in enumerate(diffs, start=1):
    # Here's the data we'll plot
    raw = read_raw(raw_file.format(**scr._asdict()), 500, 500)

    ax = fig.add_subplot(1, 4, i, projection='3d')
    ax.plot_surface(X, Y, raw, rstride=4, cstride=4, cmap=viridis, lw=0)

    ax.w_xaxis.pane.set_visible(False)
    ax.w_yaxis.pane.set_visible(False)
    ax.w_zaxis.pane.set_visible(False)

    ax.view_init(azim=115)

```



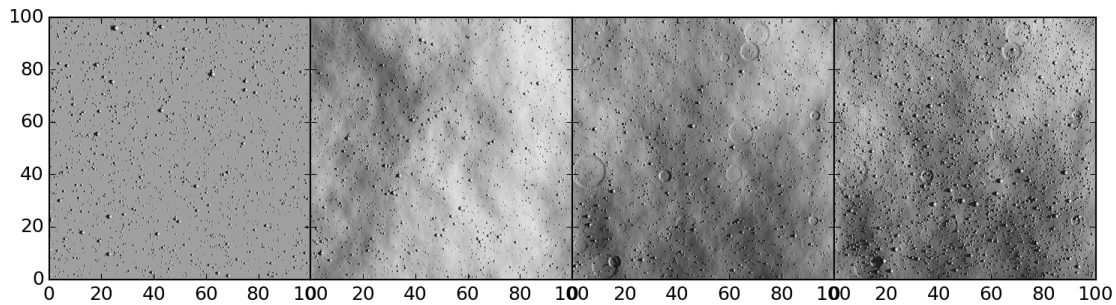
### 3.2 Image data

```
In [8]: fig, axs = plt.subplots(1, 4, sharex=True, sharey=True)
        fig.set_size_inches(12, 2.9)

        for i, scr in enumerate(diffs):
            # Here's the data we'll plot
            pgm = read_pgm(pgm_file.format(**scr._asdict()))

            ax = axs[i]
            ax.imshow(pgm, cmap=matplotlib.cm.gray, extent=(0, 100, 0, 100))

        fig.subplots_adjust(hspace=0, wspace=0)
```



### 3.3 Solutions

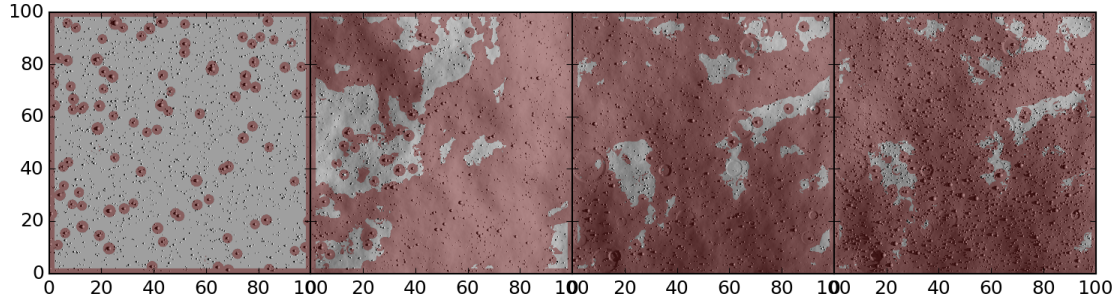
```
In [11]: fig, axs = plt.subplots(1, 4, sharex=True, sharey=True)
         fig.set_size_inches(12, 2.9)

         for i, d in enumerate(diffs):
             pgm = read_pgm(pgm_file.format(slope=d.slope, crater=d.crater, rough=d.roughness))
             soln = read_pgm(soln_file.format(slope=d.slope, crater=d.crater, rough=d.roughness))

             soln_overlay = np.ones((soln.shape[0], soln.shape[1], 4), dtype=np.uint8) * 255
             soln_overlay[:, :, 2] = soln_overlay[:, :, 1] = soln # make it red
             soln_overlay[:, :, 3] = (255 - soln) * 0.4 # only color red, with alpha mask

             ax = axs[i]
             ax.imshow(pgm, cmap=matplotlib.cm.gray, extent=(0, 100, 0, 100))
             ax.imshow(soln_overlay, extent=(0, 100, 0, 100))

         fig.subplots_adjust(hspace=0, wspace=0)
```



## 4 Neural Network Basics

For our problem, we must take a set of input data, namely the height and image data about a particular landing site, and use that to classify if we can safely land in that location. To do this, we use a neural network. Here we will cover what exactly a neural network is and how we can use a neural network to perform a classification.

### 4.1 Neural Nets as Linear regression

In the most simple form (no activation function, zero bias), a neural network is a fancy way of saying a complex linear mapping. That is to say we take our set of input parameters as a vector and multiply it by a matrix to map it onto the space of possible outputs, that is “safe” and “unsafe”. That is we can think of mapping from the input space to the output space as:

$$y = W^{(1)}x$$

where  $x$  is the input parameters,  $y$  is the output, and  $W^{(1)}$  is a matrix that maps from the input to the output. In our example,  $x$  is the height and image data and  $y$  is a two-dimensional vector:

$$y = \begin{bmatrix} y_{safe} \\ y_{unsafe} \end{bmatrix}$$

This is termed a one-hot representation, where for classified points

$$\text{safe} \Rightarrow y = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \quad (1)$$

$$\text{unsafe} \Rightarrow y = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad (2)$$

The idea here is for a given input, the larger of the two values will be our classification for the input. With a proper normalization, the values of  $y$  can correspond to the predicted probability of each of the options. We call the  $W^{(i)}$  matrices the weight matrix, and each individual element  $w_{j,k}^{(i)}$  is termed the weight, which weights the influence of the  $k$ th element of  $x$  on the  $j$ th element of  $y$ .

A schematic of this is shown below:

```
In [12]: %%tikz -f svg -l matrix,positioning --size 250,300
          \matrix (m) [matrix of math nodes, row sep=0.5em, column sep=4em]
          { x_1 & y_1 \\
            x_2 & y_2 \\
            \vdots & \vdots }
```

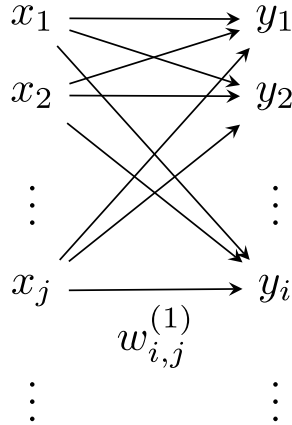


```

x_j & y_i \\
\vdots & \vdots \\
\path[-stealth]
(m-1-1) edge (m-1-2)
(m-1-1) edge (m-2-2)
(m-1-1) edge (m-4-2)
(m-2-1) edge (m-1-2)
(m-2-1) edge (m-2-2)
(m-2-1) edge (m-4-2)
(m-4-1) edge (m-1-2)
(m-4-1) edge (m-2-2)
(m-4-1) edge node [below] {$w^{(1)}_{i,j}$} (m-4-2);
\node (x) [above=2em of m-1-1] {$x$}
node (y) [above=2em of m-1-2] {$y$};
\path [-stealth]
(x) edge [double] node [above] {$W^{(1)}$} (y);

```

$$x \xRightarrow{W^{(1)}} y$$



## 4.2 Adding neurons

Essentially, at this point, this is a glorified multidimensional linear regression. Here comes the “neuron” part. What we do is break up the single matrix step into multiple matrices. In this case, what we end up with in the end is equivalent, but this step will let us do interesting things with these intermediate values. Take in this case three matrices, so now:

$$y = W^{(3)}W^{(2)}W^{(1)}x$$

The intermediate values, which we call  $h^{(i)}$  are the so called hidden layers, and each element in a hidden layer corresponds to a neuron. Our new schematic looks like:

```

In [13]: %%tikz -f svg -l matrix,positioning --size 450,300
\matrix (m) [matrix of math nodes, row sep=0.5em, column sep=4em]
{ x_1 & h^{(1)}_1 & h^{(2)}_1 & y_1 \\

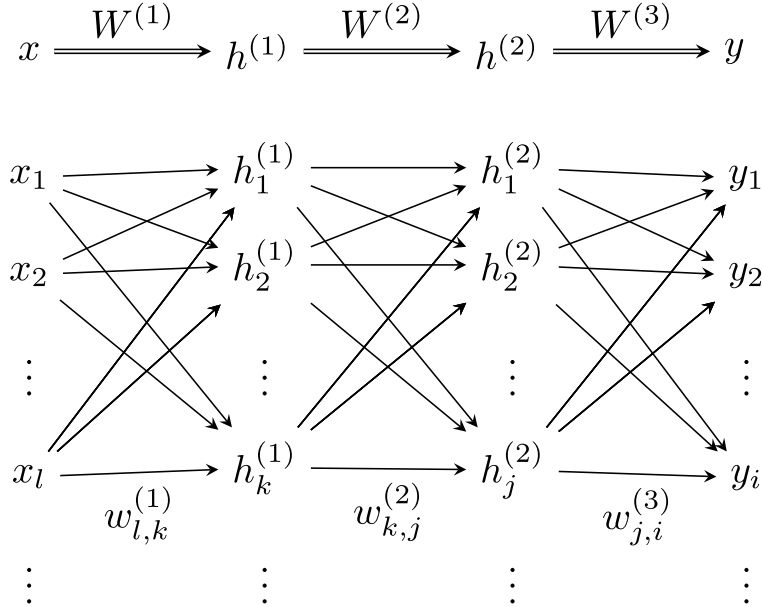
```

```

x_2 & h^{\{1\}}_2 & h^{\{2\}}_2 & y_2 \\
\vdots & \vdots & \vdots & \vdots \\
x_l & h^{\{1\}}_k & h^{\{2\}}_j & y_i \\
\vdots & \vdots & \vdots & \vdots \\
\foreach \i in {1,2} {
  \foreach \j in {1,2,4} {
    \path[-stealth] (m-\i-1) edge (m-\j-2)
                     (m-4-1) edge (m-\i-2)
                     (m-\i-2) edge (m-\j-3)
                     (m-4-2) edge (m-\i-3)
                     (m-\i-3) edge (m-\j-4)
                     (m-4-3) edge (m-\i-4);
  }
}
\path [-stealth]
(m-4-1) edge node [below] {\$w^{\{1\}}_{1,k}\$} (m-4-2)
(m-4-2) edge node [below] {\$w^{\{2\}}_{k,j}\$} (m-4-3)
(m-4-3) edge node [below] {\$w^{\{3\}}_{j,i}\$} (m-4-4);

\node (x) [above=2em of m-1-1] {\$x\$}
node (h1) [right=4em of x] {\$h^{\{1\}}\$}
node (h2) [right=4em of h1] {\$h^{\{2\}}\$}
node (y) [right=4em of h2] {\$y\$};
\path [-stealth]
(x) edge [double] node [above] {\$W^{\{1\}}\$} (h1)
(h1) edge [double] node [above] {\$W^{\{2\}}\$} (h2)
(h2) edge [double] node [above] {\$W^{\{3\}}\$} (y);

```



Note that we have not specified the dimensionality of any of the intermediate vectors, such that we can have arbitrarily many hidden layers and arbitrarily many elements in each hidden layer.

### 4.3 Making neurons behave like neurons

At this point, the neurons are just superfluous intermediate terms in a large matrix product. Because we just have a linear regression model, there we are not able to model interesting higher order behavior. To do this, we make our hidden layers behave more like neurons.

To do this, we apply to each hidden element an activation function. The idea here is if we map a very large value onto our neuron, it turns on and contributes to the next layer, where as if a very small value is mapped onto the neuron, it turns off and does not contribute to the subsequent layer of calculation. This is how the neuron analogy works in, by properly selecting the weights, we can activate or suppress the action of certain neurons, thus leading to pathways which can enforce and suppress each other to activate one or the other output.

A classic choice of activation function is the sigmoid function. The sigmoid function is defined as:

$$S(x) = (1 + e^{-x})^{-1}$$

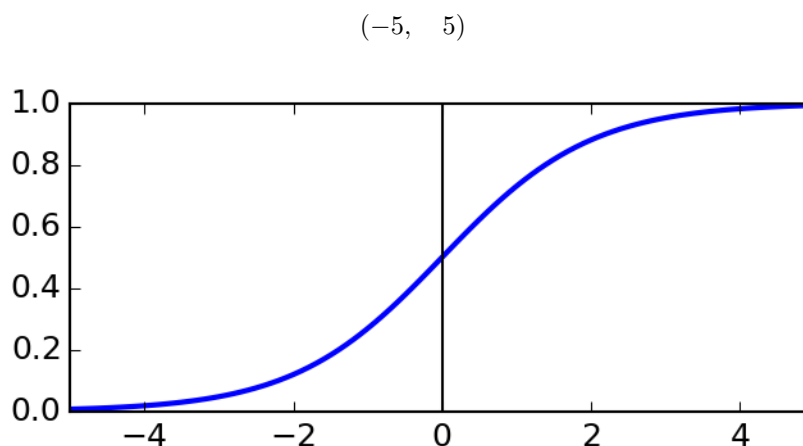
The sigmoid is a nice choice because it smoothly transitions from 0 to 1. The plot of the sigmoid looks like:

```
In [14]: fig, ax = plt.subplots()
         fig.set_size_inches(5, 2)

         x = np.linspace(-5, 5, 101)
         y = 1 / (1 + np.exp(-x))

         ax.plot(x, y, lw=2)
         ax.plot([0, 0], [0, 1], 'k-')
         ax.set_xlim(-5, 5)
```

Out[14]:



We see that it goes to 1 in the limit  $x \rightarrow \infty$ , corresponding to the neuron being activated, and it goes to 0 in the limit  $x \rightarrow -\infty$ , corresponding to the neuron being deactivated.

A key here is that by applying this function to each neuron before we calculate the subsequent layer means we no longer have a linear function. This step of applying a non-linear function at each of the neurons is sufficient to make the neural net capable of modeling complex behavior and determining higher-order patterns in the data.

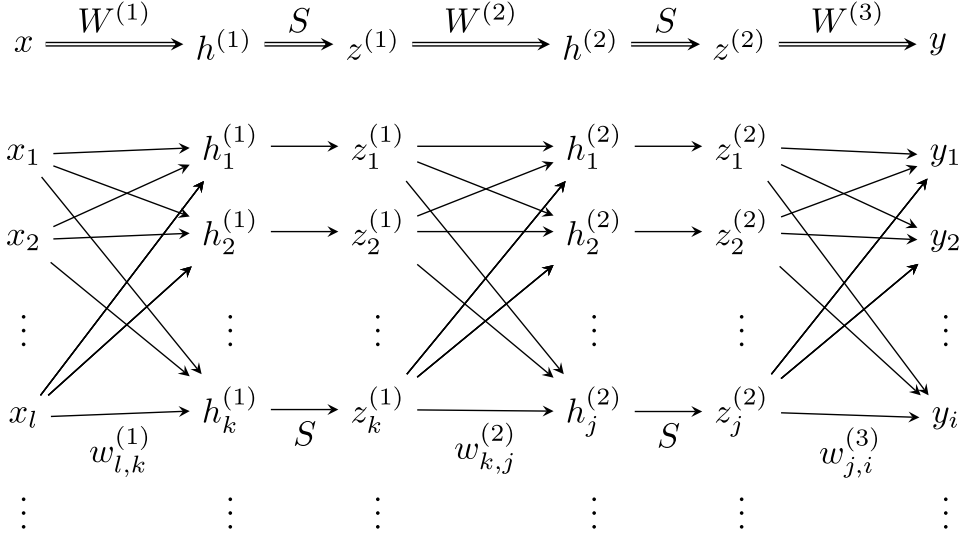
At this point, we have the following setup:

```

In [15]: %%tikz -f svg -l matrix,positioning --size 600,300
\matrix (m) [matrix of math nodes, row sep=0.5em, column sep=2em]
{ x_1 && h^{\{1\}}_1 & z^{\{1\}}_1 && h^{\{2\}}_1 & z^{\{2\}}_1 && y_1 \\
  x_2 && h^{\{1\}}_2 & z^{\{1\}}_2 && h^{\{2\}}_2 & z^{\{2\}}_2 && y_2 \\
  \vdots && \vdots & \vdots && \vdots & \vdots && \vdots \\
  x_l && h^{\{1\}}_k & z^{\{1\}}_k && h^{\{2\}}_j & z^{\{2\}}_j && y_i \\
  \vdots && \vdots & \vdots && \vdots & \vdots && \vdots \\
\foreach \i in {1,2} {
  \path[-stealth] (m-\i-3) edge (m-\i-4)
                  (m-\i-6) edge (m-\i-7);
  \foreach \j in {1,2,4} {
    \path[-stealth] (m-\i-1) edge (m-\j-3)
                  (m-4-1) edge (m-\i-3)
                  (m-\i-4) edge (m-\j-6)
                  (m-4-4) edge (m-\i-6)
                  (m-\i-7) edge (m-\j-9)
                  (m-4-7) edge (m-\i-9);
  }
}
\path[-stealth]
(m-4-1) edge node [below] {\mathcal{W}^{\{1\}}_{1,k}} (m-4-3)
(m-4-3) edge node [below] {\mathcal{S}} (m-4-4)
(m-4-4) edge node [below] {\mathcal{W}^{\{2\}}_{k,j}} (m-4-6)
(m-4-6) edge node [below] {\mathcal{S}} (m-4-7)
(m-4-7) edge node [below] {\mathcal{W}^{\{3\}}_{j,i}} (m-4-9);

\node (x) [above=2em of m-1-1] {\mathcal{X}}
node (h1) [right=4em of x] {\mathcal{H}^{\{1\}}}
node (z1) [right=2em of h1] {\mathcal{Z}^{\{1\}}}
node (h2) [right=4em of z1] {\mathcal{H}^{\{2\}}}
node (z2) [right=2em of h2] {\mathcal{Z}^{\{2\}}}
node (y) [right=4em of z2] {\mathcal{Y}};
\path [-stealth]
(x) edge [double] node [above] {\mathcal{W}^{\{1\}}} (h1)
(h1) edge [double] node [above] {\mathcal{S}} (z1)
(z1) edge [double] node [above] {\mathcal{W}^{\{2\}}} (h2)
(h2) edge [double] node [above] {\mathcal{S}} (z2)
(z2) edge [double] node [above] {\mathcal{W}^{\{3\}}} (y);

```



#### 4.4 Adding a bias

The final step is to add a bias to each of the neurons. This bias value sets the default behavior of the neuron, whether it defaults to be more or less activated. Using the matrix notation from above, we can say a hidden layer  $i$  is assigned a vector of bias values  $b_j^{(i)}$  which adds to the  $h_j^{(i)}$  value before the activation is computed. Calling the activation of the  $i$ th hidden layer as  $z^{(i)}$ , adopting the above matrix convention, the final expression for the activation of a hidden layer is:

$$z^{(i)} = S \left( W^{(i)} z^{(i-1)} + b^{(i)} \right)$$

where the sigmoid function,  $S$ , is applied element-wise. In this expression, the final output  $y$  is computed in the same way using the last hidden layer as  $z^{(i-1)}$ , and we can think of the input data  $x$  as being the  $z^{(0)}$  activation.

The final graphical representation of this is:

```
In [16]: %\tikz -f svg -l matrix,positioning --size 600,300
\matrix (m) [matrix of math nodes, row sep=0.5em, column sep=2em]
{ 1 &&& 1 &&& 1 && \\\
  x_1 && h^{(1)}_1 && z^{(1)}_1 && h^{(2)}_1 && z^{(2)}_1 && y_1 \\\
  x_2 && h^{(1)}_2 && z^{(1)}_2 && h^{(2)}_2 && z^{(2)}_2 && y_2 \\\
  \vdots && \vdots && \vdots && \vdots && \vdots && \vdots \\\
  x_l && h^{(1)}_k && z^{(1)}_k && h^{(2)}_j && z^{(2)}_j && y_i \\\
  \vdots && \vdots && \vdots && \vdots && \vdots && \vdots \\\
}
\foreach \i in {2,3} {
  \path[-stealth] (m-\i-3) edge (m-\i-4)
                  (m-\i-6) edge (m-\i-7)
                  (m-5-1) edge (m-\i-3)
                  (m-5-4) edge (m-\i-6)
                  (m-5-7) edge (m-\i-9);
  \foreach \j in {2,3,5} {
    \path[-stealth] (m-\i-1) edge (m-\j-3)
                  (m-\i-4) edge (m-\j-6)
                  (m-\i-7) edge (m-\j-9);
  }
}
```

```

}
}

\foreach \i in {3,5} {
  \path[-stealth,dashed] (m-1-1) edge (m-\i-3)
                        (m-1-4) edge (m-\i-6)
                        (m-1-7) edge (m-\i-9);
}

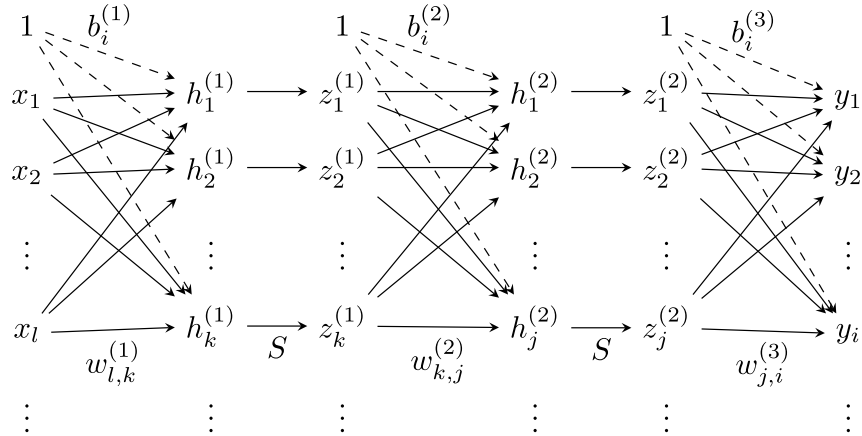
\path[-stealth,dashed] (m-1-1) edge node [above] {\$b^{\{1\}}_i\$} (m-2-3)
                        (m-1-4) edge node [above] {\$b^{\{2\}}_i\$} (m-2-6)
                        (m-1-7) edge node [above] {\$b^{\{3\}}_i\$} (m-2-9);

\path[-stealth]
(m-5-1) edge node [below] {\$w^{\{1\}}_{l,k}\$} (m-5-3)
(m-5-3) edge node [below] {\$S\$} (m-5-4)
(m-5-4) edge node [below] {\$w^{\{2\}}_{k,j}\$} (m-5-6)
(m-5-6) edge node [below] {\$S\$} (m-5-7)
(m-5-7) edge node [below] {\$w^{\{3\}}_{j,i}\$} (m-5-9);

\node (x) [above=4em of m-2-1] {\$x\$}
node (h1) [right=4em of x] {\$h^{\{1\}}\$}
node (z1) [right=2em of h1] {\$z^{\{1\}}\$}
node (h2) [right=4em of z1] {\$h^{\{2\}}\$}
node (z2) [right=2em of h2] {\$z^{\{2\}}\$}
node (y) [right=4em of z2] {\$y\$};
\path [-stealth]
(x) edge [double] node [above] {\$W^{\{1\}}\$} (h1)
(h1) edge [double] node [above] {\$S\$} (z1)
(z1) edge [double] node [above] {\$W^{\{2\}}\$} (h2)
(h2) edge [double] node [above] {\$S\$} (z2)
(z2) edge [double] node [above] {\$W^{\{3\}}\$} (y);

```

$$x \xrightarrow{W^{(1)}} h^{(1)} \xrightarrow{S} z^{(1)} \xrightarrow{W^{(2)}} h^{(2)} \xrightarrow{S} z^{(2)} \xrightarrow{W^{(3)}} y$$



## 4.5 Adding a softmax layer

At the end, we have some vector of outputs  $y$ , but these are not normalized in any meaningful way. In order to normalize and assign probabilities, we add what is called a softmax layer. To draw a statistical mechanics analogy that physicists will appreciate, we can take the output we have computed to be something like an energy state,  $-E$ , of a system. At this point, we can compute the probability for a system to be in any one of the given states with the Boltzmann distribution. For some given inputs,  $x$ , we can assign probabilities to each of the output states as:

$$p_i(x) = \frac{e^{y_i(x)}}{\sum_i e^{y_i(x)}}$$

where the  $y_i(x)$  are the values computed above.

## 4.6 Assessing goodness of fit

The next thing we want is to make our neural net good at making predictions, but first we need some way to say how good the neural network performs. To do this we use what is called the negative log-likelihood. Neural nets are a supervised learning technique, so they require a labeled data set to train the parameters. For a given test case with some input data  $x$  and known classification  $Y$  which we take to be the  $i$  category, the likelihood of this given by the neural net is:

$$p(Y|x) = p_i(x)$$

If we have a sample of input data  $x^{(i)}$  each with a known classification  $Y^{(i)}$ , the likelihood for this is the product

$$P(Y^{(1)}|x^{(1)}), \dots) = \prod_i p(Y^{(i)}|x^{(i)})$$

In order to make the math nice, we use the log function; because log is monotonic, a larger value of the likelihood will give a larger value of the log-likelihood. We use the log because:

$$\log \prod_i p(Y^{(i)}|x^{(i)}) = \sum_i \log p(Y^{(i)}|x^{(i)})$$

This simplifies the following calculation, as each test case contributes individually to the total log-likelihood. Because we want to maximize the log-likelihood, we minimize the negative log-likelihood. This then is the same as minimizing the cross entropy of the system.

## 4.7 Minimizing NLL

To minimize the negative log-likelihood, we use what is called gradient descent. Basically, for a given input  $x$ , we have a function which takes as parameters all of the weights and biases and returns the probabilities which give the NLL. Because we want to minimize the NLL, we can compute the gradient of the NLL with respect to the weight parameters and adjust the weights appropriately. That is:

$$w_{j,k}^{(i)} := w_{j,k}^{(i)} - \eta \frac{\partial}{\partial w_{j,k}^{(i)}} \left[ \sum_i \log p(Y^{(i)}|x^{(i)}) \right]$$

where  $\eta$  is an adjustable learning rate.

# 5 Optimizing training

In order to effectively train on large data sets, we employ several techniques that reduce the computational cost of training while not reducing training ability.

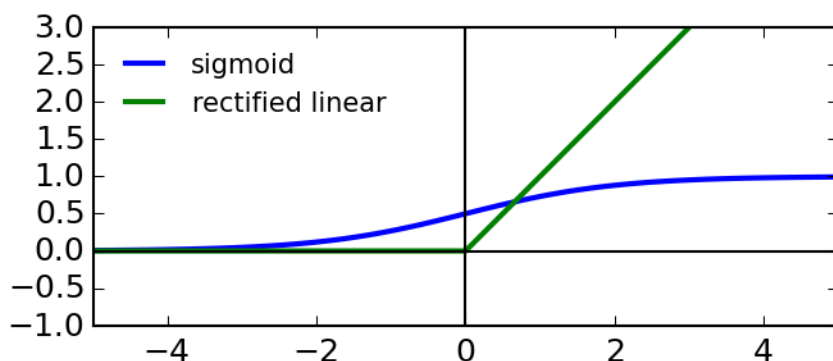
## 5.1 Rectified Linear Activation

First, while the sigmoid is a very nice function for thinking about the intuition behind a neural network and has nice smoothness properties allowing us to define the derivative for the computation of the gradient, it is computationally expensive. Instead, we use a rectified linear activation function, which has a profile:

```
In [17]: fig, ax = plt.subplots()
         fig.set_size_inches(5, 2)

         x = np.linspace(-5, 5, 101)
         y1 = 1 / (1 + np.exp(-x))
         y2 = np.maximum(x, 0)

         plt.plot(x, y1, label='sigmoid', lw=2)
         plt.plot(x, y2, label='rectified linear', lw=2)
         ax.plot([0, 0], [-1, 3], 'k-')
         ax.plot([-5, 5], [0, 0], 'k-')
         ax.set_xlim(-5, 5)
         ax.set_ylim(-1, 3)
         ax.set_aspect('equal')
         ax.legend(loc=2, fontsize=10).draw_frame(False)
```



This greatly reduces the computation of both the activation of the neuron and the computation of the gradient. This method also does not reduce the training ability of the neural net.

## 5.2 Max norm

A very important concept in machine learning is normalization. Because of the potentially very large number of parameters in setting up the hidden layers, we can fit arbitrarily well to a given data set, but the resulting neural network does not generalize well to other data sets. In order to prevent this from happening, we make sure the values of the weights do not become too large. One way to do this is to add a cost proportional to the norm of the weight matrices to the NLL cost function. Another more computationally simple method is to enforce a maximum to the norm of the weight matrices. This has a similar effect to adding a cost to the weight norm.

## 5.3 Dropout

Another normalization technique we implement is dropout. To do this, on each iteration of training, a randomly selected selection of weights are temporarily zeroed. This has the dual effect of simplifying the computation, as each iteration only considers a subset of the neurons, and improves the training of the net.



The basic idea behind dropout is to promote multiple independently reinforced pathways to activate the necessary neurons for each classification.

## 5.4 Stochastic Gradient Descent

When running the gradient descent algorithm, we need to compute the contribution to the gradient from every training data point. For very large training data sets, this can take a very long time. In order to speed up learning, we can consider only a subset of the training data. By partitioning this data into batches and approximate the full gradient by the gradient of the batch, we can speed up learning. This is called stochastic gradient descent. When doing this, we no longer have guarantee that the changes to the weights will lower the total cost function, but by iterating over the entire training data set, we get a good approximation.

## 5.5 Momentum

One we to mitigate some of the problems of stochastic gradient descent is to use momentum, which is basically to add the previous computed gradient to the current gradient term when performing gradient descent. This basically gives a memory to the gradient term, so that the gradient computed for other terms aren't totally neglected. In addition to smoothing out the stochastic descent, using momentum helps the gradient descent algorithm move through areas in parameter space where the cost either plateaus and keeps the gradient descent from getting stuck in local minima.

## 5.6 Changing learning rate

As we learn, we adapt the learning rate parameter, denoted  $\eta$  above. A large learning rate are best early to quickly move the parameters towards the minimum value. However, as we approach a final configuration, we want to slow the learning rate so we do not overshoot the optimal location. To do this, we simply scale the learning rate down with each iteration of gradient descent.

## 6 The Plan

Try to classify by brute force, anything that is sufficiently safe ( $\geq 0.9$  m clearance,  $< 8^\circ$  tilt for configurations) is safe, grossly unsafe (0.2 m into base,  $> 13^\circ$  tilt) marked unsafe, everything else fed into neural net

## 7 Processing Data

For each data set, we have almost 1 million data points to work with, now we need to construct the input data for each input point. each landing site has the points of roughly:

```
In [46]: # Parameters for lander
         r = 17
         r_foot = 2.5

         # How to extract positions under the feet
         x = np.arange(-18, 19, 2)
         y = np.arange(0, 19, 2)
         X_foot, Y_foot = np.meshgrid(x, y)
         sel_foot = np.logical_and(X_foot**2 + Y_foot**2 >= (r - (2 * r_foot + 2))**2,
                                   X_foot**2 + Y_foot**2 <= (r + 2)**2)

         # Distance between foot positions
         spacing = 0.1
         x = -X_foot[sel_foot] * spacing
```

```

y = -Y_foot[sel_foot] * spacing
run = np.sqrt((2*x)**2 + (2*y)**2)

# How to extract positions under the base
x = np.arange(-18, 19, 2)
y = np.arange(-18, 19, 2)
X_base, Y_base = np.meshgrid(x, y)
sel_base = X_base**2 + Y_base**2 <= (r + 2)**2

fig, ax = plt.subplots(figsize=(8, 8))

ax.set_xticks([])
ax.set_yticks([])

ax.set_xlim(-19, 19)
ax.set_ylim(-19, 19)

ax.plot(0, 0, 'ok')

for i in np.arange(-18, 19):
    ax.plot([-19, 19], [i, i], '--', color='0.75')
    ax.plot([i, i], [-19, 19], '--', color='0.75')

for i in np.arange(-17, 19, 2):
    ax.plot([-19, 19], [i, i], 'k-')
    ax.plot([i, i], [-19, 19], 'k-')

x = np.linspace(-r, r, 200)
y = np.sqrt(r**2 - x**2)

ax.plot(x, y, 'g-', lw=2)
ax.plot(x, -y, 'g-', lw=2)

x = np.linspace(r - 2 * r_foot, r, 100)
y = np.sqrt(r_foot**2 - (x - (r - r_foot))**2)

ax.plot(x, y, 'b-', lw=1)
ax.plot(x, -y, 'b-', lw=1)

ax.plot(-x, y, 'b-', lw=1)
ax.plot(-x, -y, 'b-', lw=1)

ax.plot(y, x, 'b-', lw=1)
ax.plot(-y, x, 'b-', lw=1)

ax.plot(y, -x, 'b-', lw=1)
ax.plot(-y, -x, 'b-', lw=1)

x = np.linspace(-(r - 2 * r_foot), (r - 2 * r_foot), 200)
y = np.sqrt((r - 2 * r_foot)**2 - x**2)

ax.plot(x, y, 'b-', lw=2)
ax.plot(x, -y, 'b-', lw=2)

```

```

x = np.linspace(-(r + 0.5), (r + 0.5), 200)
y = np.sqrt((r + 0.5)**2 - x**2)

ax.plot(x, y, 'b--', lw=2)
ax.plot(x, -y, 'b--', lw=2)

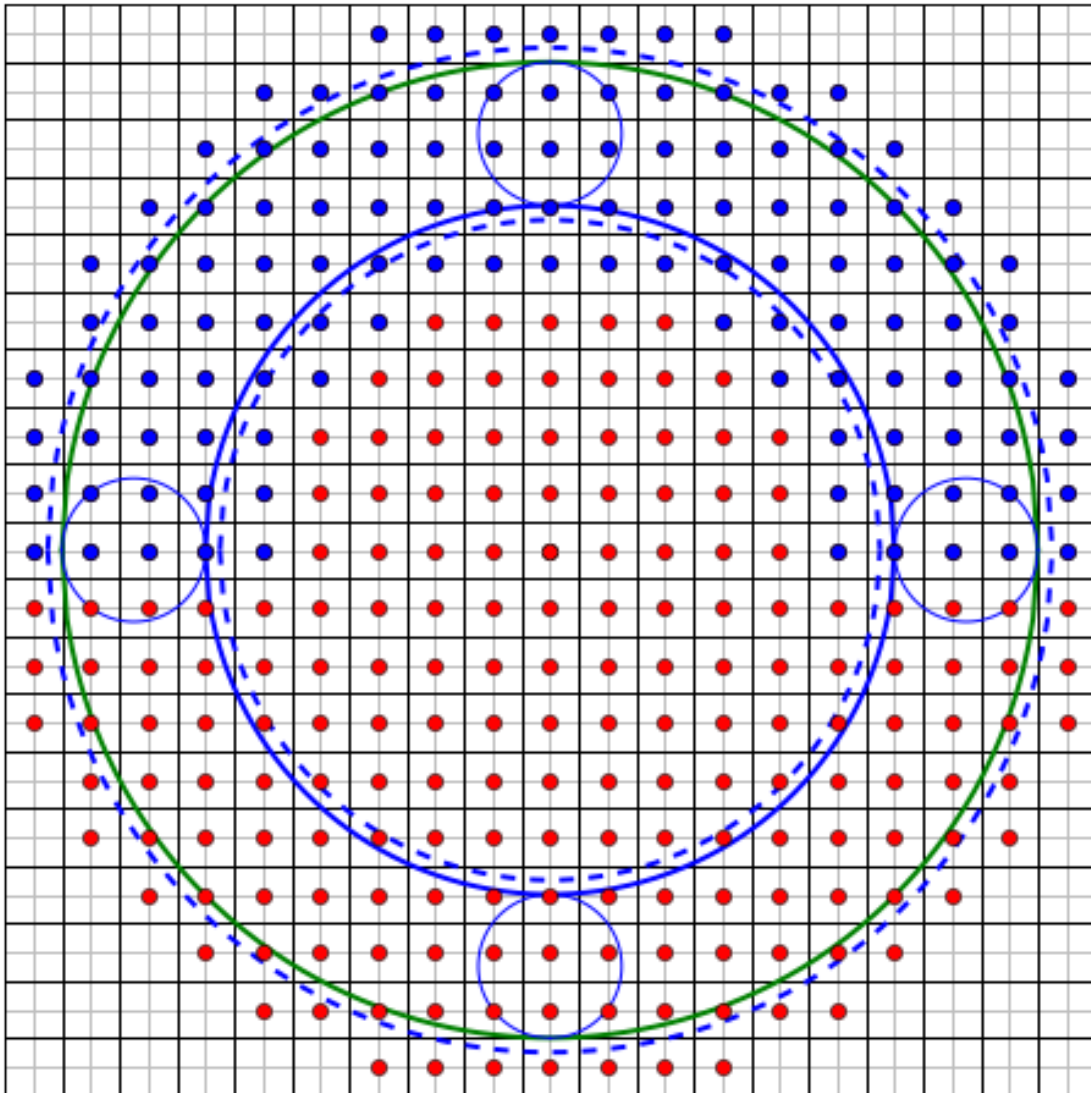
x = np.linspace(-(r - 2 * r_foot - 0.5), (r - 2 * r_foot - 0.5), 200)
y = np.sqrt((r - 2 * r_foot - 0.5)**2 - x**2)

ax.plot(x, y, 'b--', lw=2)
ax.plot(x, -y, 'b--', lw=2)

ax.plot(X_base[sel_base], Y_base[sel_base], 'ro')
ax.plot(X_foot[sel_foot], Y_foot[sel_foot], 'bo')

```

Out[46]: [<matplotlib.lines.Line2D at 0x336c1f28>]



Some general functions we'll use for all cases. Here, we also see the pickle format that pylearn2 requires.

```
In [4]: r = 17  # in units of 0.2 m
        x = np.arange(-20, 21, 2)
        y = np.arange(-20, 21, 2)
        X_base, Y_base = np.meshgrid(x, y)

        # Locations that must be checked for unsafe classification
        sel_base_unsafe = X_base**2 + Y_base**2 <= r**2

        # Locations that must be checked for safe classification
        sel_base_safe = X_base**2 + Y_base**2 <= (r + 4)**2

In [95]: # sentinels, where unsafe = 0, safe = 255 (to match pgm)
        UNSAFE, UNKNOWN, SAFE = 0x00, 0xff // 2, 0xff

        pickle_x_train = os.path.join(output_dir, "X_train.pkl")
        pickle_x_test = os.path.join(output_dir, "X_test.pkl")
        pickle_y_train = os.path.join(output_dir, "y_train.pkl")
        pickle_y_test = os.path.join(output_dir, "y_test.pkl")

        preprocessing_pgm = os.path.join(output_dir, "out_preprocessing_S{slope}C{crater}R{roughness}.pgm")
        final_pgm = os.path.join(output_dir, "out_final_S{slope}C{crater}R{roughness}.pgm")

        # shape of the height data
        height_rows = height_cols = 500
        # we'll automatically fail an edge of 21 points around the landing zone
        edge_buffer = 21

        # Dimensions of lander to number of height points
        ncols = 21
        # Dimensions of lander to number of image points
        nn_window = 35

        # Number of features we'll feed in
        nn_feat = nn_window**2

def generate_nn_input(scr, selection, solution, image):
    # generate a comparison file
    cmp_file = os.path.join(output_dir, "preprocessed.png").format(**scr._asdict())
    compare_guesses(selection, solution, image, cmp_file)

    # Figure out how much to feed into net
    n_safe = np.sum(np.logical_and(selection == UNKNOWN, solution == SAFE))
    n_unsafe = np.sum(np.logical_and(selection == UNKNOWN, solution == UNSAFE))
    # and allocate some arrays for it
    output_safe = np.empty((n_safe, nn_feat), dtype=np.float32)
    output_unsafe = np.empty((n_unsafe, nn_feat), dtype=np.float32)

    row, col = np.indices((solution.shape))
    # Populate each array
    sel = np.logical_and(selection == UNKNOWN, solution == SAFE)
    rows, cols = row[sel].flatten(), col[sel].flatten()
    for n, (i, j) in enumerate(zip(rows, cols)):
        output_safe[n, :] = image[i-nn_window//2-1:i+nn_window//2,
```

```

        j-nn_window//2-1:j+nn_window//2].flatten()

sel = np.logical_and(selection == UNKNOWN, solution == UNSAFE)
rows, cols = row[sel].flatten(), col[sel].flatten()
for n, (i, j) in enumerate(zip(rows, cols)):
    output_unsafe[n, :] = image[i-nn_window//2-1:i+nn_window//2,
                                j-nn_window//2-1:j+nn_window//2].flatten()

# Normalize output
output_safe = (output_safe - 159) / 256
output_unsafe = (output_unsafe - 159) / 256

print("Generated {:d} safe and {:d} unsafe training data points".format(n_safe, n_unsafe))
return output_safe, output_unsafe

def create_pickle(scr, output_safe, output_unsafe):
    n_safe = output_safe.shape[0]
    n_unsafe = output_unsafe.shape[0]

    n_train_safe = int(0.9 * n_safe)
    n_train_unsafe = int(0.9 * n_unsafe)
    n_test_safe = n_safe - n_train_safe
    n_test_unsafe = n_unsafe - n_train_unsafe

    # XXX IS THIS GOOD TO DO???
    # n_train_safe = int(0.9 * min(n_safe, n_unsafe))
    # n_test_safe = min(n_safe, n_unsafe) - n_train

    print("Saving data... ", end="")
    X_train = np.vstack([
        output_safe[:n_train_safe, :],
        output_unsafe[:n_train_unsafe, :]
    ])
    X_test = np.vstack([
        output_safe[n_train_safe:n_train_safe+n_test_safe, :],
        output_unsafe[n_train_unsafe:n_train_unsafe+n_test_unsafe, :]
    ])

    y_train = np.vstack([
        np.ones((n_train_safe, 1), dtype=int),
        np.zeros((n_train_unsafe, 1), dtype=int),
    ])
    y_test = np.vstack([
        np.ones((n_test_safe, 1), dtype=int),
        np.zeros((n_test_unsafe, 1), dtype=int),
    ])

    serial.save(pickle_x_train.format(**scr._asdict()), X_train)
    serial.save(pickle_x_test.format(**scr._asdict()), X_test)
    serial.save(pickle_y_train.format(**scr._asdict()), y_train)
    serial.save(pickle_y_test.format(**scr._asdict()), y_test)
    print("done")

```

## 7.1 No slopes

The easiest data set has no slopes, and so the slope hazards do not need to be taken into consideration. For this, we only need to look at the points within the above area around any point and check the heights of the points.

```
In [68]: # limits for defining safe/unsafe
height_safe = 0.29
height_unsafe = 0.39

def preprocess_noslopes(scr):
    # Read in the data and make a value for outputs
    height = read_raw(raw_file.format(**scr._asdict()), height_rows, height_cols)
    # Read in the image
    image = read_pgm(pgm_file.format(**scr._asdict()))
    # Read in the solution
    soln = read_pgm(soln_file.format(**scr._asdict()))

    # Compute the safe/unsafe/unknown landing sites
    gen_output = compute_noslopes(height)

    # double the selection matrix in each dimension
    gen_output = np.hstack((gen_output, gen_output)).reshape((-1, 1))
    gen_output = np.hstack((gen_output, gen_output)).reshape(soln.shape)
    # fix the edge of the selection
    gen_output[:edge_buffer, :] = UNSAFE
    gen_output[-edge_buffer:, :] = UNSAFE
    gen_output[:, :edge_buffer] = UNSAFE
    gen_output[:, -edge_buffer] = UNSAFE

    # Write the output
    write_pgm(gen_output, preprocessing_pgm.format(**scr._asdict()))

    # Create the NN input
    df_safe, df_unsafe = generate_nn_input(scr, gen_output, soln, image)

    # Generate the NN input pickle
    create_pickle(scr, df_safe, df_unsafe)

def compute_noslopes(height): # Initialize fully unsafe values
    output = np.zeros_like(height, dtype=np.uint8)
    for i in range(edge_buffer // 2, height_cols - edge_buffer // 2):
        for j in range(edge_buffer // 2, height_rows - edge_buffer // 2):
            z = height[i-ncols//2:i+ncols//2+1, j-ncols//2:j+ncols//2+1]

            # Check if all in large radius is safe
            z_safe = z[sel_base_safe]
            if (np.max(z_safe) - np.min(z_safe)) < height_safe:
                output[i, j] = SAFE
                continue

            # Check if any in small radius has any unsafe
            z_unsafe = z[sel_base_unsafe]
            if (np.max(z_unsafe) - np.min(z_unsafe)) > height_unsafe:
                output[i, j] = UNSAFE
```

```

        continue

        output[i, j] = UNKNOWN
    return output

In [69]: # Just use the easiest one
        scr = diffs[0]

        out = output_dir.format(**scr._asdict())
        if not os.path.exists(out):
            os.makedirs(out)

        preprocess_noslopes(scr)

Accuracy:          100.0%
F1 (safe):         1.00
F1 (unsafe):       1.00

Safe classification accuracy: 100.0% (670989 / 670989)
Unsafe classification accuracy: 100.0% (151352 / 151352)

Unknown safe:      75.9% (134907 / 177659)
Unknown unsafe:    24.1% (42752 / 177659)
Generated 134907 safe and 42752 unsafe training data points
Saving data... done

```

## 7.2 With slopes

For slope considerations, we implemented a rudimentary checker that iterated over all possible triplets of landing foot positions and checked if any height would collide with it in this configuration. The entirety of this algorithm uses big matrix multiplication to do the coordinate transformation to bring the triplet of and checking for large values, and would have been super easy with numpy, but our original implementation in C++ is complex, but it is tested. I ran out of time to re-implement it in Python here, so we'll just call the compiled versions.

The required output from the C code is included in the git directory, so if you cannot compile or run this, you can comment out the subprocess call and it will read in the needed pgm output file.

```

In [60]: gen_full_executable = os.path.abspath(os.path.join(".", "Sean", "src", "gen_full"))

        if os.name == 'nt':
            gen_full_executable += ".exe"

        output_nn = os.path.join(output_dir, "nn_outS{slope}C{crater}R{roughness}")

        def preprocess_slopes(scr):
            # Read in the data and make a value for outputs
            height = read_raw(raw_file.format(**scr._asdict()), height_rows, height_cols)
            # Read in the image
            image = read_pgm(pgm_file.format(**scr._asdict()))
            # Read in the solution
            soln = read_pgm(soln_file.format(**scr._asdict()))

            subprocess.check_call([gen_full_executable,
                                   raw_file.format(**scr._asdict())],

```

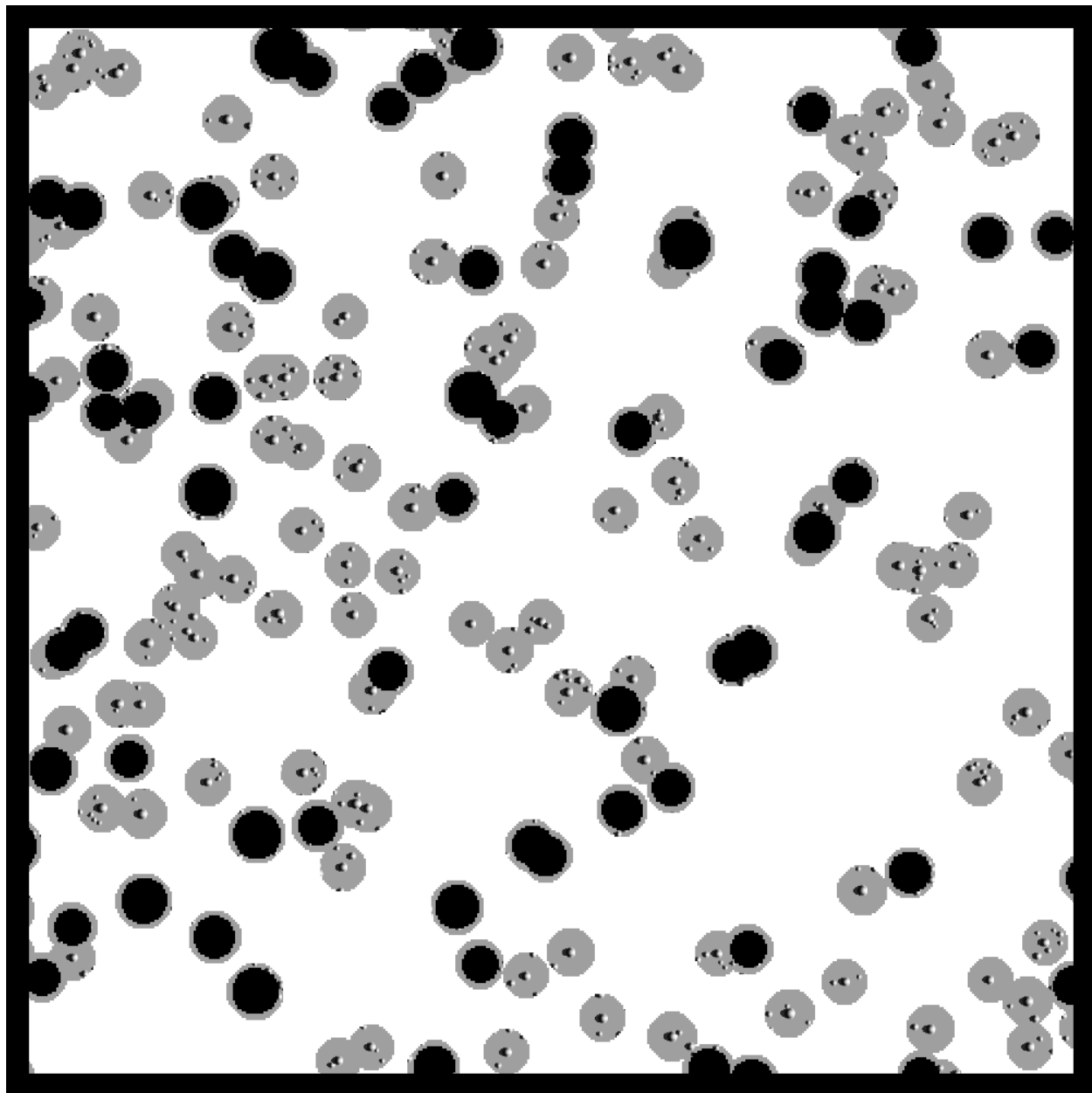


Figure 5:



```

pgm_file.format(**scr._asdict()),
soln_file.format(**scr._asdict()),
output_pgm.format(**scr._asdict()),
output_nn.format(**scr._asdict()))

# Read the comparison file in
gen_output = read_pgm(preprocessing_pgm.format(**scr._asdict()))

# Create the NN input
df_safe, df_unsafe = generate_nn_input(scr, gen_output, soln, image)

# Generate the NN input pickle
create_pickle(scr, df_safe, df_unsafe)

```

In [63]: preprocess\_slopes(diffs[1])

```

Accuracy:          99.3%
F1 (safe):         nan
F1 (unsafe):       1.00

```

```

Safe classification accuracy:    0.0% (0 / 5105)
Unsafe classification accuracy: 100.0% (678466 / 678466)

```

```

Unknown safe:    67.3% (213077 / 316429)
Unknown unsafe:  32.7% (103352 / 316429)
Generated 213077 safe and 103352 unsafe training data points
Saving data... done

```

In [64]: preprocess\_slopes(diffs[2])

```

Accuracy:          99.4%
F1 (safe):         nan
F1 (unsafe):       1.00

```

```

Safe classification accuracy:    0.0% (0 / 4624)
Unsafe classification accuracy: 100.0% (752105 / 752105)

```

```

Unknown safe:    49.2% (119728 / 243271)
Unknown unsafe:  50.8% (123543 / 243271)
Generated 119728 safe and 123543 unsafe training data points
Saving data... done

```

In [65]: preprocess\_slopes(diffs[3])

```

Accuracy:          99.0%
F1 (safe):         nan
F1 (unsafe):       0.99

```

```

Safe classification accuracy:    0.0% (0 / 8821)
Unsafe classification accuracy: 100.0% (838391 / 838391)

```

```

Unknown safe:    50.8% (77644 / 152788)
Unknown unsafe:  49.2% (75144 / 152788)
Generated 77644 safe and 75144 unsafe training data points
Saving data... done

```

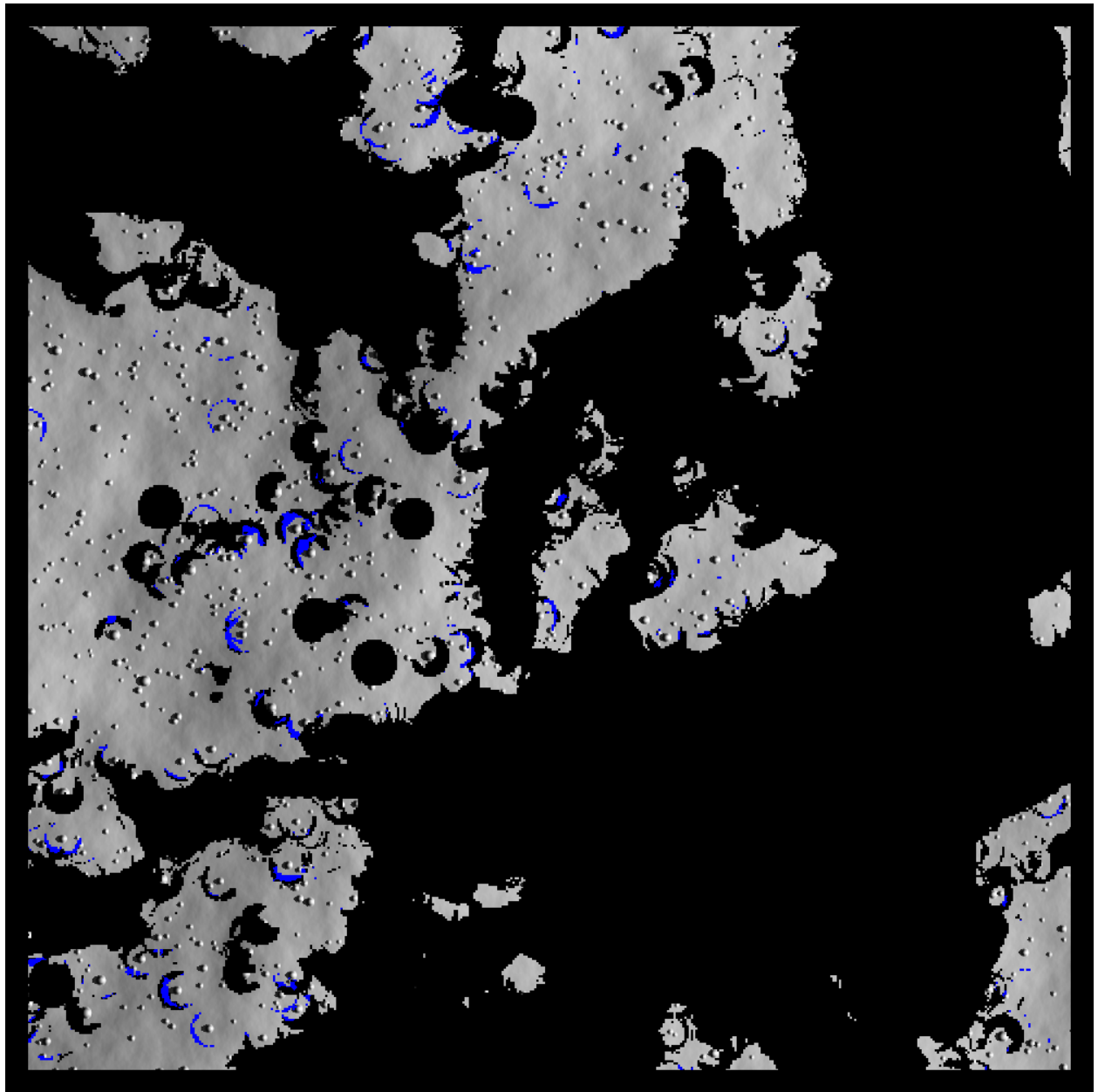


Figure 6:

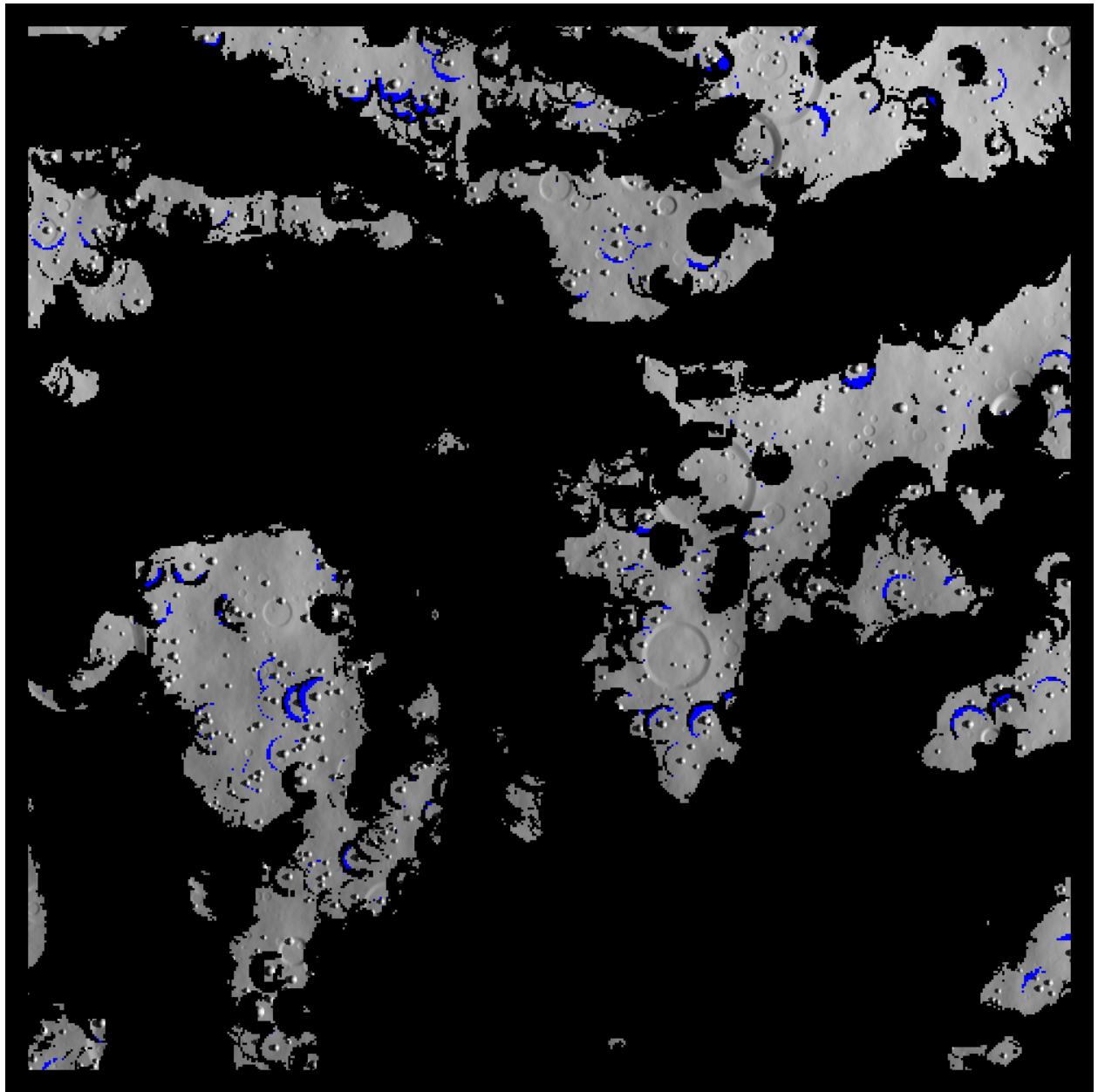


Figure 7:

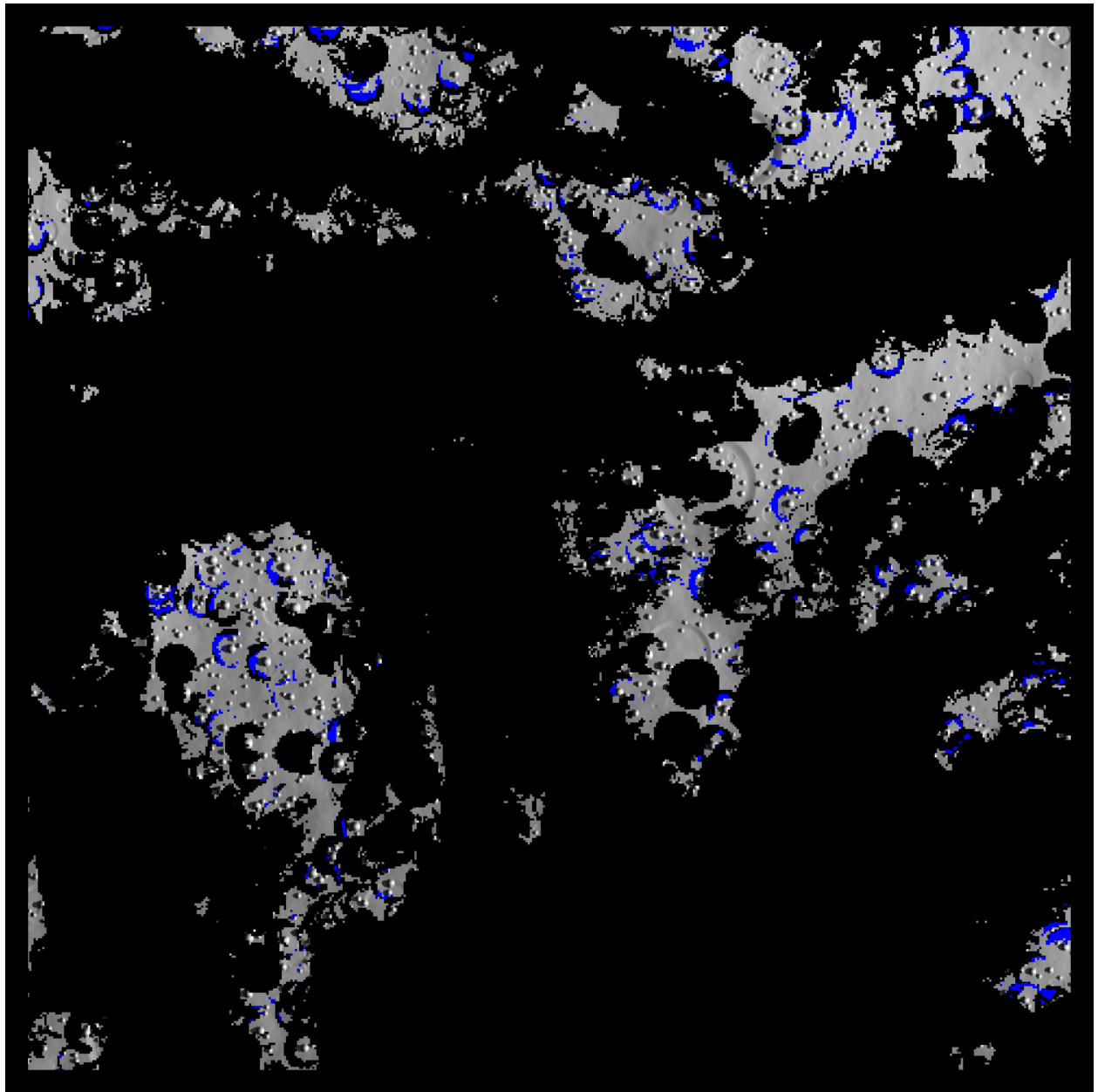


Figure 8:

## 8 Using Pylearn2

```
In [11]: yaml = """\
!obj:pylearn2.train.Train {{{
  dataset: &train !obj:pylearn2.datasets.dense_design_matrix.DenseDesignMatrix {{{
    X: !pk1: '{x_train}',
    y: !pk1: '{y_train}',
    y_labels: 2,
  }}}},

  model: !obj:pylearn2.models.mlp.MLP {{{
    # Setup the NN, 3 RLU hidden layers and 1 output (softmax) layer
    layers : [
      !obj:pylearn2.models.mlp.RectifiedLinear {{{
        layer_name: 'h0',
        dim: 500,
        sparse_init: 15,
        # Rather than using weight decay, we constrain the norms of the weight vectors
        max_col_norm: {max_norm}
      }}}},
      !obj:pylearn2.models.mlp.RectifiedLinear {{{
        layer_name: 'h1',
        dim: 500,
        sparse_init: 15,
        # Rather than using weight decay, we constrain the norms of the weight vectors
        max_col_norm: {max_norm}
      }}}},
      !obj:pylearn2.models.mlp.RectifiedLinear {{{
        layer_name: 'h2',
        dim: 500,
        sparse_init: 15,
        # Rather than using weight decay, we constrain the norms of the weight vectors
        max_col_norm: {max_norm}
      }}}},
      !obj:pylearn2.models.mlp.Softmax {{{
        layer_name: 'y',
        n_classes: 2,
        irange: 0,
        init_bias_target_marginals: *train
      }}}},
    ],
    nvis: {n_features},
  }}}},

  # We train using stochastic gradient descent
  algorithm: !obj:pylearn2.training_algorithms.sgd.SGD {{{
    batch_size: 100,

    learning_rate: 1e-1,
    learning_rule: !obj:pylearn2.training_algorithms.learning_rule.Momentum {{{
      init_momentum: 0.5,
    }}}},

  # We monitor how well we're doing during training on a validation set
```

```

        monitoring_dataset: {{{
            'train' : *train,
            'valid' : !obj:pylearn2.datasets.dense_design_matrix.DenseDesignMatrix {{{
                X: !pk1: '{x_test}',
                y: !pk1: '{y_test}',
                y_labels: 2,
            }}}},
        }}}},

        # Use dropout to help normalization
        cost: !obj:pylearn2.costs.mlp.dropout.Dropout {{{
            input_include_probs: {{{
                'h0' : 0.5,
                'h1' : 0.5,
                'h2' : 0.5,
                'y' : 1.
            }}}},
        }}}},

        # We stop if we don't improve after 10 epochs
        termination_criterion: !obj:pylearn2.termination_criteria.MonitorBased {{{
            channel_name: "valid_y_misclass",
            prop_decrease: 0.001,
            N: 10
        }}}},
    }}}},

    # We save the model whenever we improve on the validation set classification error
    extensions: [
        # Save the "best" net (based on validation set), form of early stopping to prevent overfitting
        !obj:pylearn2.train_extensions.best_params.MonitorBasedSaveBest {{{
            channel_name: 'valid_y_misclass',
            save_path: '{save_file_best}'
        }}}},
        # http://daemonmaker.blogspot.com/2014/12/monitoring-experiments-in-pylearn2.html
        !obj:pylearn2.train_extensions.live_monitoring.LiveMonitoring {{{{}}}},
        !obj:pylearn2.training_algorithms.learning_rule.MomentumAdjustor {{{
            start: 1,
            saturate: 100,
            final_momentum: .1
        }}}},
        !obj:pylearn2.training_algorithms.sgd.LinearDecayOverEpoch {{{
            start: 1,
            saturate: 100,
            decay_factor: 1e-3
        }}}},
    ],

    save_path: '{save_file}',
    save_freq: 1,
    }}}
"""

def run_pylearn(scr):

```

```

yaml_in = yaml.format(
    n_features=nn_feat,
    max_norm=0.75,
    save_file=os.path.join(output_dir, "nn_train.pkl"),
    save_file_best=os.path.join(output_dir, "nn_train_best.pkl"),
    x_train=pickle_x_train,
    x_test=pickle_x_test,
    y_train=pickle_y_train,
    y_test=pickle_y_test
).format(**scr._asdict())
train = yaml_parse.load(yaml_in)
train.main_loop()

```

## 8.1 S0 C0 R10

In [12]: `run_pylearn(diffs[0])`

Parameter and initial learning rate summary:

```

h0.W: 0.1
h0.b: 0.1
h1.W: 0.1
h1.b: 0.1
h2.W: 0.1
h2.b: 0.1
softmax.b: 0.1
softmax.W: 0.1

```

Compiling `sgd_update...`

Compiling `sgd_update` done. Time elapsed: 0.716071 seconds

compiling `begin_record_entry...`

compiling `begin_record_entry` done. Time elapsed: 0.234023 seconds

Monitored channels:

```

learning_rate
momentum
total_seconds_last_epoch
train_h0_col_norms_max
train_h0_col_norms_mean
train_h0_col_norms_min
train_h0_max_x_max_u
train_h0_max_x_mean_u
train_h0_max_x_min_u
train_h0_mean_x_max_u
train_h0_mean_x_mean_u
train_h0_mean_x_min_u
train_h0_min_x_max_u
train_h0_min_x_mean_u
train_h0_min_x_min_u
train_h0_range_x_max_u
train_h0_range_x_mean_u
train_h0_range_x_min_u
train_h0_row_norms_max
train_h0_row_norms_mean
train_h0_row_norms_min
train_h1_col_norms_max
train_h1_col_norms_mean
train_h1_col_norms_min

```

train\_h1\_max\_x\_max\_u  
train\_h1\_max\_x\_mean\_u  
train\_h1\_max\_x\_min\_u  
train\_h1\_mean\_x\_max\_u  
train\_h1\_mean\_x\_mean\_u  
train\_h1\_mean\_x\_min\_u  
train\_h1\_min\_x\_max\_u  
train\_h1\_min\_x\_mean\_u  
train\_h1\_min\_x\_min\_u  
train\_h1\_range\_x\_max\_u  
train\_h1\_range\_x\_mean\_u  
train\_h1\_range\_x\_min\_u  
train\_h1\_row\_norms\_max  
train\_h1\_row\_norms\_mean  
train\_h1\_row\_norms\_min  
train\_h2\_col\_norms\_max  
train\_h2\_col\_norms\_mean  
train\_h2\_col\_norms\_min  
train\_h2\_max\_x\_max\_u  
train\_h2\_max\_x\_mean\_u  
train\_h2\_max\_x\_min\_u  
train\_h2\_mean\_x\_max\_u  
train\_h2\_mean\_x\_mean\_u  
train\_h2\_mean\_x\_min\_u  
train\_h2\_min\_x\_max\_u  
train\_h2\_min\_x\_mean\_u  
train\_h2\_min\_x\_min\_u  
train\_h2\_range\_x\_max\_u  
train\_h2\_range\_x\_mean\_u  
train\_h2\_range\_x\_min\_u  
train\_h2\_row\_norms\_max  
train\_h2\_row\_norms\_mean  
train\_h2\_row\_norms\_min  
train\_objective  
train\_y\_col\_norms\_max  
train\_y\_col\_norms\_mean  
train\_y\_col\_norms\_min  
train\_y\_max\_max\_class  
train\_y\_mean\_max\_class  
train\_y\_min\_max\_class  
train\_y\_misclass  
train\_y\_nll  
train\_y\_row\_norms\_max  
train\_y\_row\_norms\_mean  
train\_y\_row\_norms\_min  
training\_seconds\_this\_epoch  
valid\_h0\_col\_norms\_max  
valid\_h0\_col\_norms\_mean  
valid\_h0\_col\_norms\_min  
valid\_h0\_max\_x\_max\_u  
valid\_h0\_max\_x\_mean\_u  
valid\_h0\_max\_x\_min\_u  
valid\_h0\_mean\_x\_max\_u  
valid\_h0\_mean\_x\_mean\_u



valid\_h0\_mean\_x\_min\_u  
valid\_h0\_min\_x\_max\_u  
valid\_h0\_min\_x\_mean\_u  
valid\_h0\_min\_x\_min\_u  
valid\_h0\_range\_x\_max\_u  
valid\_h0\_range\_x\_mean\_u  
valid\_h0\_range\_x\_min\_u  
valid\_h0\_row\_norms\_max  
valid\_h0\_row\_norms\_mean  
valid\_h0\_row\_norms\_min  
valid\_h1\_col\_norms\_max  
valid\_h1\_col\_norms\_mean  
valid\_h1\_col\_norms\_min  
valid\_h1\_max\_x\_max\_u  
valid\_h1\_max\_x\_mean\_u  
valid\_h1\_max\_x\_min\_u  
valid\_h1\_mean\_x\_max\_u  
valid\_h1\_mean\_x\_mean\_u  
valid\_h1\_mean\_x\_min\_u  
valid\_h1\_min\_x\_max\_u  
valid\_h1\_min\_x\_mean\_u  
valid\_h1\_min\_x\_min\_u  
valid\_h1\_range\_x\_max\_u  
valid\_h1\_range\_x\_mean\_u  
valid\_h1\_range\_x\_min\_u  
valid\_h1\_row\_norms\_max  
valid\_h1\_row\_norms\_mean  
valid\_h1\_row\_norms\_min  
valid\_h2\_col\_norms\_max  
valid\_h2\_col\_norms\_mean  
valid\_h2\_col\_norms\_min  
valid\_h2\_max\_x\_max\_u  
valid\_h2\_max\_x\_mean\_u  
valid\_h2\_max\_x\_min\_u  
valid\_h2\_mean\_x\_max\_u  
valid\_h2\_mean\_x\_mean\_u  
valid\_h2\_mean\_x\_min\_u  
valid\_h2\_min\_x\_max\_u  
valid\_h2\_min\_x\_mean\_u  
valid\_h2\_min\_x\_min\_u  
valid\_h2\_range\_x\_max\_u  
valid\_h2\_range\_x\_mean\_u  
valid\_h2\_range\_x\_min\_u  
valid\_h2\_row\_norms\_max  
valid\_h2\_row\_norms\_mean  
valid\_h2\_row\_norms\_min  
valid\_objective  
valid\_y\_col\_norms\_max  
valid\_y\_col\_norms\_mean  
valid\_y\_col\_norms\_min  
valid\_y\_max\_max\_class  
valid\_y\_mean\_max\_class  
valid\_y\_min\_max\_class  
valid\_y\_misclass

```

    valid_y_nll
    valid_y_row_norms_max
    valid_y_row_norms_mean
    valid_y_row_norms_min
Compiling accum...
graph size: 268
graph size: 264
Compiling accum done. Time elapsed: 4.089409 seconds
Monitoring step:
    Epochs seen: 0
    Batches seen: 0
    Examples seen: 0
    learning_rate: 0.10000000000000304
    momentum: 0.5000000000000047
    total_seconds_last_epoch: 0.0
    train_h0_col_norms_max: 0.7500000000000068
    train_h0_col_norms_mean: 0.7500000000000068
    train_h0_col_norms_min: 0.7500000000000068
    train_h0_max_x_max_u: 0.5388659843055673
    train_h0_max_x_mean_u: 0.2357672407826534
    train_h0_max_x_min_u: 0.06588638355184376
    train_h0_mean_x_max_u: 0.08044572875667297
    train_h0_mean_x_mean_u: 0.030610242581956933
    train_h0_mean_x_min_u: 0.005592671290416129
    train_h0_min_x_max_u: 0.0
    train_h0_min_x_mean_u: 0.0
    train_h0_min_x_min_u: 0.0
    train_h0_range_x_max_u: 0.5388659843055673
    train_h0_range_x_mean_u: 0.2357672407826534
    train_h0_range_x_min_u: 0.06588638355184376
    train_h0_row_norms_max: 0.9473073874924695
    train_h0_row_norms_mean: 0.45112367217004
    train_h0_row_norms_min: 0.0
    train_h1_col_norms_max: 0.7500000000000068
    train_h1_col_norms_mean: 0.7500000000000068
    train_h1_col_norms_min: 0.7500000000000068
    train_h1_max_x_max_u: 0.29719029384263507
    train_h1_max_x_mean_u: 0.10900189554746885
    train_h1_max_x_min_u: 0.0022223465628394986
    train_h1_mean_x_max_u: 0.06866036085032923
    train_h1_mean_x_mean_u: 0.018582516993667832
    train_h1_mean_x_min_u: 3.733647284547955e-05
    train_h1_min_x_max_u: 0.0017331643566588348
    train_h1_min_x_mean_u: 4.403690950402833e-06
    train_h1_min_x_min_u: 0.0
    train_h1_range_x_max_u: 0.2971719110957747
    train_h1_range_x_mean_u: 0.10899749185651852
    train_h1_range_x_min_u: 0.0022223465628394986
    train_h1_row_norms_max: 1.1743750618400093
    train_h1_row_norms_mean: 0.7349743966732963
    train_h1_row_norms_min: 0.3011737652442418
    train_h2_col_norms_max: 0.7500000000000068
    train_h2_col_norms_mean: 0.7500000000000068
    train_h2_col_norms_min: 0.7500000000000068

```

train\_h2\_max\_x\_max\_u: 0.15501403326304045  
train\_h2\_max\_x\_mean\_u: 0.05165263409570769  
train\_h2\_max\_x\_min\_u: 8.730125514080171e-08  
train\_h2\_mean\_x\_max\_u: 0.04972923575554638  
train\_h2\_mean\_x\_mean\_u: 0.010268362216016765  
train\_h2\_mean\_x\_min\_u: 1.2337728303750503e-09  
train\_h2\_min\_x\_max\_u: 0.007929601473887134  
train\_h2\_min\_x\_mean\_u: 3.914870538688551e-05  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.15435962266755118  
train\_h2\_range\_x\_mean\_u: 0.05161348539032075  
train\_h2\_range\_x\_min\_u: 8.730125514080171e-08  
train\_h2\_row\_norms\_max: 1.2131149672178743  
train\_h2\_row\_norms\_mean: 0.7335647006152959  
train\_h2\_row\_norms\_min: 0.3075633754711794  
train\_objective: 0.5518135677581042  
train\_y\_col\_norms\_max: 0.0  
train\_y\_col\_norms\_mean: 0.0  
train\_y\_col\_norms\_min: 0.0  
train\_y\_max\_max\_class: 0.7593625697345424  
train\_y\_mean\_max\_class: 0.7593625697345425  
train\_y\_min\_max\_class: 0.7593625697345424  
train\_y\_misclass: 0.24063743026543088  
train\_y\_nll: 0.5518135677581042  
train\_y\_row\_norms\_max: 0.0  
train\_y\_row\_norms\_mean: 0.0  
train\_y\_row\_norms\_min: 0.0  
training\_seconds\_this\_epoch: 0.0  
valid\_h0\_col\_norms\_max: 0.7499999999999973  
valid\_h0\_col\_norms\_mean: 0.7499999999999973  
valid\_h0\_col\_norms\_min: 0.7499999999999972  
valid\_h0\_max\_x\_max\_u: 0.5151195932255352  
valid\_h0\_max\_x\_mean\_u: 0.22942840309836027  
valid\_h0\_max\_x\_min\_u: 0.062434753570091914  
valid\_h0\_mean\_x\_max\_u: 0.07632479492749654  
valid\_h0\_mean\_x\_mean\_u: 0.029330755286785533  
valid\_h0\_mean\_x\_min\_u: 0.005090967709002158  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.5151195932255352  
valid\_h0\_range\_x\_mean\_u: 0.22942840309836027  
valid\_h0\_range\_x\_min\_u: 0.062434753570091914  
valid\_h0\_row\_norms\_max: 0.9473073874924988  
valid\_h0\_row\_norms\_mean: 0.4511236721700336  
valid\_h0\_row\_norms\_min: 0.0  
valid\_h1\_col\_norms\_max: 0.7499999999999973  
valid\_h1\_col\_norms\_mean: 0.7499999999999973  
valid\_h1\_col\_norms\_min: 0.7499999999999972  
valid\_h1\_max\_x\_max\_u: 0.2825580592093576  
valid\_h1\_max\_x\_mean\_u: 0.10585143704552916  
valid\_h1\_max\_x\_min\_u: 0.0023001160399689986  
valid\_h1\_mean\_x\_max\_u: 0.0657869969956128  
valid\_h1\_mean\_x\_mean\_u: 0.01798618351779575

```

valid_h1_mean_x_min_u: 3.9073447615644105e-05
valid_h1_min_x_max_u: 0.0015608205031647454
valid_h1_min_x_mean_u: 4.007495107542308e-06
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.28250347122163616
valid_h1_range_x_mean_u: 0.10584742955042163
valid_h1_range_x_min_u: 0.0023001160399689986
valid_h1_row_norms_max: 1.1743750618400184
valid_h1_row_norms_mean: 0.7349743966733107
valid_h1_row_norms_min: 0.3011737652442465
valid_h2_col_norms_max: 0.7499999999999973
valid_h2_col_norms_mean: 0.7499999999999973
valid_h2_col_norms_min: 0.7499999999999972
valid_h2_max_x_max_u: 0.14842707233194521
valid_h2_max_x_mean_u: 0.05006084120855997
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.04805110287775307
valid_h2_mean_x_mean_u: 0.009975511591093889
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.00744259793778655
valid_h2_min_x_mean_u: 3.7159719110560556e-05
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.14756064354793327
valid_h2_range_x_mean_u: 0.050023681489449384
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.213114967217896
valid_h2_row_norms_mean: 0.7335647006152757
valid_h2_row_norms_min: 0.30756337547117496
valid_objective: 0.5518520385175953
valid_y_col_norms_max: 0.0
valid_y_col_norms_mean: 0.0
valid_y_col_norms_min: 0.0
valid_y_max_max_class: 0.7593625697345727
valid_y_mean_max_class: 0.7593625697345728
valid_y_min_max_class: 0.7593625697345727
valid_y_misclass: 0.24067090673720917
valid_y_nll: 0.5518520385175953
valid_y_row_norms_max: 0.0
valid_y_row_norms_mean: 0.0
valid_y_row_norms_min: 0.0
Saving to ..\Sean\nn_files_SOCOR10\nn_train_best.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train_best.pkl done. Time elapsed: 0.046004 seconds
Time this epoch: 50.872086 seconds
Monitoring step:
  Epochs seen: 1
  Batches seen: 1599
  Examples seen: 159892
  learning_rate: 0.0990009999999985
  momentum: 0.5000000000000047
  total_seconds_last_epoch: 0.0
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7484359493515181
  train_h0_col_norms_min: 0.7359446266084869
  train_h0_max_x_max_u: 0.6235041780755121

```

train\_h0\_max\_x\_mean\_u: 0.25156247579272945  
train\_h0\_max\_x\_min\_u: 0.037819370933850786  
train\_h0\_mean\_x\_max\_u: 0.09686476149282011  
train\_h0\_mean\_x\_mean\_u: 0.030638418526797686  
train\_h0\_mean\_x\_min\_u: 0.0013368269599090693  
train\_h0\_min\_x\_max\_u: 0.0  
train\_h0\_min\_x\_mean\_u: 0.0  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.6235041780755121  
train\_h0\_range\_x\_mean\_u: 0.25156247579272945  
train\_h0\_range\_x\_min\_u: 0.037819370933850786  
train\_h0\_row\_norms\_max: 0.9293761037299314  
train\_h0\_row\_norms\_mean: 0.456944882367832  
train\_h0\_row\_norms\_min: 0.12882710353674215  
train\_h1\_col\_norms\_max: 0.75000000000000068  
train\_h1\_col\_norms\_mean: 0.748497021047411  
train\_h1\_col\_norms\_min: 0.739275659631047  
train\_h1\_max\_x\_max\_u: 0.39857392789863394  
train\_h1\_max\_x\_mean\_u: 0.13135576364057125  
train\_h1\_max\_x\_min\_u: 0.0007261068762417181  
train\_h1\_mean\_x\_max\_u: 0.09661502827778756  
train\_h1\_mean\_x\_mean\_u: 0.022572067379276584  
train\_h1\_mean\_x\_min\_u: 9.90678150222905e-06  
train\_h1\_min\_x\_max\_u: 0.006213342855122966  
train\_h1\_min\_x\_mean\_u: 2.910182914751803e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.3985260923662762  
train\_h1\_range\_x\_mean\_u: 0.13132666181142372  
train\_h1\_range\_x\_min\_u: 0.0007261068762417181  
train\_h1\_row\_norms\_max: 1.1748605131103655  
train\_h1\_row\_norms\_mean: 0.7336944683072658  
train\_h1\_row\_norms\_min: 0.29826644481309994  
train\_h2\_col\_norms\_max: 0.75000000000000068  
train\_h2\_col\_norms\_mean: 0.7495475883268184  
train\_h2\_col\_norms\_min: 0.7457646605017959  
train\_h2\_max\_x\_max\_u: 0.31779659898703894  
train\_h2\_max\_x\_mean\_u: 0.07844791293300758  
train\_h2\_max\_x\_min\_u: 5.004913166107311e-07  
train\_h2\_mean\_x\_max\_u: 0.10017360456205526  
train\_h2\_mean\_x\_mean\_u: 0.017093944756361765  
train\_h2\_mean\_x\_min\_u: 6.947672527857532e-09  
train\_h2\_min\_x\_max\_u: 0.01234139398027237  
train\_h2\_min\_x\_mean\_u: 0.00043564452502573584  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.3123624206382009  
train\_h2\_range\_x\_mean\_u: 0.07801226840798181  
train\_h2\_range\_x\_min\_u: 5.004913166107311e-07  
train\_h2\_row\_norms\_max: 1.2087358391226826  
train\_h2\_row\_norms\_mean: 0.7332797690391042  
train\_h2\_row\_norms\_min: 0.30688963896645677  
train\_objective: 0.4528458755999038  
train\_y\_col\_norms\_max: 0.8972326461877307  
train\_y\_col\_norms\_mean: 0.8972326461877307  
train\_y\_col\_norms\_min: 0.8972326461877307

train\_y\_max\_max\_class: 0.9558212644470557  
train\_y\_mean\_max\_class: 0.8909235234039228  
train\_y\_min\_max\_class: 0.7030823360361649  
train\_y\_misclass: 0.23130613163885666  
train\_y\_nll: 0.494123651296452  
train\_y\_row\_norms\_max: 0.1869357240793949  
train\_y\_row\_norms\_mean: 0.04574718013329027  
train\_y\_row\_norms\_min: 0.00022439565911069512  
training\_seconds\_this\_epoch: 50.87208599999908  
valid\_h0\_col\_norms\_max: 0.7500000000000004  
valid\_h0\_col\_norms\_mean: 0.7484359493515342  
valid\_h0\_col\_norms\_min: 0.7359446266085053  
valid\_h0\_max\_x\_max\_u: 0.6078397397637587  
valid\_h0\_max\_x\_mean\_u: 0.24737558795923514  
valid\_h0\_max\_x\_min\_u: 0.03735676381525339  
valid\_h0\_mean\_x\_max\_u: 0.09373566757903623  
valid\_h0\_mean\_x\_mean\_u: 0.03037696944190463  
valid\_h0\_mean\_x\_min\_u: 0.0014023051461908062  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.6078397397637587  
valid\_h0\_range\_x\_mean\_u: 0.24737558795923514  
valid\_h0\_range\_x\_min\_u: 0.03735676381525339  
valid\_h0\_row\_norms\_max: 0.9293761037299066  
valid\_h0\_row\_norms\_mean: 0.45694488236784603  
valid\_h0\_row\_norms\_min: 0.12882710353674537  
valid\_h1\_col\_norms\_max: 0.7500000000000039  
valid\_h1\_col\_norms\_mean: 0.748497021047404  
valid\_h1\_col\_norms\_min: 0.7392756596310299  
valid\_h1\_max\_x\_max\_u: 0.3825660865355998  
valid\_h1\_max\_x\_mean\_u: 0.12900567297107696  
valid\_h1\_max\_x\_min\_u: 0.00062911673152896  
valid\_h1\_mean\_x\_max\_u: 0.09643390871982539  
valid\_h1\_mean\_x\_mean\_u: 0.022671749183907755  
valid\_h1\_mean\_x\_min\_u: 8.73889294623942e-06  
valid\_h1\_min\_x\_max\_u: 0.005530189742576072  
valid\_h1\_min\_x\_mean\_u: 2.446264583007542e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.3825660865355998  
valid\_h1\_range\_x\_mean\_u: 0.12898121032524687  
valid\_h1\_range\_x\_min\_u: 0.00062911673152896  
valid\_h1\_row\_norms\_max: 1.1748605131103849  
valid\_h1\_row\_norms\_mean: 0.7336944683072848  
valid\_h1\_row\_norms\_min: 0.2982664448130879  
valid\_h2\_col\_norms\_max: 0.7499999999999973  
valid\_h2\_col\_norms\_mean: 0.7495475883268077  
valid\_h2\_col\_norms\_min: 0.7457646605017804  
valid\_h2\_max\_x\_max\_u: 0.3051847155026258  
valid\_h2\_max\_x\_mean\_u: 0.07628991700261471  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.10062451533714813  
valid\_h2\_mean\_x\_mean\_u: 0.01723370572344307  
valid\_h2\_mean\_x\_min\_u: 0.0

```

valid_h2_min_x_max_u: 0.010984832670217912
valid_h2_min_x_mean_u: 0.000320245511224258
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.30149427065042383
valid_h2_range_x_mean_u: 0.07596967149139044
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2087358391226994
valid_h2_row_norms_mean: 0.7332797690390808
valid_h2_row_norms_min: 0.3068896389664581
valid_objective: 0.4784016134366677
valid_y_col_norms_max: 0.8972326461877411
valid_y_col_norms_mean: 0.8972326461877409
valid_y_col_norms_min: 0.8972326461877409
valid_y_max_max_class: 0.9564518772585442
valid_y_mean_max_class: 0.8929340768886167
valid_y_min_max_class: 0.7255337868821061
valid_y_misclass: 0.23352282321157186
valid_y_nll: 0.5207130153483188
valid_y_row_norms_max: 0.18693572407939885
valid_y_row_norms_mean: 0.0457471801332888
valid_y_row_norms_min: 0.0002243956591106997
Saving to ..\Sean\nn_files_SOCOR10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.best.pkl done. Time elapsed: 0.045005 seconds
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.050005 seconds
Time this epoch: 50.250025 seconds
Monitoring step:
  Epochs seen: 2
  Batches seen: 3198
  Examples seen: 319784
  learning_rate: 0.09800200000000195
  momentum: 0.49595959595959005
  total_seconds_last_epoch: 94.2544240000026
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7479776585582479
  train_h0_col_norms_min: 0.7307162673655945
  train_h0_max_x_max_u: 0.6630232076176944
  train_h0_max_x_mean_u: 0.2394431608319093
  train_h0_max_x_min_u: 0.0027012272598370512
  train_h0_mean_x_max_u: 0.09211068812663732
  train_h0_mean_x_mean_u: 0.023250290497755843
  train_h0_mean_x_min_u: 4.7604973021946815e-05
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.6630232076176944
  train_h0_range_x_mean_u: 0.2394431608319093
  train_h0_range_x_min_u: 0.0027012272598370512
  train_h0_row_norms_max: 0.870520649704008
  train_h0_row_norms_mean: 0.4633152866831853
  train_h0_row_norms_min: 0.19863382266168572
  train_h1_col_norms_max: 0.7500000000000068
  train_h1_col_norms_mean: 0.7481615691676651
  train_h1_col_norms_min: 0.7403092629593417

```

train\_h1\_max\_x\_max\_u: 0.392720929359599  
train\_h1\_max\_x\_mean\_u: 0.12345596418575129  
train\_h1\_max\_x\_min\_u: 0.0001002354239868492  
train\_h1\_mean\_x\_max\_u: 0.11900716229471568  
train\_h1\_mean\_x\_mean\_u: 0.019426719767884362  
train\_h1\_mean\_x\_min\_u: 1.1775026030414178e-06  
train\_h1\_min\_x\_max\_u: 0.010325876004583852  
train\_h1\_min\_x\_mean\_u: 4.008702635475905e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.39258877067168757  
train\_h1\_range\_x\_mean\_u: 0.12341587715939659  
train\_h1\_range\_x\_min\_u: 0.0001002354239868492  
train\_h1\_row\_norms\_max: 1.1632670123435653  
train\_h1\_row\_norms\_mean: 0.7339991351426226  
train\_h1\_row\_norms\_min: 0.3147853706234447  
train\_h2\_col\_norms\_max: 0.7500000000000068  
train\_h2\_col\_norms\_mean: 0.7494249309061787  
train\_h2\_col\_norms\_min: 0.7453886536307198  
train\_h2\_max\_x\_max\_u: 0.3669276774756154  
train\_h2\_max\_x\_mean\_u: 0.08324114482760987  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.11921036201669508  
train\_h2\_mean\_x\_mean\_u: 0.020130582247630216  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.02435651209013983  
train\_h2\_min\_x\_mean\_u: 0.0010479901528944386  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.35519454311297094  
train\_h2\_range\_x\_mean\_u: 0.08219315467471534  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.209088449620643  
train\_h2\_row\_norms\_mean: 0.7333328046617524  
train\_h2\_row\_norms\_min: 0.31374063829851695  
train\_objective: 0.4074168079543095  
train\_y\_col\_norms\_max: 1.0277032000938358  
train\_y\_col\_norms\_mean: 1.0277032000938358  
train\_y\_col\_norms\_min: 1.0277032000938358  
train\_y\_max\_max\_class: 0.9668037214645058  
train\_y\_mean\_max\_class: 0.8901105600535905  
train\_y\_min\_max\_class: 0.6863076425630363  
train\_y\_misclass: 0.21483876616716321  
train\_y\_nll: 0.42708010859335893  
train\_y\_row\_norms\_max: 0.18773865889374897  
train\_y\_row\_norms\_mean: 0.055920458917769776  
train\_y\_row\_norms\_min: 5.560492596570638e-05  
training\_seconds\_this\_epoch: 50.25002500000095  
valid\_h0\_col\_norms\_max: 0.7500000000000004  
valid\_h0\_col\_norms\_mean: 0.7479776585582573  
valid\_h0\_col\_norms\_min: 0.7307162673656091  
valid\_h0\_max\_x\_max\_u: 0.6353274080236272  
valid\_h0\_max\_x\_mean\_u: 0.23782014324608214  
valid\_h0\_max\_x\_min\_u: 0.003173672441707447  
valid\_h0\_mean\_x\_max\_u: 0.09182041346155259  
valid\_h0\_mean\_x\_mean\_u: 0.023280714371683928



valid\_h0\_mean\_x\_min\_u: 6.335588562630687e-05  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.6353274080236272  
valid\_h0\_range\_x\_mean\_u: 0.23782014324608214  
valid\_h0\_range\_x\_min\_u: 0.003173672441707447  
valid\_h0\_row\_norms\_max: 0.8705206497040355  
valid\_h0\_row\_norms\_mean: 0.463315286683177  
valid\_h0\_row\_norms\_min: 0.1986338226616858  
valid\_h1\_col\_norms\_max: 0.7500000000000039  
valid\_h1\_col\_norms\_mean: 0.7481615691676791  
valid\_h1\_col\_norms\_min: 0.740309262959321  
valid\_h1\_max\_x\_max\_u: 0.38302470795243393  
valid\_h1\_max\_x\_mean\_u: 0.1231361311421056  
valid\_h1\_max\_x\_min\_u: 7.588092179388128e-05  
valid\_h1\_mean\_x\_max\_u: 0.12099647928683936  
valid\_h1\_mean\_x\_mean\_u: 0.019787580653691492  
valid\_h1\_mean\_x\_min\_u: 8.700654438238615e-07  
valid\_h1\_min\_x\_max\_u: 0.006896574221097032  
valid\_h1\_min\_x\_mean\_u: 2.3737273713854638e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.38288724446747413  
valid\_h1\_range\_x\_mean\_u: 0.12311239386839179  
valid\_h1\_range\_x\_min\_u: 7.588092179388128e-05  
valid\_h1\_row\_norms\_max: 1.163267012343567  
valid\_h1\_row\_norms\_mean: 0.7339991351426266  
valid\_h1\_row\_norms\_min: 0.3147853706234411  
valid\_h2\_col\_norms\_max: 0.7499999999999973  
valid\_h2\_col\_norms\_mean: 0.7494249309062008  
valid\_h2\_col\_norms\_min: 0.7453886536306952  
valid\_h2\_max\_x\_max\_u: 0.35983244563131944  
valid\_h2\_max\_x\_mean\_u: 0.08252814495469865  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.12297180917349253  
valid\_h2\_mean\_x\_mean\_u: 0.020617984260874245  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.019541006060144046  
valid\_h2\_min\_x\_mean\_u: 0.0007272167164855342  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.35197132684374666  
valid\_h2\_range\_x\_mean\_u: 0.08180092823821321  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2090884496206495  
valid\_h2\_row\_norms\_mean: 0.7333328046617535  
valid\_h2\_row\_norms\_min: 0.3137406382985238  
valid\_objective: 0.4579289295337185  
valid\_y\_col\_norms\_max: 1.0277032000938517  
valid\_y\_col\_norms\_mean: 1.0277032000938517  
valid\_y\_col\_norms\_min: 1.0277032000938517  
valid\_y\_max\_max\_class: 0.9681716456670442  
valid\_y\_mean\_max\_class: 0.8893118418538274  
valid\_y\_min\_max\_class: 0.6839303449982259  
valid\_y\_misclass: 0.22643102380818367

```

valid_y_nll: 0.4736185761691449
valid_y_row_norms_max: 0.18773865889375624
valid_y_row_norms_mean: 0.05592045891777164
valid_y_row_norms_min: 5.5604925965705416e-05
Saving to ..\Sean\nn_files_S0COR10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_S0COR10\nn_train.best.pkl done. Time elapsed: 0.040004 seconds
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl done. Time elapsed: 0.047005 seconds
Time this epoch: 50.140013 seconds
Monitoring step:
  Epochs seen: 3
  Batches seen: 4797
  Examples seen: 479676
  learning_rate: 0.09700299999999822
  momentum: 0.4919191919191782
  total_seconds_last_epoch: 92.07620699999903
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7473913297563575
  train_h0_col_norms_min: 0.7335034993847225
  train_h0_max_x_max_u: 0.7080711476907863
  train_h0_max_x_mean_u: 0.2180956755906953
  train_h0_max_x_min_u: 0.00013553813295834698
  train_h0_mean_x_max_u: 0.09894938027687854
  train_h0_mean_x_mean_u: 0.018064057976661652
  train_h0_mean_x_min_u: 2.0515843615900803e-06
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7080711476907863
  train_h0_range_x_mean_u: 0.2180956755906953
  train_h0_range_x_min_u: 0.00013553813295834698
  train_h0_row_norms_max: 0.8226805349728691
  train_h0_row_norms_mean: 0.46711904680660127
  train_h0_row_norms_min: 0.2543664485666224
  train_h1_col_norms_max: 0.7500000000000068
  train_h1_col_norms_mean: 0.7480464749923444
  train_h1_col_norms_min: 0.7393312935576399
  train_h1_max_x_max_u: 0.37011433458359866
  train_h1_max_x_mean_u: 0.11114094040636159
  train_h1_max_x_min_u: 2.2248824486670984e-05
  train_h1_mean_x_max_u: 0.09561277361540686
  train_h1_mean_x_mean_u: 0.017294716305664933
  train_h1_mean_x_min_u: 4.1975767560270394e-07
  train_h1_min_x_max_u: 0.006566246886399574
  train_h1_min_x_mean_u: 2.7571146264803875e-05
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.37007394577973396
  train_h1_range_x_mean_u: 0.11111336926009674
  train_h1_range_x_min_u: 2.2248824486670984e-05
  train_h1_row_norms_max: 1.1501615361830666
  train_h1_row_norms_mean: 0.7345414509119824
  train_h1_row_norms_min: 0.3144235781371855
  train_h2_col_norms_max: 0.7500000000000068
  train_h2_col_norms_mean: 0.7494108150112889

```

train\_h2.col\_norms\_min: 0.7457052867863725  
train\_h2.max\_x\_max\_u: 0.35815091943272204  
train\_h2.max\_x\_mean\_u: 0.08106539481956214  
train\_h2.max\_x\_min\_u: 0.0  
train\_h2.mean\_x\_max\_u: 0.12285156940151416  
train\_h2.mean\_x\_mean\_u: 0.020716923512629673  
train\_h2.mean\_x\_min\_u: 0.0  
train\_h2.min\_x\_max\_u: 0.026523819810164922  
train\_h2.min\_x\_mean\_u: 0.001440165750801267  
train\_h2.min\_x\_min\_u: 0.0  
train\_h2.range\_x\_max\_u: 0.34120421797833017  
train\_h2.range\_x\_mean\_u: 0.07962522906876093  
train\_h2.range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2060265417001756  
train\_h2.row\_norms\_mean: 0.7334560152976397  
train\_h2.row\_norms\_min: 0.3180644092346892  
train\_objective: 0.3826534063254982  
train\_y.col\_norms\_max: 1.116876367823403  
train\_y.col\_norms\_mean: 1.116876367823403  
train\_y.col\_norms\_min: 1.116876367823403  
train\_y.max\_max\_class: 0.9707358982205966  
train\_y.mean\_max\_class: 0.894693662137307  
train\_y.min\_max\_class: 0.6998484946187363  
train\_y.misclass: 0.20915367873314514  
train\_y.nll: 0.3985558372232418  
train\_y.row\_norms\_max: 0.18418435174621958  
train\_y.row\_norms\_mean: 0.06316465936557152  
train\_y.row\_norms\_min: 0.0004881857372667787  
training\_seconds\_this\_epoch: 50.140013000001815  
valid\_h0.col\_norms\_max: 0.75000000000000039  
valid\_h0.col\_norms\_mean: 0.7473913297563676  
valid\_h0.col\_norms\_min: 0.7335034993847318  
valid\_h0.max\_x\_max\_u: 0.6645929210375877  
valid\_h0.max\_x\_mean\_u: 0.21615912423745015  
valid\_h0.max\_x\_min\_u: 3.258586570025244e-05  
valid\_h0.mean\_x\_max\_u: 0.09971965422114423  
valid\_h0.mean\_x\_mean\_u: 0.018002087878260967  
valid\_h0.mean\_x\_min\_u: 3.312772802180342e-07  
valid\_h0.min\_x\_max\_u: 0.0  
valid\_h0.min\_x\_mean\_u: 0.0  
valid\_h0.min\_x\_min\_u: 0.0  
valid\_h0.range\_x\_max\_u: 0.6645929210375877  
valid\_h0.range\_x\_mean\_u: 0.21615912423745015  
valid\_h0.range\_x\_min\_u: 3.258586570025244e-05  
valid\_h0.row\_norms\_max: 0.8226805349728565  
valid\_h0.row\_norms\_mean: 0.4671190468065884  
valid\_h0.row\_norms\_min: 0.25436644856663054  
valid\_h1.col\_norms\_max: 0.75000000000000039  
valid\_h1.col\_norms\_mean: 0.74804647499234  
valid\_h1.col\_norms\_min: 0.7393312935576676  
valid\_h1.max\_x\_max\_u: 0.35567666599722497  
valid\_h1.max\_x\_mean\_u: 0.11019379784393103  
valid\_h1.max\_x\_min\_u: 0.0  
valid\_h1.mean\_x\_max\_u: 0.092377319946157

```

valid_h1_mean_x_mean_u: 0.017550224137364543
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.005220239922807405
valid_h1_min_x_mean_u: 1.8330702899192073e-05
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.35567666599722497
valid_h1_range_x_mean_u: 0.11017546714103182
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.1501615361830577
valid_h1_row_norms_mean: 0.7345414509119869
valid_h1_row_norms_min: 0.31442357813718197
valid_h2_col_norms_max: 0.7499999999999973
valid_h2_col_norms_mean: 0.7494108150112716
valid_h2_col_norms_min: 0.7457052867863829
valid_h2_max_x_max_u: 0.34920821002511276
valid_h2_max_x_mean_u: 0.07970027267055753
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.12483248944651404
valid_h2_mean_x_mean_u: 0.021092437984035692
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.021646802723255573
valid_h2_min_x_mean_u: 0.0010920328715798896
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.3356180107936306
valid_h2_range_x_mean_u: 0.07860823979897762
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2060265417001244
valid_h2_row_norms_mean: 0.7334560152976194
valid_h2_row_norms_min: 0.3180644092346848
valid_objective: 0.44352795147444957
valid_y_col_norms_max: 1.116876367823437
valid_y_col_norms_mean: 1.116876367823437
valid_y_col_norms_min: 1.116876367823437
valid_y_max_max_class: 0.9711436910470151
valid_y_mean_max_class: 0.8953363274979781
valid_y_min_max_class: 0.6943763765408816
valid_y_misclass: 0.22294140822873862
valid_y_nll: 0.4602855104488711
valid_y_row_norms_max: 0.1841843517462229
valid_y_row_norms_mean: 0.0631646593655732
valid_y_row_norms_min: 0.0004881857372667726
Saving to ..\Sean\nn_files_SOCOR10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.best.pkl done. Time elapsed: 0.042004 seconds
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.057005 seconds
Time this epoch: 50.321032 seconds
Monitoring step:
  Epochs seen: 4
  Batches seen: 6396
  Examples seen: 639568
  learning_rate: 0.09600400000000152
  momentum: 0.48787878787877514
  total_seconds_last_epoch: 92.77527599999738
  train_h0_col_norms_max: 0.7500000000000068

```

train\_h0.col\_norms\_mean: 0.7473036396176335  
train\_h0.col\_norms\_min: 0.7289082852793042  
train\_h0.max\_x\_max\_u: 0.6945541062360713  
train\_h0.max\_x\_mean\_u: 0.20405723351047866  
train\_h0.max\_x\_min\_u: 1.9026973168243273e-05  
train\_h0.mean\_x\_max\_u: 0.08870833739407542  
train\_h0.mean\_x\_mean\_u: 0.014626436955234355  
train\_h0.mean\_x\_min\_u: 2.2166163694687547e-07  
train\_h0.min\_x\_max\_u: 0.0  
train\_h0.min\_x\_mean\_u: 0.0  
train\_h0.min\_x\_min\_u: 0.0  
train\_h0.range\_x\_max\_u: 0.6945541062360713  
train\_h0.range\_x\_mean\_u: 0.20405723351047866  
train\_h0.range\_x\_min\_u: 1.9026973168243273e-05  
train\_h0.row\_norms\_max: 0.7728899939802205  
train\_h0.row\_norms\_mean: 0.46981322922861257  
train\_h0.row\_norms\_min: 0.2840095688109564  
train\_h1.col\_norms\_max: 0.75000000000000068  
train\_h1.col\_norms\_mean: 0.747997981591296  
train\_h1.col\_norms\_min: 0.7373554326864187  
train\_h1.max\_x\_max\_u: 0.3403681372493704  
train\_h1.max\_x\_mean\_u: 0.10346703258395772  
train\_h1.max\_x\_min\_u: 2.9927185800432247e-05  
train\_h1.mean\_x\_max\_u: 0.11611681803765707  
train\_h1.mean\_x\_mean\_u: 0.016835703769427234  
train\_h1.mean\_x\_min\_u: 3.5119358055478305e-07  
train\_h1.min\_x\_max\_u: 0.014422339494701916  
train\_h1.min\_x\_mean\_u: 6.226610399404458e-05  
train\_h1.min\_x\_min\_u: 0.0  
train\_h1.range\_x\_max\_u: 0.339976585151546  
train\_h1.range\_x\_mean\_u: 0.10340476647996348  
train\_h1.range\_x\_min\_u: 2.9927185800432247e-05  
train\_h1.row\_norms\_max: 1.1328635429581866  
train\_h1.row\_norms\_mean: 0.7353393665295566  
train\_h1.row\_norms\_min: 0.3355815428600591  
train\_h2.col\_norms\_max: 0.75000000000000068  
train\_h2.col\_norms\_mean: 0.7494301748651905  
train\_h2.col\_norms\_min: 0.7435355137093314  
train\_h2.max\_x\_max\_u: 0.3801271152765319  
train\_h2.max\_x\_mean\_u: 0.08190592311954065  
train\_h2.max\_x\_min\_u: 5.429332961753637e-07  
train\_h2.mean\_x\_max\_u: 0.15753697630574487  
train\_h2.mean\_x\_mean\_u: 0.022850149416306507  
train\_h2.mean\_x\_min\_u: 6.87322078225084e-09  
train\_h2.min\_x\_max\_u: 0.03774847301751285  
train\_h2.min\_x\_mean\_u: 0.002006504045633275  
train\_h2.min\_x\_min\_u: 0.0  
train\_h2.range\_x\_max\_u: 0.35623941337398685  
train\_h2.range\_x\_mean\_u: 0.07989941907390719  
train\_h2.range\_x\_min\_u: 5.429332961753637e-07  
train\_h2.row\_norms\_max: 1.2045124125614686  
train\_h2.row\_norms\_mean: 0.7335740727732127  
train\_h2.row\_norms\_min: 0.31905274230887076  
train\_objective: 0.36391166100081346

```

train_y_col_norms_max: 1.2122013108929677
train_y_col_norms_mean: 1.2122013108929677
train_y_col_norms_min: 1.2122013108929677
train_y_max_max_class: 0.9730964787173707
train_y_mean_max_class: 0.8845923520100858
train_y_min_max_class: 0.6702162991637474
train_y_misclass: 0.18692617516823873
train_y_nll: 0.34583330079358376
train_y_row_norms_max: 0.19891425897483853
train_y_row_norms_mean: 0.06925303824149091
train_y_row_norms_min: 0.0007352900197185931
training_seconds_this_epoch: 50.32103200000165
valid_h0_col_norms_max: 0.7500000000000004
valid_h0_col_norms_mean: 0.7473036396176388
valid_h0_col_norms_min: 0.7289082852792906
valid_h0_max_x_max_u: 0.6527364516459928
valid_h0_max_x_mean_u: 0.20174216844612122
valid_h0_max_x_min_u: 0.0
valid_h0_mean_x_max_u: 0.090380743519273
valid_h0_mean_x_mean_u: 0.014461433613015435
valid_h0_mean_x_min_u: 0.0
valid_h0_min_x_max_u: 0.0
valid_h0_min_x_mean_u: 0.0
valid_h0_min_x_min_u: 0.0
valid_h0_range_x_max_u: 0.6527364516459928
valid_h0_range_x_mean_u: 0.20174216844612122
valid_h0_range_x_min_u: 0.0
valid_h0_row_norms_max: 0.772889993980209
valid_h0_row_norms_mean: 0.4698132292285997
valid_h0_row_norms_min: 0.2840095688109493
valid_h1_col_norms_max: 0.75000000000000039
valid_h1_col_norms_mean: 0.7479979815912908
valid_h1_col_norms_min: 0.7373554326864088
valid_h1_max_x_max_u: 0.3268505065939153
valid_h1_max_x_mean_u: 0.10302420561706285
valid_h1_max_x_min_u: 5.203823024491283e-05
valid_h1_mean_x_max_u: 0.10793875205135472
valid_h1_mean_x_mean_u: 0.01702453029968815
valid_h1_mean_x_min_u: 7.118391701011779e-07
valid_h1_min_x_max_u: 0.01052392837591125
valid_h1_min_x_mean_u: 3.818603589840715e-05
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.3265455743732012
valid_h1_range_x_mean_u: 0.10298601958116442
valid_h1_range_x_min_u: 5.203823024491283e-05
valid_h1_row_norms_max: 1.1328635429582066
valid_h1_row_norms_mean: 0.7353393665295535
valid_h1_row_norms_min: 0.3355815428600591
valid_h2_col_norms_max: 0.7499999999999973
valid_h2_col_norms_mean: 0.7494301748651744
valid_h2_col_norms_min: 0.7435355137093392
valid_h2_max_x_max_u: 0.3774486326965978
valid_h2_max_x_mean_u: 0.08163548651137027
valid_h2_max_x_min_u: 0.0

```

```

valid_h2_mean_x_max_u: 0.1533310508063289
valid_h2_mean_x_mean_u: 0.023182253143108695
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.02700029230789892
valid_h2_min_x_mean_u: 0.0013487813422260982
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.3596119969000628
valid_h2_range_x_mean_u: 0.08028670516914407
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2045124125614695
valid_h2_row_norms_mean: 0.7335740727731976
valid_h2_row_norms_min: 0.31905274230887387
valid_objective: 0.4498956363150104
valid_y_col_norms_max: 1.2122013108929297
valid_y_col_norms_mean: 1.2122013108929297
valid_y_col_norms_min: 1.2122013108929297
valid_y_max_max_class: 0.9739633768003904
valid_y_mean_max_class: 0.883480510071065
valid_y_min_max_class: 0.6480078257302941
valid_y_misclass: 0.21027748072268812
valid_y_nll: 0.43326567097539664
valid_y_row_norms_max: 0.19891425897483134
valid_y_row_norms_mean: 0.06925303824149422
valid_y_row_norms_min: 0.0007352900197185902
Saving to ..\Sean\nn_files_SOCOR10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.best.pkl done. Time elapsed: 0.047005 seconds
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.055006 seconds
Time this epoch: 50.282027 seconds
Monitoring step:
  Epochs seen: 5
  Batches seen: 7995
  Examples seen: 799460
  learning_rate: 0.09500499999999729
  momentum: 0.4838383838383636
  total_seconds_last_epoch: 92.9932989999978
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7468351997446898
  train_h0_col_norms_min: 0.7256835517562579
  train_h0_max_x_max_u: 0.7044165445602099
  train_h0_max_x_mean_u: 0.1870031390753005
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.08280088072562886
  train_h0_mean_x_mean_u: 0.012056744713059045
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7044165445602099
  train_h0_range_x_mean_u: 0.1870031390753005
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.7587804689109975
  train_h0_row_norms_mean: 0.47118148317687375
  train_h0_row_norms_min: 0.32469789427293805

```

train\_h1.col\_norms\_max: 0.7500000000000068  
train\_h1.col\_norms\_mean: 0.748095183033507  
train\_h1.col\_norms\_min: 0.7390094825404296  
train\_h1\_max\_x\_max\_u: 0.32715241265668965  
train\_h1\_max\_x\_mean\_u: 0.09508251992433038  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.0902621564111727  
train\_h1\_mean\_x\_mean\_u: 0.015230950755779573  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.0122869595668161  
train\_h1\_min\_x\_mean\_u: 6.392502746971432e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.3267675120162836  
train\_h1\_range\_x\_mean\_u: 0.0950185948968608  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1.row\_norms\_max: 1.119536842437926  
train\_h1.row\_norms\_mean: 0.7360341462608047  
train\_h1.row\_norms\_min: 0.3369834056670176  
train\_h2.col\_norms\_max: 0.7500000000000068  
train\_h2.col\_norms\_mean: 0.7493564527723032  
train\_h2.col\_norms\_min: 0.7450633424062642  
train\_h2\_max\_x\_max\_u: 0.39335070548829093  
train\_h2\_max\_x\_mean\_u: 0.0809234203021293  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.20672025312569287  
train\_h2\_mean\_x\_mean\_u: 0.02450973684309784  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.05851289861773871  
train\_h2\_min\_x\_mean\_u: 0.0030130615732429657  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.3605713288355413  
train\_h2\_range\_x\_mean\_u: 0.07791035872888628  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.201904873901804  
train\_h2.row\_norms\_mean: 0.7336313917099327  
train\_h2.row\_norms\_min: 0.32792056759258426  
train\_objective: 0.3433112627992233  
train\_y.col\_norms\_max: 1.3591605131609128  
train\_y.col\_norms\_mean: 1.3591605131609128  
train\_y.col\_norms\_min: 1.3591605131609128  
train\_y\_max\_max\_class: 0.9766137817987748  
train\_y\_mean\_max\_class: 0.8821277271240177  
train\_y\_min\_max\_class: 0.6645093253844909  
train\_y\_misclass: 0.17670677707452537  
train\_y\_nll: 0.3139408830584517  
train\_y.row\_norms\_max: 0.5134532958661987  
train\_y.row\_norms\_mean: 0.07578064744568352  
train\_y.row\_norms\_min: 4.576529354875566e-05  
training\_seconds\_this\_epoch: 50.28202700000108  
valid\_h0.col\_norms\_max: 0.7500000000000004  
valid\_h0.col\_norms\_mean: 0.7468351997446903  
valid\_h0.col\_norms\_min: 0.7256835517562484  
valid\_h0\_max\_x\_max\_u: 0.6784253734408953  
valid\_h0\_max\_x\_mean\_u: 0.18478493846972194



valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.08443865517519936  
valid\_h0\_mean\_x\_mean\_u: 0.011857483176318533  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.6784253734408953  
valid\_h0\_range\_x\_mean\_u: 0.18478493846972194  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.758780468910991  
valid\_h0\_row\_norms\_mean: 0.4711814831768813  
valid\_h0\_row\_norms\_min: 0.32469789427293133  
valid\_h1\_col\_norms\_max: 0.7500000000000039  
valid\_h1\_col\_norms\_mean: 0.7480951830335285  
valid\_h1\_col\_norms\_min: 0.7390094825404372  
valid\_h1\_max\_x\_max\_u: 0.31586799294886286  
valid\_h1\_max\_x\_mean\_u: 0.0947537136324309  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.08839011422913733  
valid\_h1\_mean\_x\_mean\_u: 0.015353278050069029  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.01107002051295072  
valid\_h1\_min\_x\_mean\_u: 4.454653504465215e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.31575927390781644  
valid\_h1\_range\_x\_mean\_u: 0.09470916709738621  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1195368424378818  
valid\_h1\_row\_norms\_mean: 0.7360341462607899  
valid\_h1\_row\_norms\_min: 0.33698340566701285  
valid\_h2\_col\_norms\_max: 0.7499999999999973  
valid\_h2\_col\_norms\_mean: 0.7493564527722749  
valid\_h2\_col\_norms\_min: 0.7450633424062778  
valid\_h2\_max\_x\_max\_u: 0.38593173216208615  
valid\_h2\_max\_x\_mean\_u: 0.0808236384353015  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.18089105820449564  
valid\_h2\_mean\_x\_mean\_u: 0.024778938216826762  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.04769727507728432  
valid\_h2\_min\_x\_mean\_u: 0.0022885061685860037  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.36507149558257096  
valid\_h2\_range\_x\_mean\_u: 0.07853513226671544  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.201904873901817  
valid\_h2\_row\_norms\_mean: 0.7336313917099501  
valid\_h2\_row\_norms\_min: 0.32792056759258176  
valid\_objective: 0.4334359678797821  
valid\_y\_col\_norms\_max: 1.3591605131608757  
valid\_y\_col\_norms\_mean: 1.3591605131608757  
valid\_y\_col\_norms\_min: 1.3591605131608755  
valid\_y\_max\_max\_class: 0.9788289705564024

```

valid_y_mean_max_class: 0.8800538221547481
valid_y_min_max_class: 0.6388586845604267
valid_y_misclass: 0.20003377047334947
valid_y_nll: 0.40843918795392087
valid_y_row_norms_max: 0.5134532958661955
valid_y_row_norms_mean: 0.07578064744568279
valid_y_row_norms_min: 4.576529354875427e-05
Saving to ..\Sean\nn_files_S0COR10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_S0COR10\nn_train.best.pkl done. Time elapsed: 0.049005 seconds
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl done. Time elapsed: 0.061006 seconds
Time this epoch: 49.839984 seconds
Monitoring step:
  Epochs seen: 6
  Batches seen: 9594
  Examples seen: 959352
  learning_rate: 0.09400600000000045
  momentum: 0.47979797979799155
  total_seconds_last_epoch: 92.75227399999875
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7467647235505337
  train_h0_col_norms_min: 0.7259801570150349
  train_h0_max_x_max_u: 0.7245694743775544
  train_h0_max_x_mean_u: 0.17923437354582264
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.08324323023604961
  train_h0_mean_x_mean_u: 0.010927251466808173
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7245694743775544
  train_h0_range_x_mean_u: 0.17923437354582264
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.7979044168669681
  train_h0_row_norms_mean: 0.472262162745619
  train_h0_row_norms_min: 0.3362998009847905
  train_h1_col_norms_max: 0.7500000000000068
  train_h1_col_norms_mean: 0.7483594796934764
  train_h1_col_norms_min: 0.7363573822474027
  train_h1_max_x_max_u: 0.32395112573819196
  train_h1_max_x_mean_u: 0.09004578479370969
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.08994237269621877
  train_h1_mean_x_mean_u: 0.014246002606783563
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.012146300900640332
  train_h1_min_x_mean_u: 6.507323209299641e-05
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.32379544206066324
  train_h1_range_x_mean_u: 0.0899807115616166
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.1188816239675827
  train_h1_row_norms_mean: 0.736933350842754

```

train\_h1\_row\_norms\_min: 0.367790902944536  
train\_h2\_col\_norms\_max: 0.7500000000000068  
train\_h2\_col\_norms\_mean: 0.7494422430253762  
train\_h2\_col\_norms\_min: 0.7444880985811451  
train\_h2\_max\_x\_max\_u: 0.4628665651374876  
train\_h2\_max\_x\_mean\_u: 0.07923770965736174  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.27608860968740717  
train\_h2\_mean\_x\_mean\_u: 0.025375006991844026  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.07795298970871962  
train\_h2\_min\_x\_mean\_u: 0.0041873372071818005  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.4151935596342561  
train\_h2\_range\_x\_mean\_u: 0.07505037245017995  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2035944357317454  
train\_h2\_row\_norms\_mean: 0.7337448876805798  
train\_h2\_row\_norms\_min: 0.33628935992462156  
train\_objective: 0.33128587261276643  
train\_y\_col\_norms\_max: 1.5686128883575823  
train\_y\_col\_norms\_mean: 1.5686128883575823  
train\_y\_col\_norms\_min: 1.5686128883575823  
train\_y\_max\_max\_class: 0.9820752268414176  
train\_y\_mean\_max\_class: 0.8854450748581656  
train\_y\_min\_max\_class: 0.6572048681577237  
train\_y\_misclass: 0.15828184024216346  
train\_y\_nll: 0.28213585876432895  
train\_y\_row\_norms\_max: 0.8397148884599122  
train\_y\_row\_norms\_mean: 0.08127211868878179  
train\_y\_row\_norms\_min: 0.001321257797071388  
training\_seconds\_this\_epoch: 49.83998399999965  
valid\_h0\_col\_norms\_max: 0.7500000000000004  
valid\_h0\_col\_norms\_mean: 0.7467647235505636  
valid\_h0\_col\_norms\_min: 0.7259801570150575  
valid\_h0\_max\_x\_max\_u: 0.6853176272845694  
valid\_h0\_max\_x\_mean\_u: 0.1764153790181663  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.08218897875123635  
valid\_h0\_mean\_x\_mean\_u: 0.010676975441708592  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.6853176272845694  
valid\_h0\_range\_x\_mean\_u: 0.1764153790181663  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7979044168669343  
valid\_h0\_row\_norms\_mean: 0.47226216274562743  
valid\_h0\_row\_norms\_min: 0.33629980098478096  
valid\_h1\_col\_norms\_max: 0.7500000000000039  
valid\_h1\_col\_norms\_mean: 0.748359479693463  
valid\_h1\_col\_norms\_min: 0.7363573822473887  
valid\_h1\_max\_x\_max\_u: 0.318145328745617

```

valid_h1_max_x_mean_u: 0.08902109221058215
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.0810397124897881
valid_h1_mean_x_mean_u: 0.014133151062323095
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.008932722387118
valid_h1_min_x_mean_u: 3.515026003402783e-05
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.3180210844549234
valid_h1_range_x_mean_u: 0.08898594195054811
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.11888162396755
valid_h1_row_norms_mean: 0.7369333508427837
valid_h1_row_norms_min: 0.3677909029445398
valid_h2_col_norms_max: 0.7499999999999973
valid_h2_col_norms_mean: 0.7494422430253801
valid_h2_col_norms_min: 0.7444880985811565
valid_h2_max_x_max_u: 0.45125000416236616
valid_h2_max_x_mean_u: 0.07857436950958033
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.2424889053659275
valid_h2_mean_x_mean_u: 0.025338973191351706
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.060294421573327976
valid_h2_min_x_mean_u: 0.0033010133581644154
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.4288831921822252
valid_h2_range_x_mean_u: 0.07527335615141591
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2035944357317088
valid_h2_row_norms_mean: 0.73374488768058
valid_h2_row_norms_min: 0.3362893599246332
valid_objective: 0.44448185527752176
valid_y_col_norms_max: 1.5686128883575234
valid_y_col_norms_mean: 1.5686128883575234
valid_y_col_norms_min: 1.5686128883575234
valid_y_max_max_class: 0.984929922112476
valid_y_mean_max_class: 0.8839202637627791
valid_y_min_max_class: 0.6294655898648194
valid_y_misclass: 0.1897337761017617
valid_y_nll: 0.40115727122818917
valid_y_row_norms_max: 0.8397148884598802
valid_y_row_norms_mean: 0.08127211868878403
valid_y_row_norms_min: 0.0013212577970713592
Saving to ..\Sean\nn_files_SOCOR10\nn_train_best.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train_best.pkl done. Time elapsed: 0.055006 seconds
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.058006 seconds
Time this epoch: 50.428042 seconds
Monitoring step:
  Epochs seen: 7
  Batches seen: 11193
  Examples seen: 1119244
  learning_rate: 0.09300699999999987

```

momentum: 0.47575757575759137  
total\_seconds\_last\_epoch: 91.68516800000225  
train\_h0\_col\_norms\_max: 0.7500000000000068  
train\_h0\_col\_norms\_mean: 0.7462378093156057  
train\_h0\_col\_norms\_min: 0.721461319149796  
train\_h0\_max\_x\_max\_u: 0.7334339833675707  
train\_h0\_max\_x\_mean\_u: 0.16913481166742672  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.07907715259578599  
train\_h0\_mean\_x\_mean\_u: 0.009779945617325078  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.0  
train\_h0\_min\_x\_mean\_u: 0.0  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.7334339833675707  
train\_h0\_range\_x\_mean\_u: 0.16913481166742672  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.7738694865217199  
train\_h0\_row\_norms\_mean: 0.4725676330275956  
train\_h0\_row\_norms\_min: 0.3493768373806596  
train\_h1\_col\_norms\_max: 0.7500000000000068  
train\_h1\_col\_norms\_mean: 0.748276285963169  
train\_h1\_col\_norms\_min: 0.7351676472866208  
train\_h1\_max\_x\_max\_u: 0.3155140750926783  
train\_h1\_max\_x\_mean\_u: 0.08517449138282497  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.0817863454290138  
train\_h1\_mean\_x\_mean\_u: 0.013313193556187253  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.007729344196908466  
train\_h1\_min\_x\_mean\_u: 4.063232676243201e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.3151649953115341  
train\_h1\_range\_x\_mean\_u: 0.08513385905606266  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.10518265000463  
train\_h1\_row\_norms\_mean: 0.737431872344677  
train\_h1\_row\_norms\_min: 0.3807388084339588  
train\_h2\_col\_norms\_max: 0.7500000000000068  
train\_h2\_col\_norms\_mean: 0.7492996276281414  
train\_h2\_col\_norms\_min: 0.7438152879614488  
train\_h2\_max\_x\_max\_u: 0.45837525001695095  
train\_h2\_max\_x\_mean\_u: 0.07630275065961273  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.27356910768605003  
train\_h2\_mean\_x\_mean\_u: 0.02543978166628996  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.08677174789542806  
train\_h2\_min\_x\_mean\_u: 0.0046627471568626705  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.41532010934285657  
train\_h2\_range\_x\_mean\_u: 0.0716400035027501  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2046914420711883

train\_h2.row\_norms\_mean: 0.7336035088551347  
train\_h2.row\_norms\_min: 0.32321490924368534  
train\_objective: 0.32247217844372195  
train\_y.col\_norms\_max: 1.739210178120272  
train\_y.col\_norms\_mean: 1.739210178120272  
train\_y.col\_norms\_min: 1.739210178120272  
train\_y\_max\_max\_class: 0.9841266660444765  
train\_y\_mean\_max\_class: 0.8892531865927622  
train\_y\_min\_max\_class: 0.6608867860558167  
train\_y\_misclass: 0.15826307757736477  
train\_y\_nll: 0.27633873316158886  
train\_y.row\_norms\_max: 1.0694487515055153  
train\_y.row\_norms\_mean: 0.08365985509618758  
train\_y.row\_norms\_min: 0.0019187229991460338  
training\_seconds\_this\_epoch: 50.42804199999924  
valid\_h0.col\_norms\_max: 0.7500000000000004  
valid\_h0.col\_norms\_mean: 0.7462378093156046  
valid\_h0.col\_norms\_min: 0.72146131914982  
valid\_h0\_max\_x\_max\_u: 0.6925248374773917  
valid\_h0\_max\_x\_mean\_u: 0.16646210397731823  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.07826481625007926  
valid\_h0\_mean\_x\_mean\_u: 0.009497703238115487  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.6925248374773917  
valid\_h0\_range\_x\_mean\_u: 0.16646210397731823  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.7738694865217157  
valid\_h0.row\_norms\_mean: 0.47256763302759014  
valid\_h0.row\_norms\_min: 0.3493768373806709  
valid\_h1.col\_norms\_max: 0.75000000000000039  
valid\_h1.col\_norms\_mean: 0.748276285963188  
valid\_h1.col\_norms\_min: 0.7351676472866487  
valid\_h1\_max\_x\_max\_u: 0.2970661960683014  
valid\_h1\_max\_x\_mean\_u: 0.0845882047038693  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.07431877673601081  
valid\_h1\_mean\_x\_mean\_u: 0.013187294268575695  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.004830445935045094  
valid\_h1\_min\_x\_mean\_u: 2.0100475025578555e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.2970300520065702  
valid\_h1\_range\_x\_mean\_u: 0.08456810422884367  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.1051826500046331  
valid\_h1.row\_norms\_mean: 0.7374318723446628  
valid\_h1.row\_norms\_min: 0.3807388084339684  
valid\_h2.col\_norms\_max: 0.75000000000000039  
valid\_h2.col\_norms\_mean: 0.749299627628111  
valid\_h2.col\_norms\_min: 0.7438152879614236

```

valid_h2_max_x_max_u: 0.4490092766124892
valid_h2_max_x_mean_u: 0.07648543118767921
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.2399685346247173
valid_h2_mean_x_mean_u: 0.025365759570826502
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.07048546864574273
valid_h2_min_x_mean_u: 0.0038709564446653974
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.4273647631040175
valid_h2_range_x_mean_u: 0.07261447474301384
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.204691442071226
valid_h2_row_norms_mean: 0.7336035088551437
valid_h2_row_norms_min: 0.32321490924368235
valid_objective: 0.4417851748349104
valid_y_col_norms_max: 1.7392101781203326
valid_y_col_norms_mean: 1.7392101781203326
valid_y_col_norms_min: 1.7392101781203326
valid_y_max_max_class: 0.9881030296295024
valid_y_mean_max_class: 0.8896924072108886
valid_y_min_max_class: 0.6254542041061767
valid_y_misclass: 0.19372994878144878
valid_y_nll: 0.4065268986240562
valid_y_row_norms_max: 1.0694487515055466
valid_y_row_norms_mean: 0.08365985509618762
valid_y_row_norms_min: 0.0019187229991459896
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.053005 seconds
Time this epoch: 50.960096 seconds
Monitoring step:
  Epochs seen: 8
  Batches seen: 12792
  Examples seen: 1279136
  learning_rate: 0.09200800000000292
  momentum: 0.47171717171717964
  total_seconds_last_epoch: 92.70326900000181
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7459327479631918
  train_h0_col_norms_min: 0.7250136026473747
  train_h0_max_x_max_u: 0.7429756489050191
  train_h0_max_x_mean_u: 0.16243608114325883
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.08681366987938169
  train_h0_mean_x_mean_u: 0.00919118152278235
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7429756489050191
  train_h0_range_x_mean_u: 0.16243608114325883
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.7984897526314418
  train_h0_row_norms_mean: 0.47289210304478835

```

train\_h0\_row\_norms\_min: 0.3597344285159459  
train\_h1\_col\_norms\_max: 0.75000000000000068  
train\_h1\_col\_norms\_mean: 0.7482975167470216  
train\_h1\_col\_norms\_min: 0.7322879910250824  
train\_h1\_max\_x\_max\_u: 0.3034036874426726  
train\_h1\_max\_x\_mean\_u: 0.08053791880350578  
train\_h1\_max\_x\_min\_u: 1.9199185316267396e-06  
train\_h1\_mean\_x\_max\_u: 0.10917925952375589  
train\_h1\_mean\_x\_mean\_u: 0.01324260983808422  
train\_h1\_mean\_x\_min\_u: 1.9199185316267397e-08  
train\_h1\_min\_x\_max\_u: 0.017864807609353453  
train\_h1\_min\_x\_mean\_u: 9.712204588484782e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.30114567597020814  
train\_h1\_range\_x\_mean\_u: 0.0804407967576208  
train\_h1\_range\_x\_min\_u: 1.9199185316267396e-06  
train\_h1\_row\_norms\_max: 1.105399286993567  
train\_h1\_row\_norms\_mean: 0.7378691230615075  
train\_h1\_row\_norms\_min: 0.40251152951002833  
train\_h2\_col\_norms\_max: 0.75000000000000068  
train\_h2\_col\_norms\_mean: 0.7493205302020481  
train\_h2\_col\_norms\_min: 0.7447873131191848  
train\_h2\_max\_x\_max\_u: 0.4553724218858438  
train\_h2\_max\_x\_mean\_u: 0.0713690276345014  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.27808293391396977  
train\_h2\_mean\_x\_mean\_u: 0.0235131217411219  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.08035842053905458  
train\_h2\_min\_x\_mean\_u: 0.004228963099028675  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.4101475576495882  
train\_h2\_range\_x\_mean\_u: 0.06714006453547272  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.203296120160424  
train\_h2\_row\_norms\_mean: 0.7336826889879161  
train\_h2\_row\_norms\_min: 0.3307865983735591  
train\_objective: 0.31868041126424573  
train\_y\_col\_norms\_max: 1.9062776292741122  
train\_y\_col\_norms\_mean: 1.9062776292741122  
train\_y\_col\_norms\_min: 1.9062776292741122  
train\_y\_max\_max\_class: 0.9854608705372125  
train\_y\_mean\_max\_class: 0.8885289785344239  
train\_y\_min\_max\_class: 0.653353286760728  
train\_y\_misclass: 0.16193430565631806  
train\_y\_nll: 0.27436856444564  
train\_y\_row\_norms\_max: 1.227740566009395  
train\_y\_row\_norms\_mean: 0.08704244330087908  
train\_y\_row\_norms\_min: 0.000428305760880317  
training\_seconds\_this\_epoch: 50.96009600000155  
valid\_h0\_col\_norms\_max: 0.75000000000000039  
valid\_h0\_col\_norms\_mean: 0.7459327479632193  
valid\_h0\_col\_norms\_min: 0.7250136026473717  
valid\_h0\_max\_x\_max\_u: 0.705295426020173



valid\_h0\_max\_x\_mean\_u: 0.1589139013597939  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.08324657772446713  
valid\_h0\_mean\_x\_mean\_u: 0.008874412740405522  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.705295426020173  
valid\_h0\_range\_x\_mean\_u: 0.1589139013597939  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7984897526314565  
valid\_h0\_row\_norms\_mean: 0.47289210304479884  
valid\_h0\_row\_norms\_min: 0.3597344285159503  
valid\_h1\_col\_norms\_max: 0.75000000000000039  
valid\_h1\_col\_norms\_mean: 0.7482975167470133  
valid\_h1\_col\_norms\_min: 0.7322879910250891  
valid\_h1\_max\_x\_max\_u: 0.29431347833977617  
valid\_h1\_max\_x\_mean\_u: 0.08024767102667532  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.09891957129853586  
valid\_h1\_mean\_x\_mean\_u: 0.013056428038853842  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.01529874595915481  
valid\_h1\_min\_x\_mean\_u: 6.331353346616799e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.2924557356607675  
valid\_h1\_range\_x\_mean\_u: 0.08018435749320917  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1053992869935851  
valid\_h1\_row\_norms\_mean: 0.7378691230615253  
valid\_h1\_row\_norms\_min: 0.40251152951003766  
valid\_h2\_col\_norms\_max: 0.75000000000000039  
valid\_h2\_col\_norms\_mean: 0.7493205302020768  
valid\_h2\_col\_norms\_min: 0.7447873131191823  
valid\_h2\_max\_x\_max\_u: 0.44418928585279704  
valid\_h2\_max\_x\_mean\_u: 0.07161035206411327  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.24467769645947465  
valid\_h2\_mean\_x\_mean\_u: 0.02324547419496313  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.06321368747432903  
valid\_h2\_min\_x\_mean\_u: 0.003347282265786065  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.4228688919408266  
valid\_h2\_range\_x\_mean\_u: 0.06826306979832727  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2032961201604435  
valid\_h2\_row\_norms\_mean: 0.7336826889878983  
valid\_h2\_row\_norms\_min: 0.33078659837355484  
valid\_objective: 0.44315485770084145  
valid\_y\_col\_norms\_max: 1.9062776292740569  
valid\_y\_col\_norms\_mean: 1.9062776292740569  
valid\_y\_col\_norms\_min: 1.9062776292740518

```

valid_y_max_max_class: 0.9902506253011559
valid_y_mean_max_class: 0.887533506591694
valid_y_min_max_class: 0.6168223914174219
valid_y_misclass: 0.1983452468058761
valid_y_nll: 0.4113932925196466
valid_y_row_norms_max: 1.2277405660094198
valid_y_row_norms_mean: 0.08704244330088103
valid_y_row_norms_min: 0.0004283057608802996
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl done. Time elapsed: 0.063006 seconds
Time this epoch: 50.352035 seconds
Monitoring step:
  Epochs seen: 9
  Batches seen: 14391
  Examples seen: 1439028
  learning_rate: 0.091008999999999906
  momentum: 0.46767676767676514
  total_seconds_last_epoch: 92.92729199999708
  train_h0_col_norms_max: 0.75000000000000068
  train_h0_col_norms_mean: 0.7454091425427407
  train_h0_col_norms_min: 0.7175501657502557
  train_h0_max_x_max_u: 0.7540661587582954
  train_h0_max_x_mean_u: 0.16053027061375713
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.08047059023673274
  train_h0_mean_x_mean_u: 0.008722702859752136
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7540661587582954
  train_h0_range_x_mean_u: 0.16053027061375713
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.7733651815865071
  train_h0_row_norms_mean: 0.4729147170981089
  train_h0_row_norms_min: 0.37261512752869663
  train_h1_col_norms_max: 0.75000000000000068
  train_h1_col_norms_mean: 0.7483276006526166
  train_h1_col_norms_min: 0.7352325429110814
  train_h1_max_x_max_u: 0.3010374500829952
  train_h1_max_x_mean_u: 0.07806114430274581
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.08789601789225178
  train_h1_mean_x_mean_u: 0.011959076121583923
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.017112501917926064
  train_h1_min_x_mean_u: 6.476505921570726e-05
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.3005724540451459
  train_h1_range_x_mean_u: 0.07799637924353013
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.0992441634619572
  train_h1_row_norms_mean: 0.7383481794843154
  train_h1_row_norms_min: 0.4177065113353116

```

train\_h2.col\_norms\_max: 0.7500000000000068  
train\_h2.col\_norms\_mean: 0.749390785266084  
train\_h2.col\_norms\_min: 0.7390797368803789  
train\_h2\_max\_x\_max\_u: 0.479651238098673  
train\_h2\_max\_x\_mean\_u: 0.06922247622761762  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.3162979491023597  
train\_h2\_mean\_x\_mean\_u: 0.022399431268873622  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.11142946865192785  
train\_h2\_min\_x\_mean\_u: 0.004381747823261936  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.4023477608510393  
train\_h2\_range\_x\_mean\_u: 0.06484072840435565  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2015130188696728  
train\_h2.row\_norms\_mean: 0.7337850735330607  
train\_h2.row\_norms\_min: 0.3285994200722887  
train\_objective: 0.30987008390519727  
train\_y.col\_norms\_max: 2.0368221193415827  
train\_y.col\_norms\_mean: 2.0368221193415827  
train\_y.col\_norms\_min: 2.0368221193415823  
train\_y\_max\_max\_class: 0.9875086603900891  
train\_y\_mean\_max\_class: 0.8990617753469832  
train\_y\_min\_max\_class: 0.6788939626073124  
train\_y\_misclass: 0.16073349510919868  
train\_y\_nll: 0.26995529292590975  
train\_y.row\_norms\_max: 1.3341242913516247  
train\_y.row\_norms\_mean: 0.0893971352973851  
train\_y.row\_norms\_min: 0.0013146499168493425  
training\_seconds\_this\_epoch: 50.35203499999896  
valid\_h0.col\_norms\_max: 0.7500000000000039  
valid\_h0.col\_norms\_mean: 0.7454091425427457  
valid\_h0.col\_norms\_min: 0.7175501657502702  
valid\_h0\_max\_x\_max\_u: 0.7122601941925314  
valid\_h0\_max\_x\_mean\_u: 0.15631979071568208  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.07667752130439448  
valid\_h0\_mean\_x\_mean\_u: 0.00836212055688828  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7122601941925314  
valid\_h0\_range\_x\_mean\_u: 0.15631979071568208  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.7733651815865265  
valid\_h0.row\_norms\_mean: 0.4729147170981221  
valid\_h0.row\_norms\_min: 0.3726151275286863  
valid\_h1.col\_norms\_max: 0.7500000000000039  
valid\_h1.col\_norms\_mean: 0.7483276006526006  
valid\_h1.col\_norms\_min: 0.7352325429110808  
valid\_h1\_max\_x\_max\_u: 0.2820546607283537  
valid\_h1\_max\_x\_mean\_u: 0.07692945519360359

```

valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.08560309348166768
valid_h1_mean_x_mean_u: 0.011571094252845535
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.019162890097419838
valid_h1_min_x_mean_u: 5.3123936510435315e-05
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.2819276646963911
valid_h1_range_x_mean_u: 0.07687633125709309
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.0992441634619416
valid_h1_row_norms_mean: 0.7383481794843126
valid_h1_row_norms_min: 0.4177065113352995
valid_h2_col_norms_max: 0.7499999999999973
valid_h2_col_norms_mean: 0.7493907852660789
valid_h2_col_norms_min: 0.7390797368803584
valid_h2_max_x_max_u: 0.46850832612946824
valid_h2_max_x_mean_u: 0.06879389583709197
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.2831394629001166
valid_h2_mean_x_mean_u: 0.02196505024121834
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.08698120020278975
valid_h2_min_x_mean_u: 0.003547465373850455
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.41846986073104325
valid_h2_range_x_mean_u: 0.06524643046324154
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.201513018869684
valid_h2_row_norms_mean: 0.7337850735330471
valid_h2_row_norms_min: 0.3285994200722842
valid_objective: 0.4491918106143601
valid_y_col_norms_max: 2.036822119341633
valid_y_col_norms_mean: 2.036822119341633
valid_y_col_norms_min: 2.036822119341633
valid_y_max_max_class: 0.9917795456121837
valid_y_mean_max_class: 0.901921569677694
valid_y_min_max_class: 0.6429003068263949
valid_y_misclass: 0.19710699611639562
valid_y_nll: 0.4221735167341691
valid_y_row_norms_max: 1.334124291351605
valid_y_row_norms_mean: 0.08939713529738468
valid_y_row_norms_min: 0.00131464991684934
Saving to ..\Sean\nn_files_S0C0R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S0C0R10\nn_train.pkl done. Time elapsed: 0.061007 seconds
Time this epoch: 51.072106 seconds
Monitoring step:
  Epochs seen: 10
  Batches seen: 15990
  Examples seen: 1598920
  learning_rate: 0.090010000000000195
  momentum: 0.46363636363635374
  total_seconds_last_epoch: 93.05730500000018
  train_h0_col_norms_max: 0.7500000000000068

```

train\_h0.col\_norms\_mean: 0.7451016183655268  
train\_h0.col\_norms\_min: 0.7224297537684724  
train\_h0.max\_x\_max\_u: 0.7372250255384181  
train\_h0.max\_x\_mean\_u: 0.15007214544282982  
train\_h0.max\_x\_min\_u: 0.0  
train\_h0.mean\_x\_max\_u: 0.07372634204635085  
train\_h0.mean\_x\_mean\_u: 0.007809421599287916  
train\_h0.mean\_x\_min\_u: 0.0  
train\_h0.min\_x\_max\_u: 0.0  
train\_h0.min\_x\_mean\_u: 0.0  
train\_h0.min\_x\_min\_u: 0.0  
train\_h0.range\_x\_max\_u: 0.7372250255384181  
train\_h0.range\_x\_mean\_u: 0.15007214544282982  
train\_h0.range\_x\_min\_u: 0.0  
train\_h0.row\_norms\_max: 0.8025097010749426  
train\_h0.row\_norms\_mean: 0.47294403559428067  
train\_h0.row\_norms\_min: 0.3843026834038531  
train\_h1.col\_norms\_max: 0.75000000000000068  
train\_h1.col\_norms\_mean: 0.7483401830542383  
train\_h1.col\_norms\_min: 0.732585844262687  
train\_h1.max\_x\_max\_u: 0.29569013555842955  
train\_h1.max\_x\_mean\_u: 0.07289367899852621  
train\_h1.max\_x\_min\_u: 0.0  
train\_h1.mean\_x\_max\_u: 0.10962430112175414  
train\_h1.mean\_x\_mean\_u: 0.011981421761698136  
train\_h1.mean\_x\_min\_u: 0.0  
train\_h1.min\_x\_max\_u: 0.020463289173757313  
train\_h1.min\_x\_mean\_u: 0.00010470137987922149  
train\_h1.min\_x\_min\_u: 0.0  
train\_h1.range\_x\_max\_u: 0.29443183370394416  
train\_h1.range\_x\_mean\_u: 0.07278897761864685  
train\_h1.range\_x\_min\_u: 0.0  
train\_h1.row\_norms\_max: 1.0984445225109345  
train\_h1.row\_norms\_mean: 0.7386722885679462  
train\_h1.row\_norms\_min: 0.41456875537759763  
train\_h2.col\_norms\_max: 0.75000000000000068  
train\_h2.col\_norms\_mean: 0.7493557580584852  
train\_h2.col\_norms\_min: 0.7428944308020138  
train\_h2.max\_x\_max\_u: 0.45908810799727007  
train\_h2.max\_x\_mean\_u: 0.06753175767258685  
train\_h2.max\_x\_min\_u: 0.0  
train\_h2.mean\_x\_max\_u: 0.29337762416395025  
train\_h2.mean\_x\_mean\_u: 0.023417156375185953  
train\_h2.mean\_x\_min\_u: 0.0  
train\_h2.min\_x\_max\_u: 0.1042341033719806  
train\_h2.min\_x\_mean\_u: 0.005417611803681387  
train\_h2.min\_x\_min\_u: 0.0  
train\_h2.range\_x\_max\_u: 0.3978028740852835  
train\_h2.range\_x\_mean\_u: 0.06211414586890551  
train\_h2.range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2040946341976302  
train\_h2.row\_norms\_mean: 0.7337689786344161  
train\_h2.row\_norms\_min: 0.3237257187569715  
train\_objective: 0.30682663922363884

train\_y\_col\_norms\_max: 2.168069541622861  
train\_y\_col\_norms\_mean: 2.168069541622861  
train\_y\_col\_norms\_min: 2.168069541622861  
train\_y\_max\_max\_class: 0.9870888119730712  
train\_y\_mean\_max\_class: 0.8919375571203811  
train\_y\_min\_max\_class: 0.6548402051901446  
train\_y\_misclass: 0.14606734545818428  
train\_y\_nll: 0.2524157738251776  
train\_y\_row\_norms\_max: 1.434157662527982  
train\_y\_row\_norms\_mean: 0.09173472459375792  
train\_y\_row\_norms\_min: 0.00026784961191828944  
training\_seconds\_this\_epoch: 51.072106000000081  
valid\_h0\_col\_norms\_max: 0.7500000000000039  
valid\_h0\_col\_norms\_mean: 0.7451016183655116  
valid\_h0\_col\_norms\_min: 0.7224297537684776  
valid\_h0\_max\_x\_max\_u: 0.68164547133418  
valid\_h0\_max\_x\_mean\_u: 0.14557363748984153  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.07076652695508706  
valid\_h0\_mean\_x\_mean\_u: 0.007434470518912979  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.68164547133418  
valid\_h0\_range\_x\_mean\_u: 0.14557363748984153  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.8025097010749491  
valid\_h0\_row\_norms\_mean: 0.47294403559429526  
valid\_h0\_row\_norms\_min: 0.38430268340384827  
valid\_h1\_col\_norms\_max: 0.7500000000000039  
valid\_h1\_col\_norms\_mean: 0.7483401830542572  
valid\_h1\_col\_norms\_min: 0.7325858442626921  
valid\_h1\_max\_x\_max\_u: 0.2730641680205218  
valid\_h1\_max\_x\_mean\_u: 0.07113801899884016  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.09975148346992117  
valid\_h1\_mean\_x\_mean\_u: 0.011492542648852137  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.01648723722901068  
valid\_h1\_min\_x\_mean\_u: 7.095020273985776e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.2724003732783363  
valid\_h1\_range\_x\_mean\_u: 0.07106706879610036  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0984445225109238  
valid\_h1\_row\_norms\_mean: 0.7386722885679559  
valid\_h1\_row\_norms\_min: 0.41456875537758375  
valid\_h2\_col\_norms\_max: 0.7499999999999973  
valid\_h2\_col\_norms\_mean: 0.7493557580584542  
valid\_h2\_col\_norms\_min: 0.7428944308019884  
valid\_h2\_max\_x\_max\_u: 0.44802390388731583  
valid\_h2\_max\_x\_mean\_u: 0.06632366747694596  
valid\_h2\_max\_x\_min\_u: 0.0

```

valid_h2_mean_x_max_u: 0.2596156022886535
valid_h2_mean_x_mean_u: 0.022839770430153172
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.08722258561268009
valid_h2_min_x_mean_u: 0.004749068355941455
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.40586784419593575
valid_h2_range_x_mean_u: 0.06157459912100453
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2040946341976262
valid_h2_row_norms_mean: 0.733768978634419
valid_h2_row_norms_min: 0.3237257187569647
valid_objective: 0.4407797228070101
valid_y_col_norms_max: 2.168069541622892
valid_y_col_norms_mean: 2.168069541622892
valid_y_col_norms_min: 2.168069541622892
valid_y_max_max_class: 0.9908951557523714
valid_y_mean_max_class: 0.8928394573711831
valid_y_min_max_class: 0.634400727543411
valid_y_misclass: 0.18967749197951259
valid_y_nll: 0.40530123517139377
valid_y_row_norms_max: 1.4341576625279577
valid_y_row_norms_mean: 0.09173472459375594
valid_y_row_norms_min: 0.00026784961191829014
Saving to ..\Sean\nn_files_SOCOR10\nn.train.best.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn.train.best.pkl done. Time elapsed: 0.059006 seconds
Saving to ..\Sean\nn_files_SOCOR10\nn.train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn.train.pkl done. Time elapsed: 0.073008 seconds
Time this epoch: 50.808080 seconds
Monitoring step:
  Epochs seen: 11
  Batches seen: 17589
  Examples seen: 1758812
  learning_rate: 0.089010999999999804
  momentum: 0.45959595959595134
  total_seconds_last_epoch: 93.77937700000179
  train_h0_col_norms_max: 0.75000000000000068
  train_h0_col_norms_mean: 0.7452614153531837
  train_h0_col_norms_min: 0.7141699641874565
  train_h0_max_x_max_u: 0.7555875598521818
  train_h0_max_x_mean_u: 0.14901587579688644
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.07815878946206739
  train_h0_mean_x_mean_u: 0.007731286589606481
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7555875598521818
  train_h0_range_x_mean_u: 0.14901587579688644
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.8041430130560239
  train_h0_row_norms_mean: 0.47318185037400695
  train_h0_row_norms_min: 0.3873915932814715

```

train\_h1.col\_norms\_max: 0.7500000000000068  
train\_h1.col\_norms\_mean: 0.7485465813414183  
train\_h1.col\_norms\_min: 0.7317514509646112  
train\_h1\_max\_x\_max\_u: 0.28351084033595564  
train\_h1\_max\_x\_mean\_u: 0.07052399743703185  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.0742094586545819  
train\_h1\_mean\_x\_mean\_u: 0.010599582795878238  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.015732153711720456  
train\_h1\_min\_x\_mean\_u: 7.458028690860356e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.283034146964413  
train\_h1\_range\_x\_mean\_u: 0.07044941715012322  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1.row\_norms\_max: 1.1007872410727606  
train\_h1.row\_norms\_mean: 0.7391989027070028  
train\_h1.row\_norms\_min: 0.4448067304577977  
train\_h2.col\_norms\_max: 0.7500000000000068  
train\_h2.col\_norms\_mean: 0.7494286358774624  
train\_h2.col\_norms\_min: 0.7439791293106123  
train\_h2\_max\_x\_max\_u: 0.5000005070221767  
train\_h2\_max\_x\_mean\_u: 0.06580377477755374  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.35456583217773113  
train\_h2\_mean\_x\_mean\_u: 0.023490897851402643  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.14210981724571248  
train\_h2\_min\_x\_mean\_u: 0.005832201360304776  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.3855799534524542  
train\_h2\_range\_x\_mean\_u: 0.05997157341724888  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2063550401206848  
train\_h2.row\_norms\_mean: 0.7338705787131506  
train\_h2.row\_norms\_min: 0.33335742988045325  
train\_objective: 0.30117203310358  
train\_y.col\_norms\_max: 2.265460036041985  
train\_y.col\_norms\_mean: 2.265460036041985  
train\_y.col\_norms\_min: 2.265460036041985  
train\_y\_max\_max\_class: 0.9868851072330581  
train\_y\_mean\_max\_class: 0.8944714960121376  
train\_y\_min\_max\_class: 0.6583223023206256  
train\_y\_misclass: 0.12476546669001584  
train\_y\_nll: 0.23481939778221664  
train\_y.row\_norms\_max: 1.5055971147843445  
train\_y.row\_norms\_mean: 0.09413226015175001  
train\_y.row\_norms\_min: 0.0023732265304342646  
training\_seconds\_this\_epoch: 50.80807999999995  
valid\_h0.col\_norms\_max: 0.7500000000000039  
valid\_h0.col\_norms\_mean: 0.7452614153531663  
valid\_h0.col\_norms\_min: 0.7141699641874442  
valid\_h0\_max\_x\_max\_u: 0.7211433628611262  
valid\_h0\_max\_x\_mean\_u: 0.14536719648322952



valid\_h0\_max\_x\_min\_u: 0.0  
 valid\_h0\_mean\_x\_max\_u: 0.07631353081794218  
 valid\_h0\_mean\_x\_mean\_u: 0.007366355605478828  
 valid\_h0\_mean\_x\_min\_u: 0.0  
 valid\_h0\_min\_x\_max\_u: 0.0  
 valid\_h0\_min\_x\_mean\_u: 0.0  
 valid\_h0\_min\_x\_min\_u: 0.0  
 valid\_h0\_range\_x\_max\_u: 0.7211433628611262  
 valid\_h0\_range\_x\_mean\_u: 0.14536719648322952  
 valid\_h0\_range\_x\_min\_u: 0.0  
 valid\_h0\_row\_norms\_max: 0.8041430130560338  
 valid\_h0\_row\_norms\_mean: 0.47318185037400984  
 valid\_h0\_row\_norms\_min: 0.3873915932814839  
 valid\_h1\_col\_norms\_max: 0.75000000000000039  
 valid\_h1\_col\_norms\_mean: 0.7485465813414067  
 valid\_h1\_col\_norms\_min: 0.7317514509646182  
 valid\_h1\_max\_x\_max\_u: 0.2668870657901607  
 valid\_h1\_max\_x\_mean\_u: 0.07017750235729954  
 valid\_h1\_max\_x\_min\_u: 0.0  
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 valid\_h1\_mean\_x\_mean\_u: 0.010174885873562689  
 valid\_h1\_mean\_x\_min\_u: 0.0  
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 valid\_h1\_min\_x\_min\_u: 0.0  
 valid\_h1\_range\_x\_max\_u: 0.2663631788490164  
 valid\_h1\_range\_x\_mean\_u: 0.07012949805634053  
 valid\_h1\_range\_x\_min\_u: 0.0  
 valid\_h1\_row\_norms\_max: 1.1007872410727475  
 valid\_h1\_row\_norms\_mean: 0.7391989027069852  
 valid\_h1\_row\_norms\_min: 0.44480673045778374  
 valid\_h2\_col\_norms\_max: 0.7499999999999973  
 valid\_h2\_col\_norms\_mean: 0.7494286358774748  
 valid\_h2\_col\_norms\_min: 0.7439791293106035  
 valid\_h2\_max\_x\_max\_u: 0.49111870232099203  
 valid\_h2\_max\_x\_mean\_u: 0.06624676976884211  
 valid\_h2\_max\_x\_min\_u: 0.0  
 valid\_h2\_mean\_x\_max\_u: 0.3200044354830851  
 valid\_h2\_mean\_x\_mean\_u: 0.02300016319123948  
 valid\_h2\_mean\_x\_min\_u: 0.0  
 valid\_h2\_min\_x\_max\_u: 0.10918602479723163  
 valid\_h2\_min\_x\_mean\_u: 0.005193201548649964  
 valid\_h2\_min\_x\_min\_u: 0.0  
 valid\_h2\_range\_x\_max\_u: 0.4183731013174837  
 valid\_h2\_range\_x\_mean\_u: 0.06105356822019212  
 valid\_h2\_range\_x\_min\_u: 0.0  
 valid\_h2\_row\_norms\_max: 1.2063550401206857  
 valid\_h2\_row\_norms\_mean: 0.7338705787131617  
 valid\_h2\_row\_norms\_min: 0.33335742988046696  
 valid\_objective: 0.44917595094387386  
 valid\_y\_col\_norms\_max: 2.265460036041957  
 valid\_y\_col\_norms\_mean: 2.265460036041957  
 valid\_y\_col\_norms\_min: 2.265460036041957  
 valid\_y\_max\_max\_class: 0.9912539367828026

```

valid_y_mean_max_class: 0.8918211546963036
valid_y_min_max_class: 0.6066597810932609
valid_y_misclass: 0.1797152023414195
valid_y_nll: 0.3959183542776472
valid_y_row_norms_max: 1.5055971147843086
valid_y_row_norms_mean: 0.09413226015174754
valid_y_row_norms_min: 0.002373226530434245
Saving to ..\Sean\nn_files_S0COR10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_S0COR10\nn_train.best.pkl done. Time elapsed: 0.058006 seconds
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl done. Time elapsed: 0.061006 seconds
Time this epoch: 49.629962 seconds
Monitoring step:
  Epochs seen: 12
  Batches seen: 19188
  Examples seen: 1918704
  learning_rate: 0.08801200000000167
  momentum: 0.45555555555553995
  total_seconds_last_epoch: 92.37023600000201
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7448546251567153
  train_h0_col_norms_min: 0.7141760143575384
  train_h0_max_x_max_u: 0.7557026515443672
  train_h0_max_x_mean_u: 0.14367474822947401
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.07425043569693905
  train_h0_mean_x_mean_u: 0.007237937694344127
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7557026515443672
  train_h0_range_x_mean_u: 0.14367474822947401
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.7967846094447205
  train_h0_row_norms_mean: 0.47301134701526665
  train_h0_row_norms_min: 0.38745327251927764
  train_h1_col_norms_max: 0.7500000000000068
  train_h1_col_norms_mean: 0.7485062468914748
  train_h1_col_norms_min: 0.7293608503903243
  train_h1_max_x_max_u: 0.30652950610378144
  train_h1_max_x_mean_u: 0.07260404778318172
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.1027687959227326
  train_h1_mean_x_mean_u: 0.01170171038818804
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.02613780220401367
  train_h1_min_x_mean_u: 0.00011914757300382938
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.2997983760685047
  train_h1_range_x_mean_u: 0.07248490021017798
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.100779843617005
  train_h1_row_norms_mean: 0.739467407557176

```

train\_h1\_row\_norms\_min: 0.45414836015932886  
train\_h2\_col\_norms\_max: 0.75000000000000068  
train\_h2\_col\_norms\_mean: 0.749408609786369  
train\_h2\_col\_norms\_min: 0.7305480563687751  
train\_h2\_max\_x\_max\_u: 0.5283409920566566  
train\_h2\_max\_x\_mean\_u: 0.06813818833581878  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.3740357345358158  
train\_h2\_mean\_x\_mean\_u: 0.023746513836634165  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.1589579125058348  
train\_h2\_min\_x\_mean\_u: 0.0059165726321751605  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.398095637636156  
train\_h2\_range\_x\_mean\_u: 0.062221615703643506  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2067748068104533  
train\_h2\_row\_norms\_mean: 0.7338540434194781  
train\_h2\_row\_norms\_min: 0.328013168779559  
train\_objective: 0.29946415924323044  
train\_y\_col\_norms\_max: 2.3521669718642837  
train\_y\_col\_norms\_mean: 2.3521669718642837  
train\_y\_col\_norms\_min: 2.3521669718642837  
train\_y\_max\_max\_class: 0.98767677047081  
train\_y\_mean\_max\_class: 0.8957314574883716  
train\_y\_min\_max\_class: 0.6526289130769604  
train\_y\_misclass: 0.12025617291671888  
train\_y\_nll: 0.22609227828573614  
train\_y\_row\_norms\_max: 1.5707240229797907  
train\_y\_row\_norms\_mean: 0.09527775672708486  
train\_y\_row\_norms\_min: 0.0023583664109569445  
training\_seconds\_this\_epoch: 49.62996199999936  
valid\_h0\_col\_norms\_max: 0.75000000000000039  
valid\_h0\_col\_norms\_mean: 0.7448546251567293  
valid\_h0\_col\_norms\_min: 0.714176014357552  
valid\_h0\_max\_x\_max\_u: 0.7125495083728342  
valid\_h0\_max\_x\_mean\_u: 0.13948932468847142  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.07105373649694846  
valid\_h0\_mean\_x\_mean\_u: 0.006879450259034319  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7125495083728342  
valid\_h0\_range\_x\_mean\_u: 0.13948932468847142  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7967846094446892  
valid\_h0\_row\_norms\_mean: 0.4730113470152569  
valid\_h0\_row\_norms\_min: 0.3874532725192883  
valid\_h1\_col\_norms\_max: 0.75000000000000039  
valid\_h1\_col\_norms\_mean: 0.7485062468914505  
valid\_h1\_col\_norms\_min: 0.7293608503903121  
valid\_h1\_max\_x\_max\_u: 0.2983001880240283

```

valid_h1_max_x_mean_u: 0.07154787556975759
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.09357274533170339
valid_h1_mean_x_mean_u: 0.011235988105727264
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.0181850974173194
valid_h1_min_x_mean_u: 7.453104598528169e-05
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.2927501603873984
valid_h1_range_x_mean_u: 0.07147334452377231
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.100779843616989
valid_h1_row_norms_mean: 0.7394674075571552
valid_h1_row_norms_min: 0.4541483601593164
valid_h2_col_norms_max: 0.75000000000000039
valid_h2_col_norms_mean: 0.7494086097863671
valid_h2_col_norms_min: 0.7305480563687836
valid_h2_max_x_max_u: 0.5185617869016972
valid_h2_max_x_mean_u: 0.06819757005464824
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.3389700991487293
valid_h2_mean_x_mean_u: 0.023178124667297358
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.12541782518508512
valid_h2_min_x_mean_u: 0.005236829293884606
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.42270548812970804
valid_h2_range_x_mean_u: 0.06296074076076363
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.206774806810417
valid_h2_row_norms_mean: 0.7338540434194633
valid_h2_row_norms_min: 0.3280131687795539
valid_objective: 0.4489800766908526
valid_y_col_norms_max: 2.3521669718643703
valid_y_col_norms_mean: 2.3521669718643703
valid_y_col_norms_min: 2.3521669718643703
valid_y_max_max_class: 0.9918307739266092
valid_y_mean_max_class: 0.8922422387793312
valid_y_min_max_class: 0.6049957402789893
valid_y_misclass: 0.17937749760792482
valid_y_nll: 0.39327547185159445
valid_y_row_norms_max: 1.5707240229798332
valid_y_row_norms_mean: 0.09527775672708835
valid_y_row_norms_min: 0.0023583664109569544
Saving to ..\Sean\nn_files_SOCOR10\nn_train_best.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train_best.pkl done. Time elapsed: 0.066007 seconds
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.066007 seconds
Time this epoch: 50.358035 seconds
Monitoring step:
  Epochs seen: 13
  Batches seen: 20787
  Examples seen: 2078596
  learning_rate: 0.08701299999999801

```

momentum: 0.451515151515166  
total\_seconds\_last\_epoch: 92.69026800000339  
train\_h0\_col\_norms\_max: 0.7500000000000068  
train\_h0\_col\_norms\_mean: 0.7448820348975809  
train\_h0\_col\_norms\_min: 0.7183513328837632  
train\_h0\_max\_x\_max\_u: 0.7700509199327995  
train\_h0\_max\_x\_mean\_u: 0.14281206426411377  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.07767498515816017  
train\_h0\_mean\_x\_mean\_u: 0.007208146122099816  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.0  
train\_h0\_min\_x\_mean\_u: 0.0  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.7700509199327995  
train\_h0\_range\_x\_mean\_u: 0.14281206426411377  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.7949287415153649  
train\_h0\_row\_norms\_mean: 0.47303293254602885  
train\_h0\_row\_norms\_min: 0.3936687659549154  
train\_h1\_col\_norms\_max: 0.7500000000000068  
train\_h1\_col\_norms\_mean: 0.7484333252514255  
train\_h1\_col\_norms\_min: 0.7300539224737992  
train\_h1\_max\_x\_max\_u: 0.3094515675597165  
train\_h1\_max\_x\_mean\_u: 0.06835883109999998  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.09144931100856954  
train\_h1\_mean\_x\_mean\_u: 0.010930273060918894  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.017620942575341355  
train\_h1\_min\_x\_mean\_u: 9.210051012205034e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.3054698786043329  
train\_h1\_range\_x\_mean\_u: 0.06826673058987799  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0984951761154995  
train\_h1\_row\_norms\_mean: 0.739618326965398  
train\_h1\_row\_norms\_min: 0.4542107607051696  
train\_h2\_col\_norms\_max: 0.7500000000000068  
train\_h2\_col\_norms\_mean: 0.7494207705433742  
train\_h2\_col\_norms\_min: 0.7422243067318899  
train\_h2\_max\_x\_max\_u: 0.4611297176631348  
train\_h2\_max\_x\_mean\_u: 0.061348900799762296  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.3182476344287292  
train\_h2\_mean\_x\_mean\_u: 0.021759743348579486  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.12454755919245632  
train\_h2\_min\_x\_mean\_u: 0.0055889517675451065  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.37420103316137443  
train\_h2\_range\_x\_mean\_u: 0.05575994903221717  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2061666420544088

train\_h2.row\_norms\_mean: 0.7339051497436908  
train\_h2.row\_norms\_min: 0.327978641571088  
train\_objective: 0.29275981051874417  
train\_y.col\_norms\_max: 2.4475045329340155  
train\_y.col\_norms\_mean: 2.4475045329340155  
train\_y.col\_norms\_min: 2.4475045329340155  
train\_y\_max\_max\_class: 0.9866446877679759  
train\_y\_mean\_max\_class: 0.8952888160832382  
train\_y\_min\_max\_class: 0.6754153101060357  
train\_y\_misclass: 0.13881244840267185  
train\_y\_nll: 0.24194360132836604  
train\_y.row\_norms\_max: 1.6310867367268016  
train\_y.row\_norms\_mean: 0.0977291881207279  
train\_y.row\_norms\_min: 0.0015449314575556273  
training\_seconds\_this\_epoch: 50.358034999998914  
valid\_h0.col\_norms\_max: 0.7500000000000042  
valid\_h0.col\_norms\_mean: 0.7448820348975554  
valid\_h0.col\_norms\_min: 0.7183513328837711  
valid\_h0\_max\_x\_max\_u: 0.7244778525488235  
valid\_h0\_max\_x\_mean\_u: 0.1383253432775606  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.07474578172801456  
valid\_h0\_mean\_x\_mean\_u: 0.00681511085593506  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7244778525488235  
valid\_h0\_range\_x\_mean\_u: 0.1383253432775606  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.7949287415153768  
valid\_h0.row\_norms\_mean: 0.4730329325460118  
valid\_h0.row\_norms\_min: 0.3936687659549071  
valid\_h1.col\_norms\_max: 0.7499999999999973  
valid\_h1.col\_norms\_mean: 0.7484333252514145  
valid\_h1.col\_norms\_min: 0.7300539224737822  
valid\_h1\_max\_x\_max\_u: 0.2962141358298326  
valid\_h1\_max\_x\_mean\_u: 0.06750762252548186  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.08453448235479186  
valid\_h1\_mean\_x\_mean\_u: 0.010409453744634565  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.010311727585354374  
valid\_h1\_min\_x\_mean\_u: 4.327263753460944e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.29387180420438536  
valid\_h1\_range\_x\_mean\_u: 0.06746434988794718  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.0984951761155037  
valid\_h1.row\_norms\_mean: 0.7396183269654173  
valid\_h1.row\_norms\_min: 0.4542107607051594  
valid\_h2.col\_norms\_max: 0.7499999999999973  
valid\_h2.col\_norms\_mean: 0.7494207705433483  
valid\_h2.col\_norms\_min: 0.7422243067318771

```

valid_h2_max_x_max_u: 0.45127319715250724
valid_h2_max_x_mean_u: 0.06126667563133037
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.2848409230533254
valid_h2_mean_x_mean_u: 0.02106398194838787
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.10518223904717583
valid_h2_min_x_mean_u: 0.004998687777462894
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.3911803477017602
valid_h2_range_x_mean_u: 0.05626798785386748
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2061666420544004
valid_h2_row_norms_mean: 0.7339051497436893
valid_h2_row_norms_min: 0.3279786415710952
valid_objective: 0.4526573071883126
valid_y_col_norms_max: 2.447504532933948
valid_y_col_norms_mean: 2.447504532933948
valid_y_col_norms_min: 2.447504532933944
valid_y_max_max_class: 0.992479964149134
valid_y_mean_max_class: 0.8961747172051746
valid_y_min_max_class: 0.6367408400997335
valid_y_misclass: 0.1899589125907581
valid_y_nll: 0.41288346968999423
valid_y_row_norms_max: 1.6310867367268393
valid_y_row_norms_mean: 0.09772918812073052
valid_y_row_norms_min: 0.0015449314575556566
Saving to ..\Sean\nn_files_S0C0R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S0C0R10\nn_train.pkl done. Time elapsed: 0.065006 seconds
Time this epoch: 50.732073 seconds
Monitoring step:
  Epochs seen: 14
  Batches seen: 22386
  Examples seen: 2238488
  learning_rate: 0.086014000000000076
  momentum: 0.44747474747475435
  total_seconds_last_epoch: 93.37433600000267
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7447800161442778
  train_h0_col_norms_min: 0.7170612714345774
  train_h0_max_x_max_u: 0.7536762684806259
  train_h0_max_x_mean_u: 0.1375936276843252
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.07230014511866086
  train_h0_mean_x_mean_u: 0.006706803709604494
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7536762684806259
  train_h0_range_x_mean_u: 0.1375936276843252
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.8262582710957033
  train_h0_row_norms_mean: 0.4730876613511608

```

train\_h0\_row\_norms\_min: 0.38984514035974077  
train\_h1\_col\_norms\_max: 0.75000000000000068  
train\_h1\_col\_norms\_mean: 0.7483303354811465  
train\_h1\_col\_norms\_min: 0.7278402958845437  
train\_h1\_max\_x\_max\_u: 0.2871492063089705  
train\_h1\_max\_x\_mean\_u: 0.06655510803716186  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.10178693140145678  
train\_h1\_mean\_x\_mean\_u: 0.011065445358316479  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.028159261112391722  
train\_h1\_min\_x\_mean\_u: 0.00013218177039971677  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.28457501760822357  
train\_h1\_range\_x\_mean\_u: 0.06642292626676204  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0895144912843702  
train\_h1\_row\_norms\_mean: 0.73965001738424  
train\_h1\_row\_norms\_min: 0.44576880610653724  
train\_h2\_col\_norms\_max: 0.75000000000000068  
train\_h2\_col\_norms\_mean: 0.7493811559480061  
train\_h2\_col\_norms\_min: 0.7154662976608624  
train\_h2\_max\_x\_max\_u: 0.4734360890608033  
train\_h2\_max\_x\_mean\_u: 0.06059832626544382  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.32991675729588893  
train\_h2\_mean\_x\_mean\_u: 0.021707557179852538  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.14054023318317424  
train\_h2\_min\_x\_mean\_u: 0.0055349440740154  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.36374351875282823  
train\_h2\_range\_x\_mean\_u: 0.05506338219142846  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2033356008725784  
train\_h2\_row\_norms\_mean: 0.733869189531334  
train\_h2\_row\_norms\_min: 0.32352185592992944  
train\_objective: 0.29446324561882986  
train\_y\_col\_norms\_max: 2.528463655698  
train\_y\_col\_norms\_mean: 2.528463655698  
train\_y\_col\_norms\_min: 2.528463655698  
train\_y\_max\_max\_class: 0.9854978224066941  
train\_y\_mean\_max\_class: 0.8891098113102816  
train\_y\_min\_max\_class: 0.6598889860937952  
train\_y\_misclass: 0.12034998624071251  
train\_y\_nll: 0.22710713644110214  
train\_y\_row\_norms\_max: 1.6836870888734203  
train\_y\_row\_norms\_mean: 0.0998594640863588  
train\_y\_row\_norms\_min: 0.0008992467309935123  
training\_seconds\_this\_epoch: 50.732072999999325  
valid\_h0\_col\_norms\_max: 0.75000000000000039  
valid\_h0\_col\_norms\_mean: 0.7447800161442913  
valid\_h0\_col\_norms\_min: 0.7170612714345937  
valid\_h0\_max\_x\_max\_u: 0.7219141671730175



valid\_h0\_max\_x\_mean\_u: 0.13358296739796563  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.06768149542175933  
valid\_h0\_mean\_x\_mean\_u: 0.006355001769523612  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7219141671730175  
valid\_h0\_range\_x\_mean\_u: 0.13358296739796563  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.826258271095692  
valid\_h0\_row\_norms\_mean: 0.47308766135115593  
valid\_h0\_row\_norms\_min: 0.3898451403597279  
valid\_h1\_col\_norms\_max: 0.7499999999999973  
valid\_h1\_col\_norms\_mean: 0.7483303354811419  
valid\_h1\_col\_norms\_min: 0.727840295884562  
valid\_h1\_max\_x\_max\_u: 0.27711083939188297  
valid\_h1\_max\_x\_mean\_u: 0.0663139711409678  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.10148089809021248  
valid\_h1\_mean\_x\_mean\_u: 0.010645112307434031  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.027572193757073888  
valid\_h1\_min\_x\_mean\_u: 0.0001023964877753005  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.27327502478981314  
valid\_h1\_range\_x\_mean\_u: 0.0662115746531925  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0895144912843913  
valid\_h1\_row\_norms\_mean: 0.739650017384264  
valid\_h1\_row\_norms\_min: 0.4457688061065481  
valid\_h2\_col\_norms\_max: 0.7500000000000039  
valid\_h2\_col\_norms\_mean: 0.7493811559480371  
valid\_h2\_col\_norms\_min: 0.7154662976608734  
valid\_h2\_max\_x\_max\_u: 0.46314905708315524  
valid\_h2\_max\_x\_mean\_u: 0.06088683813870289  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.2960640291070818  
valid\_h2\_mean\_x\_mean\_u: 0.02116284874949843  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.11393865902024823  
valid\_h2\_min\_x\_mean\_u: 0.004980127361267415  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.3831549318359654  
valid\_h2\_range\_x\_mean\_u: 0.05590671077743547  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2033356008725666  
valid\_h2\_row\_norms\_mean: 0.733869189531355  
valid\_h2\_row\_norms\_min: 0.3235218559299243  
valid\_objective: 0.4429596660302997  
valid\_y\_col\_norms\_max: 2.528463655698008  
valid\_y\_col\_norms\_mean: 2.528463655698008  
valid\_y\_col\_norms\_min: 2.528463655698008

```

valid_y_max_max_class: 0.9896984557222605
valid_y_mean_max_class: 0.8835479794730855
valid_y_min_max_class: 0.6158451824492445
valid_y_misclass: 0.17746383745145486
valid_y_nll: 0.38772991281325
valid_y_row_norms_max: 1.6836870888733786
valid_y_row_norms_mean: 0.0998594640863576
valid_y_row_norms_min: 0.0008992467309935264
Saving to ..\Sean\nn_files_SOCOR10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.best.pkl done. Time elapsed: 0.057006 seconds
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.069007 seconds
Time this epoch: 50.870087 seconds
Monitoring step:
  Epochs seen: 15
  Batches seen: 23985
  Examples seen: 2398380
  learning_rate: 0.085014999999999727
  momentum: 0.4434343434343524
  total_seconds_last_epoch: 93.79837900000341
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7444852680697979
  train_h0_col_norms_min: 0.7164763320891095
  train_h0_max_x_max_u: 0.7918003042055086
  train_h0_max_x_mean_u: 0.1396793369474382
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.07642523290573214
  train_h0_mean_x_mean_u: 0.006893438992910708
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7918003042055086
  train_h0_range_x_mean_u: 0.1396793369474382
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.7889638083590066
  train_h0_row_norms_mean: 0.4729379039705807
  train_h0_row_norms_min: 0.39470146627561664
  train_h1_col_norms_max: 0.7500000000000068
  train_h1_col_norms_mean: 0.7484244720857604
  train_h1_col_norms_min: 0.725222495361975
  train_h1_max_x_max_u: 0.28777817332730454
  train_h1_max_x_mean_u: 0.06712046836165081
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.08683428502381332
  train_h1_mean_x_mean_u: 0.010588642248717237
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.010494353310738187
  train_h1_min_x_mean_u: 5.696570897531454e-05
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.2864235133544515
  train_h1_range_x_mean_u: 0.06706350265267544
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.0871461416181802

```

train\_h1\_row\_norms\_mean: 0.7399115009003485  
train\_h1\_row\_norms\_min: 0.4414229289001121  
train\_h2\_col\_norms\_max: 0.7500000000000068  
train\_h2\_col\_norms\_mean: 0.7493654371887757  
train\_h2\_col\_norms\_min: 0.7440865510028417  
train\_h2\_max\_x\_max\_u: 0.4271848898565391  
train\_h2\_max\_x\_mean\_u: 0.0636350035123739  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.28504606548315903  
train\_h2\_mean\_x\_mean\_u: 0.02378084967496811  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.1147842134882839  
train\_h2\_min\_x\_mean\_u: 0.006638134358240407  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.3554191512288027  
train\_h2\_range\_x\_mean\_u: 0.056996869154133524  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2036699764186316  
train\_h2\_row\_norms\_mean: 0.7338759477799158  
train\_h2\_row\_norms\_min: 0.33349614866991323  
train\_objective: 0.2942573949670013  
train\_y\_col\_norms\_max: 2.583235468750615  
train\_y\_col\_norms\_mean: 2.583235468750615  
train\_y\_col\_norms\_min: 2.583235468750615  
train\_y\_max\_max\_class: 0.9859598059865617  
train\_y\_mean\_max\_class: 0.8855254937634646  
train\_y\_min\_max\_class: 0.623501262126548  
train\_y\_misclass: 0.09244364946338773  
train\_y\_nll: 0.20160185115809887  
train\_y\_row\_norms\_max: 1.7275634398424509  
train\_y\_row\_norms\_mean: 0.10042238063544286  
train\_y\_row\_norms\_min: 0.00108413626232821  
training\_seconds\_this\_epoch: 50.870087000001405  
valid\_h0\_col\_norms\_max: 0.7500000000000039  
valid\_h0\_col\_norms\_mean: 0.7444852680697936  
valid\_h0\_col\_norms\_min: 0.7164763320891008  
valid\_h0\_max\_x\_max\_u: 0.7442773757842299  
valid\_h0\_max\_x\_mean\_u: 0.13421648533920455  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.07530347571833569  
valid\_h0\_mean\_x\_mean\_u: 0.006461877519448425  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7442773757842299  
valid\_h0\_range\_x\_mean\_u: 0.13421648533920455  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7889638083589836  
valid\_h0\_row\_norms\_mean: 0.4729379039705784  
valid\_h0\_row\_norms\_min: 0.3947014662756118  
valid\_h1\_col\_norms\_max: 0.7500000000000039  
valid\_h1\_col\_norms\_mean: 0.7484244720857749  
valid\_h1\_col\_norms\_min: 0.7252224953619608

```

valid_h1_max_x_max_u: 0.273412130544903
valid_h1_max_x_mean_u: 0.0659997355668579
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.07739710266074874
valid_h1_mean_x_mean_u: 0.010045095313802333
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.007193070450639058
valid_h1_min_x_mean_u: 2.6997770347990847e-05
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.27261234928667316
valid_h1_range_x_mean_u: 0.06597273779650993
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.0871461416181771
valid_h1_row_norms_mean: 0.739911500900357
valid_h1_row_norms_min: 0.4414229289001226
valid_h2_col_norms_max: 0.7499999999999973
valid_h2_col_norms_mean: 0.7493654371887926
valid_h2_col_norms_min: 0.7440865510028597
valid_h2_max_x_max_u: 0.42033742179830386
valid_h2_max_x_mean_u: 0.06373135483997781
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.25011772895827505
valid_h2_mean_x_mean_u: 0.023136996201432326
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.09597818852754322
valid_h2_min_x_mean_u: 0.005911093258380876
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.37631336800911747
valid_h2_range_x_mean_u: 0.057820261581596914
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2036699764186345
valid_h2_row_norms_mean: 0.7338759477799052
valid_h2_row_norms_min: 0.3334961486699052
valid_objective: 0.44658573792793915
valid_y_col_norms_max: 2.5832354687505457
valid_y_col_norms_mean: 2.58323546875053
valid_y_col_norms_min: 2.58323546875053
valid_y_max_max_class: 0.9899852025077592
valid_y_mean_max_class: 0.8749615254110769
valid_y_min_max_class: 0.5750282748978296
valid_y_misclass: 0.1657004559013902
valid_y_nll: 0.3683917314055512
valid_y_row_norms_max: 1.7275634398424227
valid_y_row_norms_mean: 0.10042238063544097
valid_y_row_norms_min: 0.0010841362623282584
Saving to ..\Sean\nn_files_SOCOR10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.best.pkl done. Time elapsed: 0.073007 seconds
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.078008 seconds
Time this epoch: 50.646064 seconds
Monitoring step:
  Epochs seen: 16
  Batches seen: 25584
  Examples seen: 2558272

```

learning\_rate: 0.08401599999999996  
momentum: 0.439393939393941  
total\_seconds\_last\_epoch: 93.56035500000239  
train\_h0\_col\_norms\_max: 0.7500000000000068  
train\_h0\_col\_norms\_mean: 0.7443080705376283  
train\_h0\_col\_norms\_min: 0.7083533309688391  
train\_h0\_max\_x\_max\_u: 0.7646917505852607  
train\_h0\_max\_x\_mean\_u: 0.13192029733375948  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.07013516350219798  
train\_h0\_mean\_x\_mean\_u: 0.006311770721072991  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.0  
train\_h0\_min\_x\_mean\_u: 0.0  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.7646917505852607  
train\_h0\_range\_x\_mean\_u: 0.13192029733375948  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.8018676859300207  
train\_h0\_row\_norms\_mean: 0.4728267014137122  
train\_h0\_row\_norms\_min: 0.3886442749678082  
train\_h1\_col\_norms\_max: 0.7500000000000068  
train\_h1\_col\_norms\_mean: 0.748365192568423  
train\_h1\_col\_norms\_min: 0.7260493554695109  
train\_h1\_max\_x\_max\_u: 0.2811599880180976  
train\_h1\_max\_x\_mean\_u: 0.06330320049103084  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.09172345458643635  
train\_h1\_mean\_x\_mean\_u: 0.010608073690901384  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.015497558251067921  
train\_h1\_min\_x\_mean\_u: 8.654352173179163e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.2791103508310542  
train\_h1\_range\_x\_mean\_u: 0.06321665696929912  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0853493761047244  
train\_h1\_row\_norms\_mean: 0.7400123220754512  
train\_h1\_row\_norms\_min: 0.44904651377290944  
train\_h2\_col\_norms\_max: 0.7500000000000068  
train\_h2\_col\_norms\_mean: 0.7493430966913482  
train\_h2\_col\_norms\_min: 0.7431120564101364  
train\_h2\_max\_x\_max\_u: 0.4268152342698451  
train\_h2\_max\_x\_mean\_u: 0.05837304031546846  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2860214802981312  
train\_h2\_mean\_x\_mean\_u: 0.021247275681576153  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.1256322780180824  
train\_h2\_min\_x\_mean\_u: 0.005609958583823409  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.3474534381582446  
train\_h2\_range\_x\_mean\_u: 0.05276308173164509  
train\_h2\_range\_x\_min\_u: 0.0

train\_h2.row\_norms\_max: 1.201080149158125  
train\_h2.row\_norms\_mean: 0.7339105580190237  
train\_h2.row\_norms\_min: 0.34376345344219855  
train\_objective: 0.28763432836764496  
train\_y.col\_norms\_max: 2.6364901331238264  
train\_y.col\_norms\_mean: 2.6364901331238264  
train\_y.col\_norms\_min: 2.6364901331238264  
train\_y.max\_max\_class: 0.9847128991846372  
train\_y.mean\_max\_class: 0.8900107545483322  
train\_y.min\_max\_class: 0.6677310210026891  
train\_y.misclass: 0.12506566932679564  
train\_y.nll: 0.22959430714674164  
train\_y.row\_norms\_max: 1.7731535400810907  
train\_y.row\_norms\_mean: 0.10062076034858092  
train\_y.row\_norms\_min: 0.00243460737601124  
training\_seconds\_this\_epoch: 50.64606400000079  
valid\_h0.col\_norms\_max: 0.7500000000000004  
valid\_h0.col\_norms\_mean: 0.7443080705376425  
valid\_h0.col\_norms\_min: 0.7083533309688207  
valid\_h0.max\_x\_max\_u: 0.7191512003427357  
valid\_h0.max\_x\_mean\_u: 0.12626957540698922  
valid\_h0.max\_x\_min\_u: 0.0  
valid\_h0.mean\_x\_max\_u: 0.0673116734089403  
valid\_h0.mean\_x\_mean\_u: 0.0058894304620132456  
valid\_h0.mean\_x\_min\_u: 0.0  
valid\_h0.min\_x\_max\_u: 0.0  
valid\_h0.min\_x\_mean\_u: 0.0  
valid\_h0.min\_x\_min\_u: 0.0  
valid\_h0.range\_x\_max\_u: 0.7191512003427357  
valid\_h0.range\_x\_mean\_u: 0.12626957540698922  
valid\_h0.range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.8018676859300011  
valid\_h0.row\_norms\_mean: 0.47282670141372646  
valid\_h0.row\_norms\_min: 0.3886442749678207  
valid\_h1.col\_norms\_max: 0.75000000000000039  
valid\_h1.col\_norms\_mean: 0.748365192568399  
valid\_h1.col\_norms\_min: 0.7260493554694996  
valid\_h1.max\_x\_max\_u: 0.26495514197247494  
valid\_h1.max\_x\_mean\_u: 0.062214327646297404  
valid\_h1.max\_x\_min\_u: 0.0  
valid\_h1.mean\_x\_max\_u: 0.08141471117283951  
valid\_h1.mean\_x\_mean\_u: 0.010010923566552728  
valid\_h1.mean\_x\_min\_u: 0.0  
valid\_h1.min\_x\_max\_u: 0.012070367654678097  
valid\_h1.min\_x\_mean\_u: 4.780337084057673e-05  
valid\_h1.min\_x\_min\_u: 0.0  
valid\_h1.range\_x\_max\_u: 0.26336818463046907  
valid\_h1.range\_x\_mean\_u: 0.06216652427545683  
valid\_h1.range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.0853493761047255  
valid\_h1.row\_norms\_mean: 0.7400123220754399  
valid\_h1.row\_norms\_min: 0.4490465137728981  
valid\_h2.col\_norms\_max: 0.7499999999999973  
valid\_h2.col\_norms\_mean: 0.7493430966913316

```

valid_h2.col_norms_min: 0.7431120564101362
valid_h2.max_x_max_u: 0.4144265944559132
valid_h2.max_x_mean_u: 0.058223620560901385
valid_h2.max_x_min_u: 0.0
valid_h2.mean_x_max_u: 0.25119252474099896
valid_h2.mean_x_mean_u: 0.020477383192521882
valid_h2.mean_x_min_u: 0.0
valid_h2.min_x_max_u: 0.10959237165547447
valid_h2.min_x_mean_u: 0.005134805878516586
valid_h2.min_x_min_u: 0.0
valid_h2.range_x_max_u: 0.3661604067690834
valid_h2.range_x_mean_u: 0.05308881468238481
valid_h2.range_x_min_u: 0.0
valid_h2.row_norms_max: 1.2010801491581249
valid_h2.row_norms_mean: 0.7339105580190354
valid_h2.row_norms_min: 0.3437634534421986
valid_objective: 0.4430185247721913
valid_y.col_norms_max: 2.6364901331237776
valid_y.col_norms_mean: 2.6364901331237776
valid_y.col_norms_min: 2.6364901331237776
valid_y.max_max_class: 0.9894418519433853
valid_y.mean_max_class: 0.8872878764947091
valid_y.min_max_class: 0.613542079101589
valid_y.misclass: 0.1863004446445658
valid_y_nll: 0.40236531177045687
valid_y.row_norms_max: 1.773153540081138
valid_y.row_norms_mean: 0.100620760348578
valid_y.row_norms_min: 0.002434607376011198
Saving to ..\Sean\nn_files_SOCOR10\nn.train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn.train.pkl done. Time elapsed: 0.065007 seconds
Time this epoch: 49.765976 seconds
Monitoring step:
  Epochs seen: 17
  Batches seen: 27183
  Examples seen: 2718164
  learning_rate: 0.08301700000000178
  momentum: 0.4353535353535266
  total_seconds_last_epoch: 92.8542850000013
  train_h0.col_norms_max: 0.7500000000000068
  train_h0.col_norms_mean: 0.7446719136853851
  train_h0.col_norms_min: 0.7168122839013784
  train_h0.max_x_max_u: 0.7967334377029975
  train_h0.max_x_mean_u: 0.13510660255672693
  train_h0.max_x_min_u: 0.0
  train_h0.mean_x_max_u: 0.07424455152336096
  train_h0.mean_x_mean_u: 0.006546898904275017
  train_h0.mean_x_min_u: 0.0
  train_h0.min_x_max_u: 0.0
  train_h0.min_x_mean_u: 0.0
  train_h0.min_x_min_u: 0.0
  train_h0.range_x_max_u: 0.7967334377029975
  train_h0.range_x_mean_u: 0.13510660255672693
  train_h0.range_x_min_u: 0.0
  train_h0.row_norms_max: 0.8110095450086839

```

train\_h0\_row\_norms\_mean: 0.4730707840817066  
train\_h0\_row\_norms\_min: 0.39491667200103925  
train\_h1\_col\_norms\_max: 0.75000000000000068  
train\_h1\_col\_norms\_mean: 0.7485175047968587  
train\_h1\_col\_norms\_min: 0.7246816046480345  
train\_h1\_max\_x\_max\_u: 0.2874998210060441  
train\_h1\_max\_x\_mean\_u: 0.06726150272754204  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.08022800758128461  
train\_h1\_mean\_x\_mean\_u: 0.011134320724240664  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.013815739481594203  
train\_h1\_min\_x\_mean\_u: 9.111809862969182e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.2867220834566638  
train\_h1\_range\_x\_mean\_u: 0.06717038462891235  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0874074030162655  
train\_h1\_row\_norms\_mean: 0.7403142421435198  
train\_h1\_row\_norms\_min: 0.46317701396427946  
train\_h2\_col\_norms\_max: 0.75000000000000068  
train\_h2\_col\_norms\_mean: 0.749434592350942  
train\_h2\_col\_norms\_min: 0.7428706899411599  
train\_h2\_max\_x\_max\_u: 0.43764746255319126  
train\_h2\_max\_x\_mean\_u: 0.06165699956823197  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.28914766303836165  
train\_h2\_mean\_x\_mean\_u: 0.02267035393922664  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.11933780734145079  
train\_h2\_min\_x\_mean\_u: 0.0062124471950017945  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.3665534249674919  
train\_h2\_range\_x\_mean\_u: 0.055444552373230246  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2020259788472203  
train\_h2\_row\_norms\_mean: 0.7340046296398547  
train\_h2\_row\_norms\_min: 0.33409538785689924  
train\_objective: 0.28783089430745296  
train\_y\_col\_norms\_max: 2.7050549260708525  
train\_y\_col\_norms\_mean: 2.7050549260708525  
train\_y\_col\_norms\_min: 2.7050549260708525  
train\_y\_max\_max\_class: 0.9864645179704092  
train\_y\_mean\_max\_class: 0.8847517149964007  
train\_y\_min\_max\_class: 0.6277599985246368  
train\_y\_misclass: 0.09717809521426943  
train\_y\_nll: 0.20326290194068092  
train\_y\_row\_norms\_max: 1.8180515779882784  
train\_y\_row\_norms\_mean: 0.10249651247979079  
train\_y\_row\_norms\_min: 0.002951586486240808  
training\_seconds\_this\_epoch: 49.76597600000087  
valid\_h0\_col\_norms\_max: 0.75000000000000039  
valid\_h0\_col\_norms\_mean: 0.7446719136853954  
valid\_h0\_col\_norms\_min: 0.7168122839013981



valid\_h0\_max\_x\_max\_u: 0.7415928691752321  
valid\_h0\_max\_x\_mean\_u: 0.12925698847225736  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.07114463304353777  
valid\_h0\_mean\_x\_mean\_u: 0.006092464678885511  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7415928691752321  
valid\_h0\_range\_x\_mean\_u: 0.12925698847225736  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.811009545008665  
valid\_h0\_row\_norms\_mean: 0.47307078408170883  
valid\_h0\_row\_norms\_min: 0.39491667200104597  
valid\_h1\_col\_norms\_max: 0.75000000000000039  
valid\_h1\_col\_norms\_mean: 0.7485175047968456  
valid\_h1\_col\_norms\_min: 0.7246816046480191  
valid\_h1\_max\_x\_max\_u: 0.2624025644369669  
valid\_h1\_max\_x\_mean\_u: 0.06562464966133763  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.07535714151928562  
valid\_h1\_mean\_x\_mean\_u: 0.010523589159780522  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.011958479690764835  
valid\_h1\_min\_x\_mean\_u: 5.1041360780133404e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.2616255579399717  
valid\_h1\_range\_x\_mean\_u: 0.06557360830055754  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0874074030162495  
valid\_h1\_row\_norms\_mean: 0.7403142421434998  
valid\_h1\_row\_norms\_min: 0.4631770139642912  
valid\_h2\_col\_norms\_max: 0.7499999999999973  
valid\_h2\_col\_norms\_mean: 0.7494345923509552  
valid\_h2\_col\_norms\_min: 0.7428706899411426  
valid\_h2\_max\_x\_max\_u: 0.4211392374490889  
valid\_h2\_max\_x\_mean\_u: 0.06086273610674932  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.25330878559476366  
valid\_h2\_mean\_x\_mean\_u: 0.021907466864883287  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.10195099158002745  
valid\_h2\_min\_x\_mean\_u: 0.005652023895491082  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.38045883003014735  
valid\_h2\_range\_x\_mean\_u: 0.05521071221125822  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2020259788472343  
valid\_h2\_row\_norms\_mean: 0.7340046296398631  
valid\_h2\_row\_norms\_min: 0.33409538785689397  
valid\_objective: 0.4462012718442931  
valid\_y\_col\_norms\_max: 2.7050549260708423  
valid\_y\_col\_norms\_mean: 2.7050549260708423

```

valid_y_col_norms_min: 2.7050549260708423
valid_y_max_max_class: 0.9908479404878073
valid_y_mean_max_class: 0.8724758861948793
valid_y_min_max_class: 0.5753016018889529
valid_y_misclass: 0.16783925254685653
valid_y_nll: 0.37260854780677544
valid_y_row_norms_max: 1.8180515779882707
valid_y_row_norms_mean: 0.10249651247979351
valid_y_row_norms_min: 0.002951586486240824
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.067006 seconds
Time this epoch: 50.441044 seconds
Monitoring step:
  Epochs seen: 18
  Batches seen: 28782
  Examples seen: 2878056
  learning_rate: 0.08201799999999987
  momentum: 0.43131313131312826
  total_seconds_last_epoch: 91.53515199999659
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.744432958756839
  train_h0_col_norms_min: 0.7209634693165011
  train_h0_max_x_max_u: 0.8029465498197542
  train_h0_max_x_mean_u: 0.13282186262521878
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.07343927428921891
  train_h0_mean_x_mean_u: 0.006405622587678145
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.8029465498197542
  train_h0_range_x_mean_u: 0.13282186262521878
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.8086035701122131
  train_h0_row_norms_mean: 0.4728927225896062
  train_h0_row_norms_min: 0.3914538735392292
  train_h1_col_norms_max: 0.7500000000000068
  train_h1_col_norms_mean: 0.7484262252683452
  train_h1_col_norms_min: 0.7227785314184937
  train_h1_max_x_max_u: 0.29714047347258005
  train_h1_max_x_mean_u: 0.06355343745261818
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.09189431351669625
  train_h1_mean_x_mean_u: 0.010216820156229616
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.022750378696817744
  train_h1_min_x_mean_u: 0.00013733428975183683
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.2944317068310091
  train_h1_range_x_mean_u: 0.06341610316286626
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.0857047493828185
  train_h1_row_norms_mean: 0.7403463083376887

```

train\_h1\_row\_norms\_min: 0.4270590029219357  
train\_h2\_col\_norms\_max: 0.75000000000000068  
train\_h2\_col\_norms\_mean: 0.7493766756346786  
train\_h2\_col\_norms\_min: 0.7279792263317102  
train\_h2\_max\_x\_max\_u: 0.4633360297563283  
train\_h2\_max\_x\_mean\_u: 0.05814918993722985  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.3316282470694521  
train\_h2\_mean\_x\_mean\_u: 0.021065949608123198  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.14268962818404277  
train\_h2\_min\_x\_mean\_u: 0.005716554177488175  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.351697896502707  
train\_h2\_range\_x\_mean\_u: 0.05243263575974167  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2033827657061997  
train\_h2\_row\_norms\_mean: 0.7339433182735223  
train\_h2\_row\_norms\_min: 0.33440878160922516  
train\_objective: 0.2854524866790288  
train\_y\_col\_norms\_max: 2.7512530626711347  
train\_y\_col\_norms\_mean: 2.7512530626711347  
train\_y\_col\_norms\_min: 2.7512530626711347  
train\_y\_max\_max\_class: 0.9866151182935136  
train\_y\_mean\_max\_class: 0.8946494663787784  
train\_y\_min\_max\_class: 0.6696119962049929  
train\_y\_misclass: 0.1210692217246642  
train\_y\_nll: 0.22107398788406202  
train\_y\_row\_norms\_max: 1.8508383814686205  
train\_y\_row\_norms\_mean: 0.10336766091080482  
train\_y\_row\_norms\_min: 0.0025548458361699133  
training\_seconds\_this\_epoch: 50.44104399999872  
valid\_h0\_col\_norms\_max: 0.75000000000000039  
valid\_h0\_col\_norms\_mean: 0.7444329587568471  
valid\_h0\_col\_norms\_min: 0.7209634693164828  
valid\_h0\_max\_x\_max\_u: 0.7606927980284891  
valid\_h0\_max\_x\_mean\_u: 0.12791551753634323  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.07182701719995155  
valid\_h0\_mean\_x\_mean\_u: 0.005968736277561645  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7606927980284891  
valid\_h0\_range\_x\_mean\_u: 0.12791551753634323  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.8086035701122326  
valid\_h0\_row\_norms\_mean: 0.4728927225896152  
valid\_h0\_row\_norms\_min: 0.3914538735392216  
valid\_h1\_col\_norms\_max: 0.75000000000000039  
valid\_h1\_col\_norms\_mean: 0.7484262252683533  
valid\_h1\_col\_norms\_min: 0.7227785314184842  
valid\_h1\_max\_x\_max\_u: 0.27968841058715094

```

valid_h1_max_x_mean_u: 0.06205067778841579
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.08529819885329105
valid_h1_mean_x_mean_u: 0.009560234528657839
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.01986061971480536
valid_h1_min_x_mean_u: 9.527299981059069e-05
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.27645234454753126
valid_h1_range_x_mean_u: 0.06195540478860522
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.0857047493828178
valid_h1_row_norms_mean: 0.7403463083377152
valid_h1_row_norms_min: 0.4270590029219463
valid_h2_col_norms_max: 0.7499999999999973
valid_h2_col_norms_mean: 0.749376675634671
valid_h2_col_norms_min: 0.7279792263316983
valid_h2_max_x_max_u: 0.45014708934033787
valid_h2_max_x_mean_u: 0.05750439657307174
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.2994939203658023
valid_h2_mean_x_mean_u: 0.020228305696362532
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.11284340423325989
valid_h2_min_x_mean_u: 0.005126679436280536
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.3710187157221114
valid_h2_range_x_mean_u: 0.052377717136791166
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2033827657062133
valid_h2_row_norms_mean: 0.7339433182735076
valid_h2_row_norms_min: 0.33440878160923104
valid_objective: 0.4447736261406759
valid_y_col_norms_max: 2.7512530626710396
valid_y_col_norms_mean: 2.751253062671039
valid_y_col_norms_min: 2.751253062671039
valid_y_max_max_class: 0.9914634963903751
valid_y_mean_max_class: 0.8920024052139859
valid_y_min_max_class: 0.6171186305993117
valid_y_misclass: 0.18269826082062252
valid_y_nll: 0.39711129054590405
valid_y_row_norms_max: 1.8508383814686122
valid_y_row_norms_mean: 0.10336766091080433
valid_y_row_norms_min: 0.0025548458361699545
Saving to ..\Sean\nn_files_S0C0R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S0C0R10\nn_train.pkl done. Time elapsed: 0.065007 seconds
Time this epoch: 50.443043 seconds
Monitoring step:
  Epochs seen: 19
  Batches seen: 30381
  Examples seen: 3037948
  learning_rate: 0.08101900000000067
  momentum: 0.4272727272727172
  total_seconds_last_epoch: 91.91019099999812

```

```

train_h0.col_norms_max: 0.75000000000000068
train_h0.col_norms_mean: 0.7442190106158596
train_h0.col_norms_min: 0.7141492549649244
train_h0_max_x_max_u: 0.8114651193207714
train_h0_max_x_mean_u: 0.12948314725884225
train_h0_max_x_min_u: 0.0
train_h0_mean_x_max_u: 0.07680231608234508
train_h0_mean_x_mean_u: 0.006277449103994167
train_h0_mean_x_min_u: 0.0
train_h0_min_x_max_u: 0.0
train_h0_min_x_mean_u: 0.0
train_h0_min_x_min_u: 0.0
train_h0_range_x_max_u: 0.8114651193207714
train_h0_range_x_mean_u: 0.12948314725884225
train_h0_range_x_min_u: 0.0
train_h0.row_norms_max: 0.8132326686180488
train_h0.row_norms_mean: 0.4728230816583512
train_h0.row_norms_min: 0.40359507374124937
train_h1.col_norms_max: 0.75000000000000068
train_h1.col_norms_mean: 0.7485335602423707
train_h1.col_norms_min: 0.7225726360799746
train_h1_max_x_max_u: 0.27888074291217574
train_h1_max_x_mean_u: 0.0626580630873249
train_h1_max_x_min_u: 0.0
train_h1_mean_x_max_u: 0.07182485865150302
train_h1_mean_x_mean_u: 0.010008299191022748
train_h1_mean_x_min_u: 0.0
train_h1_min_x_max_u: 0.014280791023158502
train_h1_min_x_mean_u: 8.369106893953401e-05
train_h1_min_x_min_u: 0.0
train_h1_range_x_max_u: 0.2780258786045878
train_h1_range_x_mean_u: 0.06257437201838534
train_h1_range_x_min_u: 0.0
train_h1.row_norms_max: 1.0721721517336313
train_h1.row_norms_mean: 0.7405289217786525
train_h1.row_norms_min: 0.44525769258938186
train_h2.col_norms_max: 0.75000000000000068
train_h2.col_norms_mean: 0.7495112092023785
train_h2.col_norms_min: 0.7372289273656888
train_h2_max_x_max_u: 0.47145897400635506
train_h2_max_x_mean_u: 0.05776663146449162
train_h2_max_x_min_u: 0.0
train_h2_mean_x_max_u: 0.339115425125983
train_h2_mean_x_mean_u: 0.02164469962731489
train_h2_mean_x_min_u: 0.0
train_h2_min_x_max_u: 0.1513979319393087
train_h2_min_x_mean_u: 0.006114848728113808
train_h2_min_x_min_u: 0.0
train_h2_range_x_max_u: 0.3557585633678911
train_h2_range_x_mean_u: 0.05165178273637783
train_h2_range_x_min_u: 0.0
train_h2.row_norms_max: 1.205921256350583
train_h2.row_norms_mean: 0.7341235455843343
train_h2.row_norms_min: 0.33265129734175686

```

train\_objective: 0.2826494167755106  
train\_y\_col\_norms\_max: 2.824484530854236  
train\_y\_col\_norms\_mean: 2.824484530854236  
train\_y\_col\_norms\_min: 2.824484530854236  
train\_y\_max\_max\_class: 0.9875966486698999  
train\_y\_mean\_max\_class: 0.8984401045120168  
train\_y\_min\_max\_class: 0.6666803394033943  
train\_y\_misclass: 0.11068721386936185  
train\_y\_nll: 0.2132493243075119  
train\_y\_row\_norms\_max: 1.8961897571219486  
train\_y\_row\_norms\_mean: 0.105687623261246  
train\_y\_row\_norms\_min: 0.002840463615969651  
training\_seconds\_this\_epoch: 50.44304300000023  
valid\_h0\_col\_norms\_max: 0.7500000000000039  
valid\_h0\_col\_norms\_mean: 0.7442190106158528  
valid\_h0\_col\_norms\_min: 0.714149254964927  
valid\_h0\_max\_x\_max\_u: 0.7716712472517214  
valid\_h0\_max\_x\_mean\_u: 0.12393532498297158  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.07372024992248516  
valid\_h0\_mean\_x\_mean\_u: 0.005834437896336803  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7716712472517214  
valid\_h0\_range\_x\_mean\_u: 0.12393532498297158  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.8132326686180162  
valid\_h0\_row\_norms\_mean: 0.4728230816583337  
valid\_h0\_row\_norms\_min: 0.4035950737412495  
valid\_h1\_col\_norms\_max: 0.7500000000000039  
valid\_h1\_col\_norms\_mean: 0.7485335602423803  
valid\_h1\_col\_norms\_min: 0.7225726360799917  
valid\_h1\_max\_x\_max\_u: 0.26184705718896517  
valid\_h1\_max\_x\_mean\_u: 0.061443268409317346  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.0691446898866481  
valid\_h1\_mean\_x\_mean\_u: 0.009288216490068718  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.011582585360492552  
valid\_h1\_min\_x\_mean\_u: 4.8893958107200146e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.26107397527775106  
valid\_h1\_range\_x\_mean\_u: 0.06139437445121016  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0721721517336098  
valid\_h1\_row\_norms\_mean: 0.7405289217786385  
valid\_h1\_row\_norms\_min: 0.4452576925893929  
valid\_h2\_col\_norms\_max: 0.7500000000000039  
valid\_h2\_col\_norms\_mean: 0.749511209202373  
valid\_h2\_col\_norms\_min: 0.7372289273656908  
valid\_h2\_max\_x\_max\_u: 0.4592239286525515  
valid\_h2\_max\_x\_mean\_u: 0.05755355848929168

```

valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.3072710189391412
valid_h2_mean_x_mean_u: 0.020791925767012935
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.121275979456668
valid_h2_min_x_mean_u: 0.005514455377050894
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.3739592476912879
valid_h2_range_x_mean_u: 0.05203910311224079
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2059212563505637
valid_h2_row_norms_mean: 0.7341235455843304
valid_h2_row_norms_min: 0.3326512973417475
valid_objective: 0.44969819389492904
valid_y_col_norms_max: 2.824484530854192
valid_y_col_norms_mean: 2.824484530854192
valid_y_col_norms_min: 2.824484530854192
valid_y_max_max_class: 0.9926633759548465
valid_y_mean_max_class: 0.8960340267287851
valid_y_min_max_class: 0.6088737754285483
valid_y_misclass: 0.17819553104069347
valid_y_nll: 0.40281323229831345
valid_y_row_norms_max: 1.8961897571218584
valid_y_row_norms_mean: 0.10568762326124313
valid_y_row_norms_min: 0.0028404636159696448
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.082008 seconds
Time this epoch: 51.311131 seconds
Monitoring step:
  Epochs seen: 20
  Batches seen: 31980
  Examples seen: 3197840
  learning_rate: 0.080019999999999863
  momentum: 0.4232323232323394
  total_seconds_last_epoch: 92.606258999999832
  train_h0_col_norms_max: 0.75000000000000068
  train_h0_col_norms_mean: 0.7448039966296343
  train_h0_col_norms_min: 0.7194676219378668
  train_h0_max_x_max_u: 0.7995411222445731
  train_h0_max_x_mean_u: 0.12852528895974416
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.07250203225897603
  train_h0_mean_x_mean_u: 0.006060779457960651
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7995411222445731
  train_h0_range_x_mean_u: 0.12852528895974416
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.8072735211544017
  train_h0_row_norms_mean: 0.47317511241882293
  train_h0_row_norms_min: 0.3966858360357601
  train_h1_col_norms_max: 0.75000000000000068

```

train\_h1.col\_norms\_mean: 0.7485259235150737  
train\_h1.col\_norms\_min: 0.7206221063487793  
train\_h1.max\_x\_max\_u: 0.28271619918961616  
train\_h1.max\_x\_mean\_u: 0.06255720113194921  
train\_h1.max\_x\_min\_u: 0.0  
train\_h1.mean\_x\_max\_u: 0.07282494649875468  
train\_h1.mean\_x\_mean\_u: 0.010472003008119228  
train\_h1.mean\_x\_min\_u: 0.0  
train\_h1.min\_x\_max\_u: 0.014862918187213171  
train\_h1.min\_x\_mean\_u: 9.168016379416613e-05  
train\_h1.min\_x\_min\_u: 0.0  
train\_h1.range\_x\_max\_u: 0.2818443142821399  
train\_h1.range\_x\_mean\_u: 0.06246552096815513  
train\_h1.range\_x\_min\_u: 0.0  
train\_h1.row\_norms\_max: 1.0711291070273734  
train\_h1.row\_norms\_mean: 0.7406564969214322  
train\_h1.row\_norms\_min: 0.43636097555978837  
train\_h2.col\_norms\_max: 0.75000000000000068  
train\_h2.col\_norms\_mean: 0.7494997961934665  
train\_h2.col\_norms\_min: 0.7455818822861865  
train\_h2.max\_x\_max\_u: 0.40907131665156016  
train\_h2.max\_x\_mean\_u: 0.056986280420306026  
train\_h2.max\_x\_min\_u: 0.0  
train\_h2.mean\_x\_max\_u: 0.27343525014911985  
train\_h2.mean\_x\_mean\_u: 0.0211007995244396  
train\_h2.mean\_x\_min\_u: 0.0  
train\_h2.min\_x\_max\_u: 0.11824868736885703  
train\_h2.min\_x\_mean\_u: 0.0055924236363206585  
train\_h2.min\_x\_min\_u: 0.0  
train\_h2.range\_x\_max\_u: 0.34325230782171506  
train\_h2.range\_x\_mean\_u: 0.051393856783985406  
train\_h2.range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.200532161450936  
train\_h2.row\_norms\_mean: 0.7341597298163867  
train\_h2.row\_norms\_min: 0.3341160875947901  
train\_objective: 0.28359692328173636  
train\_y.col\_norms\_max: 2.869587430374993  
train\_y.col\_norms\_mean: 2.869587430374993  
train\_y.col\_norms\_min: 2.8695874303749926  
train\_y.max\_max\_class: 0.986595461366162  
train\_y.mean\_max\_class: 0.8911657638668844  
train\_y.min\_max\_class: 0.6480853795683589  
train\_y.misclass: 0.095714607359968  
train\_y.nll: 0.20055023567958158  
train\_y.row\_norms\_max: 1.930665288062743  
train\_y.row\_norms\_mean: 0.1064218981867805  
train\_y.row\_norms\_min: 0.002584344958945296  
training\_seconds\_this\_epoch: 51.31113100000178  
valid\_h0.col\_norms\_max: 0.75000000000000039  
valid\_h0.col\_norms\_mean: 0.7448039966296347  
valid\_h0.col\_norms\_min: 0.7194676219378515  
valid\_h0.max\_x\_max\_u: 0.7768322712761079  
valid\_h0.max\_x\_mean\_u: 0.1232119124709952  
valid\_h0.max\_x\_min\_u: 0.0



valid\_h0\_mean\_x\_max\_u: 0.06731481505051186  
valid\_h0\_mean\_x\_mean\_u: 0.005626810013289051  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7768322712761079  
valid\_h0\_range\_x\_mean\_u: 0.1232119124709952  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.8072735211543949  
valid\_h0\_row\_norms\_mean: 0.4731751124188189  
valid\_h0\_row\_norms\_min: 0.3966858360357546  
valid\_h1\_col\_norms\_max: 0.7500000000000039  
valid\_h1\_col\_norms\_mean: 0.7485259235150745  
valid\_h1\_col\_norms\_min: 0.7206221063487722  
valid\_h1\_max\_x\_max\_u: 0.270351685862782  
valid\_h1\_max\_x\_mean\_u: 0.061535042466037054  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.07032911250454534  
valid\_h1\_mean\_x\_mean\_u: 0.009750323973376879  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.013436426390794159  
valid\_h1\_min\_x\_mean\_u: 5.461044432955641e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.26988982442290105  
valid\_h1\_range\_x\_mean\_u: 0.0614804320217075  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.071129107027385  
valid\_h1\_row\_norms\_mean: 0.7406564969214439  
valid\_h1\_row\_norms\_min: 0.4363609755597845  
valid\_h2\_col\_norms\_max: 0.7500000000000004  
valid\_h2\_col\_norms\_mean: 0.7494997961934382  
valid\_h2\_col\_norms\_min: 0.7455818822861797  
valid\_h2\_max\_x\_max\_u: 0.3911794199478956  
valid\_h2\_max\_x\_mean\_u: 0.056812299910112746  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.23940114344532393  
valid\_h2\_mean\_x\_mean\_u: 0.020212914987014583  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.10237541280064091  
valid\_h2\_min\_x\_mean\_u: 0.005069934452104606  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.35490288962433225  
valid\_h2\_range\_x\_mean\_u: 0.05174236545800813  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2005321614509132  
valid\_h2\_row\_norms\_mean: 0.7341597298163918  
valid\_h2\_row\_norms\_min: 0.3341160875947764  
valid\_objective: 0.46027246805247835  
valid\_y\_col\_norms\_max: 2.869587430375092  
valid\_y\_col\_norms\_mean: 2.869587430375092  
valid\_y\_col\_norms\_min: 2.869587430375092  
valid\_y\_max\_max\_class: 0.990734345536853  
valid\_y\_mean\_max\_class: 0.8823283719816095

```

valid_y_min_max_class: 0.5889731234603189
valid_y_misclass: 0.1712162998818033
valid_y_nll: 0.3863069453197264
valid_y_row_norms_max: 1.9306652880627226
valid_y_row_norms_mean: 0.10642189818678166
valid_y_row_norms_min: 0.002584344958945223
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl done. Time elapsed: 0.068006 seconds
Time this epoch: 50.951094 seconds
Monitoring step:
  Epochs seen: 21
  Batches seen: 33579
  Examples seen: 3357732
  learning_rate: 0.07902100000000042
  momentum: 0.41919191919192816
  total_seconds_last_epoch: 93.59235900000311
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7445216616431576
  train_h0_col_norms_min: 0.7101577612204341
  train_h0_max_x_max_u: 0.8044518255536997
  train_h0_max_x_mean_u: 0.12780761886602396
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.07161782792240928
  train_h0_mean_x_mean_u: 0.006023872152686111
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.8044518255536997
  train_h0_range_x_mean_u: 0.12780761886602396
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.823152939830269
  train_h0_row_norms_mean: 0.4730565458987863
  train_h0_row_norms_min: 0.39901927819943206
  train_h1_col_norms_max: 0.7500000000000068
  train_h1_col_norms_mean: 0.7485517483799532
  train_h1_col_norms_min: 0.7201523527736549
  train_h1_max_x_max_u: 0.27485377819037765
  train_h1_max_x_mean_u: 0.061446967806138696
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.07212137241880337
  train_h1_mean_x_mean_u: 0.009940168012434747
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.01174610225650711
  train_h1_min_x_mean_u: 6.594324013142462e-05
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.274149694244306
  train_h1_range_x_mean_u: 0.06138102456600724
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.0759969737173487
  train_h1_row_norms_mean: 0.7408505106233648
  train_h1_row_norms_min: 0.4341141826805648
  train_h2_col_norms_max: 0.7500000000000068
  train_h2_col_norms_mean: 0.7494721451335227

```

train\_h2.col\_norms\_min: 0.7450877912964701  
train\_h2.max\_x\_max\_u: 0.43222987566798315  
train\_h2.max\_x\_mean\_u: 0.05678528736200363  
train\_h2.max\_x\_min\_u: 0.0  
train\_h2.mean\_x\_max\_u: 0.3031541626614055  
train\_h2.mean\_x\_mean\_u: 0.021094357446839965  
train\_h2.mean\_x\_min\_u: 0.0  
train\_h2.min\_x\_max\_u: 0.13755505384828598  
train\_h2.min\_x\_mean\_u: 0.00594476863586035  
train\_h2.min\_x\_min\_u: 0.0  
train\_h2.range\_x\_max\_u: 0.33355823367106774  
train\_h2.range\_x\_mean\_u: 0.05084051872614333  
train\_h2.range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2013092290311036  
train\_h2.row\_norms\_mean: 0.7341482899640954  
train\_h2.row\_norms\_min: 0.3373013282581459  
train\_objective: 0.278583905644298  
train\_y.col\_norms\_max: 2.9128020702903314  
train\_y.col\_norms\_mean: 2.9128020702903314  
train\_y.col\_norms\_min: 2.9128020702903314  
train\_y.max\_max\_class: 0.9874287542950455  
train\_y.mean\_max\_class: 0.8978131875812423  
train\_y.min\_max\_class: 0.6666314086819698  
train\_y.misclass: 0.10005503715007624  
train\_y\_nll: 0.2015453398205455  
train\_y.row\_norms\_max: 1.961229303002648  
train\_y.row\_norms\_mean: 0.1072613291984183  
train\_y.row\_norms\_min: 0.0024572932983928162  
training\_seconds\_this\_epoch: 50.95109399999953  
valid\_h0.col\_norms\_max: 0.7500000000000004  
valid\_h0.col\_norms\_mean: 0.7445216616431776  
valid\_h0.col\_norms\_min: 0.7101577612204367  
valid\_h0.max\_x\_max\_u: 0.7700350021504071  
valid\_h0.max\_x\_mean\_u: 0.12162516697977786  
valid\_h0.max\_x\_min\_u: 0.0  
valid\_h0.mean\_x\_max\_u: 0.0686755506673797  
valid\_h0.mean\_x\_mean\_u: 0.005551168376971771  
valid\_h0.mean\_x\_min\_u: 0.0  
valid\_h0.min\_x\_max\_u: 0.0  
valid\_h0.min\_x\_mean\_u: 0.0  
valid\_h0.min\_x\_min\_u: 0.0  
valid\_h0.range\_x\_max\_u: 0.7700350021504071  
valid\_h0.range\_x\_mean\_u: 0.12162516697977786  
valid\_h0.range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.8231529398302581  
valid\_h0.row\_norms\_mean: 0.47305654589878166  
valid\_h0.row\_norms\_min: 0.3990192781994268  
valid\_h1.col\_norms\_max: 0.75000000000000039  
valid\_h1.col\_norms\_mean: 0.7485517483799686  
valid\_h1.col\_norms\_min: 0.7201523527736649  
valid\_h1.max\_x\_max\_u: 0.2528146648534788  
valid\_h1.max\_x\_mean\_u: 0.06071555117579297  
valid\_h1.max\_x\_min\_u: 0.0  
valid\_h1.mean\_x\_max\_u: 0.06821937662420832

```

valid_h1_mean_x_mean_u: 0.00920657774849066
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.01057261044696229
valid_h1_min_x_mean_u: 4.1901204520337255e-05
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.25220106818672344
valid_h1_range_x_mean_u: 0.060673649971272635
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.0759969737173645
valid_h1_row_norms_mean: 0.7408505106233473
valid_h1_row_norms_min: 0.4341141826805697
valid_h2_col_norms_max: 0.7499999999999973
valid_h2_col_norms_mean: 0.7494721451335413
valid_h2_col_norms_min: 0.7450877912964637
valid_h2_max_x_max_u: 0.4188513233729733
valid_h2_max_x_mean_u: 0.057237724373970365
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.2701889225066805
valid_h2_mean_x_mean_u: 0.02020350645131373
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.1107593071672987
valid_h2_min_x_mean_u: 0.005356316275478094
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.35852068982906177
valid_h2_range_x_mean_u: 0.051881408098492295
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2013092290311167
valid_h2_row_norms_mean: 0.7341482899641081
valid_h2_row_norms_min: 0.33730132825813225
valid_objective: 0.4535416243461232
valid_y_col_norms_max: 2.9128020702902653
valid_y_col_norms_mean: 2.9128020702902653
valid_y_col_norms_min: 2.9128020702902653
valid_y_max_max_class: 0.9914023025453534
valid_y_mean_max_class: 0.8918418045938458
valid_y_min_max_class: 0.5965276881781645
valid_y_misclass: 0.17470591546124836
valid_y_nll: 0.3923812996453329
valid_y_row_norms_max: 1.9612293030027228
valid_y_row_norms_mean: 0.10726132919841652
valid_y_row_norms_min: 0.002457293298392852
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.088009 seconds
Time this epoch: 53.238324 seconds
Monitoring step:
  Epochs seen: 22
  Batches seen: 35178
  Examples seen: 3517624
  learning_rate: 0.07802199999999779
  momentum: 0.415151515151527
  total_seconds_last_epoch: 94.38643699999936
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7442331812232728
  train_h0_col_norms_min: 0.7133544933863074

```

train\_h0\_max\_x\_max\_u: 0.8129765208116729  
train\_h0\_max\_x\_mean\_u: 0.1227473610444928  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.07220114165012878  
train\_h0\_mean\_x\_mean\_u: 0.00571585181907758  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.0  
train\_h0\_min\_x\_mean\_u: 0.0  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.8129765208116729  
train\_h0\_range\_x\_mean\_u: 0.1227473610444928  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.777998419483807  
train\_h0\_row\_norms\_mean: 0.472848237163583  
train\_h0\_row\_norms\_min: 0.3958231841440777  
train\_h1\_col\_norms\_max: 0.7500000000000068  
train\_h1\_col\_norms\_mean: 0.7485756449725095  
train\_h1\_col\_norms\_min: 0.7192377718361411  
train\_h1\_max\_x\_max\_u: 0.2829972037841518  
train\_h1\_max\_x\_mean\_u: 0.059617596517672615  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.07651010279740324  
train\_h1\_mean\_x\_mean\_u: 0.009837051528494697  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.01500616939192546  
train\_h1\_min\_x\_mean\_u: 8.660423050169649e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.28159083032138127  
train\_h1\_range\_x\_mean\_u: 0.05953099228717094  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0754519239448952  
train\_h1\_row\_norms\_mean: 0.7408856382458906  
train\_h1\_row\_norms\_min: 0.45958403179329205  
train\_h2\_col\_norms\_max: 0.7500000000000068  
train\_h2\_col\_norms\_mean: 0.749504167725537  
train\_h2\_col\_norms\_min: 0.7357734322333068  
train\_h2\_max\_x\_max\_u: 0.47903839557194866  
train\_h2\_max\_x\_mean\_u: 0.05430268233200901  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.3576052982321233  
train\_h2\_mean\_x\_mean\_u: 0.02007316307150526  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.17667333441970887  
train\_h2\_min\_x\_mean\_u: 0.005469856920689443  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.33879296265726033  
train\_h2\_range\_x\_mean\_u: 0.048832825411319614  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2021288556043455  
train\_h2\_row\_norms\_mean: 0.7342211089830759  
train\_h2\_row\_norms\_min: 0.33637158288847785  
train\_objective: 0.2791461195305195  
train\_y\_col\_norms\_max: 2.9580992092997693  
train\_y\_col\_norms\_mean: 2.9580992092997693

train\_y\_col\_norms\_min: 2.9580992092997693  
train\_y\_max\_max\_class: 0.9880813012651939  
train\_y\_mean\_max\_class: 0.9019769454798513  
train\_y\_min\_max\_class: 0.6804961730162415  
train\_y\_misclass: 0.11523403297225637  
train\_y\_nll: 0.2140596799974099  
train\_y\_row\_norms\_max: 1.992389544512104  
train\_y\_row\_norms\_mean: 0.10825970287044209  
train\_y\_row\_norms\_min: 0.003047828278723377  
training\_seconds\_this\_epoch: 53.238324000001924  
valid\_h0\_col\_norms\_max: 0.7500000000000039  
valid\_h0\_col\_norms\_mean: 0.7442331812232679  
valid\_h0\_col\_norms\_min: 0.7133544933863115  
valid\_h0\_max\_x\_max\_u: 0.7544072328005064  
valid\_h0\_max\_x\_mean\_u: 0.11640526397937442  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.06873407124016882  
valid\_h0\_mean\_x\_mean\_u: 0.005264386643836323  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7544072328005064  
valid\_h0\_range\_x\_mean\_u: 0.11640526397937442  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7779984194837803  
valid\_h0\_row\_norms\_mean: 0.47284823716360375  
valid\_h0\_row\_norms\_min: 0.3958231841440752  
valid\_h1\_col\_norms\_max: 0.7500000000000039  
valid\_h1\_col\_norms\_mean: 0.7485756449725182  
valid\_h1\_col\_norms\_min: 0.719237771836115  
valid\_h1\_max\_x\_max\_u: 0.2615117052015338  
valid\_h1\_max\_x\_mean\_u: 0.057850027125065116  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.07363824554827612  
valid\_h1\_mean\_x\_mean\_u: 0.008988975007157788  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.014394168399213921  
valid\_h1\_min\_x\_mean\_u: 5.785316875070171e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.2603646925625724  
valid\_h1\_range\_x\_mean\_u: 0.05779217395631443  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0754519239448763  
valid\_h1\_row\_norms\_mean: 0.7408856382458692  
valid\_h1\_row\_norms\_min: 0.4595840317932803  
valid\_h2\_col\_norms\_max: 0.7500000000000039  
valid\_h2\_col\_norms\_mean: 0.7495041677255607  
valid\_h2\_col\_norms\_min: 0.7357734322333019  
valid\_h2\_max\_x\_max\_u: 0.4687514954313303  
valid\_h2\_max\_x\_mean\_u: 0.053488168595688515  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.3266632324712448  
valid\_h2\_mean\_x\_mean\_u: 0.01907470371032203

```

valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.1422334455789369
valid_h2_min_x_mean_u: 0.004832592562472279
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.3594733975036469
valid_h2_range_x_mean_u: 0.048655576033216255
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2021288556043122
valid_h2_row_norms_mean: 0.7342211089830921
valid_h2_row_norms_min: 0.33637158288847724
valid_objective: 0.45657501396041567
valid_y_col_norms_max: 2.9580992092997334
valid_y_col_norms_mean: 2.9580992092997334
valid_y_col_norms_min: 2.9580992092997334
valid_y_max_max_class: 0.9931377391054155
valid_y_mean_max_class: 0.9010290833209453
valid_y_min_max_class: 0.6292674726891284
valid_y_misclass: 0.18635672876681492
valid_y_nll: 0.4153579262540329
valid_y_row_norms_max: 1.9923895445120523
valid_y_row_norms_mean: 0.10825970287044391
valid_y_row_norms_min: 0.0030478282787232617
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.088009 seconds
Time this epoch: 52.713271 seconds
Monitoring step:
  Epochs seen: 23
  Batches seen: 36777
  Examples seen: 3677516
  learning_rate: 0.077022999999999937
  momentum: 0.4111111111111159
  total_seconds_last_epoch: 98.23482299999809
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7438582729188427
  train_h0_col_norms_min: 0.7161761886689989
  train_h0_max_x_max_u: 0.7927543835097397
  train_h0_max_x_mean_u: 0.12113986133796317
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.07108953793652345
  train_h0_mean_x_mean_u: 0.005559144702598359
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7927543835097397
  train_h0_range_x_mean_u: 0.12113986133796317
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.8012930335505263
  train_h0_row_norms_mean: 0.4725109024068781
  train_h0_row_norms_min: 0.3988665852693554
  train_h1_col_norms_max: 0.7500000000000068
  train_h1_col_norms_mean: 0.7483952883937497
  train_h1_col_norms_min: 0.7185003603711532
  train_h1_max_x_max_u: 0.2603402429209285

```

train\_h1\_max\_x\_mean\_u: 0.05766803404210756  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.09213367926457626  
train\_h1\_mean\_x\_mean\_u: 0.009739991857754319  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.02293618210078866  
train\_h1\_min\_x\_mean\_u: 0.000148871542824974  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.25860152347960774  
train\_h1\_range\_x\_mean\_u: 0.05751916249928258  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.07257855463799  
train\_h1\_row\_norms\_mean: 0.740895686708565  
train\_h1\_row\_norms\_min: 0.4649850372229722  
train\_h2\_col\_norms\_max: 0.75000000000000068  
train\_h2\_col\_norms\_mean: 0.7493829022404819  
train\_h2\_col\_norms\_min: 0.7454565135925932  
train\_h2\_max\_x\_max\_u: 0.427186771814055  
train\_h2\_max\_x\_mean\_u: 0.050863137852191896  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.3030303287764975  
train\_h2\_mean\_x\_mean\_u: 0.018473241621281156  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.13697585644162252  
train\_h2\_min\_x\_mean\_u: 0.00487565611137336  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.3222820113533811  
train\_h2\_range\_x\_mean\_u: 0.04598748174081854  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2027167468966447  
train\_h2\_row\_norms\_mean: 0.7341165609612137  
train\_h2\_row\_norms\_min: 0.3405979209718517  
train\_objective: 0.2781488721118809  
train\_y\_col\_norms\_max: 2.9966852545811378  
train\_y\_col\_norms\_mean: 2.9966852545811378  
train\_y\_col\_norms\_min: 2.9966852545811378  
train\_y\_max\_max\_class: 0.988019942750802  
train\_y\_mean\_max\_class: 0.9032042762619223  
train\_y\_min\_max\_class: 0.7015505840044581  
train\_y\_misclass: 0.12364596102369102  
train\_y\_nll: 0.22090669967484053  
train\_y\_row\_norms\_max: 2.021824344124711  
train\_y\_row\_norms\_mean: 0.10834949953344454  
train\_y\_row\_norms\_min: 0.002547633251280499  
training\_seconds\_this\_epoch: 52.71327100000176  
valid\_h0\_col\_norms\_max: 0.75000000000000039  
valid\_h0\_col\_norms\_mean: 0.7438582729188251  
valid\_h0\_col\_norms\_min: 0.7161761886690003  
valid\_h0\_max\_x\_max\_u: 0.7383090057410556  
valid\_h0\_max\_x\_mean\_u: 0.11536343218475256  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.06773402574544475  
valid\_h0\_mean\_x\_mean\_u: 0.005119421672173208  
valid\_h0\_mean\_x\_min\_u: 0.0



valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7383090057410556  
valid\_h0\_range\_x\_mean\_u: 0.11536343218475256  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.8012930335505086  
valid\_h0\_row\_norms\_mean: 0.4725109024068902  
valid\_h0\_row\_norms\_min: 0.3988665852693483  
valid\_h1\_col\_norms\_max: 0.7499999999999973  
valid\_h1\_col\_norms\_mean: 0.7483952883937685  
valid\_h1\_col\_norms\_min: 0.7185003603711482  
valid\_h1\_max\_x\_max\_u: 0.24364484152234397  
valid\_h1\_max\_x\_mean\_u: 0.056485007447970415  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.0840162696611864  
valid\_h1\_mean\_x\_mean\_u: 0.00894226180892533  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.01950481634130857  
valid\_h1\_min\_x\_mean\_u: 0.00010460311040485282  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.24244269595263196  
valid\_h1\_range\_x\_mean\_u: 0.05638040433756556  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0725785546379754  
valid\_h1\_row\_norms\_mean: 0.7408956867085461  
valid\_h1\_row\_norms\_min: 0.4649850372229754  
valid\_h2\_col\_norms\_max: 0.7500000000000039  
valid\_h2\_col\_norms\_mean: 0.7493829022404852  
valid\_h2\_col\_norms\_min: 0.7454565135925901  
valid\_h2\_max\_x\_max\_u: 0.41026530743742545  
valid\_h2\_max\_x\_mean\_u: 0.050542407272585306  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.27116374991478304  
valid\_h2\_mean\_x\_mean\_u: 0.01750604945479944  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.10730631009952266  
valid\_h2\_min\_x\_mean\_u: 0.004168472715644309  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.33993987325649516  
valid\_h2\_range\_x\_mean\_u: 0.046373934556940964  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2027167468966933  
valid\_h2\_row\_norms\_mean: 0.7341165609612157  
valid\_h2\_row\_norms\_min: 0.3405979209718447  
valid\_objective: 0.4583289974782696  
valid\_y\_col\_norms\_max: 2.996685254581101  
valid\_y\_col\_norms\_mean: 2.996685254581101  
valid\_y\_col\_norms\_min: 2.9966852545811  
valid\_y\_max\_max\_class: 0.993805032416761  
valid\_y\_mean\_max\_class: 0.9063317401453137  
valid\_y\_min\_max\_class: 0.6460083507164964  
valid\_y\_misclass: 0.18849552541228123  
valid\_y\_nll: 0.42157921066295584

```

valid_y_row_norms_max: 2.021824344124661
valid_y_row_norms_mean: 0.10834949953344138
valid_y_row_norms_min: 0.0025476332512804267
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S0COR10\nn_train.pkl done. Time elapsed: 0.085008 seconds
Time this epoch: 51.300130 seconds
Monitoring step:
  Epochs seen: 24
  Batches seen: 38376
  Examples seen: 3837408
  learning_rate: 0.07602400000000127
  momentum: 0.4070707070707024
  total_seconds_last_epoch: 95.32553100000058
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7439242763702696
  train_h0_col_norms_min: 0.7089506816981771
  train_h0_max_x_max_u: 0.785661110315158
  train_h0_max_x_mean_u: 0.12174683344684283
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.06944749199676391
  train_h0_mean_x_mean_u: 0.005564342796227593
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.0
  train_h0_min_x_mean_u: 0.0
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.785661110315158
  train_h0_range_x_mean_u: 0.12174683344684283
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.8013624844232814
  train_h0_row_norms_mean: 0.4725825993311622
  train_h0_row_norms_min: 0.39704596315468443
  train_h1_col_norms_max: 0.7500000000000068
  train_h1_col_norms_mean: 0.7484913092377613
  train_h1_col_norms_min: 0.7184599481110031
  train_h1_max_x_max_u: 0.2536343884408393
  train_h1_max_x_mean_u: 0.058968404787205046
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.08889872403417347
  train_h1_mean_x_mean_u: 0.010040358773959906
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.023653163410936016
  train_h1_min_x_mean_u: 0.00011661989859370985
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.2518621607133423
  train_h1_range_x_mean_u: 0.05885178488861127
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.0667949671834989
  train_h1_row_norms_mean: 0.7410679891340461
  train_h1_row_norms_min: 0.4698391331237681
  train_h2_col_norms_max: 0.7500000000000068
  train_h2_col_norms_mean: 0.7494789176711146
  train_h2_col_norms_min: 0.7393310085886097
  train_h2_max_x_max_u: 0.45855537726017837
  train_h2_max_x_mean_u: 0.05438971225075231

```

train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.3285796536080849  
train\_h2\_mean\_x\_mean\_u: 0.02047203004636821  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.1533716536223269  
train\_h2\_min\_x\_mean\_u: 0.005381998041428812  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.33588972302185643  
train\_h2\_range\_x\_mean\_u: 0.0490077142093235  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2002611096950027  
train\_h2\_row\_norms\_mean: 0.7342484971107466  
train\_h2\_row\_norms\_min: 0.3405648939933146  
train\_objective: 0.2772616147703241  
train\_y\_col\_norms\_max: 3.0443672188075723  
train\_y\_col\_norms\_mean: 3.0443672188075723  
train\_y\_col\_norms\_min: 3.0443672188075723  
train\_y\_max\_max\_class: 0.9900989326942242  
train\_y\_mean\_max\_class: 0.904124386528342  
train\_y\_min\_max\_class: 0.671198628512919  
train\_y\_misclass: 0.09906687013734271  
train\_y\_nll: 0.19956962130173  
train\_y\_row\_norms\_max: 2.046034559577287  
train\_y\_row\_norms\_mean: 0.11021339240282849  
train\_y\_row\_norms\_min: 0.003087840861372947  
training\_seconds\_this\_epoch: 51.300130000000076  
valid\_h0\_col\_norms\_max: 0.7500000000000039  
valid\_h0\_col\_norms\_mean: 0.7439242763702575  
valid\_h0\_col\_norms\_min: 0.7089506816981918  
valid\_h0\_max\_x\_max\_u: 0.7443643918073304  
valid\_h0\_max\_x\_mean\_u: 0.11566277569663122  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.06475823890553568  
valid\_h0\_mean\_x\_mean\_u: 0.005107149433272144  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7443643918073304  
valid\_h0\_range\_x\_mean\_u: 0.11566277569663122  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.8013624844232932  
valid\_h0\_row\_norms\_mean: 0.4725825993311688  
valid\_h0\_row\_norms\_min: 0.3970459631546761  
valid\_h1\_col\_norms\_max: 0.7499999999999973  
valid\_h1\_col\_norms\_mean: 0.748491309237749  
valid\_h1\_col\_norms\_min: 0.7184599481110099  
valid\_h1\_max\_x\_max\_u: 0.24187161066364848  
valid\_h1\_max\_x\_mean\_u: 0.05770422142641268  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.08046392302228217  
valid\_h1\_mean\_x\_mean\_u: 0.009245407014910629  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.021371164309153704

```

valid_h1_min_x_mean_u: 7.886388295229374e-05
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.24026054270005726
valid_h1_range_x_mean_u: 0.05762535754346038
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.066794967183479
valid_h1_row_norms_mean: 0.7410679891340419
valid_h1_row_norms_min: 0.4698391331237736
valid_h2_col_norms_max: 0.7499999999999973
valid_h2_col_norms_mean: 0.7494789176710928
valid_h2_col_norms_min: 0.7393310085885955
valid_h2_max_x_max_u: 0.4385353666089381
valid_h2_max_x_mean_u: 0.054070525911095
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.2943788676536262
valid_h2_mean_x_mean_u: 0.019577412275825757
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.11611032169164189
valid_h2_min_x_mean_u: 0.004793752601524179
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.35663861544733955
valid_h2_range_x_mean_u: 0.04927677330957081
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2002611096950244
valid_h2_row_norms_mean: 0.7342484971107576
valid_h2_row_norms_min: 0.3405648939933182
valid_objective: 0.4580727127039734
valid_y_col_norms_max: 3.044367218807509
valid_y_col_norms_mean: 3.044367218807509
valid_y_col_norms_min: 3.0443672188075057
valid_y_max_max_class: 0.9931208017048476
valid_y_mean_max_class: 0.9000042007582378
valid_y_min_max_class: 0.6024275288068397
valid_y_misclass: 0.1730736759160241
valid_y_nll: 0.4121718871740726
valid_y_row_norms_max: 2.0460345595772313
valid_y_row_norms_mean: 0.11021339240282567
valid_y_row_norms_min: 0.0030878408613729757
Saving to ..\Sean\nn_files_S0C0R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S0C0R10\nn_train.pkl done. Time elapsed: 0.084009 seconds
Time this epoch: 51.779177 seconds
Monitoring step:
  Epochs seen: 25
  Batches seen: 39975
  Examples seen: 3997300
  learning_rate: 0.07502500000000259
  momentum: 0.4030303030302915
  total_seconds_last_epoch: 93.621362000002
  train_h0_col_norms_max: 0.7500000000000068
  train_h0_col_norms_mean: 0.7434567490188241
  train_h0_col_norms_min: 0.7189833721561782
  train_h0_max_x_max_u: 0.7697909292716846
  train_h0_max_x_mean_u: 0.11847773480726478
  train_h0_max_x_min_u: 0.0

```

train\_h0\_mean\_x\_max\_u: 0.0657367108219789  
train\_h0\_mean\_x\_mean\_u: 0.005394965393800044  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.0  
train\_h0\_min\_x\_mean\_u: 0.0  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.7697909292716846  
train\_h0\_range\_x\_mean\_u: 0.11847773480726478  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.8011307311805299  
train\_h0\_row\_norms\_mean: 0.4723072756942655  
train\_h0\_row\_norms\_min: 0.3890620401488018  
train\_h1\_col\_norms\_max: 0.75000000000000068  
train\_h1\_col\_norms\_mean: 0.7484383354250206  
train\_h1\_col\_norms\_min: 0.7183291691791138  
train\_h1\_max\_x\_max\_u: 0.2505232858068982  
train\_h1\_max\_x\_mean\_u: 0.05423783774004048  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.07246541422841019  
train\_h1\_mean\_x\_mean\_u: 0.008590840643431633  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.015129851385745813  
train\_h1\_min\_x\_mean\_u: 8.983742267697262e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.24814028920427236  
train\_h1\_range\_x\_mean\_u: 0.054148000317363554  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0651576080313572  
train\_h1\_row\_norms\_mean: 0.741108817949437  
train\_h1\_row\_norms\_min: 0.4760120992527468  
train\_h2\_col\_norms\_max: 0.75000000000000068  
train\_h2\_col\_norms\_mean: 0.7494067320472197  
train\_h2\_col\_norms\_min: 0.7298260120056467  
train\_h2\_max\_x\_max\_u: 0.425012678459755  
train\_h2\_max\_x\_mean\_u: 0.04797869505670399  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.31596601648273176  
train\_h2\_mean\_x\_mean\_u: 0.017722849130784098  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.16297315286679762  
train\_h2\_min\_x\_mean\_u: 0.004812946902056258  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.3006630664688959  
train\_h2\_range\_x\_mean\_u: 0.04316574815464773  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2012770489905114  
train\_h2\_row\_norms\_mean: 0.7341642260338841  
train\_h2\_row\_norms\_min: 0.3404454815020706  
train\_objective: 0.27965536374699884  
train\_y\_col\_norms\_max: 3.0767937860247243  
train\_y\_col\_norms\_mean: 3.0767937860247243  
train\_y\_col\_norms\_min: 3.0767937860247243  
train\_y\_max\_max\_class: 0.9882316763896783  
train\_y\_mean\_max\_class: 0.9079638446585924

train\_y\_min\_max\_class: 0.7296585794353896  
train\_y\_misclass: 0.1313011282615767  
train\_y\_nll: 0.23336926296597515  
train\_y\_row\_norms\_max: 2.061993999589551  
train\_y\_row\_norms\_mean: 0.11047698039304507  
train\_y\_row\_norms\_min: 0.0037294142849798127  
training\_seconds\_this\_epoch: 51.779177000000566  
valid\_h0\_col\_norms\_max: 0.7500000000000039  
valid\_h0\_col\_norms\_mean: 0.7434567490187963  
valid\_h0\_col\_norms\_min: 0.7189833721561527  
valid\_h0\_max\_x\_max\_u: 0.7258902527436935  
valid\_h0\_max\_x\_mean\_u: 0.11242867553999356  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.06279467465815204  
valid\_h0\_mean\_x\_mean\_u: 0.004931425204639621  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.0  
valid\_h0\_min\_x\_mean\_u: 0.0  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7258902527436935  
valid\_h0\_range\_x\_mean\_u: 0.11242867553999356  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.801130731180552  
valid\_h0\_row\_norms\_mean: 0.4723072756942792  
valid\_h0\_row\_norms\_min: 0.38906204014880624  
valid\_h1\_col\_norms\_max: 0.7500000000000039  
valid\_h1\_col\_norms\_mean: 0.7484383354250097  
valid\_h1\_col\_norms\_min: 0.71832916917911  
valid\_h1\_max\_x\_max\_u: 0.23137158127554977  
valid\_h1\_max\_x\_mean\_u: 0.053063894499155245  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.0657088520388693  
valid\_h1\_mean\_x\_mean\_u: 0.007733945919986605  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.011634853854297909  
valid\_h1\_min\_x\_mean\_u: 5.348539833382634e-05  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.2304728929853299  
valid\_h1\_range\_x\_mean\_u: 0.05301040910082143  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0651576080313272  
valid\_h1\_row\_norms\_mean: 0.7411088179494156  
valid\_h1\_row\_norms\_min: 0.4760120992527565  
valid\_h2\_col\_norms\_max: 0.7499999999999973  
valid\_h2\_col\_norms\_mean: 0.749406732047237  
valid\_h2\_col\_norms\_min: 0.729826012005634  
valid\_h2\_max\_x\_max\_u: 0.41263890940535597  
valid\_h2\_max\_x\_mean\_u: 0.047670655263404575  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.2872143235381328  
valid\_h2\_mean\_x\_mean\_u: 0.016798114045375703  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.1310359097903845  
valid\_h2\_min\_x\_mean\_u: 0.004180909021760095

```

valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.32057031446333484
valid_h2_range_x_mean_u: 0.043489746241644485
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2012770489905258
valid_h2_row_norms_mean: 0.7341642260339092
valid_h2_row_norms_min: 0.3404454815020703
valid_objective: 0.4616480722811596
valid_y_col_norms_max: 3.076793786024842
valid_y_col_norms_mean: 3.076793786024842
valid_y_col_norms_min: 3.076793786024842
valid_y_max_max_class: 0.9939577902554498
valid_y_mean_max_class: 0.9159298805464702
valid_y_min_max_class: 0.6715294006249511
valid_y_misclass: 0.1919288568694771
valid_y_nll: 0.44848751647910934
valid_y_row_norms_max: 2.061993999589561
valid_y_row_norms_mean: 0.11047698039304596
valid_y_row_norms_min: 0.0037294142849797376
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.073008 seconds
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl...
Saving to ..\Sean\nn_files_SOCOR10\nn_train.pkl done. Time elapsed: 0.091009 seconds

```

## 8.2 S4 C0 R10

In [117]: `run_pylearn(diffs[1])`

Parameter and initial learning rate summary:

```

h0.W: 0.1
h0.b: 0.1
h1.W: 0.1
h1.b: 0.1
h2.W: 0.1
h2.b: 0.1
softmax.b: 0.1
softmax.W: 0.1

```

Compiling `sgd_update`...

Compiling `sgd_update` done. Time elapsed: 0.816082 seconds

compiling `begin_record_entry`...

compiling `begin_record_entry` done. Time elapsed: 0.231023 seconds

Monitored channels:

```

learning_rate
momentum
total_seconds_last_epoch
train_h0_col_norms_max
train_h0_col_norms_mean
train_h0_col_norms_min
train_h0_max_x_max_u
train_h0_max_x_mean_u
train_h0_max_x_min_u
train_h0_mean_x_max_u
train_h0_mean_x_mean_u
train_h0_mean_x_min_u
train_h0_min_x_max_u

```

train\_h0\_min\_x\_mean\_u  
train\_h0\_min\_x\_min\_u  
train\_h0\_range\_x\_max\_u  
train\_h0\_range\_x\_mean\_u  
train\_h0\_range\_x\_min\_u  
train\_h0\_row\_norms\_max  
train\_h0\_row\_norms\_mean  
train\_h0\_row\_norms\_min  
train\_h1\_col\_norms\_max  
train\_h1\_col\_norms\_mean  
train\_h1\_col\_norms\_min  
train\_h1\_max\_x\_max\_u  
train\_h1\_max\_x\_mean\_u  
train\_h1\_max\_x\_min\_u  
train\_h1\_mean\_x\_max\_u  
train\_h1\_mean\_x\_mean\_u  
train\_h1\_mean\_x\_min\_u  
train\_h1\_min\_x\_max\_u  
train\_h1\_min\_x\_mean\_u  
train\_h1\_min\_x\_min\_u  
train\_h1\_range\_x\_max\_u  
train\_h1\_range\_x\_mean\_u  
train\_h1\_range\_x\_min\_u  
train\_h1\_row\_norms\_max  
train\_h1\_row\_norms\_mean  
train\_h1\_row\_norms\_min  
train\_h2\_col\_norms\_max  
train\_h2\_col\_norms\_mean  
train\_h2\_col\_norms\_min  
train\_h2\_max\_x\_max\_u  
train\_h2\_max\_x\_mean\_u  
train\_h2\_max\_x\_min\_u  
train\_h2\_mean\_x\_max\_u  
train\_h2\_mean\_x\_mean\_u  
train\_h2\_mean\_x\_min\_u  
train\_h2\_min\_x\_max\_u  
train\_h2\_min\_x\_mean\_u  
train\_h2\_min\_x\_min\_u  
train\_h2\_range\_x\_max\_u  
train\_h2\_range\_x\_mean\_u  
train\_h2\_range\_x\_min\_u  
train\_h2\_row\_norms\_max  
train\_h2\_row\_norms\_mean  
train\_h2\_row\_norms\_min  
train\_objective  
train\_y\_col\_norms\_max  
train\_y\_col\_norms\_mean  
train\_y\_col\_norms\_min  
train\_y\_max\_max\_class  
train\_y\_mean\_max\_class  
train\_y\_min\_max\_class  
train\_y\_misclass  
train\_y\_nll  
train\_y\_row\_norms\_max



train\_y\_row\_norms\_mean  
train\_y\_row\_norms\_min  
training\_seconds\_this\_epoch  
valid\_h0\_col\_norms\_max  
valid\_h0\_col\_norms\_mean  
valid\_h0\_col\_norms\_min  
valid\_h0\_max\_x\_max\_u  
valid\_h0\_max\_x\_mean\_u  
valid\_h0\_max\_x\_min\_u  
valid\_h0\_mean\_x\_max\_u  
valid\_h0\_mean\_x\_mean\_u  
valid\_h0\_mean\_x\_min\_u  
valid\_h0\_min\_x\_max\_u  
valid\_h0\_min\_x\_mean\_u  
valid\_h0\_min\_x\_min\_u  
valid\_h0\_range\_x\_max\_u  
valid\_h0\_range\_x\_mean\_u  
valid\_h0\_range\_x\_min\_u  
valid\_h0\_row\_norms\_max  
valid\_h0\_row\_norms\_mean  
valid\_h0\_row\_norms\_min  
valid\_h1\_col\_norms\_max  
valid\_h1\_col\_norms\_mean  
valid\_h1\_col\_norms\_min  
valid\_h1\_max\_x\_max\_u  
valid\_h1\_max\_x\_mean\_u  
valid\_h1\_max\_x\_min\_u  
valid\_h1\_mean\_x\_max\_u  
valid\_h1\_mean\_x\_mean\_u  
valid\_h1\_mean\_x\_min\_u  
valid\_h1\_min\_x\_max\_u  
valid\_h1\_min\_x\_mean\_u  
valid\_h1\_min\_x\_min\_u  
valid\_h1\_range\_x\_max\_u  
valid\_h1\_range\_x\_mean\_u  
valid\_h1\_range\_x\_min\_u  
valid\_h1\_row\_norms\_max  
valid\_h1\_row\_norms\_mean  
valid\_h1\_row\_norms\_min  
valid\_h2\_col\_norms\_max  
valid\_h2\_col\_norms\_mean  
valid\_h2\_col\_norms\_min  
valid\_h2\_max\_x\_max\_u  
valid\_h2\_max\_x\_mean\_u  
valid\_h2\_max\_x\_min\_u  
valid\_h2\_mean\_x\_max\_u  
valid\_h2\_mean\_x\_mean\_u  
valid\_h2\_mean\_x\_min\_u  
valid\_h2\_min\_x\_max\_u  
valid\_h2\_min\_x\_mean\_u  
valid\_h2\_min\_x\_min\_u  
valid\_h2\_range\_x\_max\_u  
valid\_h2\_range\_x\_mean\_u  
valid\_h2\_range\_x\_min\_u

```

valid_h2_row_norms_max
valid_h2_row_norms_mean
valid_h2_row_norms_min
valid_objective
valid_y_col_norms_max
valid_y_col_norms_mean
valid_y_col_norms_min
valid_y_max_max_class
valid_y_mean_max_class
valid_y_min_max_class
valid_y_misclass
valid_y_nll
valid_y_row_norms_max
valid_y_row_norms_mean
valid_y_row_norms_min
Compiling accum...
graph size: 268
graph size: 264
Compiling accum done. Time elapsed: 4.018402 seconds
Monitoring step:
  Epochs seen: 0
  Batches seen: 0
  Examples seen: 0
  learning_rate: 0.09999999999999987
  momentum: 0.5000000000000019
  total_seconds_last_epoch: 0.0
  train_h0_col_norms_max: 0.7500000000000207
  train_h0_col_norms_mean: 0.7500000000000207
  train_h0_col_norms_min: 0.7500000000000207
  train_h0_max_x_max_u: 0.49996374735147187
  train_h0_max_x_mean_u: 0.20836989098679792
  train_h0_max_x_min_u: 0.0424562605725093
  train_h0_mean_x_max_u: 0.11260262264620804
  train_h0_mean_x_mean_u: 0.031959756943673735
  train_h0_mean_x_min_u: 0.003777853859718748
  train_h0_min_x_max_u: 0.003670808058009777
  train_h0_min_x_mean_u: 2.823601113346347e-05
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.49986114243756086
  train_h0_range_x_mean_u: 0.20834165497566423
  train_h0_range_x_min_u: 0.0424562605725093
  train_h0_row_norms_max: 0.9473073874924521
  train_h0_row_norms_mean: 0.4511236721700439
  train_h0_row_norms_min: 0.0
  train_h1_col_norms_max: 0.7500000000000207
  train_h1_col_norms_mean: 0.7500000000000207
  train_h1_col_norms_min: 0.7500000000000207
  train_h1_max_x_max_u: 0.27994160094531356
  train_h1_max_x_mean_u: 0.0948816649442611
  train_h1_max_x_min_u: 0.0002443257284802132
  train_h1_mean_x_max_u: 0.08796924937406253
  train_h1_mean_x_mean_u: 0.017830950675419444
  train_h1_mean_x_min_u: 3.4477433718843387e-06
  train_h1_min_x_max_u: 0.014600009377425751

```

train\_h1\_min\_x\_mean\_u: 9.77546870412314e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.27861180546310144  
train\_h1\_range\_x\_mean\_u: 0.09478391025722015  
train\_h1\_range\_x\_min\_u: 0.0002443257284802132  
train\_h1\_row\_norms\_max: 1.1743750618400668  
train\_h1\_row\_norms\_mean: 0.734974396673288  
train\_h1\_row\_norms\_min: 0.301173765244231  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.7500000000000207  
train\_h2\_col\_norms\_min: 0.7500000000000207  
train\_h2\_max\_x\_max\_u: 0.15877418102175822  
train\_h2\_max\_x\_mean\_u: 0.045452689920515564  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.060495230935885526  
train\_h2\_mean\_x\_mean\_u: 0.009803804034695504  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.015457186546619478  
train\_h2\_min\_x\_mean\_u: 0.0001399090899087826  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.15673941219888515  
train\_h2\_range\_x\_mean\_u: 0.04531278083060676  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2131149672179269  
train\_h2\_row\_norms\_mean: 0.733564700615294  
train\_h2\_row\_norms\_min: 0.3075633754711818  
train\_objective: 0.6317578786565131  
train\_y\_col\_norms\_max: 0.0  
train\_y\_col\_norms\_mean: 0.0  
train\_y\_col\_norms\_min: 0.0  
train\_y\_max\_max\_class: 0.6733816738943649  
train\_y\_mean\_max\_class: 0.6733816738943649  
train\_y\_min\_max\_class: 0.6733816738943649  
train\_y\_misclass: 0.32661832610566044  
train\_y\_nll: 0.6317578786565131  
train\_y\_row\_norms\_max: 0.0  
train\_y\_row\_norms\_mean: 0.0  
train\_y\_row\_norms\_min: 0.0  
training\_seconds\_this\_epoch: 0.0  
valid\_h0\_col\_norms\_max: 0.7500000000000004  
valid\_h0\_col\_norms\_mean: 0.7500000000000004  
valid\_h0\_col\_norms\_min: 0.7500000000000004  
valid\_h0\_max\_x\_max\_u: 0.5138982437122787  
valid\_h0\_max\_x\_mean\_u: 0.2170102252459308  
valid\_h0\_max\_x\_min\_u: 0.04681983343795268  
valid\_h0\_mean\_x\_max\_u: 0.1334970915945561  
valid\_h0\_mean\_x\_mean\_u: 0.036153693849097494  
valid\_h0\_mean\_x\_min\_u: 0.004520325971422042  
valid\_h0\_min\_x\_max\_u: 0.010133858648888333  
valid\_h0\_min\_x\_mean\_u: 0.00014503832330670514  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.5132738654221931  
valid\_h0\_range\_x\_mean\_u: 0.21686518692262408  
valid\_h0\_range\_x\_min\_u: 0.04681983343795268

```

valid_h0_row_norms_max: 0.9473073874924951
valid_h0_row_norms_mean: 0.45112367217003374
valid_h0_row_norms_min: 0.0
valid_h1_col_norms_max: 0.7500000000000004
valid_h1_col_norms_mean: 0.7500000000000004
valid_h1_col_norms_min: 0.7500000000000004
valid_h1_max_x_max_u: 0.29127208358306395
valid_h1_max_x_mean_u: 0.09905050308387714
valid_h1_max_x_min_u: 0.00018786990110476295
valid_h1_mean_x_max_u: 0.10065710172758784
valid_h1_mean_x_mean_u: 0.019885891136781682
valid_h1_mean_x_min_u: 2.4641766114262046e-06
valid_h1_min_x_max_u: 0.019764125420032752
valid_h1_min_x_mean_u: 0.00020899496040091968
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.2892820321724959
valid_h1_range_x_mean_u: 0.0988415081234763
valid_h1_range_x_min_u: 0.00018786990110476295
valid_h1_row_norms_max: 1.1743750618400197
valid_h1_row_norms_mean: 0.734974396673312
valid_h1_row_norms_min: 0.30117376524424716
valid_h2_col_norms_max: 0.7500000000000004
valid_h2_col_norms_mean: 0.7500000000000004
valid_h2_col_norms_min: 0.7500000000000004
valid_h2_max_x_max_u: 0.1695247029019572
valid_h2_max_x_mean_u: 0.047619838090091585
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.07212010966998861
valid_h2_mean_x_mean_u: 0.010902505753561985
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.019714178125837516
valid_h2_min_x_mean_u: 0.0002253494454207046
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.16586923571212384
valid_h2_range_x_mean_u: 0.047394488644670905
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.213114967217893
valid_h2_row_norms_mean: 0.7335647006152743
valid_h2_row_norms_min: 0.30756337547117624
valid_objective: 0.6317690750785199
valid_y_col_norms_max: 0.0
valid_y_col_norms_mean: 0.0
valid_y_col_norms_min: 0.0
valid_y_max_max_class: 0.6733816738943385
valid_y_mean_max_class: 0.6733816738943383
valid_y_min_max_class: 0.6733816738943385
valid_y_misclass: 0.32663380103653167
valid_y_nll: 0.6317690750785199
valid_y_row_norms_max: 0.0
valid_y_row_norms_mean: 0.0
valid_y_row_norms_min: 0.0
Saving to ..\Sean\nn_files_S4COR10\nn_train_best.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train_best.pkl done. Time elapsed: 0.040004 seconds
Time this epoch: 0:01:30.064006

```

Monitoring step:

Epochs seen: 1  
Batches seen: 2848  
Examples seen: 284785  
learning\_rate: 0.099000999999999902  
momentum: 0.5000000000000019  
total\_seconds\_last\_epoch: 0.0  
train\_h0\_col\_norms\_max: 0.75000000000000339  
train\_h0\_col\_norms\_mean: 0.74742036543025  
train\_h0\_col\_norms\_min: 0.7330057747152854  
train\_h0\_max\_x\_max\_u: 0.6554212209783655  
train\_h0\_max\_x\_mean\_u: 0.2057579939594349  
train\_h0\_max\_x\_min\_u: 0.004739413745577293  
train\_h0\_mean\_x\_max\_u: 0.2142454338632687  
train\_h0\_mean\_x\_mean\_u: 0.03364897495773422  
train\_h0\_mean\_x\_min\_u: 0.00012436075042940417  
train\_h0\_min\_x\_max\_u: 0.01507081980396168  
train\_h0\_min\_x\_mean\_u: 0.0001612808167335624  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.6517977528052553  
train\_h0\_range\_x\_mean\_u: 0.2055967131427013  
train\_h0\_range\_x\_min\_u: 0.004739413745577293  
train\_h0\_row\_norms\_max: 0.9240261464978111  
train\_h0\_row\_norms\_mean: 0.45486176793598804  
train\_h0\_row\_norms\_min: 0.11571094623334514  
train\_h1\_col\_norms\_max: 0.75000000000000207  
train\_h1\_col\_norms\_mean: 0.7474440732780012  
train\_h1\_col\_norms\_min: 0.7359716294608876  
train\_h1\_max\_x\_max\_u: 0.4070244946074647  
train\_h1\_max\_x\_mean\_u: 0.09223587783618926  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.14628259443637673  
train\_h1\_mean\_x\_mean\_u: 0.017624087628517842  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.021703786514875006  
train\_h1\_min\_x\_mean\_u: 0.00016325510401685368  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.4035930638592525  
train\_h1\_range\_x\_mean\_u: 0.09207262273217255  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1713551156802362  
train\_h1\_row\_norms\_mean: 0.7329459592273979  
train\_h1\_row\_norms\_min: 0.31980715096215806  
train\_h2\_col\_norms\_max: 0.75000000000000207  
train\_h2\_col\_norms\_mean: 0.7489593659043563  
train\_h2\_col\_norms\_min: 0.7405250642949638  
train\_h2\_max\_x\_max\_u: 0.25666704357795966  
train\_h2\_max\_x\_mean\_u: 0.0396661811315935  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.08811384479221408  
train\_h2\_mean\_x\_mean\_u: 0.007871813789968322  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.019918507059528596  
train\_h2\_min\_x\_mean\_u: 0.0002006474044893499

train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.2533271166395761  
train\_h2\_range\_x\_mean\_u: 0.0394655337271042  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2078490963728152  
train\_h2\_row\_norms\_mean: 0.7328108140727944  
train\_h2\_row\_norms\_min: 0.317423092774977  
train\_objective: 0.5453077665110013  
train\_y\_col\_norms\_max: 0.8840292289064676  
train\_y\_col\_norms\_mean: 0.8840292289064676  
train\_y\_col\_norms\_min: 0.8840292289064676  
train\_y\_max\_max\_class: 0.8180882194644515  
train\_y\_mean\_max\_class: 0.771877939765969  
train\_y\_min\_max\_class: 0.6507270398961806  
train\_y\_misclass: 0.29265937461593805  
train\_y\_nll: 0.585012509196021  
train\_y\_row\_norms\_max: 0.19600312306144343  
train\_y\_row\_norms\_mean: 0.0426170821403673  
train\_y\_row\_norms\_min: 0.00020219522479376822  
training\_seconds\_this\_epoch: 90.06400599999586  
valid\_h0\_col\_norms\_max: 0.7500000000000063  
valid\_h0\_col\_norms\_mean: 0.7474203654302664  
valid\_h0\_col\_norms\_min: 0.7330057747153057  
valid\_h0\_max\_x\_max\_u: 0.7113622598965504  
valid\_h0\_max\_x\_mean\_u: 0.22905434324833643  
valid\_h0\_max\_x\_min\_u: 0.010236775473244121  
valid\_h0\_mean\_x\_max\_u: 0.26085877193324053  
valid\_h0\_mean\_x\_mean\_u: 0.041393220691521744  
valid\_h0\_mean\_x\_min\_u: 0.00024120209359569582  
valid\_h0\_min\_x\_max\_u: 0.029100971675509738  
valid\_h0\_min\_x\_mean\_u: 0.0005609042884231941  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7025240763746358  
valid\_h0\_range\_x\_mean\_u: 0.22849343895991323  
valid\_h0\_range\_x\_min\_u: 0.010236775473244121  
valid\_h0\_row\_norms\_max: 0.9240261464977683  
valid\_h0\_row\_norms\_mean: 0.45486176793598976  
valid\_h0\_row\_norms\_min: 0.11571094623334782  
valid\_h1\_col\_norms\_max: 0.7500000000000063  
valid\_h1\_col\_norms\_mean: 0.7474440732780404  
valid\_h1\_col\_norms\_min: 0.7359716294609235  
valid\_h1\_max\_x\_max\_u: 0.4533322659846541  
valid\_h1\_max\_x\_mean\_u: 0.1068866442403133  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.1825082060107647  
valid\_h1\_mean\_x\_mean\_u: 0.022119964053173336  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.027156647658271096  
valid\_h1\_min\_x\_mean\_u: 0.000326819792096514  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.4441123291957381  
valid\_h1\_range\_x\_mean\_u: 0.10655982444821677  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1713551156802413

```

valid_h1_row_norms_mean: 0.7329459592274383
valid_h1_row_norms_min: 0.31980715096216017
valid_h2_col_norms_max: 0.75000000000000063
valid_h2_col_norms_mean: 0.7489593659043259
valid_h2_col_norms_min: 0.7405250642949482
valid_h2_max_x_max_u: 0.29740303938675583
valid_h2_max_x_mean_u: 0.04796346861022421
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.10789872029907066
valid_h2_mean_x_mean_u: 0.009871139260113524
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.02206687991754167
valid_h2_min_x_mean_u: 0.0002567287770524914
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.29146285980025355
valid_h2_range_x_mean_u: 0.04770673983317172
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2078490963728403
valid_h2_row_norms_mean: 0.7328108140727646
valid_h2_row_norms_min: 0.31742309277499936
valid_objective: 0.5055580177830883
valid_y_col_norms_max: 0.8840292289064337
valid_y_col_norms_mean: 0.8840292289064337
valid_y_col_norms_min: 0.8840292289064337
valid_y_max_max_class: 0.8179131247885849
valid_y_mean_max_class: 0.7600436445466887
valid_y_min_max_class: 0.6278023778606872
valid_y_misclass: 0.2730059410946785
valid_y_nll: 0.5490788901067521
valid_y_row_norms_max: 0.19600312306143652
valid_y_row_norms_mean: 0.042617082140368856
valid_y_row_norms_min: 0.00020219522479376163
Saving to ..\Sean\nn_files_S4COR10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.best.pkl done. Time elapsed: 0.052005 seconds
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.048005 seconds
Time this epoch: 0:01:26.376637
Monitoring step:
  Epochs seen: 2
  Batches seen: 5696
  Examples seen: 569570
  learning_rate: 0.09800200000000533
  momentum: 0.49595959595962874
  total_seconds_last_epoch: 164.44244300000176
  train_h0_col_norms_max: 0.7500000000000339
  train_h0_col_norms_mean: 0.7470519224018188
  train_h0_col_norms_min: 0.7282829473688117
  train_h0_max_x_max_u: 0.7172872732207027
  train_h0_max_x_mean_u: 0.20595310713694248
  train_h0_max_x_min_u: 0.0017437995347284324
  train_h0_mean_x_max_u: 0.24497986190097634
  train_h0_mean_x_mean_u: 0.03102496039043049
  train_h0_mean_x_min_u: 3.619184083274231e-05
  train_h0_min_x_max_u: 0.012739139385886479

```

train\_h0\_min\_x\_mean\_u: 0.00012769722829631463  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.7143570783351907  
train\_h0\_range\_x\_mean\_u: 0.20582540990864628  
train\_h0\_range\_x\_min\_u: 0.0017437995347284324  
train\_h0\_row\_norms\_max: 0.9071784611087037  
train\_h0\_row\_norms\_mean: 0.45969594014984244  
train\_h0\_row\_norms\_min: 0.1772825104317686  
train\_h1\_col\_norms\_max: 0.7500000000000207  
train\_h1\_col\_norms\_mean: 0.7473419606388376  
train\_h1\_col\_norms\_min: 0.7349747623889794  
train\_h1\_max\_x\_max\_u: 0.44526224697884076  
train\_h1\_max\_x\_mean\_u: 0.10034323416487448  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.15820571421558202  
train\_h1\_mean\_x\_mean\_u: 0.019406163175165015  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.02455308470228174  
train\_h1\_min\_x\_mean\_u: 0.0002107283620554088  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.4431730731773958  
train\_h1\_range\_x\_mean\_u: 0.10013250580281947  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1895191178294506  
train\_h1\_row\_norms\_mean: 0.733306528860952  
train\_h1\_row\_norms\_min: 0.33889088474530976  
train\_h2\_col\_norms\_max: 0.7500000000000339  
train\_h2\_col\_norms\_mean: 0.7489562936942255  
train\_h2\_col\_norms\_min: 0.7407127906892909  
train\_h2\_max\_x\_max\_u: 0.3996399015415047  
train\_h2\_max\_x\_mean\_u: 0.04629824490260229  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.13592092432390254  
train\_h2\_mean\_x\_mean\_u: 0.010591778134209329  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.017226777863289668  
train\_h2\_min\_x\_mean\_u: 0.0001972428099062844  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.39751089316426996  
train\_h2\_range\_x\_mean\_u: 0.04610100209269595  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2059265846519807  
train\_h2\_row\_norms\_mean: 0.7330493076483727  
train\_h2\_row\_norms\_min: 0.3183414200951975  
train\_objective: 0.5280217495455292  
train\_y\_col\_norms\_max: 1.1545118313969875  
train\_y\_col\_norms\_mean: 1.1545118313969875  
train\_y\_col\_norms\_min: 1.1545118313969875  
train\_y\_max\_max\_class: 0.8601960044055207  
train\_y\_mean\_max\_class: 0.7663281622091002  
train\_y\_min\_max\_class: 0.6167550008827476  
train\_y\_misclass: 0.2766648524325359  
train\_y\_nll: 0.5604991258341901  
train\_y\_row\_norms\_max: 0.26863267872712726



train\_y\_row\_norms\_mean: 0.057292336293243554  
train\_y\_row\_norms\_min: 2.824643650850289e-05  
training\_seconds\_this\_epoch: 86.37663699999558  
valid\_h0\_col\_norms\_max: 0.7500000000000063  
valid\_h0\_col\_norms\_mean: 0.7470519224018048  
valid\_h0\_col\_norms\_min: 0.7282829473687842  
valid\_h0\_max\_x\_max\_u: 0.7774273628597912  
valid\_h0\_max\_x\_mean\_u: 0.2362944933125588  
valid\_h0\_max\_x\_min\_u: 0.002918480689806644  
valid\_h0\_mean\_x\_max\_u: 0.2885231575573438  
valid\_h0\_mean\_x\_mean\_u: 0.0384520471208266  
valid\_h0\_mean\_x\_min\_u: 5.61445710874918e-05  
valid\_h0\_min\_x\_max\_u: 0.026705532540627058  
valid\_h0\_min\_x\_mean\_u: 0.0003514240723420492  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.7708334357560508  
valid\_h0\_range\_x\_mean\_u: 0.2359430692402167  
valid\_h0\_range\_x\_min\_u: 0.002918480689806644  
valid\_h0\_row\_norms\_max: 0.9071784611087378  
valid\_h0\_row\_norms\_mean: 0.4596959401498316  
valid\_h0\_row\_norms\_min: 0.1772825104317777  
valid\_h1\_col\_norms\_max: 0.7500000000000063  
valid\_h1\_col\_norms\_mean: 0.7473419606388744  
valid\_h1\_col\_norms\_min: 0.734974762389023  
valid\_h1\_max\_x\_max\_u: 0.4929258752577254  
valid\_h1\_max\_x\_mean\_u: 0.11928012459594345  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.17636034189608962  
valid\_h1\_mean\_x\_mean\_u: 0.023338800926512745  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.022571432597396388  
valid\_h1\_min\_x\_mean\_u: 0.0002349087583534201  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.4881058013087938  
valid\_h1\_range\_x\_mean\_u: 0.11904521583759002  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1895191178294116  
valid\_h1\_row\_norms\_mean: 0.7333065288609522  
valid\_h1\_row\_norms\_min: 0.3388908847453306  
valid\_h2\_col\_norms\_max: 0.7500000000000063  
valid\_h2\_col\_norms\_mean: 0.7489562936942058  
valid\_h2\_col\_norms\_min: 0.7407127906893166  
valid\_h2\_max\_x\_max\_u: 0.45478042140707253  
valid\_h2\_max\_x\_mean\_u: 0.054473179545300295  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.1535257796906622  
valid\_h2\_mean\_x\_mean\_u: 0.011557581487470272  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.015176072788652021  
valid\_h2\_min\_x\_mean\_u: 0.0001903597526784697  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.4508509224171591  
valid\_h2\_range\_x\_mean\_u: 0.05428281979262181  
valid\_h2\_range\_x\_min\_u: 0.0

```

valid_h2_row_norms_max: 1.2059265846520324
valid_h2_row_norms_mean: 0.7330493076483507
valid_h2_row_norms_min: 0.31834142009518973
valid_objective: 0.4822709249755566
valid_y_col_norms_max: 1.1545118313969822
valid_y_col_norms_mean: 1.1545118313969824
valid_y_col_norms_min: 1.1545118313969822
valid_y_max_max_class: 0.8592840409117782
valid_y_mean_max_class: 0.7594071894554691
valid_y_min_max_class: 0.5977182996915652
valid_y_misclass: 0.25666793072936417
valid_y_nll: 0.5378313450552086
valid_y_row_norms_max: 0.2686326787271431
valid_y_row_norms_mean: 0.057292336293248314
valid_y_row_norms_min: 2.8246436508503304e-05
Saving to ..\Sean\nn_files_S4COR10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.best.pkl done. Time elapsed: 0.050005 seconds
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.053005 seconds
Time this epoch: 0:01:25.853584
Monitoring step:
  Epochs seen: 3
  Batches seen: 8544
  Examples seen: 854355
  learning_rate: 0.09700300000000518
  momentum: 0.49191919191918126
  total_seconds_last_epoch: 158.3628349999967
  train_h0_col_norms_max: 0.7500000000000339
  train_h0_col_norms_mean: 0.7465939974647341
  train_h0_col_norms_min: 0.7322850867614309
  train_h0_max_x_max_u: 0.7801944591126101
  train_h0_max_x_mean_u: 0.2136712316035321
  train_h0_max_x_min_u: 0.0005846875326280958
  train_h0_mean_x_max_u: 0.25149671879084246
  train_h0_mean_x_mean_u: 0.03176183090534029
  train_h0_mean_x_min_u: 1.044961442905923e-05
  train_h0_min_x_max_u: 0.008680637183306705
  train_h0_min_x_mean_u: 0.0001028823582808018
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7780812091261973
  train_h0_range_x_mean_u: 0.21356834924525112
  train_h0_range_x_min_u: 0.0005846875326280958
  train_h0_row_norms_max: 0.8626044224760478
  train_h0_row_norms_mean: 0.46394195262746823
  train_h0_row_norms_min: 0.21077759915613123
  train_h1_col_norms_max: 0.7500000000000207
  train_h1_col_norms_mean: 0.7475783845104215
  train_h1_col_norms_min: 0.7191047635691776
  train_h1_max_x_max_u: 0.49483378064804995
  train_h1_max_x_mean_u: 0.11108573305596467
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.1610879990532505
  train_h1_mean_x_mean_u: 0.021098957822437404
  train_h1_mean_x_min_u: 0.0

```

train\_h1\_min\_x\_max\_u: 0.018838981155838687  
train\_h1\_min\_x\_mean\_u: 0.0001740448546177517  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.4928245198205517  
train\_h1\_range\_x\_mean\_u: 0.11091168820134684  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.19953761632012  
train\_h1\_row\_norms\_mean: 0.7341783241748548  
train\_h1\_row\_norms\_min: 0.3573591763905924  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.7490201046134437  
train\_h2\_col\_norms\_min: 0.7389199558824341  
train\_h2\_max\_x\_max\_u: 0.49599900189653184  
train\_h2\_max\_x\_mean\_u: 0.0545563457210925  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.18174025924759182  
train\_h2\_mean\_x\_mean\_u: 0.01202701502627781  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.018589496454079684  
train\_h2\_min\_x\_mean\_u: 0.00017253713601863982  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.4867535237816223  
train\_h2\_range\_x\_mean\_u: 0.05438380858507391  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2037352563391739  
train\_h2\_row\_norms\_mean: 0.7334370447850758  
train\_h2\_row\_norms\_min: 0.3231549441900972  
train\_objective: 0.5140137191876651  
train\_y\_col\_norms\_max: 1.4680866241906434  
train\_y\_col\_norms\_mean: 1.4680866241906434  
train\_y\_col\_norms\_min: 1.4680866241906434  
train\_y\_max\_max\_class: 0.9082176245577044  
train\_y\_mean\_max\_class: 0.7725313566440681  
train\_y\_min\_max\_class: 0.5821428759428741  
train\_y\_misclass: 0.2645083132889713  
train\_y\_nll: 0.5355323544164455  
train\_y\_row\_norms\_max: 0.4401251721638237  
train\_y\_row\_norms\_mean: 0.07229229250213633  
train\_y\_row\_norms\_min: 0.00023389770571440046  
training\_seconds\_this\_epoch: 85.85358399999593  
valid\_h0\_col\_norms\_max: 0.7500000000000063  
valid\_h0\_col\_norms\_mean: 0.7465939974646899  
valid\_h0\_col\_norms\_min: 0.7322850867614675  
valid\_h0\_max\_x\_max\_u: 0.8556185181270168  
valid\_h0\_max\_x\_mean\_u: 0.2501895746736971  
valid\_h0\_max\_x\_min\_u: 0.0008208267637794913  
valid\_h0\_mean\_x\_max\_u: 0.30729100416360206  
valid\_h0\_mean\_x\_mean\_u: 0.039341775888360436  
valid\_h0\_mean\_x\_min\_u: 2.117977505605467e-05  
valid\_h0\_min\_x\_max\_u: 0.021788478433988075  
valid\_h0\_min\_x\_mean\_u: 0.0002349103541794751  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.848496660468103  
valid\_h0\_range\_x\_mean\_u: 0.24995466431951766

```
valid_h0_range_x_min_u: 0.0008208267637794913
valid_h0_row_norms_max: 0.8626044224760836
valid_h0_row_norms_mean: 0.4639419526274598
valid_h0_row_norms_min: 0.2107775991561165
valid_h1_col_norms_max: 0.75000000000000063
valid_h1_col_norms_mean: 0.747578384510444
valid_h1_col_norms_min: 0.7191047635691328
valid_h1_max_x_max_u: 0.5377714374745158
valid_h1_max_x_mean_u: 0.13389996100033622
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.1792435713442025
valid_h1_mean_x_mean_u: 0.02563705509241869
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.01874309989454536
valid_h1_min_x_mean_u: 0.00022681558081191154
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.5355500198541191
valid_h1_range_x_mean_u: 0.13367314541952438
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.1995376163201004
valid_h1_row_norms_mean: 0.7341783241748753
valid_h1_row_norms_min: 0.3573591763905773
valid_h2_col_norms_max: 0.75000000000000063
valid_h2_col_norms_mean: 0.7490201046134093
valid_h2_col_norms_min: 0.7389199558823921
valid_h2_max_x_max_u: 0.5499582054488866
valid_h2_max_x_mean_u: 0.0644885961288657
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.19191807048050505
valid_h2_mean_x_mean_u: 0.013179786108330383
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.011525143148936011
valid_h2_min_x_mean_u: 0.00017231200421993477
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.5456426771391304
valid_h2_range_x_mean_u: 0.06431628412464578
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2037352563390853
valid_h2_row_norms_mean: 0.7334370447850322
valid_h2_row_norms_min: 0.32315494419007684
valid_objective: 0.48416515055277565
valid_y_col_norms_max: 1.4680866241907218
valid_y_col_norms_mean: 1.4680866241907218
valid_y_col_norms_min: 1.4680866241907218
valid_y_max_max_class: 0.9110528732325418
valid_y_mean_max_class: 0.7667655153284009
valid_y_min_max_class: 0.552538419867187
valid_y_misclass: 0.2350840601693844
valid_y_nll: 0.5350451282809259
valid_y_row_norms_max: 0.4401251721638095
valid_y_row_norms_mean: 0.07229229250213202
valid_y_row_norms_min: 0.00023389770571439537
Saving to ..\Sean\nn_files_S4COR10\nn_train_best.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train_best.pkl done. Time elapsed: 0.057006 seconds
```

Saving to ..\Sean\nn\_files\_S4COR10\nn\_train.pkl...  
Saving to ..\Sean\nn\_files\_S4COR10\nn\_train.pkl done. Time elapsed: 0.058006 seconds  
Time this epoch: 0:01:26.076607  
Monitoring step:

Epochs seen: 4  
Batches seen: 11392  
Examples seen: 1139140  
learning\_rate: 0.09600399999999783  
momentum: 0.487878787878792  
total\_seconds\_last\_epoch: 157.91078900000054  
train\_h0\_col\_norms\_max: 0.7500000000000339  
train\_h0\_col\_norms\_mean: 0.7463247825264971  
train\_h0\_col\_norms\_min: 0.7229377633221497  
train\_h0\_max\_x\_max\_u: 0.8639526091982853  
train\_h0\_max\_x\_mean\_u: 0.21949022921753872  
train\_h0\_max\_x\_min\_u: 0.00022273284174474252  
train\_h0\_mean\_x\_max\_u: 0.31659486069828147  
train\_h0\_mean\_x\_mean\_u: 0.031247312135230257  
train\_h0\_mean\_x\_min\_u: 3.7733570801638563e-06  
train\_h0\_min\_x\_max\_u: 0.015243241371261857  
train\_h0\_min\_x\_mean\_u: 0.00011208518051942646  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.8559813218549417  
train\_h0\_range\_x\_mean\_u: 0.21937814403701927  
train\_h0\_range\_x\_min\_u: 0.00022273284174474252  
train\_h0\_row\_norms\_max: 0.8010591693034969  
train\_h0\_row\_norms\_mean: 0.4673570103576303  
train\_h0\_row\_norms\_min: 0.2602956876126571  
train\_h1\_col\_norms\_max: 0.7500000000000207  
train\_h1\_col\_norms\_mean: 0.7475245951370939  
train\_h1\_col\_norms\_min: 0.730951408752862  
train\_h1\_max\_x\_max\_u: 0.5356795202153262  
train\_h1\_max\_x\_mean\_u: 0.11428125183749331  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.1848341483070085  
train\_h1\_mean\_x\_mean\_u: 0.021207518006619637  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.03118422543507714  
train\_h1\_min\_x\_mean\_u: 0.000223475102129971  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.5316610054023649  
train\_h1\_range\_x\_mean\_u: 0.11405777673536328  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1922525589498623  
train\_h1\_row\_norms\_mean: 0.7349410254415251  
train\_h1\_row\_norms\_min: 0.36196849135397546  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.748935314556749  
train\_h2\_col\_norms\_min: 0.737796812184641  
train\_h2\_max\_x\_max\_u: 0.5208567011963261  
train\_h2\_max\_x\_mean\_u: 0.055570094479488616  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.19327860612656222  
train\_h2\_mean\_x\_mean\_u: 0.01206150137191896

train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.025167175061172893  
train\_h2\_min\_x\_mean\_u: 0.000241082044116062  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.510130812696371  
train\_h2\_range\_x\_mean\_u: 0.05532901243537259  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2008689236124763  
train\_h2\_row\_norms\_mean: 0.7335852190345636  
train\_h2\_row\_norms\_min: 0.3233413562795659  
train\_objective: 0.49714183278018587  
train\_y\_col\_norms\_max: 1.7110376107953778  
train\_y\_col\_norms\_mean: 1.7110376107953778  
train\_y\_col\_norms\_min: 1.7110376107953778  
train\_y\_max\_max\_class: 0.9219821695106736  
train\_y\_mean\_max\_class: 0.7631723729953456  
train\_y\_min\_max\_class: 0.5538296903575458  
train\_y\_misclass: 0.26323015608265893  
train\_y\_nll: 0.5245246872347968  
train\_y\_row\_norms\_max: 0.6224836912985632  
train\_y\_row\_norms\_mean: 0.0823482642161231  
train\_y\_row\_norms\_min: 0.00012159453098850794  
training\_seconds\_this\_epoch: 86.07660699999687  
valid\_h0\_col\_norms\_max: 0.7500000000000063  
valid\_h0\_col\_norms\_mean: 0.7463247825264555  
valid\_h0\_col\_norms\_min: 0.7229377633221844  
valid\_h0\_max\_x\_max\_u: 0.9399802756784965  
valid\_h0\_max\_x\_mean\_u: 0.261822364293022  
valid\_h0\_max\_x\_min\_u: 0.00019777388974442884  
valid\_h0\_mean\_x\_max\_u: 0.3926013925577565  
valid\_h0\_mean\_x\_mean\_u: 0.03941079980504892  
valid\_h0\_mean\_x\_min\_u: 2.9084336714886417e-06  
valid\_h0\_min\_x\_max\_u: 0.03588553195860485  
valid\_h0\_min\_x\_mean\_u: 0.00022828030924109625  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.922354549703321  
valid\_h0\_range\_x\_mean\_u: 0.261594083983781  
valid\_h0\_range\_x\_min\_u: 0.00019777388974442884  
valid\_h0\_row\_norms\_max: 0.8010591693035115  
valid\_h0\_row\_norms\_mean: 0.4673570103576646  
valid\_h0\_row\_norms\_min: 0.2602956876126662  
valid\_h1\_col\_norms\_max: 0.7500000000000063  
valid\_h1\_col\_norms\_mean: 0.7475245951371009  
valid\_h1\_col\_norms\_min: 0.7309514087528757  
valid\_h1\_max\_x\_max\_u: 0.5845920435675086  
valid\_h1\_max\_x\_mean\_u: 0.14120853993273086  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.21086569383487383  
valid\_h1\_mean\_x\_mean\_u: 0.0262330436121935  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.027950369500344293  
valid\_h1\_min\_x\_mean\_u: 0.00025771354177137013  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.5812333387827482

```

valid_h1_range_x_mean_u: 0.14095082639095952
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.1922525589498565
valid_h1_row_norms_mean: 0.7349410254415609
valid_h1_row_norms_min: 0.3619684913539845
valid_h2_col_norms_max: 0.75000000000000063
valid_h2_col_norms_mean: 0.7489353145567232
valid_h2_col_norms_min: 0.7377968121846006
valid_h2_max_x_max_u: 0.561044809163169
valid_h2_max_x_mean_u: 0.06528313875376594
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.18724016043788863
valid_h2_mean_x_mean_u: 0.012304567773526382
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.010737211321033004
valid_h2_min_x_mean_u: 0.00011722447183498157
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.5590216993340695
valid_h2_range_x_mean_u: 0.06516591428193096
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2008689236124503
valid_h2_row_norms_mean: 0.733585219034597
valid_h2_row_norms_min: 0.323341356279582
valid_objective: 0.513204872182757
valid_y_col_norms_max: 1.711037610795325
valid_y_col_norms_mean: 1.711037610795325
valid_y_col_norms_min: 1.711037610795325
valid_y_max_max_class: 0.9243581422019084
valid_y_mean_max_class: 0.7635059211189804
valid_y_min_max_class: 0.5395380230203585
valid_y_misclass: 0.28223359878649995
valid_y_nll: 0.5626082954512012
valid_y_row_norms_max: 0.6224836912985475
valid_y_row_norms_mean: 0.08234826421612577
valid_y_row_norms_min: 0.00012159453098851023
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.056006 seconds
Time this epoch: 0:01:27.833782
Monitoring step:
  Epochs seen: 5
  Batches seen: 14240
  Examples seen: 1423925
  learning_rate: 0.09500499999999758
  momentum: 0.4838383838384007
  total_seconds_last_epoch: 157.8747860000005
  train_h0_col_norms_max: 0.7500000000000339
  train_h0_col_norms_mean: 0.7459231342296644
  train_h0_col_norms_min: 0.7165288897112175
  train_h0_max_x_max_u: 0.8180935272810229
  train_h0_max_x_mean_u: 0.2228115103851227
  train_h0_max_x_min_u: 0.00017032968361182008
  train_h0_mean_x_max_u: 0.2407784310280728
  train_h0_mean_x_mean_u: 0.029621710654678304
  train_h0_mean_x_min_u: 2.5457120928892705e-06

```

train\_h0\_min\_x\_max\_u: 0.005366595467826744  
train\_h0\_min\_x\_mean\_u: 6.637805828499607e-05  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.8173100765324527  
train\_h0\_range\_x\_mean\_u: 0.2227451323268377  
train\_h0\_range\_x\_min\_u: 0.00017032968361182008  
train\_h0\_row\_norms\_max: 0.7937918923912487  
train\_h0\_row\_norms\_mean: 0.46971500598774907  
train\_h0\_row\_norms\_min: 0.2936935794210055  
train\_h1\_col\_norms\_max: 0.7500000000000207  
train\_h1\_col\_norms\_mean: 0.7476923943414003  
train\_h1\_col\_norms\_min: 0.7339682629581227  
train\_h1\_max\_x\_max\_u: 0.5478554497510298  
train\_h1\_max\_x\_mean\_u: 0.1149869464456478  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.18360874811606742  
train\_h1\_mean\_x\_mean\_u: 0.02013570983909258  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.016630985865798354  
train\_h1\_min\_x\_mean\_u: 0.0001277351851994451  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.5455103228832244  
train\_h1\_range\_x\_mean\_u: 0.1148592112604484  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1972679899753844  
train\_h1\_row\_norms\_mean: 0.7358692206810211  
train\_h1\_row\_norms\_min: 0.39617044480980784  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.7490703950740132  
train\_h2\_col\_norms\_min: 0.7393016378208571  
train\_h2\_max\_x\_max\_u: 0.5373569676814874  
train\_h2\_max\_x\_mean\_u: 0.05644505679215218  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2246110596033073  
train\_h2\_mean\_x\_mean\_u: 0.011942614225116274  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.044375785089612325  
train\_h2\_min\_x\_mean\_u: 0.00037694431388819103  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5104537756957932  
train\_h2\_range\_x\_mean\_u: 0.056068112478264015  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.194510311126826  
train\_h2\_row\_norms\_mean: 0.7339777463641343  
train\_h2\_row\_norms\_min: 0.3315888470238449  
train\_objective: 0.4875693602441163  
train\_y\_col\_norms\_max: 1.9515299518230702  
train\_y\_col\_norms\_mean: 1.9515299518230702  
train\_y\_col\_norms\_min: 1.9515299518230702  
train\_y\_max\_max\_class: 0.9424859338450746  
train\_y\_mean\_max\_class: 0.7930897590703067  
train\_y\_min\_max\_class: 0.5823166332427  
train\_y\_misclass: 0.25452885510121676  
train\_y\_nll: 0.4968703340317142



train\_y\_row\_norms\_max: 0.7634642442680695  
train\_y\_row\_norms\_mean: 0.09341725981722965  
train\_y\_row\_norms\_min: 0.0003094260524659409  
training\_seconds\_this\_epoch: 87.83378199999791  
valid\_h0\_col\_norms\_max: 0.7500000000000064  
valid\_h0\_col\_norms\_mean: 0.7459231342296978  
valid\_h0\_col\_norms\_min: 0.7165288897112266  
valid\_h0\_max\_x\_max\_u: 0.870656096966537  
valid\_h0\_max\_x\_mean\_u: 0.2669189060754224  
valid\_h0\_max\_x\_min\_u: 0.00031495323334924924  
valid\_h0\_mean\_x\_max\_u: 0.28572516817393295  
valid\_h0\_mean\_x\_mean\_u: 0.037439348233849465  
valid\_h0\_mean\_x\_min\_u: 3.8092335253205163e-06  
valid\_h0\_min\_x\_max\_u: 0.013542493478874228  
valid\_h0\_min\_x\_mean\_u: 0.00010510239001530607  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.8688075423362309  
valid\_h0\_range\_x\_mean\_u: 0.26681380368540714  
valid\_h0\_range\_x\_min\_u: 0.00031495323334924924  
valid\_h0\_row\_norms\_max: 0.7937918923912288  
valid\_h0\_row\_norms\_mean: 0.46971500598773147  
valid\_h0\_row\_norms\_min: 0.2936935794209999  
valid\_h1\_col\_norms\_max: 0.7500000000000063  
valid\_h1\_col\_norms\_mean: 0.7476923943414341  
valid\_h1\_col\_norms\_min: 0.7339682629581344  
valid\_h1\_max\_x\_max\_u: 0.5995703070168171  
valid\_h1\_max\_x\_mean\_u: 0.14191991804396947  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.1966536920554735  
valid\_h1\_mean\_x\_mean\_u: 0.024618251856896547  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.012515742546746558  
valid\_h1\_min\_x\_mean\_u: 0.0001563093984854913  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.5980605883547488  
valid\_h1\_range\_x\_mean\_u: 0.141763608645484  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.197267989975413  
valid\_h1\_row\_norms\_mean: 0.7358692206810127  
valid\_h1\_row\_norms\_min: 0.3961704448098126  
valid\_h2\_col\_norms\_max: 0.7500000000000063  
valid\_h2\_col\_norms\_mean: 0.7490703950739939  
valid\_h2\_col\_norms\_min: 0.7393016378208833  
valid\_h2\_max\_x\_max\_u: 0.5667989746493458  
valid\_h2\_max\_x\_mean\_u: 0.06641243871162202  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.21700504496474818  
valid\_h2\_mean\_x\_mean\_u: 0.01223938271837437  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.021612198210586755  
valid\_h2\_min\_x\_mean\_u: 0.00017728704953968788  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.5549345202097187  
valid\_h2\_range\_x\_mean\_u: 0.06623515166208234

```

valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.1945103111268673
valid_h2_row_norms_mean: 0.7339777463641097
valid_h2_row_norms_min: 0.3315888470238396
valid_objective: 0.5104571479188496
valid_y_col_norms_max: 1.9515299518230735
valid_y_col_norms_mean: 1.9515299518230735
valid_y_col_norms_min: 1.9515299518230735
valid_y_max_max_class: 0.944322968181406
valid_y_mean_max_class: 0.7791281521371938
valid_y_min_max_class: 0.5456642666765985
valid_y_misclass: 0.26121855644039943
valid_y_nll: 0.5390407427183196
valid_y_row_norms_max: 0.7634642442680863
valid_y_row_norms_mean: 0.09341725981722901
valid_y_row_norms_min: 0.00030942605246593645
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.052005 seconds
Time this epoch: 0:01:27.611760
Monitoring step:
  Epochs seen: 6
  Batches seen: 17088
  Examples seen: 1708710
  learning_rate: 0.0940060000000037
  momentum: 0.47979797979797955
  total_seconds_last_epoch: 160.4750459999924
  train_h0_col_norms_max: 0.7500000000000339
  train_h0_col_norms_mean: 0.7454527983926748
  train_h0_col_norms_min: 0.7251626705897914
  train_h0_max_x_max_u: 0.8687974423453491
  train_h0_max_x_mean_u: 0.22682198441096174
  train_h0_max_x_min_u: 9.586088888307033e-05
  train_h0_mean_x_max_u: 0.25380164497808344
  train_h0_mean_x_mean_u: 0.02941544752045989
  train_h0_mean_x_min_u: 1.4865423851132434e-06
  train_h0_min_x_max_u: 0.006486545815951115
  train_h0_min_x_mean_u: 6.542296853586403e-05
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.8678709183641932
  train_h0_range_x_mean_u: 0.226756561442426
  train_h0_range_x_min_u: 9.586088888307033e-05
  train_h0_row_norms_max: 0.7837669306275928
  train_h0_row_norms_mean: 0.47116991081248194
  train_h0_row_norms_min: 0.3178502399307988
  train_h1_col_norms_max: 0.7500000000000339
  train_h1_col_norms_mean: 0.7474388994616886
  train_h1_col_norms_min: 0.7270514873223527
  train_h1_max_x_max_u: 0.5961376819424672
  train_h1_max_x_mean_u: 0.11571489446830983
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.1903483487663682
  train_h1_mean_x_mean_u: 0.020320261413927256
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.023918360317376985

```

train\_h1\_min\_x\_mean\_u: 0.0001486105531566416  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.594533737080392  
train\_h1\_range\_x\_mean\_u: 0.11556628391515295  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1891330427201283  
train\_h1\_row\_norms\_mean: 0.7363277605334456  
train\_h1\_row\_norms\_min: 0.3985292140701089  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.7488549225854089  
train\_h2\_col\_norms\_min: 0.7389507164384471  
train\_h2\_max\_x\_max\_u: 0.5290383298693833  
train\_h2\_max\_x\_mean\_u: 0.05377907032238167  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2103007929118808  
train\_h2\_mean\_x\_mean\_u: 0.011813314387456822  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.03860270553194562  
train\_h2\_min\_x\_mean\_u: 0.0003647527992762151  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5074254361928282  
train\_h2\_range\_x\_mean\_u: 0.0534143175231055  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1932927027971887  
train\_h2\_row\_norms\_mean: 0.7340970457946504  
train\_h2\_row\_norms\_min: 0.32447973790761603  
train\_objective: 0.48184037954002706  
train\_y\_col\_norms\_max: 2.145242893464322  
train\_y\_col\_norms\_mean: 2.145242893464322  
train\_y\_col\_norms\_min: 2.145242893464322  
train\_y\_max\_max\_class: 0.9243747803043704  
train\_y\_mean\_max\_class: 0.7401240017854435  
train\_y\_min\_max\_class: 0.5347069383457695  
train\_y\_misclass: 0.23898730621345923  
train\_y\_nll: 0.4906373295722344  
train\_y\_row\_norms\_max: 0.8448427993888294  
train\_y\_row\_norms\_mean: 0.10100137263630322  
train\_y\_row\_norms\_min: 0.0002313144379518407  
training\_seconds\_this\_epoch: 87.6117599999966  
valid\_h0\_col\_norms\_max: 0.7500000000000063  
valid\_h0\_col\_norms\_mean: 0.7454527983926404  
valid\_h0\_col\_norms\_min: 0.7251626705897725  
valid\_h0\_max\_x\_max\_u: 0.9321416135178624  
valid\_h0\_max\_x\_mean\_u: 0.2736681273439752  
valid\_h0\_max\_x\_min\_u: 0.0001830100583314356  
valid\_h0\_mean\_x\_max\_u: 0.306629361438281  
valid\_h0\_mean\_x\_mean\_u: 0.03759301117173608  
valid\_h0\_mean\_x\_min\_u: 2.3147491299745875e-06  
valid\_h0\_min\_x\_max\_u: 0.016492583144053063  
valid\_h0\_min\_x\_mean\_u: 0.00012552809561761059  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.928391642650319  
valid\_h0\_range\_x\_mean\_u: 0.2735425992483576  
valid\_h0\_range\_x\_min\_u: 0.0001830100583314356

```
valid_h0_row_norms_max: 0.7837669306275707
valid_h0_row_norms_mean: 0.47116991081250276
valid_h0_row_norms_min: 0.31785023993078604
valid_h1_col_norms_max: 0.75000000000000063
valid_h1_col_norms_mean: 0.7474388994617318
valid_h1_col_norms_min: 0.7270514873223614
valid_h1_max_x_max_u: 0.6736196570564965
valid_h1_max_x_mean_u: 0.14583143324948633
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.22724599281182306
valid_h1_mean_x_mean_u: 0.025652393648622304
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.022593964782774693
valid_h1_min_x_mean_u: 0.00020004110016001123
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.6709532805385621
valid_h1_range_x_mean_u: 0.14563139214932627
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.1891330427201035
valid_h1_row_norms_mean: 0.7363277605334161
valid_h1_row_norms_min: 0.39852921407013425
valid_h2_col_norms_max: 0.7500000000000004
valid_h2_col_norms_mean: 0.7488549225853691
valid_h2_col_norms_min: 0.7389507164384223
valid_h2_max_x_max_u: 0.5743266853979051
valid_h2_max_x_mean_u: 0.06384713160271202
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.20538588779111155
valid_h2_mean_x_mean_u: 0.011596654316094473
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.015655830968283706
valid_h2_min_x_mean_u: 0.00013580768419345905
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.5685569546639796
valid_h2_range_x_mean_u: 0.06371132391851858
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.1932927027972442
valid_h2_row_norms_mean: 0.7340970457946459
valid_h2_row_norms_min: 0.32447973790762014
valid_objective: 0.530056764488611
valid_y_col_norms_max: 2.1452428934642294
valid_y_col_norms_mean: 2.1452428934642294
valid_y_col_norms_min: 2.145242893464229
valid_y_max_max_class: 0.9254365738834888
valid_y_mean_max_class: 0.7417560395466296
valid_y_min_max_class: 0.5232555890249155
valid_y_misclass: 0.2855201618000252
valid_y_nll: 0.5553005079810065
valid_y_row_norms_max: 0.8448427993888735
valid_y_row_norms_mean: 0.10100137263630164
valid_y_row_norms_min: 0.00023131443795184088
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.057006 seconds
Time this epoch: 0:01:27.743934
```

Monitoring step:

Epochs seen: 7  
Batches seen: 19936  
Examples seen: 1993495  
learning\_rate: 0.09300700000000321  
momentum: 0.47575757575755995  
total\_seconds\_last\_epoch: 161.02910100000764  
train\_h0\_col\_norms\_max: 0.7500000000000339  
train\_h0\_col\_norms\_mean: 0.7453040133901326  
train\_h0\_col\_norms\_min: 0.7193679536695652  
train\_h0\_max\_x\_max\_u: 0.9250462342653561  
train\_h0\_max\_x\_mean\_u: 0.23127664948119725  
train\_h0\_max\_x\_min\_u: 8.561553440876302e-05  
train\_h0\_mean\_x\_max\_u: 0.2766730616081867  
train\_h0\_mean\_x\_mean\_u: 0.02926848044222095  
train\_h0\_mean\_x\_min\_u: 1.3960872258630503e-06  
train\_h0\_min\_x\_max\_u: 0.005841401390673041  
train\_h0\_min\_x\_mean\_u: 6.702940821791775e-05  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.9223220975915387  
train\_h0\_range\_x\_mean\_u: 0.2312096200729792  
train\_h0\_range\_x\_min\_u: 8.561553440876302e-05  
train\_h0\_row\_norms\_max: 0.7305124022650156  
train\_h0\_row\_norms\_mean: 0.472292611207113  
train\_h0\_row\_norms\_min: 0.3350724403877779  
train\_h1\_col\_norms\_max: 0.7500000000000207  
train\_h1\_col\_norms\_mean: 0.7474773225657522  
train\_h1\_col\_norms\_min: 0.7269183523501194  
train\_h1\_max\_x\_max\_u: 0.6468810957624376  
train\_h1\_max\_x\_mean\_u: 0.1192159839408468  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.19305182258464249  
train\_h1\_mean\_x\_mean\_u: 0.02111787003712542  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.011663895900725852  
train\_h1\_min\_x\_mean\_u: 0.00012169664907241463  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6454569399984545  
train\_h1\_range\_x\_mean\_u: 0.11909428729177425  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.172896502293099  
train\_h1\_row\_norms\_mean: 0.7371629644389947  
train\_h1\_row\_norms\_min: 0.4002847617503633  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.7489836318751054  
train\_h2\_col\_norms\_min: 0.7373698527392415  
train\_h2\_max\_x\_max\_u: 0.5689386091200387  
train\_h2\_max\_x\_mean\_u: 0.05583515037843752  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.22201982085502814  
train\_h2\_mean\_x\_mean\_u: 0.01224822626382299  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.03609748591479932  
train\_h2\_min\_x\_mean\_u: 0.0004580425623098684

train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5430865138894778  
train\_h2\_range\_x\_mean\_u: 0.05537710781612758  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1915780539293626  
train\_h2\_row\_norms\_mean: 0.7344912678224681  
train\_h2\_row\_norms\_min: 0.3227514029212291  
train\_objective: 0.46327530602241856  
train\_y\_col\_norms\_max: 2.3240046904016984  
train\_y\_col\_norms\_mean: 2.3240046904016984  
train\_y\_col\_norms\_min: 2.3240046904016984  
train\_y\_max\_max\_class: 0.9475079116561469  
train\_y\_mean\_max\_class: 0.7839577980487333  
train\_y\_min\_max\_class: 0.5653104276651927  
train\_y\_misclass: 0.23757922643397647  
train\_y\_nll: 0.46709388819669206  
train\_y\_row\_norms\_max: 0.9111786096463317  
train\_y\_row\_norms\_mean: 0.10789077954792434  
train\_y\_row\_norms\_min: 0.0008018738323649881  
training\_seconds\_this\_epoch: 87.743933999999418  
valid\_h0\_col\_norms\_max: 0.75000000000000063  
valid\_h0\_col\_norms\_mean: 0.7453040133901058  
valid\_h0\_col\_norms\_min: 0.7193679536695673  
valid\_h0\_max\_x\_max\_u: 0.9965522435107842  
valid\_h0\_max\_x\_mean\_u: 0.279925944524294  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.3357312895536656  
valid\_h0\_mean\_x\_mean\_u: 0.03752548157561463  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.01076626468139273  
valid\_h0\_min\_x\_mean\_u: 8.680008642518675e-05  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.9937426294877792  
valid\_h0\_range\_x\_mean\_u: 0.2798391444378687  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7305124022649971  
valid\_h0\_row\_norms\_mean: 0.47229261120709065  
valid\_h0\_row\_norms\_min: 0.3350724403877862  
valid\_h1\_col\_norms\_max: 0.75000000000000063  
valid\_h1\_col\_norms\_mean: 0.7474773225657083  
valid\_h1\_col\_norms\_min: 0.7269183523501147  
valid\_h1\_max\_x\_max\_u: 0.7329230227126065  
valid\_h1\_max\_x\_mean\_u: 0.15011474037124356  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.22377945234883057  
valid\_h1\_mean\_x\_mean\_u: 0.026362069849903812  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.008718594899294283  
valid\_h1\_min\_x\_mean\_u: 0.00016938752879718476  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.7302110695595014  
valid\_h1\_range\_x\_mean\_u: 0.1499453528424464  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1728965022931372

```

valid_h1_row_norms_mean: 0.7371629644389837
valid_h1_row_norms_min: 0.40028476175035577
valid_h2_col_norms_max: 0.75000000000000063
valid_h2_col_norms_mean: 0.748983631875102
valid_h2_col_norms_min: 0.7373698527392673
valid_h2_max_x_max_u: 0.6032998290113643
valid_h2_max_x_mean_u: 0.06618713261754863
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.21381322670671668
valid_h2_mean_x_mean_u: 0.012153180064660572
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.012419015820316447
valid_h2_min_x_mean_u: 0.00012814248781209262
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.5966197238229751
valid_h2_range_x_mean_u: 0.06605899012973653
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.1915780539293521
valid_h2_row_norms_mean: 0.7344912678224689
valid_h2_row_norms_min: 0.322751402921244
valid_objective: 0.5105794952996168
valid_y_col_norms_max: 2.324004690401603
valid_y_col_norms_mean: 2.324004690401603
valid_y_col_norms_min: 2.324004690401603
valid_y_max_max_class: 0.9525355429524962
valid_y_mean_max_class: 0.772382049906733
valid_y_min_max_class: 0.5324141770958976
valid_y_misclass: 0.2666224244722539
valid_y_nll: 0.5410776846692865
valid_y_row_norms_max: 0.9111786096462731
valid_y_row_norms_mean: 0.10789077954792052
valid_y_row_norms_min: 0.0008018738323650223
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.064007 seconds
Time this epoch: 0:01:28.378837
Monitoring step:
  Epochs seen: 8
  Batches seen: 22784
  Examples seen: 2278280
  learning_rate: 0.092007999999999645
  momentum: 0.471717171717171901
  total_seconds_last_epoch: 161.348703000000364
  train_h0_col_norms_max: 0.75000000000000339
  train_h0_col_norms_mean: 0.7444734141455476
  train_h0_col_norms_min: 0.7108698607911356
  train_h0_max_x_max_u: 0.9067368709843308
  train_h0_max_x_mean_u: 0.23141954153838798
  train_h0_max_x_min_u: 5.258086628925872e-05
  train_h0_mean_x_max_u: 0.2579780245223751
  train_h0_mean_x_mean_u: 0.027577902945228907
  train_h0_mean_x_min_u: 1.08016710885889e-06
  train_h0_min_x_max_u: 0.004721243214146236
  train_h0_min_x_mean_u: 4.564907624851754e-05
  train_h0_min_x_min_u: 0.0

```

train\_h0\_range\_x\_max\_u: 0.9050848639931107  
train\_h0\_range\_x\_mean\_u: 0.23137389246213938  
train\_h0\_range\_x\_min\_u: 5.258086628925872e-05  
train\_h0\_row\_norms\_max: 0.6935441876434743  
train\_h0\_row\_norms\_mean: 0.4725983793857089  
train\_h0\_row\_norms\_min: 0.3597249478493504  
train\_h1\_col\_norms\_max: 0.7500000000000207  
train\_h1\_col\_norms\_mean: 0.7474355518891244  
train\_h1\_col\_norms\_min: 0.7341410263097247  
train\_h1\_max\_x\_max\_u: 0.6176404165020182  
train\_h1\_max\_x\_mean\_u: 0.1124150748255764  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.1775898176083577  
train\_h1\_mean\_x\_mean\_u: 0.01813298734912681  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.005984708532987074  
train\_h1\_min\_x\_mean\_u: 6.192989709462773e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6165737827165627  
train\_h1\_range\_x\_mean\_u: 0.1123531449284817  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.150184537315186  
train\_h1\_row\_norms\_mean: 0.7379303104140148  
train\_h1\_row\_norms\_min: 0.3994891025898209  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.7489822379511085  
train\_h2\_col\_norms\_min: 0.7378286913623415  
train\_h2\_max\_x\_max\_u: 0.5467293618565302  
train\_h2\_max\_x\_mean\_u: 0.05512706863687103  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.23809302750332445  
train\_h2\_mean\_x\_mean\_u: 0.012370508510134813  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.055112747660575334  
train\_h2\_min\_x\_mean\_u: 0.000609890915569209  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5111040713506455  
train\_h2\_range\_x\_mean\_u: 0.054517177721301886  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1914352110830164  
train\_h2\_row\_norms\_mean: 0.7346838526228133  
train\_h2\_row\_norms\_min: 0.343321867350737  
train\_objective: 0.4564765916052559  
train\_y\_col\_norms\_max: 2.4613979984527865  
train\_y\_col\_norms\_mean: 2.4613979984527865  
train\_y\_col\_norms\_min: 2.4613979984527865  
train\_y\_max\_max\_class: 0.9535268482232736  
train\_y\_mean\_max\_class: 0.7843158590691882  
train\_y\_min\_max\_class: 0.5567992884923776  
train\_y\_misclass: 0.23619923802166545  
train\_y\_nll: 0.45899507119018484  
train\_y\_row\_norms\_max: 0.942711124444789  
train\_y\_row\_norms\_mean: 0.11443887251057039  
train\_y\_row\_norms\_min: 0.00021779421500705957



training\_seconds\_this\_epoch: 88.37883699999487  
valid\_h0\_col\_norms\_max: 0.7500000000000063  
valid\_h0\_col\_norms\_mean: 0.7444734141455746  
valid\_h0\_col\_norms\_min: 0.7108698607911529  
valid\_h0\_max\_x\_max\_u: 0.9833667527226015  
valid\_h0\_max\_x\_mean\_u: 0.28067750438320366  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.32010684131918515  
valid\_h0\_mean\_x\_mean\_u: 0.03529858193688634  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.010949443995571047  
valid\_h0\_min\_x\_mean\_u: 5.0569355542785415e-05  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.9814625893766036  
valid\_h0\_range\_x\_mean\_u: 0.28062693502766084  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6935441876434456  
valid\_h0\_row\_norms\_mean: 0.4725983793857377  
valid\_h0\_row\_norms\_min: 0.35972494784937387  
valid\_h1\_col\_norms\_max: 0.7500000000000063  
valid\_h1\_col\_norms\_mean: 0.7474355518890766  
valid\_h1\_col\_norms\_min: 0.7341410263097274  
valid\_h1\_max\_x\_max\_u: 0.688375689555121  
valid\_h1\_max\_x\_mean\_u: 0.1433568846268978  
valid\_h1\_max\_x\_min\_u: 0.0  
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valid\_h1\_mean\_x\_min\_u: 0.0  
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valid\_h1\_min\_x\_mean\_u: 0.00010549965490487007  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.6866662171860969  
valid\_h1\_range\_x\_mean\_u: 0.14325138497199297  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1501845373152473  
valid\_h1\_row\_norms\_mean: 0.73793031041405  
valid\_h1\_row\_norms\_min: 0.3994891025898079  
valid\_h2\_col\_norms\_max: 0.7500000000000004  
valid\_h2\_col\_norms\_mean: 0.7489822379510952  
valid\_h2\_col\_norms\_min: 0.737828691362295  
valid\_h2\_max\_x\_max\_u: 0.5761677644592615  
valid\_h2\_max\_x\_mean\_u: 0.06623259463701073  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.21406254411892714  
valid\_h2\_mean\_x\_mean\_u: 0.012063137719260063  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.018646700347893133  
valid\_h2\_min\_x\_mean\_u: 0.00017436894194530463  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.568104591892099  
valid\_h2\_range\_x\_mean\_u: 0.06605822569506542  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.191435211083014  
valid\_h2\_row\_norms\_mean: 0.7346838526227821

```

valid_h2_row_norms_min: 0.3433218673507426
valid_objective: 0.5558219617132444
valid_y_col_norms_max: 2.461397998452805
valid_y_col_norms_mean: 2.461397998452805
valid_y_col_norms_min: 2.461397998452805
valid_y_max_max_class: 0.9539490776327645
valid_y_mean_max_class: 0.7653617352786588
valid_y_min_max_class: 0.5258647548111184
valid_y_misclass: 0.293610163064088
valid_y_nll: 0.582573846228294
valid_y_row_norms_max: 0.9427111244447621
valid_y_row_norms_mean: 0.11443887251056817
valid_y_row_norms_min: 0.0002177942150070635
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.062006 seconds
Time this epoch: 0:01:29.392939
Monitoring step:
  Epochs seen: 9
  Batches seen: 25632
  Examples seen: 2563065
  learning_rate: 0.0910089999999975
  momentum: 0.46767676767679783
  total_seconds_last_epoch: 162.28222600000134
  train_h0_col_norms_max: 0.7500000000000339
  train_h0_col_norms_mean: 0.7448312363938698
  train_h0_col_norms_min: 0.7192129911095154
  train_h0_max_x_max_u: 0.9404017594059694
  train_h0_max_x_mean_u: 0.23671106112336757
  train_h0_max_x_min_u: 6.736307383142842e-05
  train_h0_mean_x_max_u: 0.27734854481925303
  train_h0_mean_x_mean_u: 0.028564250498660723
  train_h0_mean_x_min_u: 7.488801356790919e-07
  train_h0_min_x_max_u: 0.006068218657454056
  train_h0_min_x_mean_u: 6.151232935327957e-05
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.9388155866127315
  train_h0_range_x_mean_u: 0.2366495487940143
  train_h0_range_x_min_u: 6.736307383142842e-05
  train_h0_row_norms_max: 0.653819536044333
  train_h0_row_norms_mean: 0.4733393364626091
  train_h0_row_norms_min: 0.3770041719317583
  train_h1_col_norms_max: 0.7500000000000207
  train_h1_col_norms_mean: 0.7474475425485584
  train_h1_col_norms_min: 0.7230541838452154
  train_h1_max_x_max_u: 0.6741871962039935
  train_h1_max_x_mean_u: 0.11776395830968588
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.19777878097398216
  train_h1_mean_x_mean_u: 0.019613096809806364
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.007515320865301007
  train_h1_min_x_mean_u: 8.179644908454925e-05
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.671708312863387

```

train\_h1\_range\_x\_mean\_u: 0.1176821618606014  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1464353567895647  
train\_h1\_row\_norms\_mean: 0.7383768235648883  
train\_h1\_row\_norms\_min: 0.4301167735757014  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.7489736508153871  
train\_h2\_col\_norms\_min: 0.7376543385781686  
train\_h2\_max\_x\_max\_u: 0.6076923375625839  
train\_h2\_max\_x\_mean\_u: 0.05663904585154209  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2812046270331865  
train\_h2\_mean\_x\_mean\_u: 0.012810834641541227  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.07920528594164587  
train\_h2\_min\_x\_mean\_u: 0.0006288965861084075  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5503626022319865  
train\_h2\_range\_x\_mean\_u: 0.056010149265433753  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1873285202622896  
train\_h2\_row\_norms\_mean: 0.7349401466931633  
train\_h2\_row\_norms\_min: 0.3469914189109128  
train\_objective: 0.45539797192016834  
train\_y\_col\_norms\_max: 2.592234340730258  
train\_y\_col\_norms\_mean: 2.592234340730258  
train\_y\_col\_norms\_min: 2.592234340730258  
train\_y\_max\_max\_class: 0.9575779487477308  
train\_y\_mean\_max\_class: 0.7785159185421494  
train\_y\_min\_max\_class: 0.5330511233763487  
train\_y\_misclass: 0.22787014765524893  
train\_y\_nll: 0.4561069467596372  
train\_y\_row\_norms\_max: 0.9844654448697249  
train\_y\_row\_norms\_mean: 0.11924811166060999  
train\_y\_row\_norms\_min: 0.001439834042104545  
training\_seconds\_this\_epoch: 89.39293899999518  
valid\_h0\_col\_norms\_max: 0.7500000000000063  
valid\_h0\_col\_norms\_mean: 0.7448312363939025  
valid\_h0\_col\_norms\_min: 0.719212991109516  
valid\_h0\_max\_x\_max\_u: 1.0230282447676589  
valid\_h0\_max\_x\_mean\_u: 0.28687067023618035  
valid\_h0\_max\_x\_min\_u: 1.9769232425319154e-05  
valid\_h0\_mean\_x\_max\_u: 0.3454732723230889  
valid\_h0\_mean\_x\_mean\_u: 0.03646670642395866  
valid\_h0\_mean\_x\_min\_u: 1.9769232425319157e-07  
valid\_h0\_min\_x\_max\_u: 0.013281726122923446  
valid\_h0\_min\_x\_mean\_u: 8.467426574344054e-05  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.0197457479558156  
valid\_h0\_range\_x\_mean\_u: 0.28678599597043686  
valid\_h0\_range\_x\_min\_u: 1.9769232425319154e-05  
valid\_h0\_row\_norms\_max: 0.6538195360443071  
valid\_h0\_row\_norms\_mean: 0.4733393364625881  
valid\_h0\_row\_norms\_min: 0.3770041719317797

valid\_h1.col\_norms\_max: 0.7500000000000063  
valid\_h1.col\_norms\_mean: 0.7474475425485375  
valid\_h1.col\_norms\_min: 0.723054183845239  
valid\_h1\_max\_x\_max\_u: 0.7605595743653703  
valid\_h1\_max\_x\_mean\_u: 0.14871310302721327  
valid\_h1\_max\_x\_min\_u: 0.0  
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valid\_h1\_mean\_x\_mean\_u: 0.02431717602844611  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.0075403513729755435  
valid\_h1\_min\_x\_mean\_u: 0.00014599434448148157  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.7561114095721811  
valid\_h1\_range\_x\_mean\_u: 0.14856710868273176  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.1464353567895404  
valid\_h1.row\_norms\_mean: 0.7383768235648649  
valid\_h1.row\_norms\_min: 0.43011677357568956  
valid\_h2.col\_norms\_max: 0.7500000000000063  
valid\_h2.col\_norms\_mean: 0.7489736508154136  
valid\_h2.col\_norms\_min: 0.7376543385782129  
valid\_h2\_max\_x\_max\_u: 0.6391865715254509  
valid\_h2\_max\_x\_mean\_u: 0.06591368374820582  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.2722629588828462  
valid\_h2\_mean\_x\_mean\_u: 0.01233192651592453  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.03578121324450557  
valid\_h2\_min\_x\_mean\_u: 0.00019983809830719673  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.614945646910674  
valid\_h2\_range\_x\_mean\_u: 0.0657138456498986  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2.row\_norms\_max: 1.1873285202623565  
valid\_h2.row\_norms\_mean: 0.7349401466931985  
valid\_h2.row\_norms\_min: 0.34699141891089813  
valid\_objective: 0.5489524151554618  
valid\_y.col\_norms\_max: 2.592234340730155  
valid\_y.col\_norms\_mean: 2.592234340730155  
valid\_y.col\_norms\_min: 2.592234340730155  
valid\_y\_max\_max\_class: 0.9605824288902759  
valid\_y\_mean\_max\_class: 0.7772645906434942  
valid\_y\_min\_max\_class: 0.5249949807266101  
valid\_y\_misclass: 0.30444950069523447  
valid\_y\_nll: 0.5886332841413712  
valid\_y.row\_norms\_max: 0.9844654448697848  
valid\_y.row\_norms\_mean: 0.11924811166061457  
valid\_y.row\_norms\_min: 0.0014398340421044524

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Saving to ..\Sean\nn\_files\_S4COR10\nn\_train.pkl done. Time elapsed: 0.057005 seconds

Time this epoch: 0:01:29.056547

Monitoring step:

Epochs seen: 10

Batches seen: 28480

Examples seen: 2847850  
learning\_rate: 0.09001000000000349  
momentum: 0.4636363636363546  
total\_seconds\_last\_epoch: 163.51435000000316  
train\_h0\_col\_norms\_max: 0.7500000000000339  
train\_h0\_col\_norms\_mean: 0.7446110042422374  
train\_h0\_col\_norms\_min: 0.7177003790109641  
train\_h0\_max\_x\_max\_u: 0.9971966742851303  
train\_h0\_max\_x\_mean\_u: 0.23366772654611048  
train\_h0\_max\_x\_min\_u: 2.4001767267909854e-05  
train\_h0\_mean\_x\_max\_u: 0.31120895384084746  
train\_h0\_mean\_x\_mean\_u: 0.02767730049788766  
train\_h0\_mean\_x\_min\_u: 3.6962941355852415e-07  
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train\_h0\_min\_x\_mean\_u: 5.9094659962059584e-05  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.9945300204315519  
train\_h0\_range\_x\_mean\_u: 0.23360863188614822  
train\_h0\_range\_x\_min\_u: 2.4001767267909854e-05  
train\_h0\_row\_norms\_max: 0.6456791029584148  
train\_h0\_row\_norms\_mean: 0.473542870941417  
train\_h0\_row\_norms\_min: 0.37983286341709077  
train\_h1\_col\_norms\_max: 0.7500000000000207  
train\_h1\_col\_norms\_mean: 0.7476571460190236  
train\_h1\_col\_norms\_min: 0.7260173015991224  
train\_h1\_max\_x\_max\_u: 0.6643628430039438  
train\_h1\_max\_x\_mean\_u: 0.11652958520760039  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.19930605069268043  
train\_h1\_mean\_x\_mean\_u: 0.019843620555899638  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.016880323174946078  
train\_h1\_min\_x\_mean\_u: 0.00011032135568334531  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.663085877781726  
train\_h1\_range\_x\_mean\_u: 0.11641926385191682  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1429244571289918  
train\_h1\_row\_norms\_mean: 0.739183465409964  
train\_h1\_row\_norms\_min: 0.43479463265275675  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.7489449186681637  
train\_h2\_col\_norms\_min: 0.7391777027887424  
train\_h2\_max\_x\_max\_u: 0.5760790713103526  
train\_h2\_max\_x\_mean\_u: 0.05259606851587991  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2460471875205974  
train\_h2\_mean\_x\_mean\_u: 0.012067459605853587  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.060024560264205495  
train\_h2\_min\_x\_mean\_u: 0.0006475969503273696  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5294015412193225  
train\_h2\_range\_x\_mean\_u: 0.0519484715655525

train\_h2.range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.1834866224869693  
train\_h2.row\_norms\_mean: 0.7350302574017278  
train\_h2.row\_norms\_min: 0.3461251821627785  
train\_objective: 0.4460712743583628  
train\_y.col\_norms\_max: 2.691857267582131  
train\_y.col\_norms\_mean: 2.691857267582131  
train\_y.col\_norms\_min: 2.691857267582131  
train\_y\_max\_max\_class: 0.9514144355715641  
train\_y\_mean\_max\_class: 0.7779781824914244  
train\_y\_min\_max\_class: 0.5504275968275031  
train\_y\_misclass: 0.22994890882595637  
train\_y\_nll: 0.44288500581984397  
train\_y.row\_norms\_max: 1.0193007161343182  
train\_y.row\_norms\_mean: 0.12287321103495988  
train\_y.row\_norms\_min: 0.0029837308672951367  
training\_seconds\_this\_epoch: 89.05654699999917  
valid\_h0.col\_norms\_max: 0.7500000000000063  
valid\_h0.col\_norms\_mean: 0.744611004242259  
valid\_h0.col\_norms\_min: 0.7177003790109977  
valid\_h0\_max\_x\_max\_u: 1.063311748341848  
valid\_h0\_max\_x\_mean\_u: 0.2836577137270316  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.38361473515731187  
valid\_h0\_mean\_x\_mean\_u: 0.0353492426368439  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.01627979247158225  
valid\_h0\_min\_x\_mean\_u: 8.028618025682764e-05  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0.range\_x\_max\_u: 1.0579450753107955  
valid\_h0.range\_x\_mean\_u: 0.2835774275467747  
valid\_h0.range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.6456791029584019  
valid\_h0.row\_norms\_mean: 0.4735428709414278  
valid\_h0.row\_norms\_min: 0.3798328634171148  
valid\_h1.col\_norms\_max: 0.7500000000000063  
valid\_h1.col\_norms\_mean: 0.7476571460190244  
valid\_h1.col\_norms\_min: 0.7260173015991425  
valid\_h1\_max\_x\_max\_u: 0.7497363050804999  
valid\_h1\_max\_x\_mean\_u: 0.14789552006022294  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.23351713336120256  
valid\_h1\_mean\_x\_mean\_u: 0.024880250739154716  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.02174018668401649  
valid\_h1\_min\_x\_mean\_u: 0.00018610629979355626  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1.range\_x\_max\_u: 0.7468077820618481  
valid\_h1.range\_x\_mean\_u: 0.14770941376042945  
valid\_h1.range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.1429244571289532  
valid\_h1.row\_norms\_mean: 0.7391834654100105  
valid\_h1.row\_norms\_min: 0.43479463265273094  
valid\_h2.col\_norms\_max: 0.7500000000000063

```

valid_h2.col_norms_mean: 0.7489449186681945
valid_h2.col_norms_min: 0.739177702788716
valid_h2.max_x_max_u: 0.623473813736299
valid_h2.max_x_mean_u: 0.06176346303689459
valid_h2.max_x_min_u: 0.0
valid_h2.mean_x_max_u: 0.24404606451273886
valid_h2.mean_x_mean_u: 0.01152432139823546
valid_h2.mean_x_min_u: 0.0
valid_h2.min_x_max_u: 0.02324103490741551
valid_h2.min_x_mean_u: 0.00016545650101923217
valid_h2.min_x_min_u: 0.0
valid_h2.range_x_max_u: 0.6061209203700834
valid_h2.range_x_mean_u: 0.061598006535875334
valid_h2.range_x_min_u: 0.0
valid_h2.row_norms_max: 1.1834866224868872
valid_h2.row_norms_mean: 0.7350302574017304
valid_h2.row_norms_min: 0.3461251821627662
valid_objective: 0.5325826277629683
valid_y.col_norms_max: 2.6918572675820758
valid_y.col_norms_mean: 2.6918572675820758
valid_y.col_norms_min: 2.6918572675820758
valid_y.max_max_class: 0.9560535472191038
valid_y.mean_max_class: 0.7646081005156196
valid_y.min_max_class: 0.5248817596184441
valid_y.misclass: 0.29323094425483504
valid_y.nll: 0.5661436504787829
valid_y.row_norms_max: 1.0193007161343317
valid_y.row_norms_mean: 0.12287321103495735
valid_y.row_norms_min: 0.002983730867295016
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.063006 seconds
Time this epoch: 0:01:28.302121
Monitoring step:
  Epochs seen: 11
  Batches seen: 31328
  Examples seen: 3132635
  learning_rate: 0.08901100000000246
  momentum: 0.45959595959596344
  total_seconds_last_epoch: 163.5209929999982
  train_h0.col_norms_max: 0.7500000000000339
  train_h0.col_norms_mean: 0.743986070768215
  train_h0.col_norms_min: 0.7083479818970858
  train_h0.max_x_max_u: 0.9591397534691778
  train_h0.max_x_mean_u: 0.23669073270684343
  train_h0.max_x_min_u: 3.391062493458078e-05
  train_h0.mean_x_max_u: 0.2587295081850768
  train_h0.mean_x_mean_u: 0.027303612542887944
  train_h0.mean_x_min_u: 3.450098266793235e-07
  train_h0.min_x_max_u: 0.003556751264341325
  train_h0.min_x_mean_u: 3.92376076383836e-05
  train_h0.min_x_min_u: 0.0
  train_h0.range_x_max_u: 0.9579774868965858
  train_h0.range_x_mean_u: 0.23665149509920502
  train_h0.range_x_min_u: 3.391062493458078e-05

```

train\_h0\_row\_norms\_max: 0.646439805404917  
train\_h0\_row\_norms\_mean: 0.47331967960161075  
train\_h0\_row\_norms\_min: 0.3953511597235116  
train\_h1\_col\_norms\_max: 0.7500000000000207  
train\_h1\_col\_norms\_mean: 0.7476811773885456  
train\_h1\_col\_norms\_min: 0.7294564442084357  
train\_h1\_max\_x\_max\_u: 0.7248503193091757  
train\_h1\_max\_x\_mean\_u: 0.11674882893467353  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.20621971326435898  
train\_h1\_mean\_x\_mean\_u: 0.019373150088891233  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.00841428616091297  
train\_h1\_min\_x\_mean\_u: 8.107419152305632e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.7235418651414426  
train\_h1\_range\_x\_mean\_u: 0.11666775474315037  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1241184754529496  
train\_h1\_row\_norms\_mean: 0.739758313481057  
train\_h1\_row\_norms\_min: 0.4569759698801785  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.7488786876369938  
train\_h2\_col\_norms\_min: 0.7390934143291881  
train\_h2\_max\_x\_max\_u: 0.5557736107706202  
train\_h2\_max\_x\_mean\_u: 0.05166771519598459  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.23728276094202755  
train\_h2\_mean\_x\_mean\_u: 0.011598199255443621  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.06061231753094464  
train\_h2\_min\_x\_mean\_u: 0.0006376914209946087  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5075550499176196  
train\_h2\_range\_x\_mean\_u: 0.05103002377499003  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1842617640239763  
train\_h2\_row\_norms\_mean: 0.7351264921255801  
train\_h2\_row\_norms\_min: 0.3379743657863533  
train\_objective: 0.4395300842774277  
train\_y\_col\_norms\_max: 2.7750117418463245  
train\_y\_col\_norms\_mean: 2.7750117418463245  
train\_y\_col\_norms\_min: 2.7750117418463245  
train\_y\_max\_max\_class: 0.9540184382612836  
train\_y\_mean\_max\_class: 0.7935829783328322  
train\_y\_min\_max\_class: 0.5621375239236773  
train\_y\_misclass: 0.23639587759186778  
train\_y\_nll: 0.439610415619151  
train\_y\_row\_norms\_max: 1.0345264807082457  
train\_y\_row\_norms\_mean: 0.12649475349774614  
train\_y\_row\_norms\_min: 0.0017937381255440528  
training\_seconds\_this\_epoch: 88.30212100000085  
valid\_h0\_col\_norms\_max: 0.7500000000000063  
valid\_h0\_col\_norms\_mean: 0.7439860707682473



valid\_h0.col\_norms\_min: 0.7083479818970612  
valid\_h0.max\_x\_max\_u: 1.0612684283775942  
valid\_h0.max\_x\_mean\_u: 0.287567321798065  
valid\_h0.max\_x\_min\_u: 0.00011532039483794802  
valid\_h0.mean\_x\_max\_u: 0.3302607454474272  
valid\_h0.mean\_x\_mean\_u: 0.035224228541217366  
valid\_h0.mean\_x\_min\_u: 1.4433150771190024e-06  
valid\_h0.min\_x\_max\_u: 0.011287319281559691  
valid\_h0.min\_x\_mean\_u: 6.624197211965686e-05  
valid\_h0.min\_x\_min\_u: 0.0  
valid\_h0.range\_x\_max\_u: 1.0575890184557082  
valid\_h0.range\_x\_mean\_u: 0.28750107982594536  
valid\_h0.range\_x\_min\_u: 0.00011532039483794802  
valid\_h0.row\_norms\_max: 0.6464398054049085  
valid\_h0.row\_norms\_mean: 0.4733196796015816  
valid\_h0.row\_norms\_min: 0.39535115972351  
valid\_h1.col\_norms\_max: 0.7500000000000063  
valid\_h1.col\_norms\_mean: 0.7476811773885088  
valid\_h1.col\_norms\_min: 0.7294564442084224  
valid\_h1.max\_x\_max\_u: 0.8284340175336959  
valid\_h1.max\_x\_mean\_u: 0.14863013258512664  
valid\_h1.max\_x\_min\_u: 0.0  
valid\_h1.mean\_x\_max\_u: 0.24895978370768385  
valid\_h1.mean\_x\_mean\_u: 0.024290562301678278  
valid\_h1.mean\_x\_min\_u: 0.0  
valid\_h1.min\_x\_max\_u: 0.014153795639867697  
valid\_h1.min\_x\_mean\_u: 0.00016161396253857398  
valid\_h1.min\_x\_min\_u: 0.0  
valid\_h1.range\_x\_max\_u: 0.8260077238117702  
valid\_h1.range\_x\_mean\_u: 0.14846851862258806  
valid\_h1.range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.1241184754529312  
valid\_h1.row\_norms\_mean: 0.7397583134810751  
valid\_h1.row\_norms\_min: 0.4569759698801551  
valid\_h2.col\_norms\_max: 0.7500000000000063  
valid\_h2.col\_norms\_mean: 0.748878687636956  
valid\_h2.col\_norms\_min: 0.7390934143292182  
valid\_h2.max\_x\_max\_u: 0.5896458437594997  
valid\_h2.max\_x\_mean\_u: 0.06076149390489705  
valid\_h2.max\_x\_min\_u: 0.0  
valid\_h2.mean\_x\_max\_u: 0.2275897109267155  
valid\_h2.mean\_x\_mean\_u: 0.010881165992509371  
valid\_h2.mean\_x\_min\_u: 0.0  
valid\_h2.min\_x\_max\_u: 0.023438444838323087  
valid\_h2.min\_x\_mean\_u: 0.0001678701651696391  
valid\_h2.min\_x\_min\_u: 0.0  
valid\_h2.range\_x\_max\_u: 0.5711451985370846  
valid\_h2.range\_x\_mean\_u: 0.06059362373972744  
valid\_h2.range\_x\_min\_u: 0.0  
valid\_h2.row\_norms\_max: 1.184261764023985  
valid\_h2.row\_norms\_mean: 0.7351264921255537  
valid\_h2.row\_norms\_min: 0.3379743657863495  
valid\_objective: 0.5456364249922259  
valid\_y.col\_norms\_max: 2.775011741846247

```

valid_y_col_norms_mean: 2.775011741846247
valid_y_col_norms_min: 2.775011741846222
valid_y_max_max_class: 0.958481181821653
valid_y_mean_max_class: 0.781531234705059
valid_y_min_max_class: 0.5352524468093706
valid_y_misclass: 0.29958285930982187
valid_y_nll: 0.5810487793801004
valid_y_row_norms_max: 1.0345264807082961
valid_y_row_norms_mean: 0.1264947534977521
valid_y_row_norms_min: 0.0017937381255439767
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.062400 seconds
Time this epoch: 0:01:28.468167
Monitoring step:
  Epochs seen: 12
  Batches seen: 34176
  Examples seen: 3417420
  learning_rate: 0.088011999999999688
  momentum: 0.455555555555557153
  total_seconds_last_epoch: 162.0437940000038
  train_h0_col_norms_max: 0.7500000000000339
  train_h0_col_norms_mean: 0.7441500339803276
  train_h0_col_norms_min: 0.7135754935205038
  train_h0_max_x_max_u: 0.9524248031158729
  train_h0_max_x_mean_u: 0.23814424004553572
  train_h0_max_x_min_u: 1.0907549391530903e-05
  train_h0_mean_x_max_u: 0.2526021312530766
  train_h0_mean_x_mean_u: 0.027637071094199068
  train_h0_mean_x_min_u: 1.0907549391530903e-07
  train_h0_min_x_max_u: 0.003959048267544363
  train_h0_min_x_mean_u: 4.432424352868927e-05
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.9516117926368332
  train_h0_range_x_mean_u: 0.23809991580200698
  train_h0_range_x_min_u: 1.0907549391530903e-05
  train_h0_row_norms_max: 0.6370451307493576
  train_h0_row_norms_mean: 0.47353348001298373
  train_h0_row_norms_min: 0.39476103157457765
  train_h1_col_norms_max: 0.7500000000000207
  train_h1_col_norms_mean: 0.7476211570876483
  train_h1_col_norms_min: 0.7291512230123908
  train_h1_max_x_max_u: 0.7147491766453218
  train_h1_max_x_mean_u: 0.11932336734252473
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.20317335418028593
  train_h1_mean_x_mean_u: 0.02022430146517602
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.009939991476871
  train_h1_min_x_mean_u: 9.785285243380147e-05
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.7137843644403312
  train_h1_range_x_mean_u: 0.11922551449009083
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.1136529554364953

```

train\_h1\_row\_norms\_mean: 0.7402161168491442  
train\_h1\_row\_norms\_min: 0.46870864345438257  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.748860451968198  
train\_h2\_col\_norms\_min: 0.7405273014351709  
train\_h2\_max\_x\_max\_u: 0.5393524636401351  
train\_h2\_max\_x\_mean\_u: 0.052918477172043246  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.22637543836614743  
train\_h2\_mean\_x\_mean\_u: 0.011721239380850996  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.0417477950904884  
train\_h2\_min\_x\_mean\_u: 0.0005546149683126199  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5175925113947097  
train\_h2\_range\_x\_mean\_u: 0.0523638622037306  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1804982402000004  
train\_h2\_row\_norms\_mean: 0.7352450481584376  
train\_h2\_row\_norms\_min: 0.33439122587499254  
train\_objective: 0.4333209103322571  
train\_y\_col\_norms\_max: 2.905496276518305  
train\_y\_col\_norms\_mean: 2.905496276518305  
train\_y\_col\_norms\_min: 2.905496276518305  
train\_y\_max\_max\_class: 0.9641660178280756  
train\_y\_mean\_max\_class: 0.8043501196261751  
train\_y\_min\_max\_class: 0.5687614739553013  
train\_y\_misclass: 0.23747739522797875  
train\_y\_nll: 0.43475247790289895  
train\_y\_row\_norms\_max: 1.067657629765038  
train\_y\_row\_norms\_mean: 0.1317596036121701  
train\_y\_row\_norms\_min: 0.002041245242888871  
training\_seconds\_this\_epoch: 88.46816699999741  
valid\_h0\_col\_norms\_max: 0.7500000000000063  
valid\_h0\_col\_norms\_mean: 0.7441500339803613  
valid\_h0\_col\_norms\_min: 0.7135754935204591  
valid\_h0\_max\_x\_max\_u: 1.0338255758546808  
valid\_h0\_max\_x\_mean\_u: 0.28981265762883845  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.31433064881852024  
valid\_h0\_mean\_x\_mean\_u: 0.03576431046755701  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.006517128656177138  
valid\_h0\_min\_x\_mean\_u: 5.454734474714976e-05  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.0323258145355738  
valid\_h0\_range\_x\_mean\_u: 0.2897581102840913  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6370451307493397  
valid\_h0\_row\_norms\_mean: 0.4735334800129738  
valid\_h0\_row\_norms\_min: 0.3947610315745535  
valid\_h1\_col\_norms\_max: 0.7500000000000063  
valid\_h1\_col\_norms\_mean: 0.7476211570876716  
valid\_h1\_col\_norms\_min: 0.7291512230124414

```

valid_h1_max_x_max_u: 0.805609998429906
valid_h1_max_x_mean_u: 0.15198185468190153
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.24997406884741125
valid_h1_mean_x_mean_u: 0.02558222381379475
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.009872770338937287
valid_h1_min_x_mean_u: 0.0001772688202806465
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.8020178853727635
valid_h1_range_x_mean_u: 0.15180458586162077
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.1136529554365677
valid_h1_row_norms_mean: 0.7402161168491899
valid_h1_row_norms_min: 0.4687086434544122
valid_h2_col_norms_max: 0.75000000000000063
valid_h2_col_norms_mean: 0.748860451968174
valid_h2_col_norms_min: 0.7405273014351268
valid_h2_max_x_max_u: 0.5700850720565009
valid_h2_max_x_mean_u: 0.06119470318812941
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.20066392481835496
valid_h2_mean_x_mean_u: 0.010880630203543237
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.01017987120303808
valid_h2_min_x_mean_u: 9.539645610748067e-05
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.567021521766596
valid_h2_range_x_mean_u: 0.061099306732021935
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.180498240199992
valid_h2_row_norms_mean: 0.7352450481584636
valid_h2_row_norms_min: 0.33439122587500314
valid_objective: 0.5353134162215418
valid_y_col_norms_max: 2.9054962765183525
valid_y_col_norms_mean: 2.9054962765183525
valid_y_col_norms_min: 2.9054962765183525
valid_y_max_max_class: 0.9725178073892993
valid_y_mean_max_class: 0.7869782149393201
valid_y_min_max_class: 0.5362371976797775
valid_y_misclass: 0.2999936796865126
valid_y_nll: 0.582205029196634
valid_y_row_norms_max: 1.0676576297650964
valid_y_row_norms_mean: 0.1317596036121649
valid_y_row_norms_min: 0.0020412452428889773
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.062400 seconds
Time this epoch: 0:01:28.202966
Monitoring step:
  Epochs seen: 13
  Batches seen: 37024
  Examples seen: 3702205
  learning_rate: 0.08701299999999579
  momentum: 0.45151515151512894

```

total\_seconds\_last\_epoch: 161.24263299999365  
train\_h0\_col\_norms\_max: 0.7500000000000207  
train\_h0\_col\_norms\_mean: 0.7446300646986687  
train\_h0\_col\_norms\_min: 0.7171211856212459  
train\_h0\_max\_x\_max\_u: 0.9501271373500606  
train\_h0\_max\_x\_mean\_u: 0.24310929378469087  
train\_h0\_max\_x\_min\_u: 3.972359944705955e-06  
train\_h0\_mean\_x\_max\_u: 0.26691318172846074  
train\_h0\_mean\_x\_mean\_u: 0.028448104888041354  
train\_h0\_mean\_x\_min\_u: 7.482098826670153e-08  
train\_h0\_min\_x\_max\_u: 0.004059263825434736  
train\_h0\_min\_x\_mean\_u: 4.381451387186015e-05  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.9493017303429598  
train\_h0\_range\_x\_mean\_u: 0.24306547927081912  
train\_h0\_range\_x\_min\_u: 3.972359944705955e-06  
train\_h0\_row\_norms\_max: 0.6370423822274822  
train\_h0\_row\_norms\_mean: 0.4738354377222312  
train\_h0\_row\_norms\_min: 0.3788027891945735  
train\_h1\_col\_norms\_max: 0.7500000000000339  
train\_h1\_col\_norms\_mean: 0.7480916660769938  
train\_h1\_col\_norms\_min: 0.7344796055062257  
train\_h1\_max\_x\_max\_u: 0.7473324232029436  
train\_h1\_max\_x\_mean\_u: 0.12415970633640817  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.20936687655894662  
train\_h1\_mean\_x\_mean\_u: 0.021109407523669264  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.008249414773070776  
train\_h1\_min\_x\_mean\_u: 9.630076132587011e-05  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.7458557391974114  
train\_h1\_range\_x\_mean\_u: 0.12406340557508215  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.113210245223714  
train\_h1\_row\_norms\_mean: 0.7410163613684697  
train\_h1\_row\_norms\_min: 0.4850154638750625  
train\_h2\_col\_norms\_max: 0.7500000000000207  
train\_h2\_col\_norms\_mean: 0.749212979015854  
train\_h2\_col\_norms\_min: 0.7414908290626196  
train\_h2\_max\_x\_max\_u: 0.6024658450122863  
train\_h2\_max\_x\_mean\_u: 0.06169921614501129  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.27764235061449677  
train\_h2\_mean\_x\_mean\_u: 0.01420298191777232  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.06970835389623956  
train\_h2\_min\_x\_mean\_u: 0.0008103272260979192  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5705024974605544  
train\_h2\_range\_x\_mean\_u: 0.06088888891891342  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1840033517986261  
train\_h2\_row\_norms\_mean: 0.7357502952840895

train\_h2.row\_norms\_min: 0.3357326889365418  
train\_objective: 0.4331775655467808  
train\_y.col\_norms\_max: 3.0195486538019622  
train\_y.col\_norms\_mean: 3.0195486538019622  
train\_y.col\_norms\_min: 3.0195486538019622  
train\_y\_max\_max\_class: 0.9680116707757647  
train\_y\_mean\_max\_class: 0.7962295026288851  
train\_y\_min\_max\_class: 0.5512992870774497  
train\_y\_misclass: 0.1882683427849078  
train\_y\_nll: 0.38853583714433343  
train\_y.row\_norms\_max: 1.0824106622712673  
train\_y.row\_norms\_mean: 0.13767014203902433  
train\_y.row\_norms\_min: 0.0021385572300330062  
training\_seconds\_this\_epoch: 88.20296599999601  
valid\_h0.col\_norms\_max: 0.7500000000000063  
valid\_h0.col\_norms\_mean: 0.7446300646986271  
valid\_h0.col\_norms\_min: 0.7171211856212526  
valid\_h0\_max\_x\_max\_u: 1.0310092835782712  
valid\_h0\_max\_x\_mean\_u: 0.2941821259644381  
valid\_h0\_max\_x\_min\_u: 5.698560493495594e-07  
valid\_h0\_mean\_x\_max\_u: 0.3242816137699264  
valid\_h0\_mean\_x\_mean\_u: 0.03654971632782411  
valid\_h0\_mean\_x\_min\_u: 5.698560493495595e-09  
valid\_h0\_min\_x\_max\_u: 0.010164151451114963  
valid\_h0\_min\_x\_mean\_u: 5.9698920915321225e-05  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.029181303581878  
valid\_h0\_range\_x\_mean\_u: 0.29412242704352276  
valid\_h0\_range\_x\_min\_u: 5.698560493495594e-07  
valid\_h0.row\_norms\_max: 0.6370423822275056  
valid\_h0.row\_norms\_mean: 0.47383543772224346  
valid\_h0.row\_norms\_min: 0.37880278919455185  
valid\_h1.col\_norms\_max: 0.7500000000000063  
valid\_h1.col\_norms\_mean: 0.7480916660770076  
valid\_h1.col\_norms\_min: 0.7344796055062253  
valid\_h1\_max\_x\_max\_u: 0.8645318168932783  
valid\_h1\_max\_x\_mean\_u: 0.1576423916974671  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.26084844670887425  
valid\_h1\_mean\_x\_mean\_u: 0.026486354164872924  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.007697908185347489  
valid\_h1\_min\_x\_mean\_u: 0.0001815586178799144  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.8609955984933817  
valid\_h1\_range\_x\_mean\_u: 0.15746083307958722  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.1132102452237442  
valid\_h1.row\_norms\_mean: 0.7410163613684637  
valid\_h1.row\_norms\_min: 0.4850154638750933  
valid\_h2.col\_norms\_max: 0.7500000000000063  
valid\_h2.col\_norms\_mean: 0.7492129790158872  
valid\_h2.col\_norms\_min: 0.7414908290626687  
valid\_h2\_max\_x\_max\_u: 0.6473104369780266

```

valid_h2_max_x_mean_u: 0.07237581745108523
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.26225095489593986
valid_h2_mean_x_mean_u: 0.014028685674859537
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.027294101795694935
valid_h2_min_x_mean_u: 0.00021706005738168655
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.6372554126229292
valid_h2_range_x_mean_u: 0.07215875739370355
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.1840033517986455
valid_h2_row_norms_mean: 0.7357502952840507
valid_h2_row_norms_min: 0.33573268893654046
valid_objective: 0.5518836902041531
valid_y_col_norms_max: 3.0195486538019676
valid_y_col_norms_mean: 3.019548653801967
valid_y_col_norms_min: 3.019548653801967
valid_y_max_max_class: 0.9688185342019249
valid_y_mean_max_class: 0.780449196588504
valid_y_min_max_class: 0.5189055567905408
valid_y_misclass: 0.2658323852863101
valid_y_nll: 0.5373852598457096
valid_y_row_norms_max: 1.082410662271259
valid_y_row_norms_mean: 0.1376701420390217
valid_y_row_norms_min: 0.0021385572300329147
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.093601 seconds
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4COR10\nn_train.pkl done. Time elapsed: 0.062400 seconds

```

### 8.3 S4 C4 R10

In [118]: `run_pylearn(diffs[2])`

Parameter and initial learning rate summary:

```

h0_W: 0.1
h0_b: 0.1
h1_W: 0.1
h1_b: 0.1
h2_W: 0.1
h2_b: 0.1
softmax_b: 0.1
softmax_W: 0.1

```

Compiling `sgd.update...`

Compiling `sgd.update` done. Time elapsed: 0.639604 seconds

compiling `begin_record.entry...`

compiling `begin_record.entry` done. Time elapsed: 0.234002 seconds

Monitored channels:

```

learning_rate
momentum
total_seconds_last_epoch
train_h0_col_norms_max
train_h0_col_norms_mean
train_h0_col_norms_min

```

train\_h0\_max\_x\_max\_u  
train\_h0\_max\_x\_mean\_u  
train\_h0\_max\_x\_min\_u  
train\_h0\_mean\_x\_max\_u  
train\_h0\_mean\_x\_mean\_u  
train\_h0\_mean\_x\_min\_u  
train\_h0\_min\_x\_max\_u  
train\_h0\_min\_x\_mean\_u  
train\_h0\_min\_x\_min\_u  
train\_h0\_range\_x\_max\_u  
train\_h0\_range\_x\_mean\_u  
train\_h0\_range\_x\_min\_u  
train\_h0\_row\_norms\_max  
train\_h0\_row\_norms\_mean  
train\_h0\_row\_norms\_min  
train\_h1\_col\_norms\_max  
train\_h1\_col\_norms\_mean  
train\_h1\_col\_norms\_min  
train\_h1\_max\_x\_max\_u  
train\_h1\_max\_x\_mean\_u  
train\_h1\_max\_x\_min\_u  
train\_h1\_mean\_x\_max\_u  
train\_h1\_mean\_x\_mean\_u  
train\_h1\_mean\_x\_min\_u  
train\_h1\_min\_x\_max\_u  
train\_h1\_min\_x\_mean\_u  
train\_h1\_min\_x\_min\_u  
train\_h1\_range\_x\_max\_u  
train\_h1\_range\_x\_mean\_u  
train\_h1\_range\_x\_min\_u  
train\_h1\_row\_norms\_max  
train\_h1\_row\_norms\_mean  
train\_h1\_row\_norms\_min  
train\_h2\_col\_norms\_max  
train\_h2\_col\_norms\_mean  
train\_h2\_col\_norms\_min  
train\_h2\_max\_x\_max\_u  
train\_h2\_max\_x\_mean\_u  
train\_h2\_max\_x\_min\_u  
train\_h2\_mean\_x\_max\_u  
train\_h2\_mean\_x\_mean\_u  
train\_h2\_mean\_x\_min\_u  
train\_h2\_min\_x\_max\_u  
train\_h2\_min\_x\_mean\_u  
train\_h2\_min\_x\_min\_u  
train\_h2\_range\_x\_max\_u  
train\_h2\_range\_x\_mean\_u  
train\_h2\_range\_x\_min\_u  
train\_h2\_row\_norms\_max  
train\_h2\_row\_norms\_mean  
train\_h2\_row\_norms\_min  
train\_objective  
train\_y\_col\_norms\_max  
train\_y\_col\_norms\_mean



train\_y\_col\_norms\_min  
train\_y\_max\_max\_class  
train\_y\_mean\_max\_class  
train\_y\_min\_max\_class  
train\_y\_misclass  
train\_y\_nll  
train\_y\_row\_norms\_max  
train\_y\_row\_norms\_mean  
train\_y\_row\_norms\_min  
training\_seconds\_this\_epoch  
valid\_h0\_col\_norms\_max  
valid\_h0\_col\_norms\_mean  
valid\_h0\_col\_norms\_min  
valid\_h0\_max\_x\_max\_u  
valid\_h0\_max\_x\_mean\_u  
valid\_h0\_max\_x\_min\_u  
valid\_h0\_mean\_x\_max\_u  
valid\_h0\_mean\_x\_mean\_u  
valid\_h0\_mean\_x\_min\_u  
valid\_h0\_min\_x\_max\_u  
valid\_h0\_min\_x\_mean\_u  
valid\_h0\_min\_x\_min\_u  
valid\_h0\_range\_x\_max\_u  
valid\_h0\_range\_x\_mean\_u  
valid\_h0\_range\_x\_min\_u  
valid\_h0\_row\_norms\_max  
valid\_h0\_row\_norms\_mean  
valid\_h0\_row\_norms\_min  
valid\_h1\_col\_norms\_max  
valid\_h1\_col\_norms\_mean  
valid\_h1\_col\_norms\_min  
valid\_h1\_max\_x\_max\_u  
valid\_h1\_max\_x\_mean\_u  
valid\_h1\_max\_x\_min\_u  
valid\_h1\_mean\_x\_max\_u  
valid\_h1\_mean\_x\_mean\_u  
valid\_h1\_mean\_x\_min\_u  
valid\_h1\_min\_x\_max\_u  
valid\_h1\_min\_x\_mean\_u  
valid\_h1\_min\_x\_min\_u  
valid\_h1\_range\_x\_max\_u  
valid\_h1\_range\_x\_mean\_u  
valid\_h1\_range\_x\_min\_u  
valid\_h1\_row\_norms\_max  
valid\_h1\_row\_norms\_mean  
valid\_h1\_row\_norms\_min  
valid\_h2\_col\_norms\_max  
valid\_h2\_col\_norms\_mean  
valid\_h2\_col\_norms\_min  
valid\_h2\_max\_x\_max\_u  
valid\_h2\_max\_x\_mean\_u  
valid\_h2\_max\_x\_min\_u  
valid\_h2\_mean\_x\_max\_u  
valid\_h2\_mean\_x\_mean\_u

```

valid_h2_mean_x_min_u
valid_h2_min_x_max_u
valid_h2_min_x_mean_u
valid_h2_min_x_min_u
valid_h2_range_x_max_u
valid_h2_range_x_mean_u
valid_h2_range_x_min_u
valid_h2_row_norms_max
valid_h2_row_norms_mean
valid_h2_row_norms_min
valid_objective
valid_y_col_norms_max
valid_y_col_norms_mean
valid_y_col_norms_min
valid_y_max_max_class
valid_y_mean_max_class
valid_y_min_max_class
valid_y_misclass
valid_y_nll
valid_y_row_norms_max
valid_y_row_norms_mean
valid_y_row_norms_min
Compiling accum...
graph size: 268
graph size: 264
Compiling accum done. Time elapsed: 4.305628 seconds
Monitoring step:
  Epochs seen: 0
  Batches seen: 0
  Examples seen: 0
  learning_rate: 0.099999999999999672
  momentum: 0.499999999999999206
  total_seconds_last_epoch: 0.0
  train_h0_col_norms_max: 0.750000000000000133
  train_h0_col_norms_mean: 0.750000000000000133
  train_h0_col_norms_min: 0.750000000000000133
  train_h0_max_x_max_u: 0.5045230606394236
  train_h0_max_x_mean_u: 0.20228031957993442
  train_h0_max_x_min_u: 0.030445387025050796
  train_h0_mean_x_max_u: 0.14177107761225186
  train_h0_mean_x_mean_u: 0.034468467992787695
  train_h0_mean_x_min_u: 0.002378134439013314
  train_h0_min_x_max_u: 0.017784527457536635
  train_h0_min_x_mean_u: 0.00030917206641031884
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.5022307609284041
  train_h0_range_x_mean_u: 0.20197114751352405
  train_h0_range_x_min_u: 0.030445387025050796
  train_h0_row_norms_max: 0.9473073874925393
  train_h0_row_norms_mean: 0.4511236721700429
  train_h0_row_norms_min: 0.0
  train_h1_col_norms_max: 0.750000000000000133
  train_h1_col_norms_mean: 0.750000000000000133
  train_h1_col_norms_min: 0.750000000000000133

```

train\_h1\_max\_x\_max\_u: 0.2866207185933895  
train\_h1\_max\_x\_mean\_u: 0.09249765754576567  
train\_h1\_max\_x\_min\_u: 0.00015190044379951768  
train\_h1\_mean\_x\_max\_u: 0.0992417316582745  
train\_h1\_mean\_x\_mean\_u: 0.018853635826842116  
train\_h1\_mean\_x\_min\_u: 2.0490247411547843e-06  
train\_h1\_min\_x\_max\_u: 0.02077995546888679  
train\_h1\_min\_x\_mean\_u: 0.00036640918677504806  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.2827506072252814  
train\_h1\_range\_x\_mean\_u: 0.0921312483589909  
train\_h1\_range\_x\_min\_u: 0.00015190044379951768  
train\_h1\_row\_norms\_max: 1.1743750618400737  
train\_h1\_row\_norms\_mean: 0.7349743966733273  
train\_h1\_row\_norms\_min: 0.3011737652442414  
train\_h2\_col\_norms\_max: 0.7500000000000133  
train\_h2\_col\_norms\_mean: 0.7500000000000133  
train\_h2\_col\_norms\_min: 0.7500000000000133  
train\_h2\_max\_x\_max\_u: 0.16490342782833015  
train\_h2\_max\_x\_mean\_u: 0.044840874759033006  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.07114546715879584  
train\_h2\_mean\_x\_mean\_u: 0.010361205050839371  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.01938303212281026  
train\_h2\_min\_x\_mean\_u: 0.00031447104438525863  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.15823105191852055  
train\_h2\_range\_x\_mean\_u: 0.044526403714647673  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2131149672178787  
train\_h2\_row\_norms\_mean: 0.7335647006152377  
train\_h2\_row\_norms\_min: 0.30756337547117646  
train\_objective: 0.6930242462014357  
train\_y\_col\_norms\_max: 0.0  
train\_y\_col\_norms\_mean: 0.0  
train\_y\_col\_norms\_min: 0.0  
train\_y\_max\_max\_class: 0.5078399400757451  
train\_y\_mean\_max\_class: 0.5078399400757451  
train\_y\_min\_max\_class: 0.5078399400757451  
train\_y\_misclass: 0.4921600599242869  
train\_y\_nll: 0.6930242462014357  
train\_y\_row\_norms\_max: 0.0  
train\_y\_row\_norms\_mean: 0.0  
train\_y\_row\_norms\_min: 0.0  
training\_seconds\_this\_epoch: 0.0  
valid\_h0\_col\_norms\_max: 0.750000000000002  
valid\_h0\_col\_norms\_mean: 0.750000000000002  
valid\_h0\_col\_norms\_min: 0.750000000000002  
valid\_h0\_max\_x\_max\_u: 0.5616820275817009  
valid\_h0\_max\_x\_mean\_u: 0.20081094573392183  
valid\_h0\_max\_x\_min\_u: 0.00010260390319688571  
valid\_h0\_mean\_x\_max\_u: 0.25741128149386305  
valid\_h0\_mean\_x\_mean\_u: 0.04950759910025594

valid\_h0\_mean\_x\_min\_u: 1.2551265634223876e-06  
valid\_h0\_min\_x\_max\_u: 0.09618796453657119  
valid\_h0\_min\_x\_mean\_u: 0.0018223237468752282  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.5464836162734023  
valid\_h0\_range\_x\_mean\_u: 0.1989886219870469  
valid\_h0\_range\_x\_min\_u: 0.00010260390319688571  
valid\_h0\_row\_norms\_max: 0.9473073874925015  
valid\_h0\_row\_norms\_mean: 0.45112367217003174  
valid\_h0\_row\_norms\_min: 0.0  
valid\_h1\_col\_norms\_max: 0.7500000000000002  
valid\_h1\_col\_norms\_mean: 0.7500000000000002  
valid\_h1\_col\_norms\_min: 0.7500000000000002  
valid\_h1\_max\_x\_max\_u: 0.3269929081435306  
valid\_h1\_max\_x\_mean\_u: 0.0948562917300411  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.1576540882830471  
valid\_h1\_mean\_x\_mean\_u: 0.02611605498480888  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.058193072533801224  
valid\_h1\_min\_x\_mean\_u: 0.0016958850498439311  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.3125083440433519  
valid\_h1\_range\_x\_mean\_u: 0.09316040668019715  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1743750618400228  
valid\_h1\_row\_norms\_mean: 0.7349743966733054  
valid\_h1\_row\_norms\_min: 0.3011737652442459  
valid\_h2\_col\_norms\_max: 0.75000000000000031  
valid\_h2\_col\_norms\_mean: 0.7500000000000002  
valid\_h2\_col\_norms\_min: 0.7500000000000002  
valid\_h2\_max\_x\_max\_u: 0.2051793379466627  
valid\_h2\_max\_x\_mean\_u: 0.04784416726912381  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.11673644747396253  
valid\_h2\_mean\_x\_mean\_u: 0.014285880148302958  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.04371678558515956  
valid\_h2\_min\_x\_mean\_u: 0.001173047629155365  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.17883741843844567  
valid\_h2\_range\_x\_mean\_u: 0.04667111963996844  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2131149672178998  
valid\_h2\_row\_norms\_mean: 0.7335647006152755  
valid\_h2\_row\_norms\_min: 0.3075633754711752  
valid\_objective: 0.6930238982123248  
valid\_y\_col\_norms\_max: 0.0  
valid\_y\_col\_norms\_mean: 0.0  
valid\_y\_col\_norms\_min: 0.0  
valid\_y\_max\_max\_class: 0.5078399400757267  
valid\_y\_mean\_max\_class: 0.5078399400757266  
valid\_y\_min\_max\_class: 0.5078399400757267  
valid\_y\_misclass: 0.4921489641565276

```

valid_y_nll: 0.6930238982123248
valid_y_row_norms_max: 0.0
valid_y_row_norms_mean: 0.0
valid_y_row_norms_min: 0.0
Saving to ..\Sean\nn_files_S4C4R10\nn_train_best.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train_best.pkl done. Time elapsed: 0.046801 seconds
Time this epoch: 0:01:07.626433
Monitoring step:
  Epochs seen: 1
  Batches seen: 2190
  Examples seen: 218943
  learning_rate: 0.099000999999999847
  momentum: 0.499999999999999206
  total_seconds_last_epoch: 0.0
  train_h0_col_norms_max: 0.750000000000000133
  train_h0_col_norms_mean: 0.7478979195667551
  train_h0_col_norms_min: 0.7302998271582567
  train_h0_max_x_max_u: 0.7398310690835135
  train_h0_max_x_mean_u: 0.2073487488784434
  train_h0_max_x_min_u: 0.00017707162971451848
  train_h0_mean_x_max_u: 0.32274561466787816
  train_h0_mean_x_mean_u: 0.04663412082376608
  train_h0_mean_x_min_u: 2.1433812349492143e-06
  train_h0_min_x_max_u: 0.06629520585937151
  train_h0_min_x_mean_u: 0.002444778012701647
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7062121384144854
  train_h0_range_x_mean_u: 0.20490397086574158
  train_h0_range_x_min_u: 0.00017707162971451848
  train_h0_row_norms_max: 0.9197262684048835
  train_h0_row_norms_mean: 0.45359163312297124
  train_h0_row_norms_min: 0.09061453437247412
  train_h1_col_norms_max: 0.750000000000000133
  train_h1_col_norms_mean: 0.7478460615941027
  train_h1_col_norms_min: 0.7256283796293448
  train_h1_max_x_max_u: 0.5030645804437248
  train_h1_max_x_mean_u: 0.10487245662675232
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.2335469396752522
  train_h1_mean_x_mean_u: 0.027225682220601573
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.06727063859978125
  train_h1_min_x_mean_u: 0.0017388290072479673
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.4886575081696786
  train_h1_range_x_mean_u: 0.10313362761950436
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.164161642939359
  train_h1_row_norms_mean: 0.7332618210450571
  train_h1_row_norms_min: 0.3052828563610487
  train_h2_col_norms_max: 0.750000000000000133
  train_h2_col_norms_mean: 0.7490541682097288
  train_h2_col_norms_min: 0.7353876545029897
  train_h2_max_x_max_u: 0.5228553440176236

```

train\_h2\_max\_x\_mean\_u: 0.06069695054298046  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.21558401566518662  
train\_h2\_mean\_x\_mean\_u: 0.016404808172926125  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.03649753156350426  
train\_h2\_min\_x\_mean\_u: 0.0007389012146526624  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5162339258584583  
train\_h2\_range\_x\_mean\_u: 0.05995804932832784  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2181461080988503  
train\_h2\_row\_norms\_mean: 0.7328770036838188  
train\_h2\_row\_norms\_min: 0.3091783696324607  
train\_objective: 0.6193213567128609  
train\_y\_col\_norms\_max: 1.1986121163028012  
train\_y\_col\_norms\_mean: 1.1986121163028012  
train\_y\_col\_norms\_min: 1.1986121163028012  
train\_y\_max\_max\_class: 0.786337485179483  
train\_y\_mean\_max\_class: 0.6282783562323104  
train\_y\_min\_max\_class: 0.5060797933861949  
train\_y\_misclass: 0.352772182714222  
train\_y\_nll: 0.6225941016987183  
train\_y\_row\_norms\_max: 0.4170480179808318  
train\_y\_row\_norms\_mean: 0.047908507127851094  
train\_y\_row\_norms\_min: 1.1632666856449135e-05  
training\_seconds\_this\_epoch: 67.62643300000263  
valid\_h0\_col\_norms\_max: 0.75000000000000032  
valid\_h0\_col\_norms\_mean: 0.7478979195667635  
valid\_h0\_col\_norms\_min: 0.7302998271582304  
valid\_h0\_max\_x\_max\_u: 1.0041777596389272  
valid\_h0\_max\_x\_mean\_u: 0.19368709130573614  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6481831972666003  
valid\_h0\_mean\_x\_mean\_u: 0.07152032723624398  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.3107788604461117  
valid\_h0\_min\_x\_mean\_u: 0.013431830126433827  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.8381017170605866  
valid\_h0\_range\_x\_mean\_u: 0.18025526117930218  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.9197262684049189  
valid\_h0\_row\_norms\_mean: 0.45359163312294876  
valid\_h0\_row\_norms\_min: 0.09061453437247555  
valid\_h1\_col\_norms\_max: 0.75000000000000031  
valid\_h1\_col\_norms\_mean: 0.7478460615940902  
valid\_h1\_col\_norms\_min: 0.7256283796293566  
valid\_h1\_max\_x\_max\_u: 0.6306345275290329  
valid\_h1\_max\_x\_mean\_u: 0.12091201799455327  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.40994693035391483  
valid\_h1\_mean\_x\_mean\_u: 0.04878284686975701  
valid\_h1\_mean\_x\_min\_u: 0.0

```

valid_h1_min_x_max_u: 0.19550199485057232
valid_h1_min_x_mean_u: 0.0085971252886361
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.5549466962766113
valid_h1_range_x_mean_u: 0.11231489270591723
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.1641616429393522
valid_h1_row_norms_mean: 0.7332618210450633
valid_h1_row_norms_min: 0.3052828563610452
valid_h2_col_norms_max: 0.7500000000000031
valid_h2_col_norms_mean: 0.7490541682097369
valid_h2_col_norms_min: 0.7353876545030071
valid_h2_max_x_max_u: 0.5442426100788336
valid_h2_max_x_mean_u: 0.07326445585471247
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.23743003019403114
valid_h2_mean_x_mean_u: 0.025132741800696908
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.08753440049763608
valid_h2_min_x_mean_u: 0.0028204020479457945
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.5341919183553251
valid_h2_range_x_mean_u: 0.07044405380676674
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2181461080988492
valid_h2_row_norms_mean: 0.7328770036837965
valid_h2_row_norms_min: 0.3091783696324566
valid_objective: 0.6607281984475204
valid_y_col_norms_max: 1.1986121163027894
valid_y_col_norms_mean: 1.1986121163027894
valid_y_col_norms_min: 1.1986121163027892
valid_y_max_max_class: 0.8770040331580066
valid_y_mean_max_class: 0.6624868301383604
valid_y_min_max_class: 0.5076355074210177
valid_y_misclass: 0.3073824399868462
valid_y_nll: 0.5651676659463747
valid_y_row_norms_max: 0.41704801798084096
valid_y_row_norms_mean: 0.04790850712785199
valid_y_row_norms_min: 1.1632666856449606e-05
Saving to ..\Sean\nn_files_S4C4R10\nn_train.best.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.best.pkl done. Time elapsed: 0.046800 seconds
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.046800 seconds
Time this epoch: 0:01:08.110037
Monitoring step:
  Epochs seen: 2
  Batches seen: 4380
  Examples seen: 437886
  learning_rate: 0.098001999999999648
  momentum: 0.4959595959595773
  total_seconds_last_epoch: 125.01920100000106
  train_h0_col_norms_max: 0.7500000000000134
  train_h0_col_norms_mean: 0.7475242133638319
  train_h0_col_norms_min: 0.7279926083473671

```

train\_h0\_max\_x\_max\_u: 0.8247301939740849  
train\_h0\_max\_x\_mean\_u: 0.2096662976334491  
train\_h0\_max\_x\_min\_u: 6.860420196830048e-05  
train\_h0\_mean\_x\_max\_u: 0.34240611093028545  
train\_h0\_mean\_x\_mean\_u: 0.044012208341556544  
train\_h0\_mean\_x\_min\_u: 1.2442654337036986e-06  
train\_h0\_min\_x\_max\_u: 0.06740204246953943  
train\_h0\_min\_x\_mean\_u: 0.0023269775987416466  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.7981378552007156  
train\_h0\_range\_x\_mean\_u: 0.20733932003470743  
train\_h0\_range\_x\_min\_u: 6.860420196830048e-05  
train\_h0\_row\_norms\_max: 0.8684336988229376  
train\_h0\_row\_norms\_mean: 0.45813010317157277  
train\_h0\_row\_norms\_min: 0.13659798017283367  
train\_h1\_col\_norms\_max: 0.75000000000000133  
train\_h1\_col\_norms\_mean: 0.7476932678451216  
train\_h1\_col\_norms\_min: 0.7231733989223729  
train\_h1\_max\_x\_max\_u: 0.7365270103166064  
train\_h1\_max\_x\_mean\_u: 0.10852292172893978  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.3269362648785075  
train\_h1\_mean\_x\_mean\_u: 0.026242564452523855  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.07267615979818869  
train\_h1\_min\_x\_mean\_u: 0.0014772339665168588  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6864021560003385  
train\_h1\_range\_x\_mean\_u: 0.10704568776242286  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1599789030507832  
train\_h1\_row\_norms\_mean: 0.7338547250836678  
train\_h1\_row\_norms\_min: 0.32122582259792026  
train\_h2\_col\_norms\_max: 0.75000000000000133  
train\_h2\_col\_norms\_mean: 0.7488383323539796  
train\_h2\_col\_norms\_min: 0.7400460166068902  
train\_h2\_max\_x\_max\_u: 0.6189931066908022  
train\_h2\_max\_x\_mean\_u: 0.0653016812573628  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.22142760860252386  
train\_h2\_mean\_x\_mean\_u: 0.016730099039046376  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.0375588562794507  
train\_h2\_min\_x\_mean\_u: 0.0006932103012581454  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6122336862443406  
train\_h2\_range\_x\_mean\_u: 0.06460847095610456  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2158403376321396  
train\_h2\_row\_norms\_mean: 0.7329976413948196  
train\_h2\_row\_norms\_min: 0.3111825192169718  
train\_objective: 0.6054230136727239  
train\_y\_col\_norms\_max: 1.4158084124984345  
train\_y\_col\_norms\_mean: 1.4158084124984345



train\_y\_col\_norms\_min: 1.4158084124984345  
train\_y\_max\_max\_class: 0.8347390066380831  
train\_y\_mean\_max\_class: 0.6590082284258365  
train\_y\_min\_max\_class: 0.5068318547947922  
train\_y\_misclass: 0.32983470583667923  
train\_y\_nll: 0.59408822638991  
train\_y\_row\_norms\_max: 0.5408336222915329  
train\_y\_row\_norms\_mean: 0.05818814994907945  
train\_y\_row\_norms\_min: 0.00033177354966757317  
training\_seconds\_this\_epoch: 68.11003700000374  
valid\_h0\_col\_norms\_max: 0.7500000000000032  
valid\_h0\_col\_norms\_mean: 0.7475242133638259  
valid\_h0\_col\_norms\_min: 0.7279926083473853  
valid\_h0\_max\_x\_max\_u: 1.1039115090114413  
valid\_h0\_max\_x\_mean\_u: 0.20390563603939246  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6551300611950657  
valid\_h0\_mean\_x\_mean\_u: 0.07440348218758702  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.32088719942496435  
valid\_h0\_min\_x\_mean\_u: 0.012926645701303223  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.9777705375971533  
valid\_h0\_range\_x\_mean\_u: 0.19097899033808907  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.8684336988229193  
valid\_h0\_row\_norms\_mean: 0.4581301031715587  
valid\_h0\_row\_norms\_min: 0.1365979801728387  
valid\_h1\_col\_norms\_max: 0.7500000000000031  
valid\_h1\_col\_norms\_mean: 0.7476932678451647  
valid\_h1\_col\_norms\_min: 0.7231733989223531  
valid\_h1\_max\_x\_max\_u: 1.0754519131184528  
valid\_h1\_max\_x\_mean\_u: 0.12661645697840926  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.6699461948060528  
valid\_h1\_mean\_x\_mean\_u: 0.04853299850959262  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.2990961792471519  
valid\_h1\_min\_x\_mean\_u: 0.007476615273209271  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.8405284170073793  
valid\_h1\_range\_x\_mean\_u: 0.11913984170520008  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1599789030507541  
valid\_h1\_row\_norms\_mean: 0.7338547250836875  
valid\_h1\_row\_norms\_min: 0.3212258225979324  
valid\_h2\_col\_norms\_max: 0.7500000000000031  
valid\_h2\_col\_norms\_mean: 0.7488383323539557  
valid\_h2\_col\_norms\_min: 0.7400460166068759  
valid\_h2\_max\_x\_max\_u: 0.773369553253872  
valid\_h2\_max\_x\_mean\_u: 0.0684801531999565  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.28421823920255795  
valid\_h2\_mean\_x\_mean\_u: 0.02157921185128794

```

valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.08640879919672706
valid_h2_min_x_mean_u: 0.0021884839698403337
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.7690481925737817
valid_h2_range_x_mean_u: 0.0662916692301162
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2158403376321636
valid_h2_row_norms_mean: 0.7329976413948357
valid_h2_row_norms_min: 0.3111825192169824
valid_objective: 0.6543568971109955
valid_y_col_norms_max: 1.4158084124983767
valid_y_col_norms_mean: 1.4158084124983767
valid_y_col_norms_min: 1.4158084124983767
valid_y_max_max_class: 0.8772645980194121
valid_y_mean_max_class: 0.6629736226449486
valid_y_min_max_class: 0.5057626728868351
valid_y_misclass: 0.286829990134824
valid_y_nll: 0.5526002645606655
valid_y_row_norms_max: 0.540833622291553
valid_y_row_norms_mean: 0.05818814994907718
valid_y_row_norms_min: 0.0003317735496675882
Saving to ..\Sean\nn_files_S4C4R10\nn.train.best.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn.train.best.pkl done. Time elapsed: 0.046801 seconds
Saving to ..\Sean\nn_files_S4C4R10\nn.train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn.train.pkl done. Time elapsed: 0.046800 seconds
Time this epoch: 0:01:08.769482
Monitoring step:
  Epochs seen: 3
  Batches seen: 6570
  Examples seen: 656829
  learning_rate: 0.09700299999999835
  momentum: 0.49191919191921857
  total_seconds_last_epoch: 125.846006999999686
  train_h0_col_norms_max: 0.7500000000000133
  train_h0_col_norms_mean: 0.7470938867479627
  train_h0_col_norms_min: 0.7082412235832144
  train_h0_max_x_max_u: 0.8140505291692006
  train_h0_max_x_mean_u: 0.21313598112057472
  train_h0_max_x_min_u: 0.0001446520130330937
  train_h0_mean_x_max_u: 0.3090608133622316
  train_h0_mean_x_mean_u: 0.04033942182396673
  train_h0_mean_x_min_u: 2.500872583560353e-06
  train_h0_min_x_max_u: 0.05193257917963835
  train_h0_min_x_mean_u: 0.0018110758543734965
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.8001341444607283
  train_h0_range_x_mean_u: 0.21132490526620132
  train_h0_range_x_min_u: 0.0001446520130330937
  train_h0_row_norms_max: 0.8222287955117946
  train_h0_row_norms_mean: 0.4620861028950632
  train_h0_row_norms_min: 0.20046631399748008
  train_h1_col_norms_max: 0.7500000000000133
  train_h1_col_norms_mean: 0.7477169454390996

```

```

train_h1.col_norms_min: 0.7328332315681095
train_h1.max_x_max_u: 0.625580791302848
train_h1.max_x_mean_u: 0.11193293849129453
train_h1.max_x_min_u: 0.0
train_h1.mean_x_max_u: 0.22183786468164052
train_h1.mean_x_mean_u: 0.024952605184594974
train_h1.mean_x_min_u: 0.0
train_h1.min_x_max_u: 0.04094026154791718
train_h1.min_x_mean_u: 0.0011568430748240795
train_h1.min_x_min_u: 0.0
train_h1.range_x_max_u: 0.6173214548458521
train_h1.range_x_mean_u: 0.1107760954164702
train_h1.range_x_min_u: 0.0
train_h1.row_norms_max: 1.1732206740127382
train_h1.row_norms_mean: 0.7345255021608496
train_h1.row_norms_min: 0.3218957253819573
train_h2.col_norms_max: 0.75000000000000133
train_h2.col_norms_mean: 0.7488449455615598
train_h2.col_norms_min: 0.7344090857378504
train_h2.max_x_max_u: 0.8264758194940732
train_h2.max_x_mean_u: 0.07219558551458606
train_h2.max_x_min_u: 0.0
train_h2.mean_x_max_u: 0.3094393124975079
train_h2.mean_x_mean_u: 0.018562180051974533
train_h2.mean_x_min_u: 0.0
train_h2.min_x_max_u: 0.05243535480051849
train_h2.min_x_mean_u: 0.0008551659385778987
train_h2.min_x_min_u: 0.0
train_h2.range_x_max_u: 0.8089317074469229
train_h2.range_x_mean_u: 0.07134041957600802
train_h2.range_x_min_u: 0.0
train_h2.row_norms_max: 1.2185694858814906
train_h2.row_norms_mean: 0.7332657005744209
train_h2.row_norms_min: 0.31358167322213626
train_objective: 0.5835418342768856
train_y.col_norms_max: 1.5748310318416205
train_y.col_norms_mean: 1.5748310318416205
train_y.col_norms_min: 1.5748310318416205
train_y.max_max_class: 0.8828906807130527
train_y.mean_max_class: 0.6903779274649476
train_y.min_max_class: 0.5088142294239776
train_y.misclass: 0.3081989376230344
train_y.nll: 0.5662297682745878
train_y.row_norms_max: 0.6036902307664942
train_y.row_norms_mean: 0.0676132148996185
train_y.row_norms_min: 0.00024306662659521826
training_seconds_this_epoch: 68.7694820000002
valid_h0.col_norms_max: 0.75000000000000031
valid_h0.col_norms_mean: 0.7470938867479249
valid_h0.col_norms_min: 0.7082412235832284
valid_h0.max_x_max_u: 1.0388300488382265
valid_h0.max_x_mean_u: 0.21142145187970088
valid_h0.max_x_min_u: 0.0
valid_h0.mean_x_max_u: 0.6166982633233543

```

valid\_h0\_mean\_x\_mean\_u: 0.07372478841538813  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.27331855811397665  
valid\_h0\_min\_x\_mean\_u: 0.010712593084205713  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.9710349423133205  
valid\_h0\_range\_x\_mean\_u: 0.20070885879549516  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.8222287955118112  
valid\_h0\_row\_norms\_mean: 0.4620861028950465  
valid\_h0\_row\_norms\_min: 0.20046631399748666  
valid\_h1\_col\_norms\_max: 0.75000000000000031  
valid\_h1\_col\_norms\_mean: 0.7477169454391129  
valid\_h1\_col\_norms\_min: 0.7328332315681408  
valid\_h1\_max\_x\_max\_u: 0.9363180462418319  
valid\_h1\_max\_x\_mean\_u: 0.13938453627283817  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.4617226066011931  
valid\_h1\_mean\_x\_mean\_u: 0.05060588660700472  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.16387005481261538  
valid\_h1\_min\_x\_mean\_u: 0.006217581898282679  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.9073107346094943  
valid\_h1\_range\_x\_mean\_u: 0.13316695437455545  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1732206740126927  
valid\_h1\_row\_norms\_mean: 0.7345255021608348  
valid\_h1\_row\_norms\_min: 0.3218957253819661  
valid\_h2\_col\_norms\_max: 0.75000000000000031  
valid\_h2\_col\_norms\_mean: 0.7488449455615616  
valid\_h2\_col\_norms\_min: 0.7344090857378263  
valid\_h2\_max\_x\_max\_u: 1.325672813701017  
valid\_h2\_max\_x\_mean\_u: 0.08443754416081752  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.508471853677256  
valid\_h2\_mean\_x\_mean\_u: 0.02731517387672462  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.1110167788771479  
valid\_h2\_min\_x\_mean\_u: 0.0023874169697229866  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 1.2952823125836819  
valid\_h2\_range\_x\_mean\_u: 0.08205012719109449  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2185694858814722  
valid\_h2\_row\_norms\_mean: 0.7332657005743957  
valid\_h2\_row\_norms\_min: 0.3135816732221244  
valid\_objective: 0.768836490810441  
valid\_y\_col\_norms\_max: 1.5748310318416865  
valid\_y\_col\_norms\_mean: 1.5748310318416865  
valid\_y\_col\_norms\_min: 1.5748310318416865  
valid\_y\_max\_max\_class: 0.9463975329104414  
valid\_y\_mean\_max\_class: 0.7404413794786366  
valid\_y\_min\_max\_class: 0.5266243185609297

```

valid_y_misclass: 0.3602433410062485
valid_y_nll: 0.6135515984075515
valid_y_row_norms_max: 0.603690230766498
valid_y_row_norms_mean: 0.0676132148996157
valid_y_row_norms_min: 0.0002430666265952075
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.046600 seconds
Time this epoch: 0:01:07.514131
Monitoring step:
  Epochs seen: 4
  Batches seen: 8760
  Examples seen: 875772
  learning_rate: 0.09600400000000113
  momentum: 0.4878787878788037
  total_seconds_last_epoch: 125.96943500000437
  train_h0_col_norms_max: 0.7500000000000133
  train_h0_col_norms_mean: 0.7466208727542794
  train_h0_col_norms_min: 0.7127799865714616
  train_h0_max_x_max_u: 0.9352745126119711
  train_h0_max_x_mean_u: 0.2131682973600939
  train_h0_max_x_min_u: 1.5255436971142117e-05
  train_h0_mean_x_max_u: 0.3684920263954359
  train_h0_mean_x_mean_u: 0.03607616579968353
  train_h0_mean_x_min_u: 1.9107624733079975e-07
  train_h0_min_x_max_u: 0.06752359874546116
  train_h0_min_x_mean_u: 0.0013686890191035475
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.9092732355664822
  train_h0_range_x_mean_u: 0.21179960834099054
  train_h0_range_x_min_u: 1.5255436971142117e-05
  train_h0_row_norms_max: 0.788878439503823
  train_h0_row_norms_mean: 0.46562732823392317
  train_h0_row_norms_min: 0.23930112203700268
  train_h1_col_norms_max: 0.7500000000000133
  train_h1_col_norms_mean: 0.747938607482372
  train_h1_col_norms_min: 0.7338938703416977
  train_h1_max_x_max_u: 0.6212407232218082
  train_h1_max_x_mean_u: 0.10274844161635033
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.23502554619355248
  train_h1_mean_x_mean_u: 0.021187255420553053
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.050340407867372705
  train_h1_min_x_mean_u: 0.0009036276902523375
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.6119406725376998
  train_h1_range_x_mean_u: 0.10184481392609798
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.1702448082560424
  train_h1_row_norms_mean: 0.7353944207955142
  train_h1_row_norms_min: 0.33220575696927324
  train_h2_col_norms_max: 0.7500000000000133
  train_h2_col_norms_mean: 0.7488665344750893
  train_h2_col_norms_min: 0.7364194651852809

```

train\_h2\_max\_x\_max\_u: 0.7080528988564564  
train\_h2\_max\_x\_mean\_u: 0.06280078375188283  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.24064019615219517  
train\_h2\_mean\_x\_mean\_u: 0.016152420782833157  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.05274501731472051  
train\_h2\_min\_x\_mean\_u: 0.0009598702063357108  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6931493768200491  
train\_h2\_range\_x\_mean\_u: 0.06184091354554706  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2117705719808314  
train\_h2\_row\_norms\_mean: 0.733625912469266  
train\_h2\_row\_norms\_min: 0.3118703089587701  
train\_objective: 0.5632630085496856  
train\_y\_col\_norms\_max: 1.7573697488992184  
train\_y\_col\_norms\_mean: 1.7573697488992182  
train\_y\_col\_norms\_min: 1.7573697488992182  
train\_y\_max\_max\_class: 0.8804670707935657  
train\_y\_mean\_max\_class: 0.6729121852267744  
train\_y\_min\_max\_class: 0.5068320899930355  
train\_y\_misclass: 0.2944008257857068  
train\_y\_nll: 0.5568125606503675  
train\_y\_row\_norms\_max: 0.6605730073920789  
train\_y\_row\_norms\_mean: 0.07757066663696377  
train\_y\_row\_norms\_min: 0.00019404790069563898  
training\_seconds\_this\_epoch: 67.51413099999797  
valid\_h0\_col\_norms\_max: 0.75000000000000031  
valid\_h0\_col\_norms\_mean: 0.7466208727543175  
valid\_h0\_col\_norms\_min: 0.7127799865714339  
valid\_h0\_max\_x\_max\_u: 1.2591552606050251  
valid\_h0\_max\_x\_mean\_u: 0.2051495896963607  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.750538330010624  
valid\_h0\_mean\_x\_mean\_u: 0.06507264406442524  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.370859594755028  
valid\_h0\_min\_x\_mean\_u: 0.008064136357009479  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.1440353989727443  
valid\_h0\_range\_x\_mean\_u: 0.19708545333935135  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7888784395038552  
valid\_h0\_row\_norms\_mean: 0.4656273282339407  
valid\_h0\_row\_norms\_min: 0.23930112203700998  
valid\_h1\_col\_norms\_max: 0.75000000000000031  
valid\_h1\_col\_norms\_mean: 0.7479386074823657  
valid\_h1\_col\_norms\_min: 0.733893870341716  
valid\_h1\_max\_x\_max\_u: 0.9260976362162362  
valid\_h1\_max\_x\_mean\_u: 0.12778821566649923  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.46858324099262944  
valid\_h1\_mean\_x\_mean\_u: 0.042376592254645795

```

valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.19111724936223726
valid_h1_min_x_mean_u: 0.004438437686383736
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.9003166153927876
valid_h1_range_x_mean_u: 0.12334977798011555
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.170244808256011
valid_h1_row_norms_mean: 0.7353944207955153
valid_h1_row_norms_min: 0.332205756969276
valid_h2_col_norms_max: 0.7500000000000031
valid_h2_col_norms_mean: 0.7488665344751002
valid_h2_col_norms_min: 0.7364194651852592
valid_h2_max_x_max_u: 1.189441411704538
valid_h2_max_x_mean_u: 0.07152726768043942
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.37034747763342973
valid_h2_mean_x_mean_u: 0.020059220779606337
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.06906075452926748
valid_h2_min_x_mean_u: 0.0009886194493043208
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 1.1824838704473386
valid_h2_range_x_mean_u: 0.07053864823113509
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.211770571980788
valid_h2_row_norms_mean: 0.7336259124692744
valid_h2_row_norms_min: 0.31187030895877565
valid_objective: 0.6497675408558871
valid_y_col_norms_max: 1.7573697488991933
valid_y_col_norms_mean: 1.7573697488991933
valid_y_col_norms_min: 1.7573697488991928
valid_y_max_max_class: 0.9159741522953232
valid_y_mean_max_class: 0.6866799704653426
valid_y_min_max_class: 0.5045418612956585
valid_y_misclass: 0.296941795462019
valid_y_nll: 0.5500523136960185
valid_y_row_norms_max: 0.6605730073921013
valid_y_row_norms_mean: 0.07757066663696387
valid_y_row_norms_min: 0.000194047900695645
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.046600 seconds
Time this epoch: 0:01:08.042267
Monitoring step:
  Epochs seen: 5
  Batches seen: 10950
  Examples seen: 1094715
  learning_rate: 0.09500500000000271
  momentum: 0.4838383838384005
  total_seconds_last_epoch: 124.73061399999412
  train_h0_col_norms_max: 0.7500000000000134
  train_h0_col_norms_mean: 0.746362563093159
  train_h0_col_norms_min: 0.717138128842506
  train_h0_max_x_max_u: 0.9110744474712641

```

```

train_h0_max_x_mean_u: 0.2186602086789747
train_h0_max_x_min_u: 0.0
train_h0_mean_x_max_u: 0.31347726272117993
train_h0_mean_x_mean_u: 0.03409844134693248
train_h0_mean_x_min_u: 0.0
train_h0_min_x_max_u: 0.041982427858138646
train_h0_min_x_mean_u: 0.0010073520312521896
train_h0_min_x_min_u: 0.0
train_h0_range_x_max_u: 0.8999365106642901
train_h0_range_x_mean_u: 0.21765285664772246
train_h0_range_x_min_u: 0.0
train_h0_row_norms_max: 0.7745134804429944
train_h0_row_norms_mean: 0.4685792376852953
train_h0_row_norms_min: 0.28831553764520407
train_h1_col_norms_max: 0.75000000000000133
train_h1_col_norms_mean: 0.7480492302557576
train_h1_col_norms_min: 0.7355545531430145
train_h1_max_x_max_u: 0.6056164236578389
train_h1_max_x_mean_u: 0.10726500626863757
train_h1_max_x_min_u: 0.0
train_h1_mean_x_max_u: 0.21383473780798845
train_h1_mean_x_mean_u: 0.021161424342921207
train_h1_mean_x_min_u: 0.0
train_h1_min_x_max_u: 0.05705806667075663
train_h1_min_x_mean_u: 0.0007838599606376383
train_h1_min_x_min_u: 0.0
train_h1_range_x_max_u: 0.5987723381535623
train_h1_range_x_mean_u: 0.10648114630800003
train_h1_range_x_min_u: 0.0
train_h1_row_norms_max: 1.2022923112957196
train_h1_row_norms_mean: 0.7363201168627393
train_h1_row_norms_min: 0.34706295138440085
train_h2_col_norms_max: 0.75000000000000133
train_h2_col_norms_mean: 0.7489343917601144
train_h2_col_norms_min: 0.7414626925828716
train_h2_max_x_max_u: 0.7955043351247318
train_h2_max_x_mean_u: 0.07041440591096139
train_h2_max_x_min_u: 0.0
train_h2_mean_x_max_u: 0.26187353583065615
train_h2_mean_x_mean_u: 0.018598525912200445
train_h2_mean_x_min_u: 0.0
train_h2_min_x_max_u: 0.06565753140040657
train_h2_min_x_mean_u: 0.0013327027803293411
train_h2_min_x_min_u: 0.0
train_h2_range_x_max_u: 0.774061791550514
train_h2_range_x_mean_u: 0.06908170313063206
train_h2_range_x_min_u: 0.0
train_h2_row_norms_max: 1.210613479237067
train_h2_row_norms_mean: 0.7339275503855635
train_h2_row_norms_min: 0.31390289956379197
train_objective: 0.5470809679189348
train_y_col_norms_max: 1.9354535652300193
train_y_col_norms_mean: 1.9354535652300193
train_y_col_norms_min: 1.9354535652300193

```



train\_y\_max\_max\_class: 0.9140471734056744  
train\_y\_mean\_max\_class: 0.7035057458970274  
train\_y\_min\_max\_class: 0.511214730936423  
train\_y\_misclass: 0.267937317018585  
train\_y\_nll: 0.5109393080597683  
train\_y\_row\_norms\_max: 0.692840004229418  
train\_y\_row\_norms\_mean: 0.08676780375407397  
train\_y\_row\_norms\_min: 0.00025370941052695495  
training\_seconds\_this\_epoch: 68.0422669999984  
valid\_h0\_col\_norms\_max: 0.7500000000000032  
valid\_h0\_col\_norms\_mean: 0.7463625630931715  
valid\_h0\_col\_norms\_min: 0.7171381288424721  
valid\_h0\_max\_x\_max\_u: 1.1671971395659118  
valid\_h0\_max\_x\_mean\_u: 0.20786031427031137  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6374220734354363  
valid\_h0\_mean\_x\_mean\_u: 0.06119874333124884  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.24806367449597277  
valid\_h0\_min\_x\_mean\_u: 0.006474373163418947  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.110504405851241  
valid\_h0\_range\_x\_mean\_u: 0.20138594110689237  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7745134804429653  
valid\_h0\_row\_norms\_mean: 0.46857923768530374  
valid\_h0\_row\_norms\_min: 0.2883155376452156  
valid\_h1\_col\_norms\_max: 0.7500000000000032  
valid\_h1\_col\_norms\_mean: 0.7480492302557805  
valid\_h1\_col\_norms\_min: 0.7355545531429998  
valid\_h1\_max\_x\_max\_u: 0.9494387326500915  
valid\_h1\_max\_x\_mean\_u: 0.13582074782942113  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.43578152692389444  
valid\_h1\_mean\_x\_mean\_u: 0.04367981515194772  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.16636491369775974  
valid\_h1\_min\_x\_mean\_u: 0.0041503203161215325  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.9135813156140334  
valid\_h1\_range\_x\_mean\_u: 0.1316704275132996  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.2022923112957056  
valid\_h1\_row\_norms\_mean: 0.7363201168627403  
valid\_h1\_row\_norms\_min: 0.3470629513843911  
valid\_h2\_col\_norms\_max: 0.7500000000000031  
valid\_h2\_col\_norms\_mean: 0.7489343917600897  
valid\_h2\_col\_norms\_min: 0.7414626925828522  
valid\_h2\_max\_x\_max\_u: 1.572106602722805  
valid\_h2\_max\_x\_mean\_u: 0.09083015654643595  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.5522214891967253  
valid\_h2\_mean\_x\_mean\_u: 0.028534685430861125  
valid\_h2\_mean\_x\_min\_u: 0.0

```

valid_h2_min_x_max_u: 0.0949669677875194
valid_h2_min_x_mean_u: 0.0021050579193110175
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 1.541319378655042
valid_h2_range_x_mean_u: 0.08872509862712498
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2106134792370913
valid_h2_row_norms_mean: 0.7339275503855375
valid_h2_row_norms_min: 0.31390289956379197
valid_objective: 0.7914134327003026
valid_y_col_norms_max: 1.9354535652300957
valid_y_col_norms_mean: 1.9354535652300957
valid_y_col_norms_min: 1.9354535652300957
valid_y_max_max_class: 0.9674888018584832
valid_y_mean_max_class: 0.7614038929936461
valid_y_min_max_class: 0.5212824178705266
valid_y_misclass: 0.34782966129562654
valid_y_nll: 0.6452097833472878
valid_y_row_norms_max: 0.6928400042294371
valid_y_row_norms_mean: 0.08676780375407529
valid_y_row_norms_min: 0.00025370941052694547
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.062304 seconds
Time this epoch: 0:01:07.727878
Monitoring step:
  Epochs seen: 6
  Batches seen: 13140
  Examples seen: 1313658
  learning_rate: 0.094006000000000041
  momentum: 0.479797979797979866
  total_seconds_last_epoch: 124.93408899999748
  train_h0_col_norms_max: 0.750000000000000133
  train_h0_col_norms_mean: 0.7461915107831197
  train_h0_col_norms_min: 0.7143918175182926
  train_h0_max_x_max_u: 0.9362197414856316
  train_h0_max_x_mean_u: 0.22398174009177652
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.31494011262368465
  train_h0_mean_x_mean_u: 0.03334425601564053
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.03581936464126542
  train_h0_min_x_mean_u: 0.0007042589690864118
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.926003376990911
  train_h0_range_x_mean_u: 0.22327748112268986
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.754233907871988
  train_h0_row_norms_mean: 0.4706827505135513
  train_h0_row_norms_min: 0.3114757219080947
  train_h1_col_norms_max: 0.750000000000000133
  train_h1_col_norms_mean: 0.7479424931023732
  train_h1_col_norms_min: 0.7287577630901727
  train_h1_max_x_max_u: 0.6943308481805709
  train_h1_max_x_mean_u: 0.10999750614356371

```

train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.2289466623255645  
train\_h1\_mean\_x\_mean\_u: 0.020819582686351982  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.03227462454242669  
train\_h1\_min\_x\_mean\_u: 0.0005446130174044431  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6817764282791304  
train\_h1\_range\_x\_mean\_u: 0.10945289312615933  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.2192577184226165  
train\_h1\_row\_norms\_mean: 0.7369258059220276  
train\_h1\_row\_norms\_min: 0.34840055739630493  
train\_h2\_col\_norms\_max: 0.75000000000000133  
train\_h2\_col\_norms\_mean: 0.7488470215531587  
train\_h2\_col\_norms\_min: 0.739558628263154  
train\_h2\_max\_x\_max\_u: 0.8178320419942311  
train\_h2\_max\_x\_mean\_u: 0.06877784967317235  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2660082590324401  
train\_h2\_mean\_x\_mean\_u: 0.01788013384758645  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.05973891458297777  
train\_h2\_min\_x\_mean\_u: 0.001174703088664305  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.7990478106338871  
train\_h2\_range\_x\_mean\_u: 0.06760314658450814  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2011198455675671  
train\_h2\_row\_norms\_mean: 0.7342350107786615  
train\_h2\_row\_norms\_min: 0.32052606173044856  
train\_objective: 0.5312838681714682  
train\_y\_col\_norms\_max: 2.006711619885824  
train\_y\_col\_norms\_mean: 2.006711619885824  
train\_y\_col\_norms\_min: 2.006711619885824  
train\_y\_max\_max\_class: 0.9200964116123136  
train\_y\_mean\_max\_class: 0.701053443459259  
train\_y\_min\_max\_class: 0.5106332996126101  
train\_y\_misclass: 0.24410462997218502  
train\_y\_nll: 0.49563880537336735  
train\_y\_row\_norms\_max: 0.7021024697832117  
train\_y\_row\_norms\_mean: 0.090743142812647  
train\_y\_row\_norms\_min: 3.181211133262821e-05  
training\_seconds\_this\_epoch: 67.72787799999722  
valid\_h0\_col\_norms\_max: 0.75000000000000032  
valid\_h0\_col\_norms\_mean: 0.7461915107831504  
valid\_h0\_col\_norms\_min: 0.7143918175182816  
valid\_h0\_max\_x\_max\_u: 1.2016450836766195  
valid\_h0\_max\_x\_mean\_u: 0.21383197309055874  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.63102959996325  
valid\_h0\_mean\_x\_mean\_u: 0.060451806383582316  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.21829768775312397

valid\_h0\_min\_x\_mean\_u: 0.004423779503136431  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.1355060687789202  
valid\_h0\_range\_x\_mean\_u: 0.2094081935874222  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7542339078720124  
valid\_h0\_row\_norms\_mean: 0.4706827505135686  
valid\_h0\_row\_norms\_min: 0.3114757219080978  
valid\_h1\_col\_norms\_max: 0.7500000000000031  
valid\_h1\_col\_norms\_mean: 0.7479424931023448  
valid\_h1\_col\_norms\_min: 0.7287577630901441  
valid\_h1\_max\_x\_max\_u: 1.1498053114126559  
valid\_h1\_max\_x\_mean\_u: 0.1429606625779614  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.5340343749299284  
valid\_h1\_mean\_x\_mean\_u: 0.04256722771174558  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.12632062559431495  
valid\_h1\_min\_x\_mean\_u: 0.0026917427765043114  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 1.0943210183234553  
valid\_h1\_range\_x\_mean\_u: 0.14026891980145717  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.2192577184226352  
valid\_h1\_row\_norms\_mean: 0.7369258059220616  
valid\_h1\_row\_norms\_min: 0.3484005573963162  
valid\_h2\_col\_norms\_max: 0.7500000000000002  
valid\_h2\_col\_norms\_mean: 0.7488470215531278  
valid\_h2\_col\_norms\_min: 0.7395586282631805  
valid\_h2\_max\_x\_max\_u: 1.6922538076555578  
valid\_h2\_max\_x\_mean\_u: 0.08692550878603648  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.5759497713669678  
valid\_h2\_mean\_x\_mean\_u: 0.024416939414455722  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.08783135948351188  
valid\_h2\_min\_x\_mean\_u: 0.0012611625490949543  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 1.6694323568252691  
valid\_h2\_range\_x\_mean\_u: 0.0856643462369416  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2011198455675836  
valid\_h2\_row\_norms\_mean: 0.7342350107786819  
valid\_h2\_row\_norms\_min: 0.320526061730446  
valid\_objective: 0.7289950113117405  
valid\_y\_col\_norms\_max: 2.0067116198859263  
valid\_y\_col\_norms\_mean: 2.0067116198859263  
valid\_y\_col\_norms\_min: 2.0067116198859263  
valid\_y\_max\_max\_class: 0.9542238494837686  
valid\_y\_mean\_max\_class: 0.7348966308952297  
valid\_y\_min\_max\_class: 0.5090958871922877  
valid\_y\_misclass: 0.32744163104242036  
valid\_y\_nll: 0.5842508325944951  
valid\_y\_row\_norms\_max: 0.7021024697832328

```

    valid_y_row_norms_mean: 0.09074314281264861
    valid_y_row_norms_min: 3.181211133262977e-05
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.062304 seconds
Time this epoch: 0:01:08.132857
Monitoring step:
    Epochs seen: 7
    Batches seen: 15330
    Examples seen: 1532601
    learning_rate: 0.09300700000000306
    momentum: 0.47575757575756794
    total_seconds_last_epoch: 124.23996600000211
    train_h0_col_norms_max: 0.7500000000000133
    train_h0_col_norms_mean: 0.7458581489383941
    train_h0_col_norms_min: 0.7059891298750844
    train_h0_max_x_max_u: 0.9583143769287517
    train_h0_max_x_mean_u: 0.2277055817098441
    train_h0_max_x_min_u: 0.0
    train_h0_mean_x_max_u: 0.30927514786507115
    train_h0_mean_x_mean_u: 0.03272049564761768
    train_h0_mean_x_min_u: 0.0
    train_h0_min_x_max_u: 0.041437764227530066
    train_h0_min_x_mean_u: 0.0007536685096337203
    train_h0_min_x_min_u: 0.0
    train_h0_range_x_max_u: 0.9475170184952516
    train_h0_range_x_mean_u: 0.2269519132002105
    train_h0_range_x_min_u: 0.0
    train_h0_row_norms_max: 0.7278158439804363
    train_h0_row_norms_mean: 0.47203291390415414
    train_h0_row_norms_min: 0.33013046583179906
    train_h1_col_norms_max: 0.7500000000000133
    train_h1_col_norms_mean: 0.7478770388068288
    train_h1_col_norms_min: 0.7361461833743741
    train_h1_max_x_max_u: 0.7215899505257154
    train_h1_max_x_mean_u: 0.11509847685786262
    train_h1_max_x_min_u: 0.0
    train_h1_mean_x_max_u: 0.23729083245988275
    train_h1_mean_x_mean_u: 0.022280604560570683
    train_h1_mean_x_min_u: 0.0
    train_h1_min_x_max_u: 0.03260275918471007
    train_h1_min_x_mean_u: 0.0007508315864761423
    train_h1_min_x_min_u: 0.0
    train_h1_range_x_max_u: 0.7093182467370827
    train_h1_range_x_mean_u: 0.1143476452713864
    train_h1_range_x_min_u: 0.0
    train_h1_row_norms_max: 1.224843336664756
    train_h1_row_norms_mean: 0.7375214377355218
    train_h1_row_norms_min: 0.3510240415700196
    train_h2_col_norms_max: 0.7500000000000133
    train_h2_col_norms_mean: 0.7489604068769811
    train_h2_col_norms_min: 0.7398204687245914
    train_h2_max_x_max_u: 0.9004394457837376
    train_h2_max_x_mean_u: 0.07242064358671321
    train_h2_max_x_min_u: 0.0

```

train\_h2\_mean\_x\_max\_u: 0.2918497859138653  
train\_h2\_mean\_x\_mean\_u: 0.018838011510164673  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.06731507434252691  
train\_h2\_min\_x\_mean\_u: 0.0012928271829746826  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.8793080164630568  
train\_h2\_range\_x\_mean\_u: 0.07112781640373839  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1953855234456534  
train\_h2\_row\_norms\_mean: 0.7346374337374849  
train\_h2\_row\_norms\_min: 0.32379991570344935  
train\_objective: 0.5222991981445043  
train\_y\_col\_norms\_max: 2.1720021914693795  
train\_y\_col\_norms\_mean: 2.1720021914693795  
train\_y\_col\_norms\_min: 2.1720021914693795  
train\_y\_max\_max\_class: 0.9313527913637529  
train\_y\_mean\_max\_class: 0.7171716122412555  
train\_y\_min\_max\_class: 0.513067695828297  
train\_y\_misclass: 0.23972906190195648  
train\_y\_nll: 0.4805341168749321  
train\_y\_row\_norms\_max: 0.7290198934767037  
train\_y\_row\_norms\_mean: 0.09906939280187757  
train\_y\_row\_norms\_min: 0.0005522811936740708  
training\_seconds\_this\_epoch: 68.13285699999784  
valid\_h0\_col\_norms\_max: 0.7500000000000032  
valid\_h0\_col\_norms\_mean: 0.7458581489384015  
valid\_h0\_col\_norms\_min: 0.7059891298750642  
valid\_h0\_max\_x\_max\_u: 1.2126178654183102  
valid\_h0\_max\_x\_mean\_u: 0.21727822735897928  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6355516208602296  
valid\_h0\_mean\_x\_mean\_u: 0.059830248164151646  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.23490510655134134  
valid\_h0\_min\_x\_mean\_u: 0.004716972472226609  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.16140783014118  
valid\_h0\_range\_x\_mean\_u: 0.21256125488675273  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7278158439804597  
valid\_h0\_row\_norms\_mean: 0.47203291390417407  
valid\_h0\_row\_norms\_min: 0.33013046583180017  
valid\_h1\_col\_norms\_max: 0.7500000000000032  
valid\_h1\_col\_norms\_mean: 0.7478770388068124  
valid\_h1\_col\_norms\_min: 0.7361461833743981  
valid\_h1\_max\_x\_max\_u: 1.21958260179543  
valid\_h1\_max\_x\_mean\_u: 0.15599745628973682  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.57758766257692  
valid\_h1\_mean\_x\_mean\_u: 0.04952115934307923  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.16097839739779565  
valid\_h1\_min\_x\_mean\_u: 0.00436516633364814

```

valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 1.1434879260951034
valid_h1_range_x_mean_u: 0.15163228995608868
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.2248433366647808
valid_h1_row_norms_mean: 0.7375214377355186
valid_h1_row_norms_min: 0.35102404157001815
valid_h2_col_norms_max: 0.75000000000000031
valid_h2_col_norms_mean: 0.748960406876955
valid_h2_col_norms_min: 0.7398204687245504
valid_h2_max_x_max_u: 1.9747375570501986
valid_h2_max_x_mean_u: 0.0968765167726842
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.7263638065754173
valid_h2_mean_x_mean_u: 0.02988199468843105
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.1340393244376236
valid_h2_min_x_mean_u: 0.0022912145250115904
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 1.927774422229096
valid_h2_range_x_mean_u: 0.09458530224767257
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.1953855234456308
valid_h2_row_norms_mean: 0.7346374337374506
valid_h2_row_norms_min: 0.3237999157034374
valid_objective: 0.893278366390303
valid_y_col_norms_max: 2.1720021914694385
valid_y_col_norms_mean: 2.1720021914694385
valid_y_col_norms_min: 2.1720021914694385
valid_y_max_max_class: 0.9751938988138786
valid_y_mean_max_class: 0.7828413551841776
valid_y_min_max_class: 0.5286676486300267
valid_y_misclass: 0.3726159158171657
valid_y_nll: 0.7130982923470842
valid_y_row_norms_max: 0.7290198934767173
valid_y_row_norms_mean: 0.09906939280187468
valid_y_row_norms_min: 0.000552281193674059
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.046728 seconds
Time this epoch: 0:01:08.275573
Monitoring step:
  Epochs seen: 8
  Batches seen: 17520
  Examples seen: 1751544
  learning_rate: 0.09200800000000442
  momentum: 0.4717171717171533
  total_seconds_last_epoch: 125.09765000000453
  train_h0_col_norms_max: 0.7500000000000133
  train_h0_col_norms_mean: 0.7456509978444977
  train_h0_col_norms_min: 0.715644535816947
  train_h0_max_x_max_u: 0.9413296601616066
  train_h0_max_x_mean_u: 0.22603735543457634
  train_h0_max_x_min_u: 1.0834090699608324e-05
  train_h0_mean_x_max_u: 0.2855173147923086

```

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train_h0_mean_x_mean_u: 0.03083065537449824
train_h0_mean_x_min_u: 1.5409931540524485e-07
train_h0_min_x_max_u: 0.03335630465383132
train_h0_min_x_mean_u: 0.0005328811224270929
train_h0_min_x_min_u: 0.0
train_h0_range_x_max_u: 0.9338553483077563
train_h0_range_x_mean_u: 0.2255044743121493
train_h0_range_x_min_u: 1.0834090699608324e-05
train_h0_row_norms_max: 0.6832470645018476
train_h0_row_norms_mean: 0.472956715276702
train_h0_row_norms_min: 0.3528458471429237
train_h1_col_norms_max: 0.75000000000000133
train_h1_col_norms_mean: 0.7479287211255903
train_h1_col_norms_min: 0.735282565741418
train_h1_max_x_max_u: 0.7255696549874566
train_h1_max_x_mean_u: 0.10824640149477202
train_h1_max_x_min_u: 0.0
train_h1_mean_x_max_u: 0.22918874268055378
train_h1_mean_x_mean_u: 0.02001958583528055
train_h1_mean_x_min_u: 0.0
train_h1_min_x_max_u: 0.029379936793254336
train_h1_min_x_mean_u: 0.000514715017389766
train_h1_min_x_min_u: 0.0
train_h1_range_x_max_u: 0.7146450429232424
train_h1_range_x_mean_u: 0.10773168647738209
train_h1_range_x_min_u: 0.0
train_h1_row_norms_max: 1.2348266646180026
train_h1_row_norms_mean: 0.7382105178008708
train_h1_row_norms_min: 0.37265324831172586
train_h2_col_norms_max: 0.75000000000000133
train_h2_col_norms_mean: 0.7489455845904052
train_h2_col_norms_min: 0.7381683985475801
train_h2_max_x_max_u: 0.7991205614562088
train_h2_max_x_mean_u: 0.06699245413000642
train_h2_max_x_min_u: 0.0
train_h2_mean_x_max_u: 0.26767605043267756
train_h2_mean_x_mean_u: 0.017512386836419074
train_h2_mean_x_min_u: 0.0
train_h2_min_x_max_u: 0.06247007439448337
train_h2_min_x_mean_u: 0.0011411341810360523
train_h2_min_x_min_u: 0.0
train_h2_range_x_max_u: 0.7754463132739432
train_h2_range_x_mean_u: 0.06585131994897031
train_h2_range_x_min_u: 0.0
train_h2_row_norms_max: 1.1927273498398132
train_h2_row_norms_mean: 0.7348902197077213
train_h2_row_norms_min: 0.3158741382762326
train_objective: 0.5158547515986837
train_y_col_norms_max: 2.296090816207134
train_y_col_norms_mean: 2.296090816207134
train_y_col_norms_min: 2.296090816207134
train_y_max_max_class: 0.9427706228717809
train_y_mean_max_class: 0.7184928085362148
train_y_min_max_class: 0.5097172266936147

```



train\_y\_misclass: 0.2256843105283113  
train\_y\_nll: 0.46761999131563864  
train\_y\_row\_norms\_max: 0.7413046228725446  
train\_y\_row\_norms\_mean: 0.10495487439457579  
train\_y\_row\_norms\_min: 0.00020364131912923984  
training\_seconds\_this\_epoch: 68.27557299999854  
valid\_h0\_col\_norms\_max: 0.75000000000000031  
valid\_h0\_col\_norms\_mean: 0.745650997844498  
valid\_h0\_col\_norms\_min: 0.7156445358169187  
valid\_h0\_max\_x\_max\_u: 1.1588631229271487  
valid\_h0\_max\_x\_mean\_u: 0.2134184836100586  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5972763172717713  
valid\_h0\_mean\_x\_mean\_u: 0.055838316429509476  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.21234100593802127  
valid\_h0\_min\_x\_mean\_u: 0.003487315174957329  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.1175097018081401  
valid\_h0\_range\_x\_mean\_u: 0.2099311684351015  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6832470645018679  
valid\_h0\_row\_norms\_mean: 0.47295671527672817  
valid\_h0\_row\_norms\_min: 0.35284584714293177  
valid\_h1\_col\_norms\_max: 0.75000000000000031  
valid\_h1\_col\_norms\_mean: 0.7479287211255695  
valid\_h1\_col\_norms\_min: 0.7352825657414113  
valid\_h1\_max\_x\_max\_u: 1.2553477158349473  
valid\_h1\_max\_x\_mean\_u: 0.14119251480821976  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.5857830325516447  
valid\_h1\_mean\_x\_mean\_u: 0.04137728564251608  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.14479258506002507  
valid\_h1\_min\_x\_mean\_u: 0.0028634434109971007  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 1.1777054951164028  
valid\_h1\_range\_x\_mean\_u: 0.13832907139722264  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.2348266646179873  
valid\_h1\_row\_norms\_mean: 0.7382105178008741  
valid\_h1\_row\_norms\_min: 0.3726532483117192  
valid\_h2\_col\_norms\_max: 0.75000000000000031  
valid\_h2\_col\_norms\_mean: 0.7489455845903751  
valid\_h2\_col\_norms\_min: 0.7381683985475925  
valid\_h2\_max\_x\_max\_u: 1.580730247408478  
valid\_h2\_max\_x\_mean\_u: 0.08071661737703116  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.5195476946812734  
valid\_h2\_mean\_x\_mean\_u: 0.02170426854632487  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.08004646983046595  
valid\_h2\_min\_x\_mean\_u: 0.0009170837284446486  
valid\_h2\_min\_x\_min\_u: 0.0

```

valid_h2_range_x_max_u: 1.5607767146413747
valid_h2_range_x_mean_u: 0.07979953364858655
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.1927273498398017
valid_h2_row_norms_mean: 0.7348902197077227
valid_h2_row_norms_min: 0.3158741382762312
valid_objective: 0.6724651306645538
valid_y_col_norms_max: 2.2960908162071365
valid_y_col_norms_mean: 2.2960908162071365
valid_y_col_norms_min: 2.2960908162071365
valid_y_max_max_class: 0.9499201757560035
valid_y_mean_max_class: 0.729323954589944
valid_y_min_max_class: 0.5072912030561882
valid_y_misclass: 0.30224432752384084
valid_y_nll: 0.5579368887024067
valid_y_row_norms_max: 0.7413046228725559
valid_y_row_norms_mean: 0.10495487439457984
valid_y_row_norms_min: 0.00020364131912925122
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.054970 seconds
Time this epoch: 0:01:11.842184
Monitoring step:
  Epochs seen: 9
  Batches seen: 19710
  Examples seen: 1970487
  learning_rate: 0.09100899999999755
  momentum: 0.46767676767675126
  total_seconds_last_epoch: 127.45476500000512
  train_h0_col_norms_max: 0.7500000000000133
  train_h0_col_norms_mean: 0.7458803044411387
  train_h0_col_norms_min: 0.7149884758605616
  train_h0_max_x_max_u: 0.9698659821745917
  train_h0_max_x_mean_u: 0.23149988037843772
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.2979249764721765
  train_h0_mean_x_mean_u: 0.03158397540422833
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.02872634791574139
  train_h0_min_x_mean_u: 0.0005577180371627057
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.9638373459232862
  train_h0_range_x_mean_u: 0.23094216234127482
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.6580874952896879
  train_h0_row_norms_mean: 0.4738731865209966
  train_h0_row_norms_min: 0.3651794677338768
  train_h1_col_norms_max: 0.7500000000000133
  train_h1_col_norms_mean: 0.7479286401119813
  train_h1_col_norms_min: 0.7334126310422263
  train_h1_max_x_max_u: 0.8209119559578001
  train_h1_max_x_mean_u: 0.12263074759573954
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.2759363016996906
  train_h1_mean_x_mean_u: 0.024069003397192645

```

train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.04144595784580035  
train\_h1\_min\_x\_mean\_u: 0.0008683649406187177  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.8017078674694235  
train\_h1\_range\_x\_mean\_u: 0.12176238265512063  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.2344298103222349  
train\_h1\_row\_norms\_mean: 0.7388331368478844  
train\_h1\_row\_norms\_min: 0.3953837429585867  
train\_h2\_col\_norms\_max: 0.75000000000000133  
train\_h2\_col\_norms\_mean: 0.7488819116725545  
train\_h2\_col\_norms\_min: 0.7392533918044085  
train\_h2\_max\_x\_max\_u: 1.0477525337381757  
train\_h2\_max\_x\_mean\_u: 0.07708538693426845  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.3374928076299086  
train\_h2\_mean\_x\_mean\_u: 0.020222769069155357  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.07150301048788425  
train\_h2\_min\_x\_mean\_u: 0.0014068699827204975  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 1.016539971942749  
train\_h2\_range\_x\_mean\_u: 0.07567851695154788  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1839689863208782  
train\_h2\_row\_norms\_mean: 0.7350887274455695  
train\_h2\_row\_norms\_min: 0.3172551188135313  
train\_objective: 0.5062780351060547  
train\_y\_col\_norms\_max: 2.384726658204615  
train\_y\_col\_norms\_mean: 2.384726658204615  
train\_y\_col\_norms\_min: 2.384726658204615  
train\_y\_max\_max\_class: 0.9487224056106534  
train\_y\_mean\_max\_class: 0.7368724308248916  
train\_y\_min\_max\_class: 0.5177266941288847  
train\_y\_misclass: 0.2171706791265311  
train\_y\_nll: 0.45222058072106813  
train\_y\_row\_norms\_max: 0.7465776254762809  
train\_y\_row\_norms\_mean: 0.10939726541314221  
train\_y\_row\_norms\_min: 0.0002474287649171913  
training\_seconds\_this\_epoch: 71.84218400000046  
valid\_h0\_col\_norms\_max: 0.75000000000000032  
valid\_h0\_col\_norms\_mean: 0.7458803044411825  
valid\_h0\_col\_norms\_min: 0.7149884758605607  
valid\_h0\_max\_x\_max\_u: 1.2206052067379836  
valid\_h0\_max\_x\_mean\_u: 0.22512678738905403  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5832129301052322  
valid\_h0\_mean\_x\_mean\_u: 0.06048691231413915  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.17499563417071648  
valid\_h0\_min\_x\_mean\_u: 0.0036897337071256395  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.1929428707546386

```
valid_h0_range_x_mean_u: 0.22143705368192834
valid_h0_range_x_min_u: 0.0
valid_h0_row_norms_max: 0.6580874952896643
valid_h0_row_norms_mean: 0.473873186521006
valid_h0_row_norms_min: 0.36517946773386323
valid_h1_col_norms_max: 0.75000000000000031
valid_h1_col_norms_mean: 0.7479286401119567
valid_h1_col_norms_min: 0.7334126310422504
valid_h1_max_x_max_u: 1.4691122236239826
valid_h1_max_x_mean_u: 0.1758754751940509
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.723166620587368
valid_h1_mean_x_mean_u: 0.05767660452621381
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.20220706296548818
valid_h1_min_x_mean_u: 0.004751270181129689
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 1.3553972404507086
valid_h1_range_x_mean_u: 0.1711242050129213
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.234429810322204
valid_h1_row_norms_mean: 0.7388331368478652
valid_h1_row_norms_min: 0.3953837429585972
valid_h2_col_norms_max: 0.75000000000000031
valid_h2_col_norms_mean: 0.7488819116725721
valid_h2_col_norms_min: 0.7392533918044152
valid_h2_max_x_max_u: 2.3712418798673984
valid_h2_max_x_mean_u: 0.10968787897608304
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.9403291116884719
valid_h2_mean_x_mean_u: 0.03549928188563659
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.14325475763711215
valid_h2_min_x_mean_u: 0.002511745615886858
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 2.2921152253311603
valid_h2_range_x_mean_u: 0.10717613336019621
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.18396898632089
valid_h2_row_norms_mean: 0.7350887274455703
valid_h2_row_norms_min: 0.31725511881351753
valid_objective: 0.9879704599545613
valid_y_col_norms_max: 2.3847266582045954
valid_y_col_norms_mean: 2.3847266582045954
valid_y_col_norms_min: 2.3847266582045954
valid_y_max_max_class: 0.9849411794611599
valid_y_mean_max_class: 0.8111081663967538
valid_y_min_max_class: 0.5332145706568477
valid_y_misclass: 0.36916310424202586
valid_y_nll: 0.8181132232341924
valid_y_row_norms_max: 0.7465776254763111
valid_y_row_norms_mean: 0.10939726541313813
valid_y_row_norms_min: 0.000247428764917197
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
```

Saving to ..\Sean\nn\_files\_S4C4R10\nn\_train.pkl done. Time elapsed: 0.059968 seconds

Time this epoch: 0:01:10.712794

Monitoring step:

Epochs seen: 10  
Batches seen: 21900  
Examples seen: 2189430  
learning\_rate: 0.09000999999999915  
momentum: 0.463636363636337  
total\_seconds\_last\_epoch: 131.91572700000415  
train\_h0\_col\_norms\_max: 0.7500000000000134  
train\_h0\_col\_norms\_mean: 0.7452453886232787  
train\_h0\_col\_norms\_min: 0.7159277817524147  
train\_h0\_max\_x\_max\_u: 1.0123449089806735  
train\_h0\_max\_x\_mean\_u: 0.22924813192385696  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.3584067125285652  
train\_h0\_mean\_x\_mean\_u: 0.03043311978234735  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.042036037970973224  
train\_h0\_min\_x\_mean\_u: 0.0005751723628823863  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.001158297487873  
train\_h0\_range\_x\_mean\_u: 0.228672959560975  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.6569323373608942  
train\_h0\_row\_norms\_mean: 0.4739182611159576  
train\_h0\_row\_norms\_min: 0.3688254650771182  
train\_h1\_col\_norms\_max: 0.7500000000000133  
train\_h1\_col\_norms\_mean: 0.7478338874211097  
train\_h1\_col\_norms\_min: 0.7324474141602278  
train\_h1\_max\_x\_max\_u: 0.7932393838445635  
train\_h1\_max\_x\_mean\_u: 0.11164164558372879  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.25746073871949715  
train\_h1\_mean\_x\_mean\_u: 0.020692048229913586  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.03692117253295245  
train\_h1\_min\_x\_mean\_u: 0.0006762610327131096  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.776542172607765  
train\_h1\_range\_x\_mean\_u: 0.11096538455101566  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.2266768813090387  
train\_h1\_row\_norms\_mean: 0.7394403511901803  
train\_h1\_row\_norms\_min: 0.4301282144541503  
train\_h2\_col\_norms\_max: 0.7500000000000133  
train\_h2\_col\_norms\_mean: 0.7488491796481656  
train\_h2\_col\_norms\_min: 0.7392496234715188  
train\_h2\_max\_x\_max\_u: 0.8845898444780651  
train\_h2\_max\_x\_mean\_u: 0.07105644366848382  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.29311484655036973  
train\_h2\_mean\_x\_mean\_u: 0.01916971629509184  
train\_h2\_mean\_x\_min\_u: 0.0

train\_h2\_min\_x\_max\_u: 0.06560788606461461  
train\_h2\_min\_x\_mean\_u: 0.0014462384640560968  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.8578824095862333  
train\_h2\_range\_x\_mean\_u: 0.06961020520442773  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1751599927631  
train\_h2\_row\_norms\_mean: 0.7352281100493917  
train\_h2\_row\_norms\_min: 0.3233258544479839  
train\_objective: 0.5048567637420238  
train\_y\_col\_norms\_max: 2.473275197149955  
train\_y\_col\_norms\_mean: 2.473275197149955  
train\_y\_col\_norms\_min: 2.473275197149955  
train\_y\_max\_max\_class: 0.9533716573466845  
train\_y\_mean\_max\_class: 0.7420290781476472  
train\_y\_min\_max\_class: 0.5209063629894196  
train\_y\_misclass: 0.2298452108539673  
train\_y\_nll: 0.4605237409817578  
train\_y\_row\_norms\_max: 0.7566287905145301  
train\_y\_row\_norms\_mean: 0.11354031468101441  
train\_y\_row\_norms\_min: 0.000520261945660268  
training\_seconds\_this\_epoch: 70.71279399999891  
valid\_h0\_col\_norms\_max: 0.7500000000000032  
valid\_h0\_col\_norms\_mean: 0.745245388623312  
valid\_h0\_col\_norms\_min: 0.7159277817523775  
valid\_h0\_max\_x\_max\_u: 1.2951366322309603  
valid\_h0\_max\_x\_mean\_u: 0.22289168666362355  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.7082259254465076  
valid\_h0\_mean\_x\_mean\_u: 0.05792049929257284  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.25573462965855576  
valid\_h0\_min\_x\_mean\_u: 0.0036804855838875818  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2260042396822104  
valid\_h0\_range\_x\_mean\_u: 0.21921120107973593  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6569323373609236  
valid\_h0\_row\_norms\_mean: 0.4739182611159391  
valid\_h0\_row\_norms\_min: 0.36882546507711406  
valid\_h1\_col\_norms\_max: 0.7500000000000031  
valid\_h1\_col\_norms\_mean: 0.7478338874210951  
valid\_h1\_col\_norms\_min: 0.7324474141602398  
valid\_h1\_max\_x\_max\_u: 1.35018316282303  
valid\_h1\_max\_x\_mean\_u: 0.14946670866829867  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.6364958886786035  
valid\_h1\_mean\_x\_mean\_u: 0.04487524369999741  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.17895940983099262  
valid\_h1\_min\_x\_mean\_u: 0.003523549465647755  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 1.264434572230719  
valid\_h1\_range\_x\_mean\_u: 0.14594315920265102

```

valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.2266768813090463
valid_h1_row_norms_mean: 0.7394403511901451
valid_h1_row_norms_min: 0.4301282144541311
valid_h2_col_norms_max: 0.7500000000000031
valid_h2_col_norms_mean: 0.7488491796481384
valid_h2_col_norms_min: 0.7392496234715111
valid_h2_max_x_max_u: 1.8371920521238043
valid_h2_max_x_mean_u: 0.08565262819452846
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.6619000199731124
valid_h2_mean_x_mean_u: 0.02551341531722759
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.09878606481057839
valid_h2_min_x_mean_u: 0.0016095780434497787
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 1.7931356705827894
valid_h2_range_x_mean_u: 0.08404305015107866
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.1751599927631629
valid_h2_row_norms_mean: 0.7352281100494188
valid_h2_row_norms_min: 0.3233258544479735
valid_objective: 0.714934633546771
valid_y_col_norms_max: 2.4732751971498073
valid_y_col_norms_mean: 2.4732751971498073
valid_y_col_norms_min: 2.4732751971498073
valid_y_max_max_class: 0.9642426600935247
valid_y_mean_max_class: 0.7584384820957448
valid_y_min_max_class: 0.5141152968205204
valid_y_misclass: 0.29858599145018083
valid_y_nll: 0.5762581776124472
valid_y_row_norms_max: 0.756628790514524
valid_y_row_norms_mean: 0.113540314681015
valid_y_row_norms_min: 0.0005202619456602862
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.049990 seconds
Time this epoch: 0:01:11.001797
Monitoring step:
  Epochs seen: 11
  Batches seen: 24090
  Examples seen: 2408373
  learning_rate: 0.08901099999999662
  momentum: 0.45959595959597815
  total_seconds_last_epoch: 129.85040299999704
  train_h0_col_norms_max: 0.7500000000000133
  train_h0_col_norms_mean: 0.7454370304250745
  train_h0_col_norms_min: 0.7168624281686554
  train_h0_max_x_max_u: 0.9611221331135029
  train_h0_max_x_mean_u: 0.22639236793227374
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.3099379160620064
  train_h0_mean_x_mean_u: 0.029085932761840582
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.029660171227895347

```

train\_h0\_min\_x\_mean\_u: 0.00038110830206657104  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.9532143366496125  
train\_h0\_range\_x\_mean\_u: 0.22601125963020724  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.6616674193918017  
train\_h0\_row\_norms\_mean: 0.4743234650868293  
train\_h0\_row\_norms\_min: 0.38370954400274926  
train\_h1\_col\_norms\_max: 0.75000000000000133  
train\_h1\_col\_norms\_mean: 0.7479353305212767  
train\_h1\_col\_norms\_min: 0.7312455967582911  
train\_h1\_max\_x\_max\_u: 0.7518162756680874  
train\_h1\_max\_x\_mean\_u: 0.11698669753298521  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.23197005070275747  
train\_h1\_mean\_x\_mean\_u: 0.021017553984669264  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.02681400868913953  
train\_h1\_min\_x\_mean\_u: 0.0005879864696918227  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.7382970574795364  
train\_h1\_range\_x\_mean\_u: 0.11639871106329346  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.2087075840555153  
train\_h1\_row\_norms\_mean: 0.7401111369688768  
train\_h1\_row\_norms\_min: 0.44244314653732253  
train\_h2\_col\_norms\_max: 0.75000000000000133  
train\_h2\_col\_norms\_mean: 0.7489495266032288  
train\_h2\_col\_norms\_min: 0.7394077508320587  
train\_h2\_max\_x\_max\_u: 0.8527871103649167  
train\_h2\_max\_x\_mean\_u: 0.07446576773630918  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.277004863633311  
train\_h2\_mean\_x\_mean\_u: 0.020199564767593124  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.06500468730555711  
train\_h2\_min\_x\_mean\_u: 0.0015046651235349983  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.8357604406817065  
train\_h2\_range\_x\_mean\_u: 0.07296110261277423  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1676933130144258  
train\_h2\_row\_norms\_mean: 0.735464873122402  
train\_h2\_row\_norms\_min: 0.3261763735789841  
train\_objective: 0.4858340431742737  
train\_y\_col\_norms\_max: 2.53988758017867  
train\_y\_col\_norms\_mean: 2.53988758017867  
train\_y\_col\_norms\_min: 2.53988758017867  
train\_y\_max\_max\_class: 0.9584288002363247  
train\_y\_mean\_max\_class: 0.7347676407124952  
train\_y\_min\_max\_class: 0.5134612865168331  
train\_y\_misclass: 0.19600535299141844  
train\_y\_nll: 0.4296346354575059  
train\_y\_row\_norms\_max: 0.7450324413113781



train\_y\_row\_norms\_mean: 0.11750310611011303  
train\_y\_row\_norms\_min: 9.579774375566515e-05  
training\_seconds\_this\_epoch: 71.00179699999764  
valid\_h0\_col\_norms\_max: 0.7500000000000032  
valid\_h0\_col\_norms\_mean: 0.7454370304250512  
valid\_h0\_col\_norms\_min: 0.7168624281686561  
valid\_h0\_max\_x\_max\_u: 1.185179297478248  
valid\_h0\_max\_x\_mean\_u: 0.2182973687688945  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6140020127813652  
valid\_h0\_mean\_x\_mean\_u: 0.054518111034928166  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.18778422740791617  
valid\_h0\_min\_x\_mean\_u: 0.0026457472959762946  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.1515240435147038  
valid\_h0\_range\_x\_mean\_u: 0.21565162147291822  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.661667419391787  
valid\_h0\_row\_norms\_mean: 0.4743234650868524  
valid\_h0\_row\_norms\_min: 0.38370954400276036  
valid\_h1\_col\_norms\_max: 0.7500000000000031  
valid\_h1\_col\_norms\_mean: 0.7479353305213007  
valid\_h1\_col\_norms\_min: 0.7312455967583044  
valid\_h1\_max\_x\_max\_u: 1.312057801913054  
valid\_h1\_max\_x\_mean\_u: 0.16330059085549933  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.6051274413174297  
valid\_h1\_mean\_x\_mean\_u: 0.04788369180674006  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.14798475508060105  
valid\_h1\_min\_x\_mean\_u: 0.0033519759440747325  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 1.2327309004338594  
valid\_h1\_range\_x\_mean\_u: 0.15994861491142476  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.208707584055532  
valid\_h1\_row\_norms\_mean: 0.740111136968854  
valid\_h1\_row\_norms\_min: 0.44244314653731553  
valid\_h2\_col\_norms\_max: 0.7500000000000031  
valid\_h2\_col\_norms\_mean: 0.7489495266032155  
valid\_h2\_col\_norms\_min: 0.7394077508320925  
valid\_h2\_max\_x\_max\_u: 1.845542758759862  
valid\_h2\_max\_x\_mean\_u: 0.09551489778793391  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.6417001757266033  
valid\_h2\_mean\_x\_mean\_u: 0.028329181918528564  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.10448375365988168  
valid\_h2\_min\_x\_mean\_u: 0.0016876980520081446  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 1.8153716760836978  
valid\_h2\_range\_x\_mean\_u: 0.09382719973592575  
valid\_h2\_range\_x\_min\_u: 0.0

```

valid_h2_row_norms_max: 1.1676933130143878
valid_h2_row_norms_mean: 0.7354648731223855
valid_h2_row_norms_min: 0.3261763735789851
valid_objective: 0.7938897141866136
valid_y_col_norms_max: 2.5398875801785867
valid_y_col_norms_mean: 2.5398875801785867
valid_y_col_norms_min: 2.5398875801785867
valid_y_max_max_class: 0.9717079716917711
valid_y_mean_max_class: 0.768977968432936
valid_y_min_max_class: 0.514040168336125
valid_y_misclass: 0.351529102268991
valid_y_nll: 0.6399842562317335
valid_y_row_norms_max: 0.7450324413113544
valid_y_row_norms_mean: 0.11750310611011688
valid_y_row_norms_min: 9.579774375566734e-05
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.059988 seconds
Time this epoch: 0:01:10.706856
Monitoring step:
  Epochs seen: 12
  Batches seen: 26280
  Examples seen: 2627316
  learning_rate: 0.088011999999999834
  momentum: 0.455555555555555759
  total_seconds_last_epoch: 130.58987699999253
  train_h0_col_norms_max: 0.75000000000000133
  train_h0_col_norms_mean: 0.7450953029429248
  train_h0_col_norms_min: 0.7093272952407138
  train_h0_max_x_max_u: 0.9800759917691292
  train_h0_max_x_mean_u: 0.22608829194765473
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.2887114062679903
  train_h0_mean_x_mean_u: 0.02891152716964413
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.028625181940532873
  train_h0_min_x_mean_u: 0.0004275606156401646
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.9749737705475489
  train_h0_range_x_mean_u: 0.22566073133201445
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.6825994606846607
  train_h0_row_norms_mean: 0.4742838469158442
  train_h0_row_norms_min: 0.38836609687690116
  train_h1_col_norms_max: 0.75000000000000133
  train_h1_col_norms_mean: 0.7480179529689059
  train_h1_col_norms_min: 0.7334673745101861
  train_h1_max_x_max_u: 0.81000601142549
  train_h1_max_x_mean_u: 0.12250353068304315
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.25294628288194626
  train_h1_mean_x_mean_u: 0.02293837257584448
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.03492238555912771
  train_h1_min_x_mean_u: 0.0007739926657948207

```

train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.7941638189812956  
train\_h1\_range\_x\_mean\_u: 0.12172953801724819  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.2137991879284487  
train\_h1\_row\_norms\_mean: 0.7405341960377844  
train\_h1\_row\_norms\_min: 0.4393494131609909  
train\_h2\_col\_norms\_max: 0.7500000000000000133  
train\_h2\_col\_norms\_mean: 0.7489155022471392  
train\_h2\_col\_norms\_min: 0.7390449056589147  
train\_h2\_max\_x\_max\_u: 0.9946202863674738  
train\_h2\_max\_x\_mean\_u: 0.0806489843061593  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.34133047413106954  
train\_h2\_mean\_x\_mean\_u: 0.021506165872377126  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.08118897861897748  
train\_h2\_min\_x\_mean\_u: 0.0015988162739464693  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.9689415065649168  
train\_h2\_range\_x\_mean\_u: 0.07905016803221279  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1600507964039035  
train\_h2\_row\_norms\_mean: 0.7356335103863512  
train\_h2\_row\_norms\_min: 0.32941280507478227  
train\_objective: 0.487593273936147  
train\_y\_col\_norms\_max: 2.6115062320209144  
train\_y\_col\_norms\_mean: 2.6115062320209144  
train\_y\_col\_norms\_min: 2.6115062320209144  
train\_y\_max\_max\_class: 0.9608663657810425  
train\_y\_mean\_max\_class: 0.7410116929015966  
train\_y\_min\_max\_class: 0.5134289968618567  
train\_y\_misclass: 0.1912461234202511  
train\_y\_nll: 0.4172129280505987  
train\_y\_row\_norms\_max: 0.7467026799306141  
train\_y\_row\_norms\_mean: 0.12060386810369782  
train\_y\_row\_norms\_min: 0.00022889572813357338  
training\_seconds\_this\_epoch: 70.70685599999703  
valid\_h0\_col\_norms\_max: 0.7500000000000000031  
valid\_h0\_col\_norms\_mean: 0.745095302942958  
valid\_h0\_col\_norms\_min: 0.709327295240699  
valid\_h0\_max\_x\_max\_u: 1.2090555621415526  
valid\_h0\_max\_x\_mean\_u: 0.21846663780066478  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5553907814588741  
valid\_h0\_mean\_x\_mean\_u: 0.05496616858990692  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.1758311901839627  
valid\_h0\_min\_x\_mean\_u: 0.0027479763946369083  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.1818671705765142  
valid\_h0\_range\_x\_mean\_u: 0.21571866140602777  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6825994606846362

```

valid_h0_row_norms_mean: 0.47428384691583797
valid_h0_row_norms_min: 0.38836609687689166
valid_h1_col_norms_max: 0.75000000000000031
valid_h1_col_norms_mean: 0.7480179529688878
valid_h1_col_norms_min: 0.7334673745101707
valid_h1_max_x_max_u: 1.4790630480441558
valid_h1_max_x_mean_u: 0.17544889776170786
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.6886930081950697
valid_h1_mean_x_mean_u: 0.055080399116426045
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.17180095501187906
valid_h1_min_x_mean_u: 0.004507327308731916
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 1.3813987125202762
valid_h1_range_x_mean_u: 0.1709415704529758
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.2137991879284897
valid_h1_row_norms_mean: 0.7405341960378244
valid_h1_row_norms_min: 0.4393494131610062
valid_h2_col_norms_max: 0.75000000000000031
valid_h2_col_norms_mean: 0.7489155022471616
valid_h2_col_norms_min: 0.7390449056589297
valid_h2_max_x_max_u: 2.184598023200615
valid_h2_max_x_mean_u: 0.10744117223353973
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.8338514691923129
valid_h2_mean_x_mean_u: 0.03461144231478767
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.15324828988035388
valid_h2_min_x_mean_u: 0.002851255635017015
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 2.1227353048992796
valid_h2_range_x_mean_u: 0.10458991659852267
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.1600507964039342
valid_h2_row_norms_mean: 0.7356335103863317
valid_h2_row_norms_min: 0.32941280507477105
valid_objective: 0.948098791875258
valid_y_col_norms_max: 2.6115062320208855
valid_y_col_norms_mean: 2.611506232020884
valid_y_col_norms_min: 2.611506232020884
valid_y_max_max_class: 0.9841502958274744
valid_y_mean_max_class: 0.8096279458462675
valid_y_min_max_class: 0.532608418884845
valid_y_misclass: 0.3830154554422892
valid_y_nll: 0.7819267793173575
valid_y_row_norms_max: 0.7467026799306158
valid_y_row_norms_mean: 0.12060386810370494
valid_y_row_norms_min: 0.00022889572813357075
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.059996 seconds
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R10\nn_train.pkl done. Time elapsed: 0.069996 seconds

```

## 8.4 S4 C4 R20

```
In [119]: run_pylearn(diffs[3])
```

Parameter and initial learning rate summary:

```
h0_W: 0.1
h0_b: 0.1
h1_W: 0.1
h1_b: 0.1
h2_W: 0.1
h2_b: 0.1
softmax_b: 0.1
softmax_W: 0.1
```

Compiling sgd\_update...

Compiling sgd\_update done. Time elapsed: 0.904946 seconds

compiling begin\_record\_entry...

compiling begin\_record\_entry done. Time elapsed: 0.244985 seconds

Monitored channels:

```
learning_rate
momentum
total_seconds_last_epoch
train_h0_col_norms_max
train_h0_col_norms_mean
train_h0_col_norms_min
train_h0_max_x_max_u
train_h0_max_x_mean_u
train_h0_max_x_min_u
train_h0_mean_x_max_u
train_h0_mean_x_mean_u
train_h0_mean_x_min_u
train_h0_min_x_max_u
train_h0_min_x_mean_u
train_h0_min_x_min_u
train_h0_range_x_max_u
train_h0_range_x_mean_u
train_h0_range_x_min_u
train_h0_row_norms_max
train_h0_row_norms_mean
train_h0_row_norms_min
train_h1_col_norms_max
train_h1_col_norms_mean
train_h1_col_norms_min
train_h1_max_x_max_u
train_h1_max_x_mean_u
train_h1_max_x_min_u
train_h1_mean_x_max_u
train_h1_mean_x_mean_u
train_h1_mean_x_min_u
train_h1_min_x_max_u
train_h1_min_x_mean_u
train_h1_min_x_min_u
train_h1_range_x_max_u
train_h1_range_x_mean_u
train_h1_range_x_min_u
train_h1_row_norms_max
```

train\_h1\_row\_norms\_mean  
train\_h1\_row\_norms\_min  
train\_h2\_col\_norms\_max  
train\_h2\_col\_norms\_mean  
train\_h2\_col\_norms\_min  
train\_h2\_max\_x\_max\_u  
train\_h2\_max\_x\_mean\_u  
train\_h2\_max\_x\_min\_u  
train\_h2\_mean\_x\_max\_u  
train\_h2\_mean\_x\_mean\_u  
train\_h2\_mean\_x\_min\_u  
train\_h2\_min\_x\_max\_u  
train\_h2\_min\_x\_mean\_u  
train\_h2\_min\_x\_min\_u  
train\_h2\_range\_x\_max\_u  
train\_h2\_range\_x\_mean\_u  
train\_h2\_range\_x\_min\_u  
train\_h2\_row\_norms\_max  
train\_h2\_row\_norms\_mean  
train\_h2\_row\_norms\_min  
train\_objective  
train\_y\_col\_norms\_max  
train\_y\_col\_norms\_mean  
train\_y\_col\_norms\_min  
train\_y\_max\_max\_class  
train\_y\_mean\_max\_class  
train\_y\_min\_max\_class  
train\_y\_misclass  
train\_y\_nll  
train\_y\_row\_norms\_max  
train\_y\_row\_norms\_mean  
train\_y\_row\_norms\_min  
training\_seconds\_this\_epoch  
valid\_h0\_col\_norms\_max  
valid\_h0\_col\_norms\_mean  
valid\_h0\_col\_norms\_min  
valid\_h0\_max\_x\_max\_u  
valid\_h0\_max\_x\_mean\_u  
valid\_h0\_max\_x\_min\_u  
valid\_h0\_mean\_x\_max\_u  
valid\_h0\_mean\_x\_mean\_u  
valid\_h0\_mean\_x\_min\_u  
valid\_h0\_min\_x\_max\_u  
valid\_h0\_min\_x\_mean\_u  
valid\_h0\_min\_x\_min\_u  
valid\_h0\_range\_x\_max\_u  
valid\_h0\_range\_x\_mean\_u  
valid\_h0\_range\_x\_min\_u  
valid\_h0\_row\_norms\_max  
valid\_h0\_row\_norms\_mean  
valid\_h0\_row\_norms\_min  
valid\_h1\_col\_norms\_max  
valid\_h1\_col\_norms\_mean  
valid\_h1\_col\_norms\_min

valid\_h1\_max\_x\_max\_u  
valid\_h1\_max\_x\_mean\_u  
valid\_h1\_max\_x\_min\_u  
valid\_h1\_mean\_x\_max\_u  
valid\_h1\_mean\_x\_mean\_u  
valid\_h1\_mean\_x\_min\_u  
valid\_h1\_min\_x\_max\_u  
valid\_h1\_min\_x\_mean\_u  
valid\_h1\_min\_x\_min\_u  
valid\_h1\_range\_x\_max\_u  
valid\_h1\_range\_x\_mean\_u  
valid\_h1\_range\_x\_min\_u  
valid\_h1\_row\_norms\_max  
valid\_h1\_row\_norms\_mean  
valid\_h1\_row\_norms\_min  
valid\_h2\_col\_norms\_max  
valid\_h2\_col\_norms\_mean  
valid\_h2\_col\_norms\_min  
valid\_h2\_max\_x\_max\_u  
valid\_h2\_max\_x\_mean\_u  
valid\_h2\_max\_x\_min\_u  
valid\_h2\_mean\_x\_max\_u  
valid\_h2\_mean\_x\_mean\_u  
valid\_h2\_mean\_x\_min\_u  
valid\_h2\_min\_x\_max\_u  
valid\_h2\_min\_x\_mean\_u  
valid\_h2\_min\_x\_min\_u  
valid\_h2\_range\_x\_max\_u  
valid\_h2\_range\_x\_mean\_u  
valid\_h2\_range\_x\_min\_u  
valid\_h2\_row\_norms\_max  
valid\_h2\_row\_norms\_mean  
valid\_h2\_row\_norms\_min  
valid\_objective  
valid\_y\_col\_norms\_max  
valid\_y\_col\_norms\_mean  
valid\_y\_col\_norms\_min  
valid\_y\_max\_max\_class  
valid\_y\_mean\_max\_class  
valid\_y\_min\_max\_class  
valid\_y\_misclass  
valid\_y\_nll  
valid\_y\_row\_norms\_max  
valid\_y\_row\_norms\_mean  
valid\_y\_row\_norms\_min

Compiling accum...

graph size: 268

graph size: 264

Compiling accum done. Time elapsed: 4.484731 seconds

Monitoring step:

Epochs seen: 0

Batches seen: 0

Examples seen: 0

learning\_rate: 0.1000000000000000184

momentum: 0.49999999999999961  
total\_seconds\_last\_epoch: 0.0  
train\_h0\_col\_norms\_max: 0.7500000000000019  
train\_h0\_col\_norms\_mean: 0.7500000000000019  
train\_h0\_col\_norms\_min: 0.75000000000000189  
train\_h0\_max\_x\_max\_u: 0.59446043911829  
train\_h0\_max\_x\_mean\_u: 0.2692351957993289  
train\_h0\_max\_x\_min\_u: 0.062342553853997215  
train\_h0\_mean\_x\_max\_u: 0.1520433326597699  
train\_h0\_mean\_x\_mean\_u: 0.04555054428790526  
train\_h0\_mean\_x\_min\_u: 0.005267020704955818  
train\_h0\_min\_x\_max\_u: 0.00821004481924186  
train\_h0\_min\_x\_mean\_u: 7.181264705395428e-05  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 0.5936690972590178  
train\_h0\_range\_x\_mean\_u: 0.2691633831522754  
train\_h0\_range\_x\_min\_u: 0.062342553853997215  
train\_h0\_row\_norms\_max: 0.9473073874924789  
train\_h0\_row\_norms\_mean: 0.4511236721700384  
train\_h0\_row\_norms\_min: 0.0  
train\_h1\_col\_norms\_max: 0.7500000000000019  
train\_h1\_col\_norms\_mean: 0.7500000000000019  
train\_h1\_col\_norms\_min: 0.75000000000000189  
train\_h1\_max\_x\_max\_u: 0.34709244786053967  
train\_h1\_max\_x\_mean\_u: 0.12434543035545584  
train\_h1\_max\_x\_min\_u: 0.00035846029512074024  
train\_h1\_mean\_x\_max\_u: 0.11459060007006809  
train\_h1\_mean\_x\_mean\_u: 0.024878201478687734  
train\_h1\_mean\_x\_min\_u: 4.925816397062485e-06  
train\_h1\_min\_x\_max\_u: 0.018773225710348545  
train\_h1\_min\_x\_mean\_u: 0.0001835393662742415  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.34552217221122544  
train\_h1\_range\_x\_mean\_u: 0.12416189098918164  
train\_h1\_range\_x\_min\_u: 0.00035846029512074024  
train\_h1\_row\_norms\_max: 1.1743750618400186  
train\_h1\_row\_norms\_mean: 0.7349743966733155  
train\_h1\_row\_norms\_min: 0.30117376524425377  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7500000000000019  
train\_h2\_col\_norms\_min: 0.75000000000000189  
train\_h2\_max\_x\_max\_u: 0.19895826507359674  
train\_h2\_max\_x\_mean\_u: 0.05998346992211297  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.08120698322811631  
train\_h2\_mean\_x\_mean\_u: 0.013592926052160318  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.021276714672027856  
train\_h2\_min\_x\_mean\_u: 0.00023168534259833455  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.1941148999683533  
train\_h2\_range\_x\_mean\_u: 0.05975178457951461  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2131149672178985



train\_h2.row\_norms\_mean: 0.7335647006152948  
train\_h2.row\_norms\_min: 0.3075633754711711  
train\_objective: 0.6930133058660692  
train\_y.col\_norms\_max: 0.0  
train\_y.col\_norms\_mean: 0.0  
train\_y.col\_norms\_min: 0.0  
train\_y\_max\_max\_class: 0.5081813421764673  
train\_y\_mean\_max\_class: 0.5081813421764673  
train\_y\_min\_max\_class: 0.5081813421764673  
train\_y\_misclass: 0.49181865782354184  
train\_y\_nll: 0.6930133058660692  
train\_y.row\_norms\_max: 0.0  
train\_y.row\_norms\_mean: 0.0  
train\_y.row\_norms\_min: 0.0  
training\_seconds\_this\_epoch: 0.0  
valid\_h0.col\_norms\_max: 0.7499999999999996  
valid\_h0.col\_norms\_mean: 0.7499999999999993  
valid\_h0.col\_norms\_min: 0.7499999999999993  
valid\_h0\_max\_x\_max\_u: 0.6253408870504377  
valid\_h0\_max\_x\_mean\_u: 0.24952033603946608  
valid\_h0\_max\_x\_min\_u: 0.005260175473177208  
valid\_h0\_mean\_x\_max\_u: 0.2618547396836567  
valid\_h0\_mean\_x\_mean\_u: 0.05652027655150279  
valid\_h0\_mean\_x\_min\_u: 0.00011762153061695741  
valid\_h0\_min\_x\_max\_u: 0.07055114976550654  
valid\_h0\_min\_x\_mean\_u: 0.0008509321113173873  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.6160778512899875  
valid\_h0\_range\_x\_mean\_u: 0.2486694039281487  
valid\_h0\_range\_x\_min\_u: 0.005260175473177208  
valid\_h0.row\_norms\_max: 0.9473073874925024  
valid\_h0.row\_norms\_mean: 0.45112367217003335  
valid\_h0.row\_norms\_min: 0.0  
valid\_h1.col\_norms\_max: 0.7499999999999996  
valid\_h1.col\_norms\_mean: 0.7499999999999993  
valid\_h1.col\_norms\_min: 0.7499999999999993  
valid\_h1\_max\_x\_max\_u: 0.3731864956910933  
valid\_h1\_max\_x\_mean\_u: 0.11844509548465997  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.16291064904052224  
valid\_h1\_mean\_x\_mean\_u: 0.030103185931695118  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.0544118512702764  
valid\_h1\_min\_x\_mean\_u: 0.0011182193513238558  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.3606206928401779  
valid\_h1\_range\_x\_mean\_u: 0.11732687613333606  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.1743750618400235  
valid\_h1.row\_norms\_mean: 0.7349743966733112  
valid\_h1.row\_norms\_min: 0.3011737652442475  
valid\_h2.col\_norms\_max: 0.7499999999999996  
valid\_h2.col\_norms\_mean: 0.7499999999999993  
valid\_h2.col\_norms\_min: 0.7499999999999993

```

valid_h2_max_x_max_u: 0.2259215857438036
valid_h2_max_x_mean_u: 0.059190026605116304
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.11692583511076424
valid_h2_mean_x_mean_u: 0.016415872402615248
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.04212645681570578
valid_h2_min_x_mean_u: 0.0008738524493134276
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.20558675394664203
valid_h2_range_x_mean_u: 0.058316174155802876
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2131149672178938
valid_h2_row_norms_mean: 0.7335647006152777
valid_h2_row_norms_min: 0.3075633754711758
valid_objective: 0.6930133292309397
valid_y_col_norms_max: 0.0
valid_y_col_norms_mean: 0.0
valid_y_col_norms_min: 0.0
valid_y_max_max_class: 0.5081813421764565
valid_y_mean_max_class: 0.5081813421764568
valid_y_min_max_class: 0.5081813421764565
valid_y_misclass: 0.49181937172774837
valid_y_nll: 0.6930133292309397
valid_y_row_norms_max: 0.0
valid_y_row_norms_mean: 0.0
valid_y_row_norms_min: 0.0
Saving to ..\Sean\nn_files_S4C4R20\nn_train_best.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train_best.pkl done. Time elapsed: 0.039998 seconds
Time this epoch: 45.287283 seconds
Monitoring step:
  Epochs seen: 1
  Batches seen: 1376
  Examples seen: 137508
  learning_rate: 0.09900099999999956
  momentum: 0.49999999999999961
  total_seconds_last_epoch: 0.0
  train_h0_col_norms_max: 0.7500000000000019
  train_h0_col_norms_mean: 0.748845166114506
  train_h0_col_norms_min: 0.7358304788841422
  train_h0_max_x_max_u: 0.7628208490724311
  train_h0_max_x_mean_u: 0.2795540095180698
  train_h0_max_x_min_u: 0.03546217151424046
  train_h0_mean_x_max_u: 0.26600192296878805
  train_h0_mean_x_mean_u: 0.055104751430768116
  train_h0_mean_x_min_u: 0.002090300357294543
  train_h0_min_x_max_u: 0.043314575383210756
  train_h0_min_x_mean_u: 0.00120473167265021
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.7519833236705546
  train_h0_range_x_mean_u: 0.27834927784541946
  train_h0_range_x_min_u: 0.03546217151424046
  train_h0_row_norms_max: 0.916367660823679
  train_h0_row_norms_mean: 0.4528275075520235

```

train\_h0\_row\_norms\_min: 0.0647686917482533  
train\_h1\_col\_norms\_max: 0.7500000000000019  
train\_h1\_col\_norms\_mean: 0.7484499777176495  
train\_h1\_col\_norms\_min: 0.7299760603865485  
train\_h1\_max\_x\_max\_u: 0.5409693393108831  
train\_h1\_max\_x\_mean\_u: 0.1367280499104717  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.22335534184159073  
train\_h1\_mean\_x\_mean\_u: 0.03160015518238973  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.06831254629310625  
train\_h1\_min\_x\_mean\_u: 0.001373479569770759  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.5285881202909263  
train\_h1\_range\_x\_mean\_u: 0.13535457034070056  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1765886087359745  
train\_h1\_row\_norms\_mean: 0.7336396163887045  
train\_h1\_row\_norms\_min: 0.3044608469621072  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7492465395525978  
train\_h2\_col\_norms\_min: 0.7436477953581648  
train\_h2\_max\_x\_max\_u: 0.3941419264639164  
train\_h2\_max\_x\_mean\_u: 0.06970274825003722  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.16456639230129735  
train\_h2\_mean\_x\_mean\_u: 0.016589872429472373  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.03681506934450733  
train\_h2\_min\_x\_mean\_u: 0.0007699265604164269  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.38385833608889963  
train\_h2\_range\_x\_mean\_u: 0.06893282168962102  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.212796956566724  
train\_h2\_row\_norms\_mean: 0.7329049946216883  
train\_h2\_row\_norms\_min: 0.30817955236458616  
train\_objective: 0.6516346835261193  
train\_y\_col\_norms\_max: 0.6750747875341144  
train\_y\_col\_norms\_mean: 0.6750747875341144  
train\_y\_col\_norms\_min: 0.6750747875341144  
train\_y\_max\_max\_class: 0.7572183281275424  
train\_y\_mean\_max\_class: 0.6336954803588616  
train\_y\_min\_max\_class: 0.5153509821645363  
train\_y\_misclass: 0.3908354423015395  
train\_y\_nll: 0.6401431079003933  
train\_y\_row\_norms\_max: 0.1981417941568616  
train\_y\_row\_norms\_mean: 0.031653596963925154  
train\_y\_row\_norms\_min: 3.1637263964684185e-05  
training\_seconds\_this\_epoch: 45.28728300000042  
valid\_h0\_col\_norms\_max: 0.7499999999999997  
valid\_h0\_col\_norms\_mean: 0.7488451661144975  
valid\_h0\_col\_norms\_min: 0.7358304788841643  
valid\_h0\_max\_x\_max\_u: 0.8707508373103212

valid\_h0\_max\_x\_mean\_u: 0.2459053786967022  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.4666347057112281  
valid\_h0\_mean\_x\_mean\_u: 0.0745118978597946  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.21940839997478517  
valid\_h0\_min\_x\_mean\_u: 0.009440931446486993  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.8014564811020041  
valid\_h0\_range\_x\_mean\_u: 0.23646444725021523  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.9163676608236679  
valid\_h0\_row\_norms\_mean: 0.45282750755203155  
valid\_h0\_row\_norms\_min: 0.06476869174825249  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7484499777176704  
valid\_h1\_col\_norms\_min: 0.7299760603865623  
valid\_h1\_max\_x\_max\_u: 0.6611716890814907  
valid\_h1\_max\_x\_mean\_u: 0.13383757961432258  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.3814756701027741  
valid\_h1\_mean\_x\_mean\_u: 0.05114232696772838  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.20047887484425833  
valid\_h1\_min\_x\_mean\_u: 0.009591053478886884  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.5923955288159058  
valid\_h1\_range\_x\_mean\_u: 0.1242465261354357  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1765886087359796  
valid\_h1\_row\_norms\_mean: 0.7336396163887187  
valid\_h1\_row\_norms\_min: 0.3044608469621077  
valid\_h2\_col\_norms\_max: 0.7499999999999996  
valid\_h2\_col\_norms\_mean: 0.7492465395526064  
valid\_h2\_col\_norms\_min: 0.7436477953581702  
valid\_h2\_max\_x\_max\_u: 0.5407460951897924  
valid\_h2\_max\_x\_mean\_u: 0.08115480060190311  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.3038681114263226  
valid\_h2\_mean\_x\_mean\_u: 0.032278636101819885  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.13825603567571498  
valid\_h2\_min\_x\_mean\_u: 0.005851174571382831  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.4819565697827483  
valid\_h2\_range\_x\_mean\_u: 0.07530362603052025  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2127969565667414  
valid\_h2\_row\_norms\_mean: 0.732904994621697  
valid\_h2\_row\_norms\_min: 0.30817955236458416  
valid\_objective: 0.7010749370278491  
valid\_y\_col\_norms\_max: 0.675074787534111  
valid\_y\_col\_norms\_mean: 0.675074787534111  
valid\_y\_col\_norms\_min: 0.675074787534111

```

valid_y_max_max_class: 0.8596159864338984
valid_y_mean_max_class: 0.6850056163031383
valid_y_min_max_class: 0.5285491966057383
valid_y_misclass: 0.37814136125654435
valid_y_nll: 0.6296529977568406
valid_y_row_norms_max: 0.19814179415685693
valid_y_row_norms_mean: 0.03165359696392543
valid_y_row_norms_min: 3.163726396468385e-05
Saving to ..\Sean\nn_files_S4C4R20\nn_train.best.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.best.pkl done. Time elapsed: 0.044997 seconds
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.049997 seconds
Time this epoch: 44.577326 seconds
Monitoring step:
  Epochs seen: 2
  Batches seen: 2752
  Examples seen: 275016
  learning_rate: 0.09800200000000135
  momentum: 0.4959595959596099
  total_seconds_last_epoch: 83.10501300000128
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.7482962164214352
  train_h0_col_norms_min: 0.7298902855374848
  train_h0_max_x_max_u: 0.8559817700557832
  train_h0_max_x_mean_u: 0.27976668772709945
  train_h0_max_x_min_u: 0.007196720924972222
  train_h0_mean_x_max_u: 0.3217858274158376
  train_h0_mean_x_mean_u: 0.05331799959383999
  train_h0_mean_x_min_u: 0.00016724270686178832
  train_h0_min_x_max_u: 0.05302806171442175
  train_h0_min_x_mean_u: 0.001306407203470707
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 0.8365303714384554
  train_h0_range_x_mean_u: 0.2784602805236281
  train_h0_range_x_min_u: 0.007196720924972222
  train_h0_row_norms_max: 0.8965752034088985
  train_h0_row_norms_mean: 0.45589081873537085
  train_h0_row_norms_min: 0.11552124047229771
  train_h1_col_norms_max: 0.750000000000019
  train_h1_col_norms_mean: 0.7476190767420637
  train_h1_col_norms_min: 0.7257796688339094
  train_h1_max_x_max_u: 0.6152486395505593
  train_h1_max_x_mean_u: 0.12685648137654926
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.22303672576852854
  train_h1_mean_x_mean_u: 0.024521569946243257
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.03317952140739739
  train_h1_min_x_mean_u: 0.0005415340308542253
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.606922870188681
  train_h1_range_x_mean_u: 0.12631494734569507
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.169530816592235

```

train\_h1\_row\_norms\_mean: 0.7332803096690692  
train\_h1\_row\_norms\_min: 0.3162861244686932  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7488548416619801  
train\_h2\_col\_norms\_min: 0.7292021804456968  
train\_h2\_max\_x\_max\_u: 0.46997659966054317  
train\_h2\_max\_x\_mean\_u: 0.06368806889922304  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.17571408572630315  
train\_h2\_mean\_x\_mean\_u: 0.013418621794514252  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.03673331384452754  
train\_h2\_min\_x\_mean\_u: 0.000297494732893794  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.4654494757092661  
train\_h2\_range\_x\_mean\_u: 0.06339057416632937  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2122588581047593  
train\_h2\_row\_norms\_mean: 0.7326475129415356  
train\_h2\_row\_norms\_min: 0.3101222135425167  
train\_objective: 0.6252455134914031  
train\_y\_col\_norms\_max: 1.137921451959489  
train\_y\_col\_norms\_mean: 1.137921451959489  
train\_y\_col\_norms\_min: 1.137921451959489  
train\_y\_max\_max\_class: 0.7919213697580065  
train\_y\_mean\_max\_class: 0.6421006016919448  
train\_y\_min\_max\_class: 0.5086498641044315  
train\_y\_misclass: 0.3883264973674255  
train\_y\_nll: 0.6458454736164293  
train\_y\_row\_norms\_max: 0.4565213725814914  
train\_y\_row\_norms\_mean: 0.05001214798187546  
train\_y\_row\_norms\_min: 1.4872912336450205e-05  
training\_seconds\_this\_epoch: 44.57732600000156  
valid\_h0\_col\_norms\_max: 0.7500000000000003  
valid\_h0\_col\_norms\_mean: 0.7482962164214232  
valid\_h0\_col\_norms\_min: 0.7298902855374981  
valid\_h0\_max\_x\_max\_u: 1.0032292507357943  
valid\_h0\_max\_x\_mean\_u: 0.2274512675658247  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5989169357281271  
valid\_h0\_mean\_x\_mean\_u: 0.0679107104167812  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.2903814462111354  
valid\_h0\_min\_x\_mean\_u: 0.010187150863330432  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 0.8819700649830204  
valid\_h0\_range\_x\_mean\_u: 0.21726411670249435  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.8965752034088778  
valid\_h0\_row\_norms\_mean: 0.45589081873537296  
valid\_h0\_row\_norms\_min: 0.11552124047229544  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.747619076742079  
valid\_h1\_col\_norms\_min: 0.7257796688339225

```

valid_h1_max_x_max_u: 0.619176544650307
valid_h1_max_x_mean_u: 0.10805961644933633
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.3077761464702021
valid_h1_mean_x_mean_u: 0.03390769608382692
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.13839193390414622
valid_h1_min_x_mean_u: 0.004362253471102507
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.571524878797196
valid_h1_range_x_mean_u: 0.10369736297823375
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.1695308165922484
valid_h1_row_norms_mean: 0.7332803096690472
valid_h1_row_norms_min: 0.3162861244686884
valid_h2_col_norms_max: 0.7499999999999996
valid_h2_col_norms_mean: 0.7488548416619611
valid_h2_col_norms_min: 0.7292021804456922
valid_h2_max_x_max_u: 0.39508623237257157
valid_h2_max_x_mean_u: 0.05170275248817348
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.16854971165609633
valid_h2_mean_x_mean_u: 0.012698913333982018
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.06320645060919691
valid_h2_min_x_mean_u: 0.0008466797514199927
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.38699011836613506
valid_h2_range_x_mean_u: 0.05085607273675346
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2122588581047808
valid_h2_row_norms_mean: 0.7326475129415418
valid_h2_row_norms_min: 0.31012221354251196
valid_objective: 0.6060005339599759
valid_y_col_norms_max: 1.137921451959527
valid_y_col_norms_mean: 1.137921451959527
valid_y_col_norms_min: 1.137921451959527
valid_y_max_max_class: 0.7558017005055937
valid_y_mean_max_class: 0.6231731247979531
valid_y_min_max_class: 0.5111511331317845
valid_y_misclass: 0.32971204188481684
valid_y_nll: 0.6160375585933404
valid_y_row_norms_max: 0.4565213725814977
valid_y_row_norms_mean: 0.05001214798187572
valid_y_row_norms_min: 1.4872912336449819e-05
Saving to ..\Sean\nn_files_S4C4R20\nn_train_best.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train_best.pkl done. Time elapsed: 0.049997 seconds
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.044997 seconds
Time this epoch: 46.791733 seconds
Monitoring step:
  Epochs seen: 3
  Batches seen: 4128
  Examples seen: 412524

```

learning\_rate: 0.09700299999999701  
momentum: 0.4919191919191771  
total\_seconds\_last\_epoch: 82.18506900000008  
train\_h0\_col\_norms\_max: 0.750000000000019  
train\_h0\_col\_norms\_mean: 0.7481625805618978  
train\_h0\_col\_norms\_min: 0.7303261691416629  
train\_h0\_max\_x\_max\_u: 1.0520723576375564  
train\_h0\_max\_x\_mean\_u: 0.2946834966030336  
train\_h0\_max\_x\_min\_u: 0.0076456515486988345  
train\_h0\_mean\_x\_max\_u: 0.4105718019285848  
train\_h0\_mean\_x\_mean\_u: 0.05494762719678052  
train\_h0\_mean\_x\_min\_u: 0.00021179911711774013  
train\_h0\_min\_x\_max\_u: 0.07448827072244284  
train\_h0\_min\_x\_mean\_u: 0.002033654288044799  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.0092289000424284  
train\_h0\_range\_x\_mean\_u: 0.29264984231498886  
train\_h0\_range\_x\_min\_u: 0.0076456515486988345  
train\_h0\_row\_norms\_max: 0.8600480008448865  
train\_h0\_row\_norms\_mean: 0.4600274132010667  
train\_h0\_row\_norms\_min: 0.1695542065718525  
train\_h1\_col\_norms\_max: 0.750000000000019  
train\_h1\_col\_norms\_mean: 0.7477154532210564  
train\_h1\_col\_norms\_min: 0.7321558934400498  
train\_h1\_max\_x\_max\_u: 0.7165557892133616  
train\_h1\_max\_x\_mean\_u: 0.1371702156012408  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.2955505356105547  
train\_h1\_mean\_x\_mean\_u: 0.027923173013399822  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.05088208221103685  
train\_h1\_min\_x\_mean\_u: 0.0012392561925517363  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6883137442786652  
train\_h1\_range\_x\_mean\_u: 0.1359309594086891  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.1713954018473833  
train\_h1\_row\_norms\_mean: 0.7339442613111961  
train\_h1\_row\_norms\_min: 0.3272359779144817  
train\_h2\_col\_norms\_max: 0.750000000000019  
train\_h2\_col\_norms\_mean: 0.7488456458994787  
train\_h2\_col\_norms\_min: 0.7392992365655525  
train\_h2\_max\_x\_max\_u: 0.5970493222761151  
train\_h2\_max\_x\_mean\_u: 0.07289657426790067  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2137973970163153  
train\_h2\_mean\_x\_mean\_u: 0.01583325002804195  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.04143845395125056  
train\_h2\_min\_x\_mean\_u: 0.00044917988048742734  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5910559442639282  
train\_h2\_range\_x\_mean\_u: 0.07244739438741322  
train\_h2\_range\_x\_min\_u: 0.0



train\_h2.row\_norms\_max: 1.2110203604622214  
train\_h2.row\_norms\_mean: 0.7328828189226615  
train\_h2.row\_norms\_min: 0.31363493892900096  
train\_objective: 0.5994825513538878  
train\_y.col\_norms\_max: 1.39276043743947  
train\_y.col\_norms\_mean: 1.39276043743947  
train\_y.col\_norms\_min: 1.39276043743947  
train\_y\_max\_max\_class: 0.8602565803962907  
train\_y\_mean\_max\_class: 0.6720226110977584  
train\_y\_min\_max\_class: 0.5070447151136989  
train\_y\_misclass: 0.3124981819239608  
train\_y\_nll: 0.5789455404136634  
train\_y.row\_norms\_max: 0.531941453642248  
train\_y.row\_norms\_mean: 0.06241103692005811  
train\_y.row\_norms\_min: 9.692735427125098e-05  
training\_seconds\_this\_epoch: 46.79173300000057  
valid\_h0.col\_norms\_max: 0.7499999999999996  
valid\_h0.col\_norms\_mean: 0.7481625805618878  
valid\_h0.col\_norms\_min: 0.7303261691416717  
valid\_h0\_max\_x\_max\_u: 1.3822105092761987  
valid\_h0\_max\_x\_mean\_u: 0.2511113991383271  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.8749560597664697  
valid\_h0\_mean\_x\_mean\_u: 0.08015413191158703  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.43037542345712054  
valid\_h0\_min\_x\_mean\_u: 0.01549818814546529  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.1107219485087785  
valid\_h0\_range\_x\_mean\_u: 0.23561321099286212  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.8600480008449054  
valid\_h0.row\_norms\_mean: 0.4600274132010615  
valid\_h0.row\_norms\_min: 0.16955420657185227  
valid\_h1.col\_norms\_max: 0.7499999999999997  
valid\_h1.col\_norms\_mean: 0.7477154532210413  
valid\_h1.col\_norms\_min: 0.7321558934400327  
valid\_h1\_max\_x\_max\_u: 0.9393941352972809  
valid\_h1\_max\_x\_mean\_u: 0.12807739099360932  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.5962901770713978  
valid\_h1\_mean\_x\_mean\_u: 0.04852467261220243  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.2821287892782155  
valid\_h1\_min\_x\_mean\_u: 0.010448047481818464  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.7305803443971015  
valid\_h1\_range\_x\_mean\_u: 0.1176293435117908  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.1713954018473896  
valid\_h1.row\_norms\_mean: 0.7339442613112102  
valid\_h1.row\_norms\_min: 0.3272359779144778  
valid\_h2.col\_norms\_max: 0.7499999999999996  
valid\_h2.col\_norms\_mean: 0.7488456458994627

```

valid_h2.col_norms_min: 0.7392992365655616
valid_h2.max_x_max_u: 0.6370048347322909
valid_h2.max_x_mean_u: 0.06689732199380288
valid_h2.max_x_min_u: 0.0
valid_h2.mean_x_max_u: 0.29966600691286066
valid_h2.mean_x_mean_u: 0.021600673346248322
valid_h2.mean_x_min_u: 0.0
valid_h2.min_x_max_u: 0.137890977514895
valid_h2.min_x_mean_u: 0.003192872558603868
valid_h2.min_x_min_u: 0.0
valid_h2.range_x_max_u: 0.5942819499890672
valid_h2.range_x_mean_u: 0.06370444943519901
valid_h2.range_x_min_u: 0.0
valid_h2.row_norms_max: 1.21102036046223
valid_h2.row_norms_mean: 0.7328828189226514
valid_h2.row_norms_min: 0.31363493892900185
valid_objective: 0.712252116423599
valid_y.col_norms_max: 1.3927604374394762
valid_y.col_norms_mean: 1.3927604374394762
valid_y.col_norms_min: 1.3927604374394762
valid_y.max_max_class: 0.8811899604126303
valid_y.mean_max_class: 0.6892593628838931
valid_y.min_max_class: 0.5100226105442996
valid_y.misclass: 0.2617801047120419
valid_y.nll: 0.5384586542104237
valid_y.row_norms_max: 0.531941453642261
valid_y.row_norms_mean: 0.06241103692005875
valid_y.row_norms_min: 9.692735427124922e-05
Saving to ..\Sean\nn_files_S4C4R20\nn_train.best.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.best.pkl done. Time elapsed: 0.052000 seconds
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.047000 seconds
Time this epoch: 45.015306 seconds
Monitoring step:
  Epochs seen: 4
  Batches seen: 5504
  Examples seen: 550032
  learning_rate: 0.09600399999999866
  momentum: 0.4878787878787813
  total_seconds_last_epoch: 84.569733000000081
  train_h0.col_norms_max: 0.7500000000000019
  train_h0.col_norms_mean: 0.7476495765336061
  train_h0.col_norms_min: 0.7284271204872206
  train_h0.max_x_max_u: 1.0405170241181358
  train_h0.max_x_mean_u: 0.2952374858104304
  train_h0.max_x_min_u: 0.003684834068028375
  train_h0.mean_x_max_u: 0.38124742978328585
  train_h0.mean_x_mean_u: 0.04918012755100615
  train_h0.mean_x_min_u: 8.313469543849299e-05
  train_h0.min_x_max_u: 0.06663980657345626
  train_h0.min_x_mean_u: 0.0017933990342550808
  train_h0.min_x_min_u: 0.0
  train_h0.range_x_max_u: 1.0111011752306025
  train_h0.range_x_mean_u: 0.29344408677617495

```

train\_h0.range\_x\_min\_u: 0.003684834068028375  
train\_h0.row\_norms\_max: 0.8224386745681899  
train\_h0.row\_norms\_mean: 0.4636772166620278  
train\_h0.row\_norms\_min: 0.21948423823220384  
train\_h1.col\_norms\_max: 0.7500000000000019  
train\_h1.col\_norms\_mean: 0.7477330418101632  
train\_h1.col\_norms\_min: 0.7346569516445727  
train\_h1.max\_x\_max\_u: 0.7206349764960114  
train\_h1.max\_x\_mean\_u: 0.13475589685289235  
train\_h1.max\_x\_min\_u: 0.0  
train\_h1.mean\_x\_max\_u: 0.2460773178107898  
train\_h1.mean\_x\_mean\_u: 0.025809203493832377  
train\_h1.mean\_x\_min\_u: 0.0  
train\_h1.min\_x\_max\_u: 0.033406707980372395  
train\_h1.min\_x\_mean\_u: 0.0011593861286087177  
train\_h1.min\_x\_min\_u: 0.0  
train\_h1.range\_x\_max\_u: 0.7045422641613842  
train\_h1.range\_x\_mean\_u: 0.1335965107242836  
train\_h1.range\_x\_min\_u: 0.0  
train\_h1.row\_norms\_max: 1.1600864019004742  
train\_h1.row\_norms\_mean: 0.7345655117132704  
train\_h1.row\_norms\_min: 0.3559860947791384  
train\_h2.col\_norms\_max: 0.7500000000000019  
train\_h2.col\_norms\_mean: 0.7489272977284207  
train\_h2.col\_norms\_min: 0.7372421258689181  
train\_h2.max\_x\_max\_u: 0.6835754905655372  
train\_h2.max\_x\_mean\_u: 0.0770779265585186  
train\_h2.max\_x\_min\_u: 0.0  
train\_h2.mean\_x\_max\_u: 0.24158824142593305  
train\_h2.mean\_x\_mean\_u: 0.01707597001253189  
train\_h2.mean\_x\_min\_u: 0.0  
train\_h2.min\_x\_max\_u: 0.05193664545627258  
train\_h2.min\_x\_mean\_u: 0.0006459521135425856  
train\_h2.min\_x\_min\_u: 0.0  
train\_h2.range\_x\_max\_u: 0.6668337454784662  
train\_h2.range\_x\_mean\_u: 0.0764319744449759  
train\_h2.range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2129722700445265  
train\_h2.row\_norms\_mean: 0.7331226864936894  
train\_h2.row\_norms\_min: 0.32038407409727987  
train\_objective: 0.5826606821072297  
train\_y.col\_norms\_max: 1.5443396332822927  
train\_y.col\_norms\_mean: 1.5443396332822927  
train\_y.col\_norms\_min: 1.5443396332822927  
train\_y.max\_max\_class: 0.8907752984350268  
train\_y.mean\_max\_class: 0.6905758295692987  
train\_y.min\_max\_class: 0.5090562580106429  
train\_y.misclass: 0.29172848125199974  
train\_y.nll: 0.5520103478515878  
train\_y.row\_norms\_max: 0.5470577023951827  
train\_y.row\_norms\_mean: 0.07192075177718411  
train\_y.row\_norms\_min: 0.0002391130823738819  
training\_seconds\_this\_epoch: 45.015306000001225  
valid\_h0.col\_norms\_max: 0.7500000000000003

valid\_h0.col\_norms\_mean: 0.7476495765335914  
valid\_h0.col\_norms\_min: 0.7284271204872416  
valid\_h0.max\_x\_max\_u: 1.3209215490510056  
valid\_h0.max\_x\_mean\_u: 0.24752487163633544  
valid\_h0.max\_x\_min\_u: 0.0  
valid\_h0.mean\_x\_max\_u: 0.7716147534650236  
valid\_h0.mean\_x\_mean\_u: 0.07383953779209561  
valid\_h0.mean\_x\_min\_u: 0.0  
valid\_h0.min\_x\_max\_u: 0.36990222882220447  
valid\_h0.min\_x\_mean\_u: 0.013984209141787112  
valid\_h0.min\_x\_min\_u: 0.0  
valid\_h0.range\_x\_max\_u: 1.1114196115676762  
valid\_h0.range\_x\_mean\_u: 0.23354066249454816  
valid\_h0.range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.8224386745681896  
valid\_h0.row\_norms\_mean: 0.46367721666201556  
valid\_h0.row\_norms\_min: 0.21948423823219934  
valid\_h1.col\_norms\_max: 0.7499999999999996  
valid\_h1.col\_norms\_mean: 0.7477330418101608  
valid\_h1.col\_norms\_min: 0.7346569516445737  
valid\_h1.max\_x\_max\_u: 0.9547535581486757  
valid\_h1.max\_x\_mean\_u: 0.12866944067372538  
valid\_h1.max\_x\_min\_u: 0.0  
valid\_h1.mean\_x\_max\_u: 0.5004721080992293  
valid\_h1.mean\_x\_mean\_u: 0.04870601808745913  
valid\_h1.mean\_x\_min\_u: 0.0  
valid\_h1.min\_x\_max\_u: 0.21914565468721328  
valid\_h1.min\_x\_mean\_u: 0.010645330869050201  
valid\_h1.min\_x\_min\_u: 0.0  
valid\_h1.range\_x\_max\_u: 0.8235041083275032  
valid\_h1.range\_x\_mean\_u: 0.11802410980467518  
valid\_h1.range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.1600864019004375  
valid\_h1.row\_norms\_mean: 0.734565511713263  
valid\_h1.row\_norms\_min: 0.355986094779137  
valid\_h2.col\_norms\_max: 0.7499999999999996  
valid\_h2.col\_norms\_mean: 0.7489272977284184  
valid\_h2.col\_norms\_min: 0.737242125868919  
valid\_h2.max\_x\_max\_u: 0.8383588747602744  
valid\_h2.max\_x\_mean\_u: 0.07239378780487518  
valid\_h2.max\_x\_min\_u: 0.0  
valid\_h2.mean\_x\_max\_u: 0.35596179734661487  
valid\_h2.mean\_x\_mean\_u: 0.024260381701820537  
valid\_h2.mean\_x\_min\_u: 0.0  
valid\_h2.min\_x\_max\_u: 0.12648026996081901  
valid\_h2.min\_x\_mean\_u: 0.003884643025566658  
valid\_h2.min\_x\_min\_u: 0.0  
valid\_h2.range\_x\_max\_u: 0.7812413695478367  
valid\_h2.range\_x\_mean\_u: 0.06850914477930849  
valid\_h2.range\_x\_min\_u: 0.0  
valid\_h2.row\_norms\_max: 1.2129722700445316  
valid\_h2.row\_norms\_mean: 0.7331226864936734  
valid\_h2.row\_norms\_min: 0.32038407409728176  
valid\_objective: 0.772548567671431

```

valid_y_col_norms_max: 1.544339633282311
valid_y_col_norms_mean: 1.544339633282311
valid_y_col_norms_min: 1.544339633282311
valid_y_max_max_class: 0.9101042497831695
valid_y_mean_max_class: 0.7202414207589509
valid_y_min_max_class: 0.5230467631319071
valid_y_misclass: 0.2835732984293194
valid_y_nll: 0.5615146017752118
valid_y_row_norms_max: 0.5470577023951703
valid_y_row_norms_mean: 0.0719207517771854
valid_y_row_norms_min: 0.00023911308237388806
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.049999 seconds
Time this epoch: 44.779105 seconds
Monitoring step:
  Epochs seen: 5
  Batches seen: 6880
  Examples seen: 687540
  learning_rate: 0.0950050000000001
  momentum: 0.48383838383839317
  total_seconds_last_epoch: 82.45955700000168
  train_h0_col_norms_max: 0.7500000000000019
  train_h0_col_norms_mean: 0.7474245245614204
  train_h0_col_norms_min: 0.7258511900389
  train_h0_max_x_max_u: 1.0950029368383531
  train_h0_max_x_mean_u: 0.2914697199361687
  train_h0_max_x_min_u: 0.0010420068950839896
  train_h0_mean_x_max_u: 0.40091226179307476
  train_h0_mean_x_mean_u: 0.0435653564294293
  train_h0_mean_x_min_u: 1.7246691170161314e-05
  train_h0_min_x_max_u: 0.06168741289409504
  train_h0_min_x_mean_u: 0.001205736625061588
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.0610138215344567
  train_h0_range_x_mean_u: 0.29026398331110703
  train_h0_range_x_min_u: 0.0010420068950839896
  train_h0_row_norms_max: 0.7916771211273366
  train_h0_row_norms_mean: 0.4669502913848341
  train_h0_row_norms_min: 0.25485004750360407
  train_h1_col_norms_max: 0.7500000000000019
  train_h1_col_norms_mean: 0.7477831173201339
  train_h1_col_norms_min: 0.7337577860812191
  train_h1_max_x_max_u: 0.7154787177369891
  train_h1_max_x_mean_u: 0.1294859029779829
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.25114989856077563
  train_h1_mean_x_mean_u: 0.02317672718624901
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.03464181374353271
  train_h1_min_x_mean_u: 0.0007494167770596629
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.6988226401286778
  train_h1_range_x_mean_u: 0.12873648620092332
  train_h1_range_x_min_u: 0.0

```

train\_h1\_row\_norms\_max: 1.1617738162932514  
train\_h1\_row\_norms\_mean: 0.7352349498081483  
train\_h1\_row\_norms\_min: 0.3552795989471862  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7489768507646781  
train\_h2\_col\_norms\_min: 0.7395103754883959  
train\_h2\_max\_x\_max\_u: 0.6019760661144126  
train\_h2\_max\_x\_mean\_u: 0.07552981408561078  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.20166414352281406  
train\_h2\_mean\_x\_mean\_u: 0.016926665648654356  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.041312983719212694  
train\_h2\_min\_x\_mean\_u: 0.0006340941517166849  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.593959501142628  
train\_h2\_range\_x\_mean\_u: 0.07489571993389392  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2113611046394392  
train\_h2\_row\_norms\_mean: 0.7334581859401729  
train\_h2\_row\_norms\_min: 0.33373876320968654  
train\_objective: 0.5566903017333377  
train\_y\_col\_norms\_max: 1.679199102995501  
train\_y\_col\_norms\_mean: 1.679199102995501  
train\_y\_col\_norms\_min: 1.679199102995501  
train\_y\_max\_max\_class: 0.8951217152245512  
train\_y\_mean\_max\_class: 0.680941529085628  
train\_y\_min\_max\_class: 0.5060741617269497  
train\_y\_misclass: 0.2506472350699594  
train\_y\_nll: 0.5153982541140673  
train\_y\_row\_norms\_max: 0.5664073525573169  
train\_y\_row\_norms\_mean: 0.07899766662673988  
train\_y\_row\_norms\_min: 4.001780853009564e-05  
training\_seconds\_this\_epoch: 44.77910499999861  
valid\_h0\_col\_norms\_max: 0.7500000000000003  
valid\_h0\_col\_norms\_mean: 0.747424524561419  
valid\_h0\_col\_norms\_min: 0.7258511900389089  
valid\_h0\_max\_x\_max\_u: 1.4417099127622763  
valid\_h0\_max\_x\_mean\_u: 0.23551693222743347  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.8269960554769776  
valid\_h0\_mean\_x\_mean\_u: 0.06457027124299788  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.346679729007119  
valid\_h0\_min\_x\_mean\_u: 0.010126170861531695  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2169979297079536  
valid\_h0\_range\_x\_mean\_u: 0.2253907613659017  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7916771211273629  
valid\_h0\_row\_norms\_mean: 0.46695029138482347  
valid\_h0\_row\_norms\_min: 0.2548500475036014  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7477831173201475

```

valid_h1.col_norms_min: 0.7337577860812132
valid_h1.max_x_max_u: 0.952355117770879
valid_h1.max_x_mean_u: 0.12104811712918714
valid_h1.max_x_min_u: 0.0
valid_h1.mean_x_max_u: 0.5399780695944394
valid_h1.mean_x_mean_u: 0.042229502629020775
valid_h1.mean_x_min_u: 0.0
valid_h1.min_x_max_u: 0.2174654835605815
valid_h1.min_x_mean_u: 0.007413953447085665
valid_h1.min_x_min_u: 0.0
valid_h1.range_x_max_u: 0.8233910935030709
valid_h1.range_x_mean_u: 0.11363416368210148
valid_h1.range_x_min_u: 0.0
valid_h1.row_norms_max: 1.1617738162932603
valid_h1.row_norms_mean: 0.7352349498081671
valid_h1.row_norms_min: 0.35527959894717853
valid_h2.col_norms_max: 0.7499999999999996
valid_h2.col_norms_mean: 0.748976850764655
valid_h2.col_norms_min: 0.7395103754884186
valid_h2.max_x_max_u: 0.7395603440856604
valid_h2.max_x_mean_u: 0.06985123991731153
valid_h2.max_x_min_u: 0.0
valid_h2.mean_x_max_u: 0.2840171696631736
valid_h2.mean_x_mean_u: 0.021057588844149773
valid_h2.mean_x_min_u: 0.0
valid_h2.min_x_max_u: 0.08318118937962232
valid_h2.min_x_mean_u: 0.002346085779226223
valid_h2.min_x_min_u: 0.0
valid_h2.range_x_max_u: 0.7180722754780517
valid_h2.range_x_mean_u: 0.06750515413808536
valid_h2.range_x_min_u: 0.0
valid_h2.row_norms_max: 1.2113611046394486
valid_h2.row_norms_mean: 0.7334581859401922
valid_h2.row_norms_min: 0.3337387632096858
valid_objective: 0.7388069106639045
valid_y.col_norms_max: 1.6791991029955136
valid_y.col_norms_mean: 1.6791991029955136
valid_y.col_norms_min: 1.6791991029955136
valid_y.max_max_class: 0.9015786776177439
valid_y.mean_max_class: 0.6985212758094798
valid_y.min_max_class: 0.5113871561345404
valid_y.misclass: 0.27467277486910985
valid_y.nll: 0.5477198553382798
valid_y.row_norms_max: 0.5664073525573173
valid_y.row_norms_mean: 0.07899766662674013
valid_y.row_norms_min: 4.001780853009462e-05
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.054999 seconds
Time this epoch: 45.499090 seconds
Monitoring step:
  Epochs seen: 6
  Batches seen: 8256
  Examples seen: 825048
  learning_rate: 0.09400599999999905

```

momentum: 0.4797979797979969  
total\_seconds\_last\_epoch: 82.33335399999908  
train\_h0\_col\_norms\_max: 0.7500000000000019  
train\_h0\_col\_norms\_mean: 0.747334408621587  
train\_h0\_col\_norms\_min: 0.7260143384509646  
train\_h0\_max\_x\_max\_u: 1.0347298239445237  
train\_h0\_max\_x\_mean\_u: 0.2909262352572566  
train\_h0\_max\_x\_min\_u: 0.0006658575203759403  
train\_h0\_mean\_x\_max\_u: 0.3270201339193903  
train\_h0\_mean\_x\_mean\_u: 0.03951436131039631  
train\_h0\_mean\_x\_min\_u: 1.2904630259277338e-05  
train\_h0\_min\_x\_max\_u: 0.03836837857169593  
train\_h0\_min\_x\_mean\_u: 0.0006778518545289332  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.0272675413211287  
train\_h0\_range\_x\_mean\_u: 0.29024838340272807  
train\_h0\_range\_x\_min\_u: 0.0006658575203759403  
train\_h0\_row\_norms\_max: 0.7605581409720157  
train\_h0\_row\_norms\_mean: 0.4696271172312751  
train\_h0\_row\_norms\_min: 0.2920693554585123  
train\_h1\_col\_norms\_max: 0.7500000000000019  
train\_h1\_col\_norms\_mean: 0.7478891891811047  
train\_h1\_col\_norms\_min: 0.7301226575841477  
train\_h1\_max\_x\_max\_u: 0.6937101213333184  
train\_h1\_max\_x\_mean\_u: 0.12691466254421227  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.23083355912371697  
train\_h1\_mean\_x\_mean\_u: 0.021276350814965934  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.0313554709908741  
train\_h1\_min\_x\_mean\_u: 0.0005151223085456319  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.682581788283007  
train\_h1\_range\_x\_mean\_u: 0.12639954023566655  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.155703128110776  
train\_h1\_row\_norms\_mean: 0.7361496300292529  
train\_h1\_row\_norms\_min: 0.36519154059911146  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7489551043309934  
train\_h2\_col\_norms\_min: 0.7423031149019031  
train\_h2\_max\_x\_max\_u: 0.5887212892220629  
train\_h2\_max\_x\_mean\_u: 0.07504835021193643  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.20665429020900478  
train\_h2\_mean\_x\_mean\_u: 0.01645665909465153  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.058779368609537024  
train\_h2\_min\_x\_mean\_u: 0.0006474125281617324  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5788037511419842  
train\_h2\_range\_x\_mean\_u: 0.07440093768377468  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2106658839622617



train\_h2.row\_norms\_mean: 0.7336587223848118  
train\_h2.row\_norms\_min: 0.3305024496169119  
train\_objective: 0.5420457700899629  
train\_y.col\_norms\_max: 1.7969218466479302  
train\_y.col\_norms\_mean: 1.7969218466479302  
train\_y.col\_norms\_min: 1.7969218466479302  
train\_y\_max\_max\_class: 0.9100089891531631  
train\_y\_mean\_max\_class: 0.6962383094817389  
train\_y\_min\_max\_class: 0.5073347655838398  
train\_y\_misclass: 0.243840358379149  
train\_y\_nll: 0.5006829034047342  
train\_y.row\_norms\_max: 0.5887393843627752  
train\_y.row\_norms\_mean: 0.08538689358929782  
train\_y.row\_norms\_min: 6.476827606481021e-05  
training\_seconds\_this\_epoch: 45.499089999999996  
valid\_h0.col\_norms\_max: 0.7499999999999999  
valid\_h0.col\_norms\_mean: 0.747334408621586  
valid\_h0.col\_norms\_min: 0.7260143384509796  
valid\_h0\_max\_x\_max\_u: 1.2506807381890621  
valid\_h0\_max\_x\_mean\_u: 0.23171491417221457  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.630378920173424  
valid\_h0\_mean\_x\_mean\_u: 0.05673956906486868  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.2455987992942877  
valid\_h0\_min\_x\_mean\_u: 0.006184611377593151  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.17230493646262  
valid\_h0\_range\_x\_mean\_u: 0.22553030279462144  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.7605581409720036  
valid\_h0.row\_norms\_mean: 0.4696271172312629  
valid\_h0.row\_norms\_min: 0.29206935545850876  
valid\_h1.col\_norms\_max: 0.7499999999999999  
valid\_h1.col\_norms\_mean: 0.7478891891811122  
valid\_h1.col\_norms\_min: 0.7301226575841377  
valid\_h1\_max\_x\_max\_u: 0.8399621678373648  
valid\_h1\_max\_x\_mean\_u: 0.11129610886564123  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.4409642920634595  
valid\_h1\_mean\_x\_mean\_u: 0.032939941929725255  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.17836174121520998  
valid\_h1\_min\_x\_mean\_u: 0.004462512014918321  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.7453143540459298  
valid\_h1\_range\_x\_mean\_u: 0.10683359685072287  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.1557031281107601  
valid\_h1.row\_norms\_mean: 0.736149630029231  
valid\_h1.row\_norms\_min: 0.365191540599116  
valid\_h2.col\_norms\_max: 0.7499999999999999  
valid\_h2.col\_norms\_mean: 0.7489551043310031  
valid\_h2.col\_norms\_min: 0.7423031149019178

```

valid_h2_max_x_max_u: 0.6385684474628901
valid_h2_max_x_mean_u: 0.06083114454583195
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.23161617512425506
valid_h2_mean_x_mean_u: 0.01595397154350777
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.08721062733462556
valid_h2_min_x_mean_u: 0.0012712010716082508
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.6352710951382644
valid_h2_range_x_mean_u: 0.05955994347422368
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.210665883962235
valid_h2_row_norms_mean: 0.7336587223848142
valid_h2_row_norms_min: 0.33050244961691677
valid_objective: 0.6509605056280371
valid_y_col_norms_max: 1.796921846647882
valid_y_col_norms_mean: 1.796921846647882
valid_y_col_norms_min: 1.796921846647882
valid_y_max_max_class: 0.876040486614647
valid_y_mean_max_class: 0.6663665560990961
valid_y_min_max_class: 0.5057913954845628
valid_y_misclass: 0.26780104712041897
valid_y_nll: 0.5477774532314961
valid_y_row_norms_max: 0.5887393843627542
valid_y_row_norms_mean: 0.0853868935892999
valid_y_row_norms_min: 6.476827606481135e-05
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.049999 seconds
Time this epoch: 45.069269 seconds
Monitoring step:
  Epochs seen: 7
  Batches seen: 9632
  Examples seen: 962556
  learning_rate: 0.09300700000000131
  momentum: 0.47575757575756483
  total_seconds_last_epoch: 83.20833499999794
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.7471609687211965
  train_h0_col_norms_min: 0.7292134247271654
  train_h0_max_x_max_u: 1.1152845504760762
  train_h0_max_x_mean_u: 0.29028994912883177
  train_h0_max_x_min_u: 0.00031804678199895766
  train_h0_mean_x_max_u: 0.3674707195529916
  train_h0_mean_x_mean_u: 0.03753266458917505
  train_h0_mean_x_min_u: 5.636316360398262e-06
  train_h0_min_x_max_u: 0.0425682348781369
  train_h0_min_x_mean_u: 0.0007007837660515559
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.101972113339153
  train_h0_range_x_mean_u: 0.28958916536278007
  train_h0_range_x_min_u: 0.00031804678199895766
  train_h0_row_norms_max: 0.7210034491995453
  train_h0_row_norms_mean: 0.47158097773192353

```

```

train_h0_row_norms_min: 0.3200678187529609
train_h1_col_norms_max: 0.7500000000000019
train_h1_col_norms_mean: 0.7479180798415233
train_h1_col_norms_min: 0.7332972940952419
train_h1_max_x_max_u: 0.7838318597592071
train_h1_max_x_mean_u: 0.12975744320064356
train_h1_max_x_min_u: 0.0
train_h1_mean_x_max_u: 0.2581406058682091
train_h1_mean_x_mean_u: 0.022810294074567066
train_h1_mean_x_min_u: 0.0
train_h1_min_x_max_u: 0.028196841256470817
train_h1_min_x_mean_u: 0.000743747897466817
train_h1_min_x_min_u: 0.0
train_h1_range_x_max_u: 0.7675143753415188
train_h1_range_x_mean_u: 0.12901369530317677
train_h1_range_x_min_u: 0.0
train_h1_row_norms_max: 1.1465660618278337
train_h1_row_norms_mean: 0.7369008649299434
train_h1_row_norms_min: 0.37645805017689227
train_h2_col_norms_max: 0.7500000000000019
train_h2_col_norms_mean: 0.7489272980559142
train_h2_col_norms_min: 0.7353741067466094
train_h2_max_x_max_u: 0.6783041588109431
train_h2_max_x_mean_u: 0.08284332653750219
train_h2_max_x_min_u: 0.0
train_h2_mean_x_max_u: 0.23837176795834908
train_h2_mean_x_mean_u: 0.020289013989626653
train_h2_mean_x_min_u: 0.0
train_h2_min_x_max_u: 0.07093086256859618
train_h2_min_x_mean_u: 0.0012514404696536787
train_h2_min_x_min_u: 0.0
train_h2_range_x_max_u: 0.6645903041636828
train_h2_range_x_mean_u: 0.08159188606784851
train_h2_range_x_min_u: 0.0
train_h2_row_norms_max: 1.2152624030439283
train_h2_row_norms_mean: 0.7337825340833898
train_h2_row_norms_min: 0.3300654671667368
train_objective: 0.557379288092843
train_y_col_norms_max: 1.9019010334058721
train_y_col_norms_mean: 1.9019010334058721
train_y_col_norms_min: 1.9019010334058721
train_y_max_max_class: 0.9350022508901786
train_y_mean_max_class: 0.7132868478780263
train_y_min_max_class: 0.5097509742017563
train_y_misclass: 0.23008115891439035
train_y_nll: 0.47429698693210415
train_y_row_norms_max: 0.5822984951335709
train_y_row_norms_mean: 0.09125557301362741
train_y_row_norms_min: 0.0006155568433364475
training_seconds_this_epoch: 45.069269000000085
valid_h0_col_norms_max: 0.7500000000000003
valid_h0_col_norms_mean: 0.7471609687211862
valid_h0_col_norms_min: 0.7292134247271691
valid_h0_max_x_max_u: 1.4199924776274822

```

valid\_h0\_max\_x\_mean\_u: 0.22805293657714354  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.8075267844020744  
valid\_h0\_mean\_x\_mean\_u: 0.05685714073820969  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.3210827151915045  
valid\_h0\_min\_x\_mean\_u: 0.006558517797866468  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.302289211853509  
valid\_h0\_range\_x\_mean\_u: 0.22149441877927714  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.7210034491995365  
valid\_h0\_row\_norms\_mean: 0.47158097773191365  
valid\_h0\_row\_norms\_min: 0.32006781875296436  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7479180798415079  
valid\_h1\_col\_norms\_min: 0.7332972940952196  
valid\_h1\_max\_x\_max\_u: 1.0240055028441828  
valid\_h1\_max\_x\_mean\_u: 0.12571206333898644  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.5397398981839915  
valid\_h1\_mean\_x\_mean\_u: 0.04275752842850784  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.20064395810345792  
valid\_h1\_min\_x\_mean\_u: 0.007084614320412277  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.8851566059870973  
valid\_h1\_range\_x\_mean\_u: 0.11862744901857415  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.1465660618278675  
valid\_h1\_row\_norms\_mean: 0.7369008649299291  
valid\_h1\_row\_norms\_min: 0.3764580501768835  
valid\_h2\_col\_norms\_max: 0.7499999999999996  
valid\_h2\_col\_norms\_mean: 0.7489272980558963  
valid\_h2\_col\_norms\_min: 0.7353741067465968  
valid\_h2\_max\_x\_max\_u: 0.9926229595807722  
valid\_h2\_max\_x\_mean\_u: 0.08520535152330677  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.39532742897662887  
valid\_h2\_mean\_x\_mean\_u: 0.02929689845807428  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.14501358418149304  
valid\_h2\_min\_x\_mean\_u: 0.004678968499933419  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.9506213799626854  
valid\_h2\_range\_x\_mean\_u: 0.08052638302337337  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.215262403043926  
valid\_h2\_row\_norms\_mean: 0.7337825340833766  
valid\_h2\_row\_norms\_min: 0.33006546716673124  
valid\_objective: 0.9553281982532632  
valid\_y\_col\_norms\_max: 1.9019010334059254  
valid\_y\_col\_norms\_mean: 1.9019010334059254  
valid\_y\_col\_norms\_min: 1.9019010334059254

```

valid_y_max_max_class: 0.9502361573115298
valid_y_mean_max_class: 0.7569054848711776
valid_y_min_max_class: 0.5472274440864822
valid_y_misclass: 0.3518324607329842
valid_y_nll: 0.6668189638275435
valid_y_row_norms_max: 0.5822984951335576
valid_y_row_norms_mean: 0.09125557301362597
valid_y_row_norms_min: 0.0006155568433364484
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.055000 seconds
Time this epoch: 44.995000 seconds
Monitoring step:
  Epochs seen: 8
  Batches seen: 11008
  Examples seen: 1100064
  learning_rate: 0.09200800000000264
  momentum: 0.4717171717171784
  total_seconds_last_epoch: 82.80926900000155
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.7464960629114477
  train_h0_col_norms_min: 0.7225535996276973
  train_h0_max_x_max_u: 1.0345669509868898
  train_h0_max_x_mean_u: 0.28330319937561815
  train_h0_max_x_min_u: 7.329568597422134e-05
  train_h0_mean_x_max_u: 0.2885395744840161
  train_h0_mean_x_mean_u: 0.03261899367636257
  train_h0_mean_x_min_u: 1.2350062647619098e-06
  train_h0_min_x_max_u: 0.02954171656463625
  train_h0_min_x_mean_u: 0.0004223360371637425
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.0298124030290958
  train_h0_range_x_mean_u: 0.28288086333845436
  train_h0_range_x_min_u: 7.329568597422134e-05
  train_h0_row_norms_max: 0.7036235623780113
  train_h0_row_norms_mean: 0.4725911447480328
  train_h0_row_norms_min: 0.33643248709207757
  train_h1_col_norms_max: 0.750000000000019
  train_h1_col_norms_mean: 0.7477335750562176
  train_h1_col_norms_min: 0.7305005104826262
  train_h1_max_x_max_u: 0.6443557580098361
  train_h1_max_x_mean_u: 0.11761964614635877
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.1906774641162744
  train_h1_mean_x_mean_u: 0.0192421596984802
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.020315696705324227
  train_h1_min_x_mean_u: 0.00046348148914450833
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.6375644696849494
  train_h1_range_x_mean_u: 0.1171561646572143
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.1262806832527672
  train_h1_row_norms_mean: 0.7374857884872899
  train_h1_row_norms_min: 0.3916601960231558

```

train\_h2.col\_norms\_max: 0.750000000000019  
train\_h2.col\_norms\_mean: 0.7487730753074616  
train\_h2.col\_norms\_min: 0.7379695047284937  
train\_h2\_max\_x\_max\_u: 0.6187140032779878  
train\_h2\_max\_x\_mean\_u: 0.07422171236661715  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.22779728282402875  
train\_h2\_mean\_x\_mean\_u: 0.018043468496636378  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.07164971058902317  
train\_h2\_min\_x\_mean\_u: 0.0012576293606786759  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.5960262711544286  
train\_h2\_range\_x\_mean\_u: 0.07296408300593848  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2170956706991263  
train\_h2.row\_norms\_mean: 0.7338384131840808  
train\_h2.row\_norms\_min: 0.3352484332732857  
train\_objective: 0.5009691466787041  
train\_y\_col\_norms\_max: 2.0044237248914136  
train\_y\_col\_norms\_mean: 2.0044237248914136  
train\_y\_col\_norms\_min: 2.0044237248914136  
train\_y\_max\_max\_class: 0.9416625693224188  
train\_y\_mean\_max\_class: 0.7287808855814648  
train\_y\_min\_max\_class: 0.5107178712647286  
train\_y\_misclass: 0.20923146289670416  
train\_y\_nll: 0.45691292657663396  
train\_y\_row\_norms\_max: 0.5824856930951346  
train\_y\_row\_norms\_mean: 0.09636556875793657  
train\_y\_row\_norms\_min: 0.00026976538018579055  
training\_seconds\_this\_epoch: 44.99499999999886  
valid\_h0.col\_norms\_max: 0.7499999999999996  
valid\_h0.col\_norms\_mean: 0.7464960629114636  
valid\_h0.col\_norms\_min: 0.7225535996277163  
valid\_h0\_max\_x\_max\_u: 1.216467965871899  
valid\_h0\_max\_x\_mean\_u: 0.22001866724971855  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5976998021866298  
valid\_h0\_mean\_x\_mean\_u: 0.04796997174439915  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.21201306632540964  
valid\_h0\_min\_x\_mean\_u: 0.003915308197270233  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.1708384250000252  
valid\_h0\_range\_x\_mean\_u: 0.21610335905244832  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.7036235623780086  
valid\_h0.row\_norms\_mean: 0.4725911447480246  
valid\_h0.row\_norms\_min: 0.33643248709206564  
valid\_h1.col\_norms\_max: 0.7499999999999996  
valid\_h1.col\_norms\_mean: 0.7477335750562325  
valid\_h1.col\_norms\_min: 0.7305005104826426  
valid\_h1\_max\_x\_max\_u: 0.8044221169238615  
valid\_h1\_max\_x\_mean\_u: 0.11261450147489786

```

valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.3838705411442852
valid_h1_mean_x_mean_u: 0.03457292284417915
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.13321948892892493
valid_h1_min_x_mean_u: 0.004160486849206651
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.7441684728385258
valid_h1_range_x_mean_u: 0.10845401462569113
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.1262806832528096
valid_h1_row_norms_mean: 0.7374857884872833
valid_h1_row_norms_min: 0.39166019602315266
valid_h2_col_norms_max: 0.7499999999999996
valid_h2_col_norms_mean: 0.7487730753074435
valid_h2_col_norms_min: 0.7379695047285192
valid_h2_max_x_max_u: 0.8610445901104148
valid_h2_max_x_mean_u: 0.06969766826982267
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.324561113533019
valid_h2_mean_x_mean_u: 0.020622800018909145
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.11373767681555629
valid_h2_min_x_mean_u: 0.0020577113597251054
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.8453807507594554
valid_h2_range_x_mean_u: 0.06763995691009755
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.217095670699082
valid_h2_row_norms_mean: 0.7338384131840923
valid_h2_row_norms_min: 0.3352484332732905
valid_objective: 0.6934335161481703
valid_y_col_norms_max: 2.0044237248914145
valid_y_col_norms_mean: 2.0044237248914145
valid_y_col_norms_min: 2.0044237248914145
valid_y_max_max_class: 0.9190394740465412
valid_y_mean_max_class: 0.7134618466314381
valid_y_min_max_class: 0.5078781953940721
valid_y_misclass: 0.2602094240837697
valid_y_nll: 0.5334826923923779
valid_y_row_norms_max: 0.5824856930951368
valid_y_row_norms_mean: 0.096365568757935
valid_y_row_norms_min: 0.00026976538018579316
Saving to ..\Sean\nn_files_S4C4R20\nn_train_best.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train_best.pkl done. Time elapsed: 0.060000 seconds
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.065000 seconds
Time this epoch: 44.905000 seconds
Monitoring step:
  Epochs seen: 9
  Batches seen: 12384
  Examples seen: 1237572
  learning_rate: 0.091008999999999873
  momentum: 0.46767676767677985

```

total\_seconds\_last\_epoch: 82.71500000000279  
train\_h0\_col\_norms\_max: 0.750000000000019  
train\_h0\_col\_norms\_mean: 0.7465700780305138  
train\_h0\_col\_norms\_min: 0.7244284183156234  
train\_h0\_max\_x\_max\_u: 1.0645846722753358  
train\_h0\_max\_x\_mean\_u: 0.2765945547469174  
train\_h0\_max\_x\_min\_u: 6.89335902286951e-05  
train\_h0\_mean\_x\_max\_u: 0.2714170525772672  
train\_h0\_mean\_x\_mean\_u: 0.029980742480193445  
train\_h0\_mean\_x\_min\_u: 7.106568229112412e-07  
train\_h0\_min\_x\_max\_u: 0.018740956350413514  
train\_h0\_min\_x\_mean\_u: 0.0002839644713259981  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.0610060100365362  
train\_h0\_range\_x\_mean\_u: 0.2763105902755914  
train\_h0\_range\_x\_min\_u: 6.89335902286951e-05  
train\_h0\_row\_norms\_max: 0.6773221604587305  
train\_h0\_row\_norms\_mean: 0.4737511995173149  
train\_h0\_row\_norms\_min: 0.3524047373090209  
train\_h1\_col\_norms\_max: 0.750000000000019  
train\_h1\_col\_norms\_mean: 0.747977148657221  
train\_h1\_col\_norms\_min: 0.7330555504132986  
train\_h1\_max\_x\_max\_u: 0.6686895876945765  
train\_h1\_max\_x\_mean\_u: 0.11839373275745482  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.20449617486898183  
train\_h1\_mean\_x\_mean\_u: 0.019342432438227697  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.021449358333253628  
train\_h1\_min\_x\_mean\_u: 0.00037731323644825697  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6611941213162474  
train\_h1\_range\_x\_mean\_u: 0.11801641952100665  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0976764491807236  
train\_h1\_row\_norms\_mean: 0.7384207857942782  
train\_h1\_row\_norms\_min: 0.40172726995586666  
train\_h2\_col\_norms\_max: 0.750000000000019  
train\_h2\_col\_norms\_mean: 0.7489415175778737  
train\_h2\_col\_norms\_min: 0.740145034203808  
train\_h2\_max\_x\_max\_u: 0.6435845996608539  
train\_h2\_max\_x\_mean\_u: 0.07497247515448917  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2231585203112517  
train\_h2\_mean\_x\_mean\_u: 0.017976710239710342  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.06474681633603983  
train\_h2\_min\_x\_mean\_u: 0.0010769467069189796  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6233515502267217  
train\_h2\_range\_x\_mean\_u: 0.0738955284475702  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2171573717482624  
train\_h2\_row\_norms\_mean: 0.7341914607800846



train\_h2.row\_norms\_min: 0.33465346473934154  
train\_objective: 0.4972344870612331  
train\_y.col\_norms\_max: 2.104001766087122  
train\_y.col\_norms\_mean: 2.104001766087122  
train\_y.col\_norms\_min: 2.104001766087122  
train\_y\_max\_max\_class: 0.9415165268725092  
train\_y\_mean\_max\_class: 0.7188601467637775  
train\_y\_min\_max\_class: 0.5073328895055101  
train\_y\_misclass: 0.1834220554440468  
train\_y\_nll: 0.43234532897213235  
train\_y.row\_norms\_max: 0.6011333923571349  
train\_y.row\_norms\_mean: 0.10105482362934883  
train\_y.row\_norms\_min: 0.0007757382584516171  
training\_seconds\_this\_epoch: 44.904999999999205  
valid\_h0.col\_norms\_max: 0.7500000000000003  
valid\_h0.col\_norms\_mean: 0.7465700780305013  
valid\_h0.col\_norms\_min: 0.7244284183156311  
valid\_h0\_max\_x\_max\_u: 1.2435415693388874  
valid\_h0\_max\_x\_mean\_u: 0.20695699377999835  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5841877257108343  
valid\_h0\_mean\_x\_mean\_u: 0.04199790634754784  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.18460860930571735  
valid\_h0\_min\_x\_mean\_u: 0.0026966924227568973  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.198228794044037  
valid\_h0\_range\_x\_mean\_u: 0.20426030135724138  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.6773221604587214  
valid\_h0.row\_norms\_mean: 0.47375119951733025  
valid\_h0.row\_norms\_min: 0.3524047373090171  
valid\_h1.col\_norms\_max: 0.7499999999999996  
valid\_h1.col\_norms\_mean: 0.7479771486572295  
valid\_h1.col\_norms\_min: 0.7330555504132814  
valid\_h1\_max\_x\_max\_u: 0.8096706213331559  
valid\_h1\_max\_x\_mean\_u: 0.10565484578536241  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.38146010315452855  
valid\_h1\_mean\_x\_mean\_u: 0.0300932667516892  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.122620106309266  
valid\_h1\_min\_x\_mean\_u: 0.003187228871396546  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.737739212271541  
valid\_h1\_range\_x\_mean\_u: 0.10246761691396586  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.0976764491807298  
valid\_h1.row\_norms\_mean: 0.7384207857942987  
valid\_h1.row\_norms\_min: 0.40172726995587077  
valid\_h2.col\_norms\_max: 0.7499999999999996  
valid\_h2.col\_norms\_mean: 0.7489415175778898  
valid\_h2.col\_norms\_min: 0.7401450342038002  
valid\_h2\_max\_x\_max\_u: 0.8430763404264804

```

valid_h2_max_x_mean_u: 0.06421730118226542
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.30328287182945896
valid_h2_mean_x_mean_u: 0.01841558922450645
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.10553491738937984
valid_h2_min_x_mean_u: 0.0019071421275745361
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.8327464520097454
valid_h2_range_x_mean_u: 0.06231015905469088
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2171573717482504
valid_h2_row_norms_mean: 0.7341914607800856
valid_h2_row_norms_min: 0.3346534647393343
valid_objective: 0.6882925991929798
valid_y_col_norms_max: 2.104001766087084
valid_y_col_norms_mean: 2.104001766087084
valid_y_col_norms_min: 2.104001766087084
valid_y_max_max_class: 0.9055348019217853
valid_y_mean_max_class: 0.6824310449145911
valid_y_min_max_class: 0.5051248834036719
valid_y_misclass: 0.27048429319371714
valid_y_nll: 0.547714408241829
valid_y_row_norms_max: 0.6011333923571319
valid_y_row_norms_mean: 0.10105482362934953
valid_y_row_norms_min: 0.0007757382584516044
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.065000 seconds
Time this epoch: 45.065000 seconds
Monitoring step:
  Epochs seen: 10
  Batches seen: 13760
  Examples seen: 1375080
  learning_rate: 0.09000999999999999
  momentum: 0.463636363636358
  total_seconds_last_epoch: 82.49000000000125
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.7461431092629734
  train_h0_col_norms_min: 0.7194707308751822
  train_h0_max_x_max_u: 1.1221910989848876
  train_h0_max_x_mean_u: 0.2733990248892027
  train_h0_max_x_min_u: 8.418713999955676e-06
  train_h0_mean_x_max_u: 0.33687264949559675
  train_h0_mean_x_mean_u: 0.02914296931581784
  train_h0_mean_x_min_u: 8.418713999955675e-08
  train_h0_min_x_max_u: 0.027089491371418115
  train_h0_min_x_mean_u: 0.0003419520868801209
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.110262848138083
  train_h0_range_x_mean_u: 0.27305707280232266
  train_h0_range_x_min_u: 8.418713999955676e-06
  train_h0_row_norms_max: 0.6615474925234711
  train_h0_row_norms_mean: 0.4741597807389048
  train_h0_row_norms_min: 0.3748429026855454

```

train\_h1.col\_norms\_max: 0.750000000000019  
train\_h1.col\_norms\_mean: 0.7479125452221375  
train\_h1.col\_norms\_min: 0.7310616198796611  
train\_h1\_max\_x\_max\_u: 0.6992046235771076  
train\_h1\_max\_x\_mean\_u: 0.11918186388031381  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.22750274098119969  
train\_h1\_mean\_x\_mean\_u: 0.02066226619377738  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.031785432314007676  
train\_h1\_min\_x\_mean\_u: 0.0005699945417797593  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6884263747898473  
train\_h1\_range\_x\_mean\_u: 0.11861186933853393  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1.row\_norms\_max: 1.082725387354157  
train\_h1.row\_norms\_mean: 0.7390642497042296  
train\_h1.row\_norms\_min: 0.40695149307641737  
train\_h2.col\_norms\_max: 0.750000000000019  
train\_h2.col\_norms\_mean: 0.7488567992212081  
train\_h2.col\_norms\_min: 0.7264137427217428  
train\_h2\_max\_x\_max\_u: 0.7046437466058548  
train\_h2\_max\_x\_mean\_u: 0.08108208531967089  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2405073325018113  
train\_h2\_mean\_x\_mean\_u: 0.020556240969101067  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.06417374934951618  
train\_h2\_min\_x\_mean\_u: 0.0013961010597714036  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6857499478685998  
train\_h2\_range\_x\_mean\_u: 0.07968598425989927  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2118901927569659  
train\_h2.row\_norms\_mean: 0.7342963554341012  
train\_h2.row\_norms\_min: 0.33355281051346586  
train\_objective: 0.49710436722044105  
train\_y.col\_norms\_max: 2.220824924400795  
train\_y.col\_norms\_mean: 2.220824924400795  
train\_y.col\_norms\_min: 2.220824924400795  
train\_y\_max\_max\_class: 0.956827822972217  
train\_y\_mean\_max\_class: 0.7451405958668028  
train\_y\_min\_max\_class: 0.5105924670375268  
train\_y\_misclass: 0.17393897082351567  
train\_y\_nll: 0.40694569961788163  
train\_y.row\_norms\_max: 0.6062925045476669  
train\_y.row\_norms\_mean: 0.10653032060795811  
train\_y.row\_norms\_min: 0.00035117900636194815  
training\_seconds\_this\_epoch: 45.0650000000006  
valid\_h0.col\_norms\_max: 0.7499999999999996  
valid\_h0.col\_norms\_mean: 0.7461431092629833  
valid\_h0.col\_norms\_min: 0.7194707308751747  
valid\_h0\_max\_x\_max\_u: 1.3652159504415065  
valid\_h0\_max\_x\_mean\_u: 0.2031243354976676

valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.7585302435525793  
valid\_h0\_mean\_x\_mean\_u: 0.04314596161050883  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.24491152816645073  
valid\_h0\_min\_x\_mean\_u: 0.00338426986378202  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2679455209035337  
valid\_h0\_range\_x\_mean\_u: 0.19974006563388544  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.661547492523452  
valid\_h0\_row\_norms\_mean: 0.47415978073891973  
valid\_h0\_row\_norms\_min: 0.3748429026855362  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7479125452221577  
valid\_h1\_col\_norms\_min: 0.7310616198796721  
valid\_h1\_max\_x\_max\_u: 0.9258847965178713  
valid\_h1\_max\_x\_mean\_u: 0.11776344375145353  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.47343498889440344  
valid\_h1\_mean\_x\_mean\_u: 0.037957569693872616  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.18576460551620708  
valid\_h1\_min\_x\_mean\_u: 0.005213290228811217  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.8378049356051022  
valid\_h1\_range\_x\_mean\_u: 0.11255015352264229  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0827253873541285  
valid\_h1\_row\_norms\_mean: 0.7390642497042241  
valid\_h1\_row\_norms\_min: 0.40695149307641054  
valid\_h2\_col\_norms\_max: 0.7499999999999996  
valid\_h2\_col\_norms\_mean: 0.748856799221219  
valid\_h2\_col\_norms\_min: 0.726413742721721  
valid\_h2\_max\_x\_max\_u: 1.06028761518204  
valid\_h2\_max\_x\_mean\_u: 0.08162162513246443  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.3945698996423096  
valid\_h2\_mean\_x\_mean\_u: 0.026203900100267734  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.12655736003221862  
valid\_h2\_min\_x\_mean\_u: 0.003505142332852221  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 1.030785400491908  
valid\_h2\_range\_x\_mean\_u: 0.07811648279961221  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.211890192756968  
valid\_h2\_row\_norms\_mean: 0.7342963554341235  
valid\_h2\_row\_norms\_min: 0.3335528105134703  
valid\_objective: 0.8556171559449967  
valid\_y\_col\_norms\_max: 2.2208249244008154  
valid\_y\_col\_norms\_mean: 2.2208249244008154  
valid\_y\_col\_norms\_min: 2.2208249244008154  
valid\_y\_max\_max\_class: 0.9487080056290076

```

valid_y_mean_max_class: 0.7447039145108506
valid_y_min_max_class: 0.5261934090103172
valid_y_misclass: 0.3070680628272254
valid_y_nll: 0.6089025023293803
valid_y_row_norms_max: 0.606292504547652
valid_y_row_norms_mean: 0.10653032060796164
valid_y_row_norms_min: 0.000351179006361943
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.060000 seconds
Time this epoch: 45.150000 seconds
Monitoring step:
  Epochs seen: 11
  Batches seen: 15136
  Examples seen: 1512588
  learning_rate: 0.089010999999999874
  momentum: 0.459595959595959618
  total_seconds_last_epoch: 82.744999999999857
  train_h0_col_norms_max: 0.7500000000000019
  train_h0_col_norms_mean: 0.7460370806701923
  train_h0_col_norms_min: 0.7206343547827225
  train_h0_max_x_max_u: 1.0785817519107757
  train_h0_max_x_mean_u: 0.27536879099097644
  train_h0_max_x_min_u: 6.924331401845644e-06
  train_h0_mean_x_max_u: 0.26370608478574137
  train_h0_mean_x_mean_u: 0.027956105686119448
  train_h0_mean_x_min_u: 6.924331401845642e-08
  train_h0_min_x_max_u: 0.014730589173810217
  train_h0_min_x_mean_u: 0.0001971918485279966
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.0754803166869475
  train_h0_range_x_mean_u: 0.275171599142448
  train_h0_range_x_min_u: 6.924331401845644e-06
  train_h0_row_norms_max: 0.6396321487956329
  train_h0_row_norms_mean: 0.4745563419062467
  train_h0_row_norms_min: 0.37520719601376396
  train_h1_col_norms_max: 0.7500000000000019
  train_h1_col_norms_mean: 0.7481125938021773
  train_h1_col_norms_min: 0.7317876906904418
  train_h1_max_x_max_u: 0.6537579735553912
  train_h1_max_x_mean_u: 0.11410743891110738
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.1939559162773645
  train_h1_mean_x_mean_u: 0.017803597012815236
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.01886114147239665
  train_h1_min_x_mean_u: 0.0003068834944907656
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.6465392087702636
  train_h1_range_x_mean_u: 0.11380055541661652
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.0592936691035624
  train_h1_row_norms_mean: 0.7397739388468112
  train_h1_row_norms_min: 0.4285673500768002
  train_h2_col_norms_max: 0.7500000000000019

```

train\_h2.col\_norms\_mean: 0.7489116316082906  
train\_h2.col\_norms\_min: 0.737223692554517  
train\_h2.max\_x\_max\_u: 0.6209765455885332  
train\_h2.max\_x\_mean\_u: 0.07207189746770033  
train\_h2.max\_x\_min\_u: 0.0  
train\_h2.mean\_x\_max\_u: 0.20050007499688782  
train\_h2.mean\_x\_mean\_u: 0.017618207280671094  
train\_h2.mean\_x\_min\_u: 0.0  
train\_h2.min\_x\_max\_u: 0.05508645974857013  
train\_h2.min\_x\_mean\_u: 0.0010681997076141913  
train\_h2.min\_x\_min\_u: 0.0  
train\_h2.range\_x\_max\_u: 0.6066657196244334  
train\_h2.range\_x\_mean\_u: 0.07100369776008612  
train\_h2.range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2073152406389822  
train\_h2.row\_norms\_mean: 0.7345037883296143  
train\_h2.row\_norms\_min: 0.3468962373809287  
train\_objective: 0.4838565857344437  
train\_y.col\_norms\_max: 2.2959878880650315  
train\_y.col\_norms\_mean: 2.2959878880650315  
train\_y.col\_norms\_min: 2.2959878880650315  
train\_y.max\_max\_class: 0.9609577189349644  
train\_y.mean\_max\_class: 0.7661163916224599  
train\_y.min\_max\_class: 0.5232294215647706  
train\_y.misclass: 0.21203129999709094  
train\_y.nll: 0.43099656432804934  
train\_y.row\_norms\_max: 0.6262458670699733  
train\_y.row\_norms\_mean: 0.11012854218723273  
train\_y.row\_norms\_min: 0.0016087173165316095  
training\_seconds\_this\_epoch: 45.149999999999941  
valid\_h0.col\_norms\_max: 0.7499999999999996  
valid\_h0.col\_norms\_mean: 0.7460370806702088  
valid\_h0.col\_norms\_min: 0.7206343547827319  
valid\_h0.max\_x\_max\_u: 1.2541446259229343  
valid\_h0.max\_x\_mean\_u: 0.21041355843166887  
valid\_h0.max\_x\_min\_u: 0.0  
valid\_h0.mean\_x\_max\_u: 0.5530146135560904  
valid\_h0.mean\_x\_mean\_u: 0.04015966549325223  
valid\_h0.mean\_x\_min\_u: 0.0  
valid\_h0.min\_x\_max\_u: 0.14706050785520794  
valid\_h0.min\_x\_mean\_u: 0.0018765068227659957  
valid\_h0.min\_x\_min\_u: 0.0  
valid\_h0.range\_x\_max\_u: 1.2174021905624384  
valid\_h0.range\_x\_mean\_u: 0.2085370516089028  
valid\_h0.range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.6396321487956173  
valid\_h0.row\_norms\_mean: 0.4745563419062454  
valid\_h0.row\_norms\_min: 0.37520719601375857  
valid\_h1.col\_norms\_max: 0.7499999999999996  
valid\_h1.col\_norms\_mean: 0.7481125938021751  
valid\_h1.col\_norms\_min: 0.731787690690451  
valid\_h1.max\_x\_max\_u: 0.8016989924124693  
valid\_h1.max\_x\_mean\_u: 0.10682677960535525  
valid\_h1.max\_x\_min\_u: 0.0

```

valid_h1_mean_x_max_u: 0.37233953156801
valid_h1_mean_x_mean_u: 0.028898259040172267
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.12338200999164817
valid_h1_min_x_mean_u: 0.0027200568576434938
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.7459954123694145
valid_h1_range_x_mean_u: 0.10410672274771177
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.0592936691035422
valid_h1_row_norms_mean: 0.7397739388468302
valid_h1_row_norms_min: 0.4285673500768076
valid_h2_col_norms_max: 0.7499999999999999
valid_h2_col_norms_mean: 0.7489116316083047
valid_h2_col_norms_min: 0.7372236925545298
valid_h2_max_x_max_u: 0.8666176030857652
valid_h2_max_x_mean_u: 0.06658492170352742
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.2800666735278975
valid_h2_mean_x_mean_u: 0.017962438751231307
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.08038344267309855
valid_h2_min_x_mean_u: 0.0010909615899921533
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.8603563652154705
valid_h2_range_x_mean_u: 0.06549396011353524
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2073152406389522
valid_h2_row_norms_mean: 0.7345037883296229
valid_h2_row_norms_min: 0.3468962373809188
valid_objective: 0.6191677333450597
valid_y_col_norms_max: 2.2959878880649933
valid_y_col_norms_mean: 2.2959878880649933
valid_y_col_norms_min: 2.2959878880649933
valid_y_max_max_class: 0.935538310533806
valid_y_mean_max_class: 0.7202450806686117
valid_y_min_max_class: 0.5065946101584156
valid_y_misclass: 0.24803664921465968
valid_y_nll: 0.5065869067744727
valid_y_row_norms_max: 0.6262458670699792
valid_y_row_norms_mean: 0.11012854218723148
valid_y_row_norms_min: 0.0016087173165315622
Saving to ..\Sean\nn_files_S4C4R20\nn_train.best.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.best.pkl done. Time elapsed: 0.060000 seconds
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.060000 seconds
Time this epoch: 45.080000 seconds
Monitoring step:
  Epochs seen: 12
  Batches seen: 16512
  Examples seen: 1650096
  learning_rate: 0.08801200000000007
  momentum: 0.45555555555555649
  total_seconds_last_epoch: 82.8300000000014

```

train\_h0.col\_norms\_max: 0.750000000000019  
train\_h0.col\_norms\_mean: 0.7458529804514267  
train\_h0.col\_norms\_min: 0.7161417954178975  
train\_h0\_max\_x\_max\_u: 1.1147095631283919  
train\_h0\_max\_x\_mean\_u: 0.27488723169598994  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.285574997590162  
train\_h0\_mean\_x\_mean\_u: 0.028060153380281457  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.022310301806429983  
train\_h0\_min\_x\_mean\_u: 0.0002872600617673336  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.1095850391818103  
train\_h0\_range\_x\_mean\_u: 0.27459997163422256  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0.row\_norms\_max: 0.6343600469473436  
train\_h0.row\_norms\_mean: 0.4747485175704598  
train\_h0.row\_norms\_min: 0.3967148090656273  
train\_h1.col\_norms\_max: 0.750000000000019  
train\_h1.col\_norms\_mean: 0.7481357874226736  
train\_h1.col\_norms\_min: 0.726609886687996  
train\_h1\_max\_x\_max\_u: 0.687201429195435  
train\_h1\_max\_x\_mean\_u: 0.11794371850313737  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.21548877946696465  
train\_h1\_mean\_x\_mean\_u: 0.019216889596938656  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.023609184107005264  
train\_h1\_min\_x\_mean\_u: 0.0004533759293860562  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.676138252776548  
train\_h1\_range\_x\_mean\_u: 0.11749034257375125  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1.row\_norms\_max: 1.0399880073194996  
train\_h1.row\_norms\_mean: 0.7403736084920394  
train\_h1.row\_norms\_min: 0.43900806042903506  
train\_h2.col\_norms\_max: 0.750000000000019  
train\_h2.col\_norms\_mean: 0.7489435415338639  
train\_h2.col\_norms\_min: 0.7396232846176471  
train\_h2\_max\_x\_max\_u: 0.7078084453112125  
train\_h2\_max\_x\_mean\_u: 0.07933603153813902  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2294664031008786  
train\_h2\_mean\_x\_mean\_u: 0.020313605436750096  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.0629073474057622  
train\_h2\_min\_x\_mean\_u: 0.0014972774737527146  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6922561893303031  
train\_h2\_range\_x\_mean\_u: 0.07783875406438648  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2062378585172635  
train\_h2.row\_norms\_mean: 0.734720711230919  
train\_h2.row\_norms\_min: 0.35108459465374825



train\_objective: 0.476170688194967  
train\_y\_col\_norms\_max: 2.363872976661102  
train\_y\_col\_norms\_mean: 2.363872976661102  
train\_y\_col\_norms\_min: 2.363872976661102  
train\_y\_max\_max\_class: 0.9656922403075388  
train\_y\_mean\_max\_class: 0.7727423486497126  
train\_y\_min\_max\_class: 0.5198244538632765  
train\_y\_misclass: 0.17230997469238152  
train\_y\_nll: 0.3847205985218964  
train\_y\_row\_norms\_max: 0.6425215893345685  
train\_y\_row\_norms\_mean: 0.11366517613030673  
train\_y\_row\_norms\_min: 5.8169960614549445e-05  
training\_seconds\_this\_epoch: 45.080000000000084  
valid\_h0\_col\_norms\_max: 0.7499999999999997  
valid\_h0\_col\_norms\_mean: 0.7458529804514079  
valid\_h0\_col\_norms\_min: 0.716141795417888  
valid\_h0\_max\_x\_max\_u: 1.3299045719976774  
valid\_h0\_max\_x\_mean\_u: 0.21489989297790968  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6460086009139643  
valid\_h0\_mean\_x\_mean\_u: 0.042946083086015226  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.21748308182307544  
valid\_h0\_min\_x\_mean\_u: 0.002878237685365014  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2806484758627623  
valid\_h0\_range\_x\_mean\_u: 0.2120216552925445  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6343600469473339  
valid\_h0\_row\_norms\_mean: 0.4747485175704536  
valid\_h0\_row\_norms\_min: 0.39671480906563317  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7481357874226904  
valid\_h1\_col\_norms\_min: 0.7266098866879963  
valid\_h1\_max\_x\_max\_u: 0.9373472189473646  
valid\_h1\_max\_x\_mean\_u: 0.12282541957185758  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.4730891911410213  
valid\_h1\_mean\_x\_mean\_u: 0.036869742280503735  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.1698597829623763  
valid\_h1\_min\_x\_mean\_u: 0.0041079423858495214  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.8393418870776673  
valid\_h1\_range\_x\_mean\_u: 0.11871747718600807  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0399880073195231  
valid\_h1\_row\_norms\_mean: 0.7403736084920556  
valid\_h1\_row\_norms\_min: 0.4390080604290225  
valid\_h2\_col\_norms\_max: 0.7499999999999996  
valid\_h2\_col\_norms\_mean: 0.748943541533846  
valid\_h2\_col\_norms\_min: 0.7396232846176489  
valid\_h2\_max\_x\_max\_u: 1.1656440397852195  
valid\_h2\_max\_x\_mean\_u: 0.08787850364133547

```

valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.41327272023108796
valid_h2_mean_x_mean_u: 0.027114915244905856
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.11142675850122692
valid_h2_min_x_mean_u: 0.0029792543489998765
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 1.1347928671218181
valid_h2_range_x_mean_u: 0.0848992492923356
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2062378585172606
valid_h2_row_norms_mean: 0.7347207112309163
valid_h2_row_norms_min: 0.3510845946537604
valid_objective: 0.8639224598530592
valid_y_col_norms_max: 2.3638729766611135
valid_y_col_norms_mean: 2.3638729766611135
valid_y_col_norms_min: 2.3638729766611135
valid_y_max_max_class: 0.9603904042289386
valid_y_mean_max_class: 0.7737129436528438
valid_y_min_max_class: 0.5300568159292652
valid_y_misclass: 0.287303664921466
valid_y_nll: 0.5900673212755071
valid_y_row_norms_max: 0.6425215893345838
valid_y_row_norms_mean: 0.11366517613030429
valid_y_row_norms_min: 5.816996061454792e-05
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.060000 seconds
Time this epoch: 45.235000 seconds
Monitoring step:
  Epochs seen: 13
  Batches seen: 17888
  Examples seen: 1787604
  learning_rate: 0.08701300000000174
  momentum: 0.45151515151514204
  total_seconds_last_epoch: 82.69000000000257
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.7460555441140498
  train_h0_col_norms_min: 0.7142689476462107
  train_h0_max_x_max_u: 1.081046275101279
  train_h0_max_x_mean_u: 0.26992799956634905
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.2812431308070823
  train_h0_mean_x_mean_u: 0.026963634866277328
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.019963288625034943
  train_h0_min_x_mean_u: 0.0002483849466828203
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.0779757317634493
  train_h0_range_x_mean_u: 0.26967961461966605
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.6158105530230356
  train_h0_row_norms_mean: 0.4750844913818119
  train_h0_row_norms_min: 0.40181556953862124
  train_h1_col_norms_max: 0.750000000000019

```

train\_h1.col\_norms\_mean: 0.748144378653832  
train\_h1.col\_norms\_min: 0.7274936751022654  
train\_h1.max\_x\_max\_u: 0.6636144909533919  
train\_h1.max\_x\_mean\_u: 0.11523585037847812  
train\_h1.max\_x\_min\_u: 0.0  
train\_h1.mean\_x\_max\_u: 0.20067111274938929  
train\_h1.mean\_x\_mean\_u: 0.019226042561639945  
train\_h1.mean\_x\_min\_u: 0.0  
train\_h1.min\_x\_max\_u: 0.022376696029444088  
train\_h1.min\_x\_mean\_u: 0.0004632467749693652  
train\_h1.min\_x\_min\_u: 0.0  
train\_h1.range\_x\_max\_u: 0.6555841921980566  
train\_h1.range\_x\_mean\_u: 0.11477260360350888  
train\_h1.range\_x\_min\_u: 0.0  
train\_h1.row\_norms\_max: 1.0341842303880504  
train\_h1.row\_norms\_mean: 0.7409017948216663  
train\_h1.row\_norms\_min: 0.46678513995705795  
train\_h2.col\_norms\_max: 0.7500000000000019  
train\_h2.col\_norms\_mean: 0.7490510236510285  
train\_h2.col\_norms\_min: 0.7403350163285118  
train\_h2.max\_x\_max\_u: 0.6972934430781307  
train\_h2.max\_x\_mean\_u: 0.07859050464896504  
train\_h2.max\_x\_min\_u: 0.0  
train\_h2.mean\_x\_max\_u: 0.2376845811321948  
train\_h2.mean\_x\_mean\_u: 0.0203804490110542  
train\_h2.mean\_x\_min\_u: 0.0  
train\_h2.min\_x\_max\_u: 0.07578849079432518  
train\_h2.min\_x\_mean\_u: 0.0016382371885793187  
train\_h2.min\_x\_min\_u: 0.0  
train\_h2.range\_x\_max\_u: 0.6817175138122016  
train\_h2.range\_x\_mean\_u: 0.07695226746038564  
train\_h2.range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.205320085891613  
train\_h2.row\_norms\_mean: 0.7349816393266321  
train\_h2.row\_norms\_min: 0.35292844461557193  
train\_objective: 0.4601916784319464  
train\_y.col\_norms\_max: 2.4334413514666027  
train\_y.col\_norms\_mean: 2.4334413514666027  
train\_y.col\_norms\_min: 2.4334413514666027  
train\_y.max\_max\_class: 0.9677775455165119  
train\_y.mean\_max\_class: 0.7726643478979653  
train\_y.min\_max\_class: 0.5147959067778178  
train\_y.misclass: 0.14623876429007793  
train\_y\_nll: 0.36250130898334315  
train\_y.row\_norms\_max: 0.6643467306479575  
train\_y.row\_norms\_mean: 0.11680239097116425  
train\_y.row\_norms\_min: 0.00016236936813378056  
training\_seconds\_this\_epoch: 45.235000000000062  
valid\_h0.col\_norms\_max: 0.7499999999999997  
valid\_h0.col\_norms\_mean: 0.7460555441140635  
valid\_h0.col\_norms\_min: 0.7142689476461997  
valid\_h0.max\_x\_max\_u: 1.2889079083457002  
valid\_h0.max\_x\_mean\_u: 0.20579713067623798  
valid\_h0.max\_x\_min\_u: 0.0

valid\_h0\_mean\_x\_max\_u: 0.590035692746379  
valid\_h0\_mean\_x\_mean\_u: 0.04090634974941232  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.18694010901205077  
valid\_h0\_min\_x\_mean\_u: 0.0024784112635670118  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2436172667683647  
valid\_h0\_range\_x\_mean\_u: 0.20331871941267096  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6158105530230443  
valid\_h0\_row\_norms\_mean: 0.4750844913818106  
valid\_h0\_row\_norms\_min: 0.40181556953862513  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7481443786538415  
valid\_h1\_col\_norms\_min: 0.7274936751022718  
valid\_h1\_max\_x\_max\_u: 0.8452944471138767  
valid\_h1\_max\_x\_mean\_u: 0.11432591080298941  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.40992973522602677  
valid\_h1\_mean\_x\_mean\_u: 0.03396172787428899  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.15002119671402858  
valid\_h1\_min\_x\_mean\_u: 0.0038527844439838524  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.7719649324441085  
valid\_h1\_range\_x\_mean\_u: 0.11047312635900551  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0341842303880286  
valid\_h1\_row\_norms\_mean: 0.740901794821683  
valid\_h1\_row\_norms\_min: 0.466785139957067  
valid\_h2\_col\_norms\_max: 0.7499999999999996  
valid\_h2\_col\_norms\_mean: 0.7490510236510529  
valid\_h2\_col\_norms\_min: 0.7403350163285245  
valid\_h2\_max\_x\_max\_u: 1.0566841977652057  
valid\_h2\_max\_x\_mean\_u: 0.07751295340816193  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.375682391993655  
valid\_h2\_mean\_x\_mean\_u: 0.023681538846759317  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.11072884397151438  
valid\_h2\_min\_x\_mean\_u: 0.0026022629505009407  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 1.036571524482528  
valid\_h2\_range\_x\_mean\_u: 0.07491069045766101  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2053200858916042  
valid\_h2\_row\_norms\_mean: 0.7349816393266477  
valid\_h2\_row\_norms\_min: 0.35292844461558154  
valid\_objective: 0.7994727398513369  
valid\_y\_col\_norms\_max: 2.4334413514666347  
valid\_y\_col\_norms\_mean: 2.4334413514666347  
valid\_y\_col\_norms\_min: 2.4334413514666347  
valid\_y\_max\_max\_class: 0.9458338582012933  
valid\_y\_mean\_max\_class: 0.7425481277191939

```

valid_y_min_max_class: 0.5171929021429333
valid_y_misclass: 0.29469895287958103
valid_y_nll: 0.5774504850593745
valid_y_row_norms_max: 0.6643467306479652
valid_y_row_norms_mean: 0.11680239097116125
valid_y_row_norms_min: 0.00016236936813378316
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.065000 seconds
Time this epoch: 45.120000 seconds
Monitoring step:
  Epochs seen: 14
  Batches seen: 19264
  Examples seen: 1925112
  learning_rate: 0.08601399999999804
  momentum: 0.4474747474747448
  total_seconds_last_epoch: 82.75000000000144
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.7456319440522508
  train_h0_col_norms_min: 0.7064672155576455
  train_h0_max_x_max_u: 1.101831731383497
  train_h0_max_x_mean_u: 0.2662736569009612
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.2613071299509661
  train_h0_mean_x_mean_u: 0.025539705900170306
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.01774853377846575
  train_h0_min_x_mean_u: 0.00018106942128637008
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.0977544335197875
  train_h0_range_x_mean_u: 0.26609258747967496
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.6166562259477752
  train_h0_row_norms_mean: 0.47494662551442585
  train_h0_row_norms_min: 0.3936495707233938
  train_h1_col_norms_max: 0.750000000000019
  train_h1_col_norms_mean: 0.7481763027919086
  train_h1_col_norms_min: 0.725815865366725
  train_h1_max_x_max_u: 0.6235327522899702
  train_h1_max_x_mean_u: 0.1111684030839674
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.17737567290877115
  train_h1_mean_x_mean_u: 0.01784220187054104
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.01824967581078044
  train_h1_min_x_mean_u: 0.0003410841593610621
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.6188656365410657
  train_h1_range_x_mean_u: 0.11082731892460639
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.0265989821581671
  train_h1_row_norms_mean: 0.7413095966505535
  train_h1_row_norms_min: 0.48691540840388586
  train_h2_col_norms_max: 0.750000000000019
  train_h2_col_norms_mean: 0.7489623303665569

```

train\_h2.col\_norms\_min: 0.7399610208849688  
train\_h2.max\_x\_max\_u: 0.657143791127554  
train\_h2.max\_x\_mean\_u: 0.07352647787723188  
train\_h2.max\_x\_min\_u: 0.0  
train\_h2.mean\_x\_max\_u: 0.22243414237763862  
train\_h2.mean\_x\_mean\_u: 0.018887374479071073  
train\_h2.mean\_x\_min\_u: 0.0  
train\_h2.min\_x\_max\_u: 0.07169846148417332  
train\_h2.min\_x\_mean\_u: 0.0015375349815957696  
train\_h2.min\_x\_min\_u: 0.0  
train\_h2.range\_x\_max\_u: 0.6393931650583288  
train\_h2.range\_x\_mean\_u: 0.07198894289563605  
train\_h2.range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.2066878529125133  
train\_h2.row\_norms\_mean: 0.7349935609610975  
train\_h2.row\_norms\_min: 0.35264740554968194  
train\_objective: 0.4534924931207427  
train\_y.col\_norms\_max: 2.474281343280284  
train\_y.col\_norms\_mean: 2.474281343280284  
train\_y.col\_norms\_min: 2.474281343280284  
train\_y.max\_max\_class: 0.9686875657401374  
train\_y.mean\_max\_class: 0.7803022357381935  
train\_y.min\_max\_class: 0.5255023932923593  
train\_y.misclass: 0.17729150303982313  
train\_y\_nll: 0.3799736148147977  
train\_y.row\_norms\_max: 0.6910015734762206  
train\_y.row\_norms\_mean: 0.11872149523027657  
train\_y.row\_norms\_min: 0.0011740126824718795  
training\_seconds\_this\_epoch: 45.119999999999934  
valid\_h0.col\_norms\_max: 0.7499999999999996  
valid\_h0.col\_norms\_mean: 0.7456319440522498  
valid\_h0.col\_norms\_min: 0.7064672155576618  
valid\_h0.max\_x\_max\_u: 1.297926899129611  
valid\_h0.max\_x\_mean\_u: 0.20512596020205284  
valid\_h0.max\_x\_min\_u: 0.0  
valid\_h0.mean\_x\_max\_u: 0.5712238989316434  
valid\_h0.mean\_x\_mean\_u: 0.038580002485958984  
valid\_h0.mean\_x\_min\_u: 0.0  
valid\_h0.min\_x\_max\_u: 0.14368317914720397  
valid\_h0.min\_x\_mean\_u: 0.001533531353997821  
valid\_h0.min\_x\_min\_u: 0.0  
valid\_h0.range\_x\_max\_u: 1.2610969567332662  
valid\_h0.range\_x\_mean\_u: 0.20359242884805503  
valid\_h0.range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.6166562259477735  
valid\_h0.row\_norms\_mean: 0.4749466255144163  
valid\_h0.row\_norms\_min: 0.39364957072338025  
valid\_h1.col\_norms\_max: 0.7499999999999996  
valid\_h1.col\_norms\_mean: 0.7481763027919152  
valid\_h1.col\_norms\_min: 0.725815865366748  
valid\_h1.max\_x\_max\_u: 0.8143071931084657  
valid\_h1.max\_x\_mean\_u: 0.11095519971870246  
valid\_h1.max\_x\_min\_u: 0.0  
valid\_h1.mean\_x\_max\_u: 0.3539806985245334

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valid_h1_mean_x_mean_u: 0.031108308853725865
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.1114694609003074
valid_h1_min_x_mean_u: 0.002678513481961666
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.7721994063404061
valid_h1_range_x_mean_u: 0.10827668623674083
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.026598982158156
valid_h1_row_norms_mean: 0.7413095966505715
valid_h1_row_norms_min: 0.4869154084038769
valid_h2_col_norms_max: 0.7499999999999996
valid_h2_col_norms_mean: 0.7489623303665394
valid_h2_col_norms_min: 0.7399610208849431
valid_h2_max_x_max_u: 0.9932570252485952
valid_h2_max_x_mean_u: 0.07377589653447487
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.3175854422707236
valid_h2_mean_x_mean_u: 0.020872551034801463
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.07668734026673935
valid_h2_min_x_mean_u: 0.001471846377404929
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.9860755913648218
valid_h2_range_x_mean_u: 0.07230405015706998
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2066878529125198
valid_h2_row_norms_mean: 0.7349935609610844
valid_h2_row_norms_min: 0.3526474055496764
valid_objective: 0.674731851730407
valid_y_col_norms_max: 2.474281343280285
valid_y_col_norms_mean: 2.474281343280285
valid_y_col_norms_min: 2.4742813432802846
valid_y_max_max_class: 0.9450304437541975
valid_y_mean_max_class: 0.7350031733892671
valid_y_min_max_class: 0.507666094686315
valid_y_misclass: 0.26047120418848185
valid_y_nll: 0.5224492423403317
valid_y_row_norms_max: 0.6910015734762142
valid_y_row_norms_mean: 0.11872149523027406
valid_y_row_norms_min: 0.0011740126824718651
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.065000 seconds
Time this epoch: 45.250000 seconds
Monitoring step:
  Epochs seen: 15
  Batches seen: 20640
  Examples seen: 2062620
  learning_rate: 0.08501500000000242
  momentum: 0.4434343434343479
  total_seconds_last_epoch: 82.60999999999922
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.7455458109787969
  train_h0_col_norms_min: 0.7268234776352223

```

train\_h0\_max\_x\_max\_u: 1.1122690833269226  
train\_h0\_max\_x\_mean\_u: 0.2627112802194081  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.31568348980937383  
train\_h0\_mean\_x\_mean\_u: 0.0246153314579743  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.02090030592954602  
train\_h0\_min\_x\_mean\_u: 0.0001521213410428158  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.101268632883999  
train\_h0\_range\_x\_mean\_u: 0.2625591588783652  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.6291787523283788  
train\_h0\_row\_norms\_mean: 0.474982249912573  
train\_h0\_row\_norms\_min: 0.39483799728812846  
train\_h1\_col\_norms\_max: 0.7500000000000019  
train\_h1\_col\_norms\_mean: 0.7480620616549248  
train\_h1\_col\_norms\_min: 0.723439110464812  
train\_h1\_max\_x\_max\_u: 0.6381193012802515  
train\_h1\_max\_x\_mean\_u: 0.10995626717265672  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.1955930560909681  
train\_h1\_mean\_x\_mean\_u: 0.017302477537475287  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.018372950109905525  
train\_h1\_min\_x\_mean\_u: 0.00027631232811275503  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6305066683386211  
train\_h1\_range\_x\_mean\_u: 0.10967995484454397  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0363995462769835  
train\_h1\_row\_norms\_mean: 0.7415519982335669  
train\_h1\_row\_norms\_min: 0.4890247193333876  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.748806389242851  
train\_h2\_col\_norms\_min: 0.7387170697470031  
train\_h2\_max\_x\_max\_u: 0.6620853773373659  
train\_h2\_max\_x\_mean\_u: 0.07341962465782112  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2100999756542005  
train\_h2\_mean\_x\_mean\_u: 0.01874253333801573  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.06396625056198599  
train\_h2\_min\_x\_mean\_u: 0.0013171819507504226  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.648329508685702  
train\_h2\_range\_x\_mean\_u: 0.07210244270707077  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2079957808347344  
train\_h2\_row\_norms\_mean: 0.7349404485869137  
train\_h2\_row\_norms\_min: 0.360613715677759  
train\_objective: 0.45169821000865806  
train\_y\_col\_norms\_max: 2.5199874845945653  
train\_y\_col\_norms\_mean: 2.5199874845945347



train\_y\_col\_norms\_min: 2.5199874845945347  
train\_y\_max\_max\_class: 0.9667466122568452  
train\_y\_mean\_max\_class: 0.7662106100084753  
train\_y\_min\_max\_class: 0.5113964514755421  
train\_y\_misclass: 0.1580126247200162  
train\_y\_nll: 0.3713870549655314  
train\_y\_row\_norms\_max: 0.707994885814957  
train\_y\_row\_norms\_mean: 0.12065791328485943  
train\_y\_row\_norms\_min: 0.00043123276635299726  
training\_seconds\_this\_epoch: 45.24999999999968  
valid\_h0\_col\_norms\_max: 0.7500000000000003  
valid\_h0\_col\_norms\_mean: 0.7455458109788076  
valid\_h0\_col\_norms\_min: 0.7268234776352371  
valid\_h0\_max\_x\_max\_u: 1.3188641260833984  
valid\_h0\_max\_x\_mean\_u: 0.19929390612079562  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6804069768255451  
valid\_h0\_mean\_x\_mean\_u: 0.035781127898535645  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.18895255815373996  
valid\_h0\_min\_x\_mean\_u: 0.001370573370576675  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2493647313380414  
valid\_h0\_range\_x\_mean\_u: 0.19792333275021895  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.62917875232839  
valid\_h0\_row\_norms\_mean: 0.4749822499125635  
valid\_h0\_row\_norms\_min: 0.3948379972881237  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7480620616549339  
valid\_h1\_col\_norms\_min: 0.7234391104647877  
valid\_h1\_max\_x\_max\_u: 0.8089321183975842  
valid\_h1\_max\_x\_mean\_u: 0.10676879031332308  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.3612125328017585  
valid\_h1\_mean\_x\_mean\_u: 0.02790552731463063  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.11421740716817051  
valid\_h1\_min\_x\_mean\_u: 0.0021467000552147413  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.7425901572654742  
valid\_h1\_range\_x\_mean\_u: 0.10462209025810834  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0363995462769695  
valid\_h1\_row\_norms\_mean: 0.7415519982335596  
valid\_h1\_row\_norms\_min: 0.4890247193333708  
valid\_h2\_col\_norms\_max: 0.7499999999999997  
valid\_h2\_col\_norms\_mean: 0.7488063892428717  
valid\_h2\_col\_norms\_min: 0.7387170697469867  
valid\_h2\_max\_x\_max\_u: 0.9607371425186081  
valid\_h2\_max\_x\_mean\_u: 0.07251523875190195  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.3065577555425302  
valid\_h2\_mean\_x\_mean\_u: 0.020066141070069182

```

valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.07813303844513433
valid_h2_min_x_mean_u: 0.0015214774876518202
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.953242195269092
valid_h2_range_x_mean_u: 0.07099376126425017
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2079957808347246
valid_h2_row_norms_mean: 0.7349404485869352
valid_h2_row_norms_min: 0.36061371567775036
valid_objective: 0.7006605453222033
valid_y_col_norms_max: 2.519987484594538
valid_y_col_norms_mean: 2.519987484594538
valid_y_col_norms_min: 2.519987484594538
valid_y_max_max_class: 0.9384168864263254
valid_y_mean_max_class: 0.720088121040003
valid_y_min_max_class: 0.5068846457255343
valid_y_misclass: 0.28710732984293186
valid_y_nll: 0.5599939542491891
valid_y_row_norms_max: 0.7079948858149555
valid_y_row_norms_mean: 0.12065791328485752
valid_y_row_norms_min: 0.00043123276635298577
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.070000 seconds
Time this epoch: 45.220000 seconds
Monitoring step:
  Epochs seen: 16
  Batches seen: 22016
  Examples seen: 2200128
  learning_rate: 0.084015999999999916
  momentum: 0.439393939393928
  total_seconds_last_epoch: 82.85500000000155
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.745509083240654
  train_h0_col_norms_min: 0.7135703747056307
  train_h0_max_x_max_u: 1.1448801313738648
  train_h0_max_x_mean_u: 0.26143179096966107
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.3163170627690484
  train_h0_mean_x_mean_u: 0.024429739093884583
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.025725547751649324
  train_h0_min_x_mean_u: 0.0002357989374220274
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.1374665617063988
  train_h0_range_x_mean_u: 0.26119599203223903
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.6239748266603891
  train_h0_row_norms_mean: 0.47503873405560626
  train_h0_row_norms_min: 0.39320793135738225
  train_h1_col_norms_max: 0.750000000000019
  train_h1_col_norms_mean: 0.7478777069707163
  train_h1_col_norms_min: 0.7259399252389948
  train_h1_max_x_max_u: 0.6164849535160462

```

train\_h1\_max\_x\_mean\_u: 0.10789487225737392  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.17542218341422983  
train\_h1\_mean\_x\_mean\_u: 0.016671553819696816  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.018706525128472404  
train\_h1\_min\_x\_mean\_u: 0.0002819382547983615  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6112104398420247  
train\_h1\_range\_x\_mean\_u: 0.10761293400257575  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0484086645458461  
train\_h1\_row\_norms\_mean: 0.7416326976898452  
train\_h1\_row\_norms\_min: 0.49533269567061367  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7488765513145748  
train\_h2\_col\_norms\_min: 0.7393021750441885  
train\_h2\_max\_x\_max\_u: 0.620297572546512  
train\_h2\_max\_x\_mean\_u: 0.07395263510593504  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2152111810658954  
train\_h2\_mean\_x\_mean\_u: 0.019253617633778166  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.07986189744589565  
train\_h2\_min\_x\_mean\_u: 0.0017183979758203817  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6031717139291106  
train\_h2\_range\_x\_mean\_u: 0.07223423713011445  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2109851570339623  
train\_h2\_row\_norms\_mean: 0.7351204633015148  
train\_h2\_row\_norms\_min: 0.36222275361476725  
train\_objective: 0.46081499882647076  
train\_y\_col\_norms\_max: 2.5416646389981694  
train\_y\_col\_norms\_mean: 2.5416646389981694  
train\_y\_col\_norms\_min: 2.5416646389981694  
train\_y\_max\_max\_class: 0.9718796376061057  
train\_y\_mean\_max\_class: 0.7886370511797268  
train\_y\_min\_max\_class: 0.5283343336021411  
train\_y\_misclass: 0.1792332082497019  
train\_y\_nll: 0.38164436948197744  
train\_y\_row\_norms\_max: 0.7225524921830667  
train\_y\_row\_norms\_mean: 0.12218513460017556  
train\_y\_row\_norms\_min: 2.383768317827318e-05  
training\_seconds\_this\_epoch: 45.220000000000002  
valid\_h0\_col\_norms\_max: 0.7499999999999996  
valid\_h0\_col\_norms\_mean: 0.7455090832406703  
valid\_h0\_col\_norms\_min: 0.7135703747056292  
valid\_h0\_max\_x\_max\_u: 1.4357725454245487  
valid\_h0\_max\_x\_mean\_u: 0.2016487385558888  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6857429119500149  
valid\_h0\_mean\_x\_mean\_u: 0.03593931672454157  
valid\_h0\_mean\_x\_min\_u: 0.0

valid\_h0\_min\_x\_max\_u: 0.21548571876625994  
valid\_h0\_min\_x\_mean\_u: 0.001989621786090148  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.3641692065462643  
valid\_h0\_range\_x\_mean\_u: 0.19965911676979864  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6239748266604049  
valid\_h0\_row\_norms\_mean: 0.47503873405561214  
valid\_h0\_row\_norms\_min: 0.39320793135737736  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7478777069707206  
valid\_h1\_col\_norms\_min: 0.7259399252389857  
valid\_h1\_max\_x\_max\_u: 0.7645805532033351  
valid\_h1\_max\_x\_mean\_u: 0.10453405435600581  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.3285418965405089  
valid\_h1\_mean\_x\_mean\_u: 0.027468706024831993  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.10803830553075536  
valid\_h1\_min\_x\_mean\_u: 0.002215264719469464  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.7182725073071861  
valid\_h1\_range\_x\_mean\_u: 0.10231878963653637  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0484086645458428  
valid\_h1\_row\_norms\_mean: 0.7416326976898611  
valid\_h1\_row\_norms\_min: 0.4953326956706128  
valid\_h2\_col\_norms\_max: 0.7499999999999996  
valid\_h2\_col\_norms\_mean: 0.7488765513145865  
valid\_h2\_col\_norms\_min: 0.7393021750442119  
valid\_h2\_max\_x\_max\_u: 0.83610264018724  
valid\_h2\_max\_x\_mean\_u: 0.07166961895218316  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.2739462676351085  
valid\_h2\_mean\_x\_mean\_u: 0.02040005859335478  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.10334139139960795  
valid\_h2\_min\_x\_mean\_u: 0.001911818689527652  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 0.832215018248832  
valid\_h2\_range\_x\_mean\_u: 0.06975780026265552  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2109851570339514  
valid\_h2\_row\_norms\_mean: 0.7351204633015143  
valid\_h2\_row\_norms\_min: 0.36222275361477263  
valid\_objective: 0.6973193018426945  
valid\_y\_col\_norms\_max: 2.5416646389981223  
valid\_y\_col\_norms\_mean: 2.541664638998108  
valid\_y\_col\_norms\_min: 2.541664638998108  
valid\_y\_max\_max\_class: 0.9457513220923708  
valid\_y\_mean\_max\_class: 0.7286632071370606  
valid\_y\_min\_max\_class: 0.5063976927039806  
valid\_y\_misclass: 0.26335078534031414  
valid\_y\_nll: 0.5270391150648939

```

valid_y_row_norms_max: 0.7225524921830755
valid_y_row_norms_mean: 0.12218513460017688
valid_y_row_norms_min: 2.383768317827315e-05
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.070000 seconds
Time this epoch: 45.300000 seconds
Monitoring step:
  Epochs seen: 17
  Batches seen: 23392
  Examples seen: 2337636
  learning_rate: 0.08301699999999995
  momentum: 0.4353535353535283
  total_seconds_last_epoch: 82.76999999999876
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.7456596968329351
  train_h0_col_norms_min: 0.7137674345843807
  train_h0_max_x_max_u: 1.1113217039663652
  train_h0_max_x_mean_u: 0.262689456090638
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.2699482726011144
  train_h0_mean_x_mean_u: 0.024872879921760106
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.015730708929016214
  train_h0_min_x_mean_u: 0.00019759197489727098
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.10879059678632
  train_h0_range_x_mean_u: 0.2624918641157405
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.6376882188391816
  train_h0_row_norms_mean: 0.47517298238277444
  train_h0_row_norms_min: 0.39260138235474623
  train_h1_col_norms_max: 0.750000000000019
  train_h1_col_norms_mean: 0.7482683395495189
  train_h1_col_norms_min: 0.7264926701916952
  train_h1_max_x_max_u: 0.6571872680684591
  train_h1_max_x_mean_u: 0.1123105194421881
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.2006703114906344
  train_h1_mean_x_mean_u: 0.018941059417096975
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.02216167120009025
  train_h1_min_x_mean_u: 0.0004354851921517277
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.65014328263435
  train_h1_range_x_mean_u: 0.1118750342500365
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.0233714805270748
  train_h1_row_norms_mean: 0.7423560788281466
  train_h1_row_norms_min: 0.49631578251515207
  train_h2_col_norms_max: 0.750000000000019
  train_h2_col_norms_mean: 0.7489504826296595
  train_h2_col_norms_min: 0.727610930335221
  train_h2_max_x_max_u: 0.7582229297029548
  train_h2_max_x_mean_u: 0.07929269149058607

```

train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2553426628618624  
train\_h2\_mean\_x\_mean\_u: 0.02116825147655612  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.08405491173041811  
train\_h2\_min\_x\_mean\_u: 0.0018394152938521404  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.7373039825257391  
train\_h2\_range\_x\_mean\_u: 0.07745327619673395  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2068224409080703  
train\_h2\_row\_norms\_mean: 0.7353283362889732  
train\_h2\_row\_norms\_min: 0.3587856969777756  
train\_objective: 0.4467116911184969  
train\_y\_col\_norms\_max: 2.5945000224402035  
train\_y\_col\_norms\_mean: 2.5945000224402035  
train\_y\_col\_norms\_min: 2.5945000224402035  
train\_y\_max\_max\_class: 0.9711308041050578  
train\_y\_mean\_max\_class: 0.7840251121907  
train\_y\_min\_max\_class: 0.5180058894086245  
train\_y\_misclass: 0.131621432934811  
train\_y\_nll: 0.3378818315389987  
train\_y\_row\_norms\_max: 0.7369384903128541  
train\_y\_row\_norms\_mean: 0.12452988656383798  
train\_y\_row\_norms\_min: 2.7849121202443847e-05  
training\_seconds\_this\_epoch: 45.300000000000075  
valid\_h0\_col\_norms\_max: 0.7499999999999997  
valid\_h0\_col\_norms\_mean: 0.7456596968329413  
valid\_h0\_col\_norms\_min: 0.7137674345843636  
valid\_h0\_max\_x\_max\_u: 1.3140624612074403  
valid\_h0\_max\_x\_mean\_u: 0.20676572189042625  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.558619638886702  
valid\_h0\_mean\_x\_mean\_u: 0.03890122585590238  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.1436930596720815  
valid\_h0\_min\_x\_mean\_u: 0.0017904017708083538  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2944204464017235  
valid\_h0\_range\_x\_mean\_u: 0.20497532011961778  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6376882188391645  
valid\_h0\_row\_norms\_mean: 0.475172982382758  
valid\_h0\_row\_norms\_min: 0.39260138235473896  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.748268339549512  
valid\_h1\_col\_norms\_min: 0.7264926701917079  
valid\_h1\_max\_x\_max\_u: 0.8577438633741412  
valid\_h1\_max\_x\_mean\_u: 0.12097229827293218  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.38787480623182446  
valid\_h1\_mean\_x\_mean\_u: 0.03627721328424024  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.13129852220833782

```

valid_h1_min_x_mean_u: 0.003459802746914333
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.8063591278899852
valid_h1_range_x_mean_u: 0.11751249552601782
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.0233714805270604
valid_h1_row_norms_mean: 0.7423560788281388
valid_h1_row_norms_min: 0.4963157825151365
valid_h2_col_norms_max: 0.7499999999999996
valid_h2_col_norms_mean: 0.7489504826296508
valid_h2_col_norms_min: 0.7276109303352267
valid_h2_max_x_max_u: 1.2804795416483825
valid_h2_max_x_mean_u: 0.08954914391119323
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.46157176569164027
valid_h2_mean_x_mean_u: 0.0276199851538636
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.1263683363256238
valid_h2_min_x_mean_u: 0.0030375723894821662
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 1.2465518700023126
valid_h2_range_x_mean_u: 0.08651157152171109
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2068224409080814
valid_h2_row_norms_mean: 0.7353283362889821
valid_h2_row_norms_min: 0.3587856969777659
valid_objective: 0.8619140488282439
valid_y_col_norms_max: 2.5945000224401387
valid_y_col_norms_mean: 2.5945000224401387
valid_y_col_norms_min: 2.5945000224401387
valid_y_max_max_class: 0.9636625700516472
valid_y_mean_max_class: 0.7729266438300442
valid_y_min_max_class: 0.5254753949903593
valid_y_misclass: 0.3224476439790578
valid_y_nll: 0.6228399231313894
valid_y_row_norms_max: 0.7369384903128576
valid_y_row_norms_mean: 0.12452988656383399
valid_y_row_norms_min: 2.7849121202443048e-05
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.070000 seconds
Time this epoch: 45.390000 seconds
Monitoring step:
  Epochs seen: 18
  Batches seen: 24768
  Examples seen: 2475144
  learning_rate: 0.082018000000000059
  momentum: 0.43131313131314136
  total_seconds_last_epoch: 82.81499999999998
  train_h0_col_norms_max: 0.7500000000000019
  train_h0_col_norms_mean: 0.7452737250671607
  train_h0_col_norms_min: 0.722515330234371
  train_h0_max_x_max_u: 1.1037441173968252
  train_h0_max_x_mean_u: 0.25778033271327444
  train_h0_max_x_min_u: 0.0

```

train\_h0\_mean\_x\_max\_u: 0.2769515619026797  
train\_h0\_mean\_x\_mean\_u: 0.023723048258225  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.015891565036687427  
train\_h0\_min\_x\_mean\_u: 0.00015086372709468846  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.0998320435594398  
train\_h0\_range\_x\_mean\_u: 0.2576294689861797  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.6386857068886557  
train\_h0\_row\_norms\_mean: 0.4749531220215893  
train\_h0\_row\_norms\_min: 0.40214627890224686  
train\_h1\_col\_norms\_max: 0.7500000000000019  
train\_h1\_col\_norms\_mean: 0.7483137714359447  
train\_h1\_col\_norms\_min: 0.7288187545782545  
train\_h1\_max\_x\_max\_u: 0.5847970362130834  
train\_h1\_max\_x\_mean\_u: 0.10938104152894368  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.16435753969678074  
train\_h1\_mean\_x\_mean\_u: 0.017552825204652605  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.013929381680276163  
train\_h1\_min\_x\_mean\_u: 0.00026275293061524453  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.5829862946493092  
train\_h1\_range\_x\_mean\_u: 0.1091182885983285  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0281189224013614  
train\_h1\_row\_norms\_mean: 0.7426734267538789  
train\_h1\_row\_norms\_min: 0.5121055922763567  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7490633879338019  
train\_h2\_col\_norms\_min: 0.7388375964882421  
train\_h2\_max\_x\_max\_u: 0.7010582793153817  
train\_h2\_max\_x\_mean\_u: 0.07844564883907074  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.22949477590719633  
train\_h2\_mean\_x\_mean\_u: 0.02145624836190594  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.07062016499920583  
train\_h2\_min\_x\_mean\_u: 0.0017620569592172182  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6796408104572894  
train\_h2\_range\_x\_mean\_u: 0.07668359187985364  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2067280728259393  
train\_h2\_row\_norms\_mean: 0.7356152577529815  
train\_h2\_row\_norms\_min: 0.36074530517898795  
train\_objective: 0.45317395878668143  
train\_y\_col\_norms\_max: 2.655740761740064  
train\_y\_col\_norms\_mean: 2.655740761740064  
train\_y\_col\_norms\_min: 2.655740761740064  
train\_y\_max\_max\_class: 0.9780355139064112  
train\_y\_mean\_max\_class: 0.7894723217908017



train\_y\_min\_max\_class: 0.5131500302818355  
train\_y\_misclass: 0.1514675509788522  
train\_y\_nll: 0.35203456291038854  
train\_y\_row\_norms\_max: 0.745214399003274  
train\_y\_row\_norms\_mean: 0.12735503721903663  
train\_y\_row\_norms\_min: 0.0001838082612754585  
training\_seconds\_this\_epoch: 45.38999999999996  
valid\_h0\_col\_norms\_max: 0.7500000000000003  
valid\_h0\_col\_norms\_mean: 0.7452737250671678  
valid\_h0\_col\_norms\_min: 0.7225153302343564  
valid\_h0\_max\_x\_max\_u: 1.3032193854841936  
valid\_h0\_max\_x\_mean\_u: 0.2030501733622077  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5989679696125841  
valid\_h0\_mean\_x\_mean\_u: 0.036365988167862615  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.16199143169515468  
valid\_h0\_min\_x\_mean\_u: 0.0014779537706922322  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2775681485934955  
valid\_h0\_range\_x\_mean\_u: 0.20157221959151556  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.63868570688866  
valid\_h0\_row\_norms\_mean: 0.47495312202157997  
valid\_h0\_row\_norms\_min: 0.4021462789022386  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7483137714359541  
valid\_h1\_col\_norms\_min: 0.7288187545782371  
valid\_h1\_max\_x\_max\_u: 0.6502492263325008  
valid\_h1\_max\_x\_mean\_u: 0.10920207342235422  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.27912521829213316  
valid\_h1\_mean\_x\_mean\_u: 0.02957879120308958  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.08662687445484939  
valid\_h1\_min\_x\_mean\_u: 0.0020161438773191346  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.6351666854386876  
valid\_h1\_range\_x\_mean\_u: 0.1071859295450351  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0281189224013374  
valid\_h1\_row\_norms\_mean: 0.7426734267538708  
valid\_h1\_row\_norms\_min: 0.5121055922763709  
valid\_h2\_col\_norms\_max: 0.7499999999999996  
valid\_h2\_col\_norms\_mean: 0.74906338793381  
valid\_h2\_col\_norms\_min: 0.7388375964882197  
valid\_h2\_max\_x\_max\_u: 1.0063934010368891  
valid\_h2\_max\_x\_mean\_u: 0.07661828585522606  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.33228342662552274  
valid\_h2\_mean\_x\_mean\_u: 0.020982156392373445  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.07588035000953174  
valid\_h2\_min\_x\_mean\_u: 0.0012226425999026574

```

valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.9977799023587769
valid_h2_range_x_mean_u: 0.07539564325532337
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2067280728259164
valid_h2_row_norms_mean: 0.7356152577530035
valid_h2_row_norms_min: 0.3607453051789937
valid_objective: 0.733774273053062
valid_y_col_norms_max: 2.6557407617400983
valid_y_col_norms_mean: 2.6557407617400983
valid_y_col_norms_min: 2.6557407617400983
valid_y_max_max_class: 0.9467232187739814
valid_y_mean_max_class: 0.7243471190441295
valid_y_min_max_class: 0.505155590211773
valid_y_misclass: 0.319960732984293
valid_y_nll: 0.5961947991708257
valid_y_row_norms_max: 0.7452143990032579
valid_y_row_norms_mean: 0.127355037219035
valid_y_row_norms_min: 0.00018380826127545604
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.070000 seconds
Time this epoch: 45.601000 seconds
Monitoring step:
  Epochs seen: 19
  Batches seen: 26144
  Examples seen: 2612652
  learning_rate: 0.0810189999999976
  momentum: 0.42727272727271215
  total_seconds_last_epoch: 82.95999999999701
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.7451537668140514
  train_h0_col_norms_min: 0.7078621405777518
  train_h0_max_x_max_u: 1.1058741636764229
  train_h0_max_x_mean_u: 0.258428338935093
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.2732874460224421
  train_h0_mean_x_mean_u: 0.02332293389291992
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.017406420029846922
  train_h0_min_x_mean_u: 0.00015805773485491595
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.1010165539052537
  train_h0_range_x_mean_u: 0.25827028120023815
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.635467401018748
  train_h0_row_norms_mean: 0.47487247796452264
  train_h0_row_norms_min: 0.40499888562183506
  train_h1_col_norms_max: 0.750000000000019
  train_h1_col_norms_mean: 0.7481762584181242
  train_h1_col_norms_min: 0.7224722253062636
  train_h1_max_x_max_u: 0.6801288098018328
  train_h1_max_x_mean_u: 0.10939139449307694
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.20125992856986805

```

train\_h1\_mean\_x\_mean\_u: 0.018133128223997243  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.0224561644214655  
train\_h1\_min\_x\_mean\_u: 0.00040211332702907624  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6733729823830144  
train\_h1\_range\_x\_mean\_u: 0.1089892811660478  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0172633306768881  
train\_h1\_row\_norms\_mean: 0.7427608002371289  
train\_h1\_row\_norms\_min: 0.5246551775490966  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7489134168362213  
train\_h2\_col\_norms\_min: 0.7369150701752799  
train\_h2\_max\_x\_max\_u: 0.7374162436633878  
train\_h2\_max\_x\_mean\_u: 0.07606389014043091  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2539469109267759  
train\_h2\_mean\_x\_mean\_u: 0.020666185285922203  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.09561073247891176  
train\_h2\_min\_x\_mean\_u: 0.0023052677325802683  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.703021490214607  
train\_h2\_range\_x\_mean\_u: 0.07375862240785062  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.205091624428277  
train\_h2\_row\_norms\_mean: 0.7355860360764483  
train\_h2\_row\_norms\_min: 0.37596688498941105  
train\_objective: 0.4867276847897881  
train\_y\_col\_norms\_max: 2.6807198211874437  
train\_y\_col\_norms\_mean: 2.6807198211874153  
train\_y\_col\_norms\_min: 2.6807198211874153  
train\_y\_max\_max\_class: 0.9774659694166853  
train\_y\_mean\_max\_class: 0.8238488554419805  
train\_y\_min\_max\_class: 0.571854855283643  
train\_y\_misclass: 0.22763766471768893  
train\_y\_nll: 0.42579239096684435  
train\_y\_row\_norms\_max: 0.7631189926189241  
train\_y\_row\_norms\_mean: 0.12841147673582326  
train\_y\_row\_norms\_min: 5.3577503297880943e-05  
training\_seconds\_this\_epoch: 45.601000000000965  
valid\_h0\_col\_norms\_max: 0.7500000000000003  
valid\_h0\_col\_norms\_mean: 0.7451537668140682  
valid\_h0\_col\_norms\_min: 0.7078621405777656  
valid\_h0\_max\_x\_max\_u: 1.3219569990680062  
valid\_h0\_max\_x\_mean\_u: 0.2057981605155706  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5963625176423298  
valid\_h0\_mean\_x\_mean\_u: 0.03617073418236691  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.15230834375816124  
valid\_h0\_min\_x\_mean\_u: 0.0016087298388503873  
valid\_h0\_min\_x\_min\_u: 0.0

valid\_h0\_range\_x\_max\_u: 1.280845708237504  
valid\_h0\_range\_x\_mean\_u: 0.2041894306767201  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6354674010187491  
valid\_h0\_row\_norms\_mean: 0.4748724779645063  
valid\_h0\_row\_norms\_min: 0.40499888562184366  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7481762584181311  
valid\_h1\_col\_norms\_min: 0.7224722253062713  
valid\_h1\_max\_x\_max\_u: 0.8828570915272321  
valid\_h1\_max\_x\_mean\_u: 0.11368803421609848  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.3900050321392701  
valid\_h1\_mean\_x\_mean\_u: 0.03263116372234006  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.1206847443771478  
valid\_h1\_min\_x\_mean\_u: 0.0029169767873973487  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.8228416675707388  
valid\_h1\_range\_x\_mean\_u: 0.11077105742870112  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0172633306768628  
valid\_h1\_row\_norms\_mean: 0.742760800237121  
valid\_h1\_row\_norms\_min: 0.524655177549101  
valid\_h2\_col\_norms\_max: 0.7499999999999997  
valid\_h2\_col\_norms\_mean: 0.7489134168362319  
valid\_h2\_col\_norms\_min: 0.7369150701752935  
valid\_h2\_max\_x\_max\_u: 1.1120005498770515  
valid\_h2\_max\_x\_mean\_u: 0.07937789840704848  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.38628453219924136  
valid\_h2\_mean\_x\_mean\_u: 0.0233746022780386  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.11433455666011544  
valid\_h2\_min\_x\_mean\_u: 0.001743706146907953  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 1.093892001820401  
valid\_h2\_range\_x\_mean\_u: 0.07763419226014057  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2050916244283134  
valid\_h2\_row\_norms\_mean: 0.7355860360764568  
valid\_h2\_row\_norms\_min: 0.37596688498941694  
valid\_objective: 0.6536680290704429  
valid\_y\_col\_norms\_max: 2.6807198211874788  
valid\_y\_col\_norms\_mean: 2.6807198211874788  
valid\_y\_col\_norms\_min: 2.6807198211874783  
valid\_y\_max\_max\_class: 0.9621080312058764  
valid\_y\_mean\_max\_class: 0.777174904954888  
valid\_y\_min\_max\_class: 0.509320470977825  
valid\_y\_misclass: 0.2474476439790577  
valid\_y\_nll: 0.5059875175356536  
valid\_y\_row\_norms\_max: 0.7631189926189365  
valid\_y\_row\_norms\_mean: 0.12841147673582054  
valid\_y\_row\_norms\_min: 5.3577503297882475e-05

```

Saving to ..\Sean\nn_files_S4C4R20\nn_train.best.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.best.pkl done. Time elapsed: 0.076000 seconds
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.075000 seconds
Time this epoch: 45.446000 seconds
Monitoring step:
  Epochs seen: 20
  Batches seen: 27520
  Examples seen: 2750160
  learning_rate: 0.08002000000000174
  momentum: 0.423232323232314
  total_seconds_last_epoch: 83.84900000000053
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.7455855223297384
  train_h0_col_norms_min: 0.714800228152491
  train_h0_max_x_max_u: 1.115545308778423
  train_h0_max_x_mean_u: 0.25896078252117755
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.2826563973500107
  train_h0_mean_x_mean_u: 0.02377679709196142
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.019277721317087566
  train_h0_min_x_mean_u: 0.00020181313731198528
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.1101728644372968
  train_h0_range_x_mean_u: 0.25875896938386556
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.6289725168422711
  train_h0_row_norms_mean: 0.4751402143173581
  train_h0_row_norms_min: 0.39741798300077813
  train_h1_col_norms_max: 0.750000000000019
  train_h1_col_norms_mean: 0.7483138233243328
  train_h1_col_norms_min: 0.7214651880357625
  train_h1_max_x_max_u: 0.6438183681249945
  train_h1_max_x_mean_u: 0.11043439507937722
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.18092404933510564
  train_h1_mean_x_mean_u: 0.01761468643169685
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.015670616128307294
  train_h1_min_x_mean_u: 0.0003342766632300577
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.6396350241871315
  train_h1_range_x_mean_u: 0.11010011841614727
  train_h1_range_x_min_u: 0.0
  train_h1_row_norms_max: 1.0170832805315593
  train_h1_row_norms_mean: 0.7430937157515035
  train_h1_row_norms_min: 0.5230878545952681
  train_h2_col_norms_max: 0.750000000000019
  train_h2_col_norms_mean: 0.7490919442450578
  train_h2_col_norms_min: 0.7384119966460425
  train_h2_max_x_max_u: 0.7313222195649394
  train_h2_max_x_mean_u: 0.07934089245583478
  train_h2_max_x_min_u: 0.0

```

train\_h2\_mean\_x\_max\_u: 0.25073498602911887  
train\_h2\_mean\_x\_mean\_u: 0.02217540648118492  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.08373931632584274  
train\_h2\_min\_x\_mean\_u: 0.0017801062663119064  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.7078251039460837  
train\_h2\_range\_x\_mean\_u: 0.07756078618952282  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2099079398083556  
train\_h2\_row\_norms\_mean: 0.7358131156187554  
train\_h2\_row\_norms\_min: 0.37593852548054124  
train\_objective: 0.4824235921659445  
train\_y\_col\_norms\_max: 2.719684840583961  
train\_y\_col\_norms\_mean: 2.719684840583961  
train\_y\_col\_norms\_min: 2.7196848405839606  
train\_y\_max\_max\_class: 0.9730451994807757  
train\_y\_mean\_max\_class: 0.7875576655811454  
train\_y\_min\_max\_class: 0.51221963236008  
train\_y\_misclass: 0.15687814527154836  
train\_y\_nll: 0.3646280892702572  
train\_y\_row\_norms\_max: 0.7643420484413073  
train\_y\_row\_norms\_mean: 0.13073453151760883  
train\_y\_row\_norms\_min: 0.0010213685886269804  
training\_seconds\_this\_epoch: 45.445999999999987  
valid\_h0\_col\_norms\_max: 0.7500000000000003  
valid\_h0\_col\_norms\_mean: 0.7455855223297341  
valid\_h0\_col\_norms\_min: 0.7148002281524682  
valid\_h0\_max\_x\_max\_u: 1.3363999023328994  
valid\_h0\_max\_x\_mean\_u: 0.20930038091890996  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6024228274301462  
valid\_h0\_mean\_x\_mean\_u: 0.037032093150047185  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.15846089638805202  
valid\_h0\_min\_x\_mean\_u: 0.0016344869865228926  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.3010887023697286  
valid\_h0\_range\_x\_mean\_u: 0.207665893932387  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6289725168422745  
valid\_h0\_row\_norms\_mean: 0.475140214317367  
valid\_h0\_row\_norms\_min: 0.3974179830007905  
valid\_h1\_col\_norms\_max: 0.7499999999999999  
valid\_h1\_col\_norms\_mean: 0.7483138233243257  
valid\_h1\_col\_norms\_min: 0.721465188035749  
valid\_h1\_max\_x\_max\_u: 0.8292885133027006  
valid\_h1\_max\_x\_mean\_u: 0.11372285251351642  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.35310848361887814  
valid\_h1\_mean\_x\_mean\_u: 0.031575057753242916  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.10167017758984907  
valid\_h1\_min\_x\_mean\_u: 0.002496893696864867

valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.7799489044935021  
valid\_h1\_range\_x\_mean\_u: 0.1112259588166516  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0170832805315824  
valid\_h1\_row\_norms\_mean: 0.7430937157514944  
valid\_h1\_row\_norms\_min: 0.5230878545952597  
valid\_h2\_col\_norms\_max: 0.7499999999999996  
valid\_h2\_col\_norms\_mean: 0.7490919442450652  
valid\_h2\_col\_norms\_min: 0.7384119966460544  
valid\_h2\_max\_x\_max\_u: 1.1844948690487473  
valid\_h2\_max\_x\_mean\_u: 0.0826370275788907  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.41534529615304083  
valid\_h2\_mean\_x\_mean\_u: 0.0244156506281124  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.12308688111068652  
valid\_h2\_min\_x\_mean\_u: 0.002091368115101874  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 1.1606023712667854  
valid\_h2\_range\_x\_mean\_u: 0.08054565946378883  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.2099079398083548  
valid\_h2\_row\_norms\_mean: 0.7358131156187706  
valid\_h2\_row\_norms\_min: 0.37593852548054585  
valid\_objective: 0.843117451919371  
valid\_y\_col\_norms\_max: 2.719684840583882  
valid\_y\_col\_norms\_mean: 2.719684840583882  
valid\_y\_col\_norms\_min: 2.719684840583882  
valid\_y\_max\_max\_class: 0.9602875525750821  
valid\_y\_mean\_max\_class: 0.7511085730057229  
valid\_y\_min\_max\_class: 0.5105966654033068  
valid\_y\_misclass: 0.33769633507853386  
valid\_y\_nll: 0.6348704745799463  
valid\_y\_row\_norms\_max: 0.7643420484412986  
valid\_y\_row\_norms\_mean: 0.13073453151761122  
valid\_y\_row\_norms\_min: 0.0010213685886269989

Saving to ..\Sean\nn\_files\_S4C4R20\nn\_train.pkl...

Saving to ..\Sean\nn\_files\_S4C4R20\nn\_train.pkl done. Time elapsed: 0.070000 seconds

Time this epoch: 44.660000 seconds

Monitoring step:

Epochs seen: 21  
Batches seen: 28896  
Examples seen: 2887668  
learning\_rate: 0.079020999999999905  
momentum: 0.4191919191919247  
total\_seconds\_last\_epoch: 82.543999999999843  
train\_h0\_col\_norms\_max: 0.7500000000000019  
train\_h0\_col\_norms\_mean: 0.7454912745170122  
train\_h0\_col\_norms\_min: 0.7134667901435376  
train\_h0\_max\_x\_max\_u: 1.117546820582228  
train\_h0\_max\_x\_mean\_u: 0.26041495347816895  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.3023857646560716

train\_h0\_mean\_x\_mean\_u: 0.023170319257851745  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.022384764566837113  
train\_h0\_min\_x\_mean\_u: 0.00015203606669883272  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.1108943380638638  
train\_h0\_range\_x\_mean\_u: 0.26026291741146995  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.6156689925250709  
train\_h0\_row\_norms\_mean: 0.47511667581266737  
train\_h0\_row\_norms\_min: 0.40090322799815264  
train\_h1\_col\_norms\_max: 0.7500000000000019  
train\_h1\_col\_norms\_mean: 0.7481154564657849  
train\_h1\_col\_norms\_min: 0.7188824286345142  
train\_h1\_max\_x\_max\_u: 0.6566158670282043  
train\_h1\_max\_x\_mean\_u: 0.11117467921955312  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.18496891874426802  
train\_h1\_mean\_x\_mean\_u: 0.017386186248039313  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.015958972402759748  
train\_h1\_min\_x\_mean\_u: 0.00025096809297993697  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6511453976553911  
train\_h1\_range\_x\_mean\_u: 0.11092371112657297  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.010165216948799  
train\_h1\_row\_norms\_mean: 0.7430768417109744  
train\_h1\_row\_norms\_min: 0.5189258282632236  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7490994807666222  
train\_h2\_col\_norms\_min: 0.738323200975025  
train\_h2\_max\_x\_max\_u: 0.713844144761672  
train\_h2\_max\_x\_mean\_u: 0.07839239458493995  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2517016163865667  
train\_h2\_mean\_x\_mean\_u: 0.021347253982545583  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.08742882851431011  
train\_h2\_min\_x\_mean\_u: 0.0017675920442863785  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6846961933538861  
train\_h2\_range\_x\_mean\_u: 0.07662480254065372  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.207433656749164  
train\_h2\_row\_norms\_mean: 0.7359446850428504  
train\_h2\_row\_norms\_min: 0.37242940620016013  
train\_objective: 0.45585106065667075  
train\_y\_col\_norms\_max: 2.7665990590044482  
train\_y\_col\_norms\_mean: 2.7665990590044482  
train\_y\_col\_norms\_min: 2.7665990590044482  
train\_y\_max\_max\_class: 0.9748123845308808  
train\_y\_mean\_max\_class: 0.7894182755675984  
train\_y\_min\_max\_class: 0.5137227833285193



train\_y\_misclass: 0.12143293481106596  
train\_y\_nll: 0.3219655232043566  
train\_y\_row\_norms\_max: 0.7832633087943215  
train\_y\_row\_norms\_mean: 0.13287662203601877  
train\_y\_row\_norms\_min: 6.884433451397729e-05  
training\_seconds\_this\_epoch: 44.659999999999903  
valid\_h0\_col\_norms\_max: 0.7500000000000003  
valid\_h0\_col\_norms\_mean: 0.7454912745170033  
valid\_h0\_col\_norms\_min: 0.7134667901435194  
valid\_h0\_max\_x\_max\_u: 1.319358118500683  
valid\_h0\_max\_x\_mean\_u: 0.21388788208557383  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6595977813572669  
valid\_h0\_mean\_x\_mean\_u: 0.03637302650030986  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.1880509242753059  
valid\_h0\_min\_x\_mean\_u: 0.0013607096715670883  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2800955235187566  
valid\_h0\_range\_x\_mean\_u: 0.21252717241400682  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6156689925250591  
valid\_h0\_row\_norms\_mean: 0.4751166758126617  
valid\_h0\_row\_norms\_min: 0.40090322799814593  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7481154564657688  
valid\_h1\_col\_norms\_min: 0.7188824286345233  
valid\_h1\_max\_x\_max\_u: 0.9093056754036275  
valid\_h1\_max\_x\_mean\_u: 0.11643603306111232  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.39112655345310054  
valid\_h1\_mean\_x\_mean\_u: 0.030205710218801907  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.1035337778951544  
valid\_h1\_min\_x\_mean\_u: 0.001916987585951917  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.8465398816056892  
valid\_h1\_range\_x\_mean\_u: 0.11451904547516042  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0101652169488244  
valid\_h1\_row\_norms\_mean: 0.7430768417109986  
valid\_h1\_row\_norms\_min: 0.5189258282632163  
valid\_h2\_col\_norms\_max: 0.7499999999999997  
valid\_h2\_col\_norms\_mean: 0.7490994807666099  
valid\_h2\_col\_norms\_min: 0.7383232009750433  
valid\_h2\_max\_x\_max\_u: 1.0746205463498921  
valid\_h2\_max\_x\_mean\_u: 0.08091682469316673  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.3828822740959956  
valid\_h2\_mean\_x\_mean\_u: 0.022878631392584392  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.12417652282747549  
valid\_h2\_min\_x\_mean\_u: 0.001793492389483721  
valid\_h2\_min\_x\_min\_u: 0.0

```

valid_h2_range_x_max_u: 1.058304631925301
valid_h2_range_x_mean_u: 0.07912333230368303
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2074336567491744
valid_h2_row_norms_mean: 0.7359446850428647
valid_h2_row_norms_min: 0.3724294062001663
valid_objective: 0.8667180779211869
valid_y_col_norms_max: 2.7665990590043927
valid_y_col_norms_mean: 2.7665990590043927
valid_y_col_norms_min: 2.7665990590043927
valid_y_max_max_class: 0.9560467776756219
valid_y_mean_max_class: 0.738835844276459
valid_y_min_max_class: 0.5089560348233555
valid_y_misclass: 0.36943717277486904
valid_y_nll: 0.6431185148149913
valid_y_row_norms_max: 0.7832633087943192
valid_y_row_norms_mean: 0.1328766220360155
valid_y_row_norms_min: 6.884433451397816e-05
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.090000 seconds
Time this epoch: 45.045000 seconds
Monitoring step:
  Epochs seen: 22
  Batches seen: 30272
  Examples seen: 3025176
  learning_rate: 0.07802199999999992
  momentum: 0.41515151515152593
  total_seconds_last_epoch: 81.795000000000098
  train_h0_col_norms_max: 0.7500000000000019
  train_h0_col_norms_mean: 0.745457813474781
  train_h0_col_norms_min: 0.7195487063618069
  train_h0_max_x_max_u: 1.1135278872051866
  train_h0_max_x_mean_u: 0.2510659788326571
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.2908246572793837
  train_h0_mean_x_mean_u: 0.02244662517420715
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.02152684963793762
  train_h0_min_x_mean_u: 0.000179821225165003
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.1057485397194846
  train_h0_range_x_mean_u: 0.2508861576074923
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.6160549776609544
  train_h0_row_norms_mean: 0.47505982779723405
  train_h0_row_norms_min: 0.4015885494363057
  train_h1_col_norms_max: 0.7500000000000019
  train_h1_col_norms_mean: 0.7482628629342346
  train_h1_col_norms_min: 0.720295680669514
  train_h1_max_x_max_u: 0.6816453518396017
  train_h1_max_x_mean_u: 0.10976538597194826
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.20200953048411593
  train_h1_mean_x_mean_u: 0.018067146106443267

```

train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.021247014087894124  
train\_h1\_min\_x\_mean\_u: 0.00038576611145827984  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6746718826325724  
train\_h1\_range\_x\_mean\_u: 0.10937961986049002  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0043607542087025  
train\_h1\_row\_norms\_mean: 0.7433689053900837  
train\_h1\_row\_norms\_min: 0.5186425729609472  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7490230973434617  
train\_h2\_col\_norms\_min: 0.7381197566115885  
train\_h2\_max\_x\_max\_u: 0.7477750780662892  
train\_h2\_max\_x\_mean\_u: 0.07623007991206988  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.25658117934396274  
train\_h2\_mean\_x\_mean\_u: 0.020518603965561506  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.08995638868219807  
train\_h2\_min\_x\_mean\_u: 0.001834799120487829  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.7191508229551368  
train\_h2\_range\_x\_mean\_u: 0.07439528079158202  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2065467907793832  
train\_h2\_row\_norms\_mean: 0.7359454248838875  
train\_h2\_row\_norms\_min: 0.3756163429080886  
train\_objective: 0.4278506114608765  
train\_y\_col\_norms\_max: 2.7957347640716543  
train\_y\_col\_norms\_mean: 2.7957347640716543  
train\_y\_col\_norms\_min: 2.7957347640716543  
train\_y\_max\_max\_class: 0.9725200501214548  
train\_y\_mean\_max\_class: 0.7872907687594929  
train\_y\_min\_max\_class: 0.5175883103771117  
train\_y\_misclass: 0.12245832969718139  
train\_y\_nll: 0.3231600737609327  
train\_y\_row\_norms\_max: 0.7920065866637805  
train\_y\_row\_norms\_mean: 0.13411767547744255  
train\_y\_row\_norms\_min: 0.000653996076875565  
training\_seconds\_this\_epoch: 45.044999999999918  
valid\_h0\_col\_norms\_max: 0.7499999999999996  
valid\_h0\_col\_norms\_mean: 0.7454578134747888  
valid\_h0\_col\_norms\_min: 0.7195487063617949  
valid\_h0\_max\_x\_max\_u: 1.3716973205697327  
valid\_h0\_max\_x\_mean\_u: 0.19621676904510074  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.666191578383127  
valid\_h0\_mean\_x\_mean\_u: 0.035070674845322856  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.20261700290813286  
valid\_h0\_min\_x\_mean\_u: 0.001758317744417799  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2979112859195308

```
valid_h0_range_x_mean_u: 0.1944584513006829
valid_h0_range_x_min_u: 0.0
valid_h0_row_norms_max: 0.6160549776609584
valid_h0_row_norms_mean: 0.47505982779723743
valid_h0_row_norms_min: 0.4015885494363175
valid_h1_col_norms_max: 0.7499999999999996
valid_h1_col_norms_mean: 0.7482628629342173
valid_h1_col_norms_min: 0.7202956806695254
valid_h1_max_x_max_u: 0.9473312643482085
valid_h1_max_x_mean_u: 0.11684179471189345
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.42170696816150527
valid_h1_mean_x_mean_u: 0.034647322656876624
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.1338638086064424
valid_h1_min_x_mean_u: 0.003486120829976093
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.8731835190065856
valid_h1_range_x_mean_u: 0.1133556738819174
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.004360754208687
valid_h1_row_norms_mean: 0.7433689053901049
valid_h1_row_norms_min: 0.5186425729609431
valid_h2_col_norms_max: 0.7499999999999996
valid_h2_col_norms_mean: 0.7490230973434814
valid_h2_col_norms_min: 0.7381197566115786
valid_h2_max_x_max_u: 1.1851033494845247
valid_h2_max_x_mean_u: 0.08303391218603888
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.41619163754556854
valid_h2_mean_x_mean_u: 0.024951989034297246
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.11904584645275038
valid_h2_min_x_mean_u: 0.002219778008014488
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 1.1642661298645782
valid_h2_range_x_mean_u: 0.08081413417802444
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.206546790779411
valid_h2_row_norms_mean: 0.7359454248838618
valid_h2_row_norms_min: 0.37561634290808077
valid_objective: 0.7774332975380662
valid_y_col_norms_max: 2.795734764071674
valid_y_col_norms_mean: 2.795734764071674
valid_y_col_norms_min: 2.795734764071674
valid_y_max_max_class: 0.9567129806034064
valid_y_mean_max_class: 0.7670122395120963
valid_y_min_max_class: 0.5159712849541763
valid_y_misclass: 0.27905759162303684
valid_y_nll: 0.5717345103560667
valid_y_row_norms_max: 0.7920065866637644
valid_y_row_norms_mean: 0.13411767547744194
valid_y_row_norms_min: 0.000653996076875544
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Saving to ..\Sean\nn\_files\_S4C4R20\nn\_train.pkl done. Time elapsed: 0.085000 seconds

Time this epoch: 44.600000 seconds

Monitoring step:

Epochs seen: 23  
Batches seen: 31648  
Examples seen: 3162684  
learning\_rate: 0.07702300000000034  
momentum: 0.41111111111110926  
total\_seconds\_last\_epoch: 82.34999999999962  
train\_h0\_col\_norms\_max: 0.750000000000019  
train\_h0\_col\_norms\_mean: 0.7454047825491682  
train\_h0\_col\_norms\_min: 0.7135518609742997  
train\_h0\_max\_x\_max\_u: 1.0994342682816847  
train\_h0\_max\_x\_mean\_u: 0.25226336014861467  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.29597730046717496  
train\_h0\_mean\_x\_mean\_u: 0.022951328460336422  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.022440786846822942  
train\_h0\_min\_x\_mean\_u: 0.00021647089270176913  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.0949906115524008  
train\_h0\_range\_x\_mean\_u: 0.2520468892559129  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.6204169779391308  
train\_h0\_row\_norms\_mean: 0.47504445314542276  
train\_h0\_row\_norms\_min: 0.40287973526623333  
train\_h1\_col\_norms\_max: 0.750000000000019  
train\_h1\_col\_norms\_mean: 0.7483536595211876  
train\_h1\_col\_norms\_min: 0.7213984058693326  
train\_h1\_max\_x\_max\_u: 0.6747024411342573  
train\_h1\_max\_x\_mean\_u: 0.11050104402365919  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.20339334016418661  
train\_h1\_mean\_x\_mean\_u: 0.0183637033733787  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.02062806630579402  
train\_h1\_min\_x\_mean\_u: 0.00039385848809847236  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6651181144150006  
train\_h1\_range\_x\_mean\_u: 0.11010718553556073  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0008452674871857  
train\_h1\_row\_norms\_mean: 0.7434429108189307  
train\_h1\_row\_norms\_min: 0.5055081958135791  
train\_h2\_col\_norms\_max: 0.750000000000019  
train\_h2\_col\_norms\_mean: 0.7490182135363688  
train\_h2\_col\_norms\_min: 0.7308610251150089  
train\_h2\_max\_x\_max\_u: 0.7826292934684144  
train\_h2\_max\_x\_mean\_u: 0.08077625107174718  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.27413993939642683  
train\_h2\_mean\_x\_mean\_u: 0.022521883068263755  
train\_h2\_mean\_x\_min\_u: 0.0

train\_h2\_min\_x\_max\_u: 0.09463807659782157  
train\_h2\_min\_x\_mean\_u: 0.002040964284337116  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.747447816506348  
train\_h2\_range\_x\_mean\_u: 0.07873528678741018  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2050397008183429  
train\_h2\_row\_norms\_mean: 0.7360793431508119  
train\_h2\_row\_norms\_min: 0.3792818650035223  
train\_objective: 0.42921745808739115  
train\_y\_col\_norms\_max: 2.829111421678467  
train\_y\_col\_norms\_mean: 2.829111421678467  
train\_y\_col\_norms\_min: 2.8291114216784665  
train\_y\_max\_max\_class: 0.9766132814588164  
train\_y\_mean\_max\_class: 0.7973143728077908  
train\_y\_min\_max\_class: 0.5163211758488532  
train\_y\_misclass: 0.1132443203304538  
train\_y\_nll: 0.30871221983279373  
train\_y\_row\_norms\_max: 0.8031933148561676  
train\_y\_row\_norms\_mean: 0.13560167505849283  
train\_y\_row\_norms\_min: 0.0004072861425961309  
training\_seconds\_this\_epoch: 44.600000000000081  
valid\_h0\_col\_norms\_max: 0.7499999999999997  
valid\_h0\_col\_norms\_mean: 0.7454047825491755  
valid\_h0\_col\_norms\_min: 0.7135518609742955  
valid\_h0\_max\_x\_max\_u: 1.3214182842487234  
valid\_h0\_max\_x\_mean\_u: 0.19983996980664817  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6506136590545214  
valid\_h0\_mean\_x\_mean\_u: 0.03690632082666246  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.2132758865296536  
valid\_h0\_min\_x\_mean\_u: 0.0020743138425716352  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2653748202604769  
valid\_h0\_range\_x\_mean\_u: 0.1977656559640765  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6204169779391447  
valid\_h0\_row\_norms\_mean: 0.4750444531454202  
valid\_h0\_row\_norms\_min: 0.4028797352662225  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7483536595211967  
valid\_h1\_col\_norms\_min: 0.7213984058693182  
valid\_h1\_max\_x\_max\_u: 0.9644476886765693  
valid\_h1\_max\_x\_mean\_u: 0.12105572391042041  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.43886427233411746  
valid\_h1\_mean\_x\_mean\_u: 0.035771540275840716  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.13579509904568754  
valid\_h1\_min\_x\_mean\_u: 0.003143168037402646  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.8770727049180602  
valid\_h1\_range\_x\_mean\_u: 0.11791255587301773

```

valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.000845267487201
valid_h1_row_norms_mean: 0.7434429108189419
valid_h1_row_norms_min: 0.5055081958135866
valid_h2_col_norms_max: 0.7499999999999996
valid_h2_col_norms_mean: 0.749018213536375
valid_h2_col_norms_min: 0.7308610251150223
valid_h2_max_x_max_u: 1.2511115733920115
valid_h2_max_x_mean_u: 0.08920515516618162
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.4504385328123435
valid_h2_mean_x_mean_u: 0.02711939782228185
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.13648140462979377
valid_h2_min_x_mean_u: 0.0024700411751882967
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 1.2259604685509933
valid_h2_range_x_mean_u: 0.08673511399099333
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2050397008183433
valid_h2_row_norms_mean: 0.7360793431508336
valid_h2_row_norms_min: 0.37928186500352645
valid_objective: 0.8588405389554615
valid_y_col_norms_max: 2.829111421678488
valid_y_col_norms_mean: 2.829111421678488
valid_y_col_norms_min: 2.829111421678488
valid_y_max_max_class: 0.964367614991744
valid_y_mean_max_class: 0.7670580299250556
valid_y_min_max_class: 0.516440635074122
valid_y_misclass: 0.3191099476439788
valid_y_nll: 0.6212063889632244
valid_y_row_norms_max: 0.8031933148561857
valid_y_row_norms_mean: 0.1356016750584945
valid_y_row_norms_min: 0.00040728614259614304
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.075000 seconds
Time this epoch: 45.207000 seconds
Monitoring step:
  Epochs seen: 24
  Batches seen: 33024
  Examples seen: 3300192
  learning_rate: 0.07602400000000084
  momentum: 0.4070707070707111
  total_seconds_last_epoch: 81.67499999999949
  train_h0_col_norms_max: 0.750000000000019
  train_h0_col_norms_mean: 0.745271472101638
  train_h0_col_norms_min: 0.7098708176355405
  train_h0_max_x_max_u: 1.1212654447243016
  train_h0_max_x_mean_u: 0.25024569862866713
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.27429955288690605
  train_h0_mean_x_mean_u: 0.022333908443889338
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.015673977801605607

```

train\_h0\_min\_x\_mean\_u: 0.00016074128501027227  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.1172055024236596  
train\_h0\_range\_x\_mean\_u: 0.2500849573436568  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.6489751160965961  
train\_h0\_row\_norms\_mean: 0.4749734835918264  
train\_h0\_row\_norms\_min: 0.40731247019275707  
train\_h1\_col\_norms\_max: 0.7500000000000019  
train\_h1\_col\_norms\_mean: 0.7482479464365015  
train\_h1\_col\_norms\_min: 0.7236491099689644  
train\_h1\_max\_x\_max\_u: 0.6289036687921487  
train\_h1\_max\_x\_mean\_u: 0.10577584396524431  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.18189503473060092  
train\_h1\_mean\_x\_mean\_u: 0.017335170497743583  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.017509419102391663  
train\_h1\_min\_x\_mean\_u: 0.000373151105681679  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6233250707795682  
train\_h1\_range\_x\_mean\_u: 0.1054026928595626  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0123420389574953  
train\_h1\_row\_norms\_mean: 0.7434144266109299  
train\_h1\_row\_norms\_min: 0.4975161659402859  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7489841571159556  
train\_h2\_col\_norms\_min: 0.732538692921407  
train\_h2\_max\_x\_max\_u: 0.7113398912435642  
train\_h2\_max\_x\_mean\_u: 0.07617886494887982  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.25263471226157036  
train\_h2\_mean\_x\_mean\_u: 0.021329060996769678  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.10307018873963425  
train\_h2\_min\_x\_mean\_u: 0.0022356425895187536  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6778540192278325  
train\_h2\_range\_x\_mean\_u: 0.07394322235936102  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2020310620737282  
train\_h2\_row\_norms\_mean: 0.7361261847218872  
train\_h2\_row\_norms\_min: 0.3786222309932998  
train\_objective: 0.41388250241149704  
train\_y\_col\_norms\_max: 2.8505591328269264  
train\_y\_col\_norms\_mean: 2.8505591328269264  
train\_y\_col\_norms\_min: 2.8505591328269264  
train\_y\_max\_max\_class: 0.974678993590007  
train\_y\_mean\_max\_class: 0.7951134554563336  
train\_y\_min\_max\_class: 0.5240704053308108  
train\_y\_misclass: 0.12069115978706695  
train\_y\_nll: 0.31575274907814227  
train\_y\_row\_norms\_max: 0.807915854268505



train\_y\_row\_norms\_mean: 0.1368265578630077  
train\_y\_row\_norms\_min: 0.00020496943823177525  
training\_seconds\_this\_epoch: 45.20699999999989  
valid\_h0\_col\_norms\_max: 0.7499999999999997  
valid\_h0\_col\_norms\_mean: 0.7452714721016599  
valid\_h0\_col\_norms\_min: 0.709870817635564  
valid\_h0\_max\_x\_max\_u: 1.3452467320004762  
valid\_h0\_max\_x\_mean\_u: 0.19793613877998076  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6042968469879932  
valid\_h0\_mean\_x\_mean\_u: 0.03489322571351166  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.15207728933338618  
valid\_h0\_min\_x\_mean\_u: 0.0014957473134391654  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.3062265842587766  
valid\_h0\_range\_x\_mean\_u: 0.19644039146654163  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6489751160966074  
valid\_h0\_row\_norms\_mean: 0.4749734835918348  
valid\_h0\_row\_norms\_min: 0.40731247019276523  
valid\_h1\_col\_norms\_max: 0.7499999999999996  
valid\_h1\_col\_norms\_mean: 0.7482479464364887  
valid\_h1\_col\_norms\_min: 0.7236491099689458  
valid\_h1\_max\_x\_max\_u: 0.8172682414397483  
valid\_h1\_max\_x\_mean\_u: 0.11150865220611106  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.346113270571836  
valid\_h1\_mean\_x\_mean\_u: 0.03200758250086209  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.11649184436551673  
valid\_h1\_min\_x\_mean\_u: 0.003005250329250094  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.7749115246333804  
valid\_h1\_range\_x\_mean\_u: 0.10850340187686099  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 1.0123420389575128  
valid\_h1\_row\_norms\_mean: 0.7434144266109199  
valid\_h1\_row\_norms\_min: 0.4975161659402757  
valid\_h2\_col\_norms\_max: 0.7499999999999996  
valid\_h2\_col\_norms\_mean: 0.7489841571159791  
valid\_h2\_col\_norms\_min: 0.7325386929214004  
valid\_h2\_max\_x\_max\_u: 1.0911494053425745  
valid\_h2\_max\_x\_mean\_u: 0.08335460460061017  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.3910734578739502  
valid\_h2\_mean\_x\_mean\_u: 0.025345698004349503  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.14937136739016582  
valid\_h2\_min\_x\_mean\_u: 0.0026073797622251835  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 1.0696426201939537  
valid\_h2\_range\_x\_mean\_u: 0.080747224838385  
valid\_h2\_range\_x\_min\_u: 0.0

```

valid_h2_row_norms_max: 1.2020310620737127
valid_h2_row_norms_mean: 0.736126184721898
valid_h2_row_norms_min: 0.37862223099328934
valid_objective: 0.7556956343153343
valid_y_col_norms_max: 2.8505591328268425
valid_y_col_norms_mean: 2.8505591328268425
valid_y_col_norms_min: 2.8505591328268425
valid_y_max_max_class: 0.9575822834597312
valid_y_mean_max_class: 0.7592061118684061
valid_y_min_max_class: 0.5092698964585718
valid_y_misclass: 0.28219895287958113
valid_y_nll: 0.5575262665601483
valid_y_row_norms_max: 0.807915854268518
valid_y_row_norms_mean: 0.13682655786300496
valid_y_row_norms_min: 0.00020496943823177115
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.095000 seconds
Time this epoch: 44.795000 seconds
Monitoring step:
  Epochs seen: 25
  Batches seen: 34400
  Examples seen: 3437700
  learning_rate: 0.07502500000000009
  momentum: 0.40303030303031184
  total_seconds_last_epoch: 82.34699999999806
  train_h0_col_norms_max: 0.7500000000000019
  train_h0_col_norms_mean: 0.7450270996068102
  train_h0_col_norms_min: 0.7089398721160246
  train_h0_max_x_max_u: 1.0816354341294308
  train_h0_max_x_mean_u: 0.24627928404450797
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.2623182756401675
  train_h0_mean_x_mean_u: 0.021711750596519863
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.015509946035410428
  train_h0_min_x_mean_u: 0.00014031275279846413
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.0778666623618025
  train_h0_range_x_mean_u: 0.24613897129170953
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.6409229798652077
  train_h0_row_norms_mean: 0.4748091031118424
  train_h0_row_norms_min: 0.40555302433982277
  train_h1_col_norms_max: 0.7500000000000019
  train_h1_col_norms_mean: 0.7483686185415008
  train_h1_col_norms_min: 0.725613358042126
  train_h1_max_x_max_u: 0.6120512035371624
  train_h1_max_x_mean_u: 0.10030867222895375
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.1666568396056912
  train_h1_mean_x_mean_u: 0.015405688898159447
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.013818791097697517
  train_h1_min_x_mean_u: 0.000232012017159036

```

train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6083765844105751  
train\_h1\_range\_x\_mean\_u: 0.10007666021179473  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0156400872120896  
train\_h1\_row\_norms\_mean: 0.7435277948568093  
train\_h1\_row\_norms\_min: 0.4960744632656178  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7489925132740533  
train\_h2\_col\_norms\_min: 0.7376881505252875  
train\_h2\_max\_x\_max\_u: 0.6638282612558923  
train\_h2\_max\_x\_mean\_u: 0.07212032377975046  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.23162153021562834  
train\_h2\_mean\_x\_mean\_u: 0.02071917253619612  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.0898633428588561  
train\_h2\_min\_x\_mean\_u: 0.0025140421141958765  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6345538269271559  
train\_h2\_range\_x\_mean\_u: 0.06960628166555462  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2029142298456366  
train\_h2\_row\_norms\_mean: 0.7362204920028037  
train\_h2\_row\_norms\_min: 0.38262797917700886  
train\_objective: 0.4291738274795717  
train\_y\_col\_norms\_max: 2.8890558497701866  
train\_y\_col\_norms\_mean: 2.8890558497701866  
train\_y\_col\_norms\_min: 2.8890558497701866  
train\_y\_max\_max\_class: 0.9791072347136419  
train\_y\_mean\_max\_class: 0.8149445652481292  
train\_y\_min\_max\_class: 0.5488770417741471  
train\_y\_misclass: 0.17649882188672641  
train\_y\_nll: 0.3648409684175233  
train\_y\_row\_norms\_max: 0.8157204022426816  
train\_y\_row\_norms\_mean: 0.1384754457716481  
train\_y\_row\_norms\_min: 0.0008159761746810134  
training\_seconds\_this\_epoch: 44.795000000000606  
valid\_h0\_col\_norms\_max: 0.7499999999999996  
valid\_h0\_col\_norms\_mean: 0.7450270996068192  
valid\_h0\_col\_norms\_min: 0.7089398721160318  
valid\_h0\_max\_x\_max\_u: 1.2766288745022918  
valid\_h0\_max\_x\_mean\_u: 0.1911309358731994  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5672015923067804  
valid\_h0\_mean\_x\_mean\_u: 0.03327410346068576  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.13973550130459733  
valid\_h0\_min\_x\_mean\_u: 0.0013941697532153835  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2420742052079388  
valid\_h0\_range\_x\_mean\_u: 0.1897367661199838  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6409229798652137

```

valid_h0_row_norms_mean: 0.4748091031118513
valid_h0_row_norms_min: 0.4055530243398151
valid_h1_col_norms_max: 0.7499999999999996
valid_h1_col_norms_mean: 0.7483686185415139
valid_h1_col_norms_min: 0.7256133580421015
valid_h1_max_x_max_u: 0.7816979299856905
valid_h1_max_x_mean_u: 0.10325659528086513
valid_h1_max_x_min_u: 0.0
valid_h1_mean_x_max_u: 0.31683606865861125
valid_h1_mean_x_mean_u: 0.02665981975827403
valid_h1_mean_x_min_u: 0.0
valid_h1_min_x_max_u: 0.09576841112279398
valid_h1_min_x_mean_u: 0.001949507593332636
valid_h1_min_x_min_u: 0.0
valid_h1_range_x_max_u: 0.740124755157319
valid_h1_range_x_mean_u: 0.10130708768753245
valid_h1_range_x_min_u: 0.0
valid_h1_row_norms_max: 1.0156400872121105
valid_h1_row_norms_mean: 0.7435277948568092
valid_h1_row_norms_min: 0.4960744632656069
valid_h2_col_norms_max: 0.7499999999999996
valid_h2_col_norms_mean: 0.7489925132740787
valid_h2_col_norms_min: 0.7376881505252807
valid_h2_max_x_max_u: 0.9888089015182094
valid_h2_max_x_mean_u: 0.0742999525913494
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.31781065838070843
valid_h2_mean_x_mean_u: 0.020931691135781316
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.08218723063687638
valid_h2_min_x_mean_u: 0.0014374981046144566
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 0.9803126827864691
valid_h2_range_x_mean_u: 0.072862454486735
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.2029142298456528
valid_h2_row_norms_mean: 0.7362204920028166
valid_h2_row_norms_min: 0.3826279791770149
valid_objective: 0.6462797826122497
valid_y_col_norms_max: 2.88905584977015
valid_y_col_norms_mean: 2.88905584977015
valid_y_col_norms_min: 2.8890558497701497
valid_y_max_max_class: 0.9613222869763681
valid_y_mean_max_class: 0.7617202221987845
valid_y_min_max_class: 0.5106308002144027
valid_y_misclass: 0.25929319371727755
valid_y_nll: 0.5255043055357164
valid_y_row_norms_max: 0.8157204022426912
valid_y_row_norms_mean: 0.1384754457716504
valid_y_row_norms_min: 0.0008159761746810306
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.085000 seconds
Time this epoch: 44.835000 seconds
Monitoring step:

```

Epochs seen: 26  
Batches seen: 35776  
Examples seen: 3575208  
learning\_rate: 0.0740259999999988  
momentum: 0.3989898989898934  
total\_seconds\_last\_epoch: 81.98000000000008  
train\_h0\_col\_norms\_max: 0.750000000000019  
train\_h0\_col\_norms\_mean: 0.7456576257428955  
train\_h0\_col\_norms\_min: 0.7135075289253103  
train\_h0\_max\_x\_max\_u: 1.1128907899999476  
train\_h0\_max\_x\_mean\_u: 0.25195423977825704  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.2736083527818997  
train\_h0\_mean\_x\_mean\_u: 0.02305537346078161  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.014777599961616997  
train\_h0\_min\_x\_mean\_u: 0.0001658872354792939  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.1096200122564726  
train\_h0\_range\_x\_mean\_u: 0.25178835254277787  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.6180672641835704  
train\_h0\_row\_norms\_mean: 0.4752367000119253  
train\_h0\_row\_norms\_min: 0.40556954589834504  
train\_h1\_col\_norms\_max: 0.750000000000019  
train\_h1\_col\_norms\_mean: 0.7483339874189648  
train\_h1\_col\_norms\_min: 0.7254421314450744  
train\_h1\_max\_x\_max\_u: 0.6630274829962017  
train\_h1\_max\_x\_mean\_u: 0.10795809275389852  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.18535098843189987  
train\_h1\_mean\_x\_mean\_u: 0.017370892577374022  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.019143854433525356  
train\_h1\_min\_x\_mean\_u: 0.0003442408064435048  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6573873619406073  
train\_h1\_range\_x\_mean\_u: 0.10761385194745504  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.003106831803294  
train\_h1\_row\_norms\_mean: 0.7435763090112134  
train\_h1\_row\_norms\_min: 0.4885752033350256  
train\_h2\_col\_norms\_max: 0.750000000000019  
train\_h2\_col\_norms\_mean: 0.7490978471917344  
train\_h2\_col\_norms\_min: 0.7375972922506221  
train\_h2\_max\_x\_max\_u: 0.7900072052327702  
train\_h2\_max\_x\_mean\_u: 0.08039857731299868  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2782369425803646  
train\_h2\_mean\_x\_mean\_u: 0.022908370317832806  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.11466775153259266  
train\_h2\_min\_x\_mean\_u: 0.002425621314943735  
train\_h2\_min\_x\_min\_u: 0.0

train\_h2.range\_x\_max\_u: 0.759328067403735  
train\_h2.range\_x\_mean\_u: 0.07797295599805497  
train\_h2.range\_x\_min\_u: 0.0  
train\_h2.row\_norms\_max: 1.199648751024475  
train\_h2.row\_norms\_mean: 0.7364053290377742  
train\_h2.row\_norms\_min: 0.38187248531876344  
train\_objective: 0.4147807142449107  
train\_y.col\_norms\_max: 2.9321638279653097  
train\_y.col\_norms\_mean: 2.9321638279653097  
train\_y.col\_norms\_min: 2.9321638279653097  
train\_y\_max\_max\_class: 0.9804593949010852  
train\_y\_mean\_max\_class: 0.8081929521131284  
train\_y\_min\_max\_class: 0.5242851209477428  
train\_y\_misclass: 0.10950635599383314  
train\_y\_nll: 0.2947060566212618  
train\_y.row\_norms\_max: 0.8252775689969489  
train\_y.row\_norms\_mean: 0.1408465075343954  
train\_y.row\_norms\_min: 0.0008045492829591835  
training\_seconds\_this\_epoch: 44.83499999999998  
valid\_h0.col\_norms\_max: 0.7500000000000003  
valid\_h0.col\_norms\_mean: 0.7456576257428892  
valid\_h0.col\_norms\_min: 0.713507528925321  
valid\_h0\_max\_x\_max\_u: 1.3305875190471097  
valid\_h0\_max\_x\_mean\_u: 0.20406637359823096  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.586003052139605  
valid\_h0\_mean\_x\_mean\_u: 0.037675753563762016  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.1443412792722378  
valid\_h0\_min\_x\_mean\_u: 0.001654161306689527  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0.range\_x\_max\_u: 1.2974402820011859  
valid\_h0.range\_x\_mean\_u: 0.20241221229154138  
valid\_h0.range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.6180672641835511  
valid\_h0.row\_norms\_mean: 0.4752367000119304  
valid\_h0.row\_norms\_min: 0.40556954589835154  
valid\_h1.col\_norms\_max: 0.7499999999999996  
valid\_h1.col\_norms\_mean: 0.74833398741896  
valid\_h1.col\_norms\_min: 0.7254421314450737  
valid\_h1\_max\_x\_max\_u: 0.9009621786301244  
valid\_h1\_max\_x\_mean\_u: 0.1195817312970514  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.37397448338258005  
valid\_h1\_mean\_x\_mean\_u: 0.03385268837234047  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.10965485271656226  
valid\_h1\_min\_x\_mean\_u: 0.00271275541975409  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1.range\_x\_max\_u: 0.8410103471588594  
valid\_h1.range\_x\_mean\_u: 0.11686897587729735  
valid\_h1.range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.0031068318032712  
valid\_h1.row\_norms\_mean: 0.7435763090112105

```

valid_h1_row_norms_min: 0.4885752033350367
valid_h2_col_norms_max: 0.7499999999999996
valid_h2_col_norms_mean: 0.74909784719175
valid_h2_col_norms_min: 0.7375972922506309
valid_h2_max_x_max_u: 1.2982160280567439
valid_h2_max_x_mean_u: 0.0912880218822768
valid_h2_max_x_min_u: 0.0
valid_h2_mean_x_max_u: 0.47718631130548494
valid_h2_mean_x_mean_u: 0.02772783328620372
valid_h2_mean_x_min_u: 0.0
valid_h2_min_x_max_u: 0.16513421622230712
valid_h2_min_x_mean_u: 0.002733283838400585
valid_h2_min_x_min_u: 0.0
valid_h2_range_x_max_u: 1.2700357623759164
valid_h2_range_x_mean_u: 0.08855473804387623
valid_h2_range_x_min_u: 0.0
valid_h2_row_norms_max: 1.1996487510245044
valid_h2_row_norms_mean: 0.7364053290377691
valid_h2_row_norms_min: 0.38187248531875817
valid_objective: 0.8193165384558795
valid_y_col_norms_max: 2.932163827965255
valid_y_col_norms_mean: 2.932163827965255
valid_y_col_norms_min: 2.932163827965255
valid_y_max_max_class: 0.9673630056079098
valid_y_mean_max_class: 0.7811379961177776
valid_y_min_max_class: 0.5195256887726
valid_y_misclass: 0.29175392670157074
valid_y_nll: 0.5841203004943111
valid_y_row_norms_max: 0.8252775689969261
valid_y_row_norms_mean: 0.14084650753439498
valid_y_row_norms_min: 0.0008045492829591961
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.080000 seconds
Time this epoch: 44.910000 seconds
Monitoring step:
  Epochs seen: 27
  Batches seen: 37152
  Examples seen: 3712716
  learning_rate: 0.073026999999999865
  momentum: 0.39494949494949394
  total_seconds_last_epoch: 82.00500000000003
  train_h0_col_norms_max: 0.7500000000000019
  train_h0_col_norms_mean: 0.7450993938893139
  train_h0_col_norms_min: 0.7128364643493527
  train_h0_max_x_max_u: 1.0946094622227456
  train_h0_max_x_mean_u: 0.2485503900555772
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.25455298817161875
  train_h0_mean_x_mean_u: 0.021886349376114868
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.015649536376328908
  train_h0_min_x_mean_u: 0.0001349460451838003
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.0919089577022725

```

train\_h0\_range\_x\_mean\_u: 0.24841544401039328  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.6324125738148225  
train\_h0\_row\_norms\_mean: 0.47491231494637176  
train\_h0\_row\_norms\_min: 0.4058434568824211  
train\_h1\_col\_norms\_max: 0.7500000000000019  
train\_h1\_col\_norms\_mean: 0.7482705228024599  
train\_h1\_col\_norms\_min: 0.7246589915737901  
train\_h1\_max\_x\_max\_u: 0.6538249241991062  
train\_h1\_max\_x\_mean\_u: 0.10470386625511936  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.19297442959847  
train\_h1\_mean\_x\_mean\_u: 0.016182204614219656  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.01567116660563218  
train\_h1\_min\_x\_mean\_u: 0.00026941011734897113  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6484859214799273  
train\_h1\_range\_x\_mean\_u: 0.10443445613777046  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 0.9978140721528334  
train\_h1\_row\_norms\_mean: 0.7435785558048164  
train\_h1\_row\_norms\_min: 0.4944064178543544  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7490470898336998  
train\_h2\_col\_norms\_min: 0.7375027318630476  
train\_h2\_max\_x\_max\_u: 0.7160002713472391  
train\_h2\_max\_x\_mean\_u: 0.07618018937694124  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.2573581595666156  
train\_h2\_mean\_x\_mean\_u: 0.021493882958899462  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.1109741951933349  
train\_h2\_min\_x\_mean\_u: 0.002405017112231579  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6847982453578618  
train\_h2\_range\_x\_mean\_u: 0.07377517226470981  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.1992962763240451  
train\_h2\_row\_norms\_mean: 0.7364654197946782  
train\_h2\_row\_norms\_min: 0.38372085635397607  
train\_objective: 0.4103936710241964  
train\_y\_col\_norms\_max: 2.9565500866272236  
train\_y\_col\_norms\_mean: 2.9565500866272236  
train\_y\_col\_norms\_min: 2.9565500866272236  
train\_y\_max\_max\_class: 0.9765721859750877  
train\_y\_mean\_max\_class: 0.7955433771471442  
train\_y\_min\_max\_class: 0.5170292543178967  
train\_y\_misclass: 0.10501207202490058  
train\_y\_nll: 0.30228174234193445  
train\_y\_row\_norms\_max: 0.8357983656337117  
train\_y\_row\_norms\_mean: 0.14210293460621198  
train\_y\_row\_norms\_min: 0.001319467220636788  
training\_seconds\_this\_epoch: 44.91000000000048



valid\_h0.col\_norms\_max: 0.7500000000000003  
valid\_h0.col\_norms\_mean: 0.7450993938893233  
valid\_h0.col\_norms\_min: 0.7128364643493654  
valid\_h0\_max\_x\_max\_u: 1.3102760285138442  
valid\_h0\_max\_x\_mean\_u: 0.19657734795187093  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5336607005991727  
valid\_h0\_mean\_x\_mean\_u: 0.03364888995572179  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.1282573834119393  
valid\_h0\_min\_x\_mean\_u: 0.0011899263938080463  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.2856659132580648  
valid\_h0\_range\_x\_mean\_u: 0.19538742155806285  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6324125738148132  
valid\_h0\_row\_norms\_mean: 0.47491231494636377  
valid\_h0\_row\_norms\_min: 0.40584345688242895  
valid\_h1.col\_norms\_max: 0.7499999999999996  
valid\_h1.col\_norms\_mean: 0.7482705228024464  
valid\_h1.col\_norms\_min: 0.7246589915737808  
valid\_h1\_max\_x\_max\_u: 0.8580680426445696  
valid\_h1\_max\_x\_mean\_u: 0.11044912172524925  
valid\_h1\_max\_x\_min\_u: 0.0  
valid\_h1\_mean\_x\_max\_u: 0.3824508926302429  
valid\_h1\_mean\_x\_mean\_u: 0.029090438032923466  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.11425011370714316  
valid\_h1\_min\_x\_mean\_u: 0.0020623848310740525  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.8114468935124319  
valid\_h1\_range\_x\_mean\_u: 0.1083867368941753  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1\_row\_norms\_max: 0.997814072152852  
valid\_h1\_row\_norms\_mean: 0.7435785558048063  
valid\_h1\_row\_norms\_min: 0.4944064178543601  
valid\_h2.col\_norms\_max: 0.7499999999999996  
valid\_h2.col\_norms\_mean: 0.7490470898337064  
valid\_h2.col\_norms\_min: 0.7375027318630699  
valid\_h2\_max\_x\_max\_u: 1.0726467929967465  
valid\_h2\_max\_x\_mean\_u: 0.08227651123811143  
valid\_h2\_max\_x\_min\_u: 0.0  
valid\_h2\_mean\_x\_max\_u: 0.3763722858833968  
valid\_h2\_mean\_x\_mean\_u: 0.023808767301873788  
valid\_h2\_mean\_x\_min\_u: 0.0  
valid\_h2\_min\_x\_max\_u: 0.15488197356720035  
valid\_h2\_min\_x\_mean\_u: 0.0022834795520219344  
valid\_h2\_min\_x\_min\_u: 0.0  
valid\_h2\_range\_x\_max\_u: 1.0562627634396127  
valid\_h2\_range\_x\_mean\_u: 0.07999303168608951  
valid\_h2\_range\_x\_min\_u: 0.0  
valid\_h2\_row\_norms\_max: 1.1992962763240451  
valid\_h2\_row\_norms\_mean: 0.7364654197946893  
valid\_h2\_row\_norms\_min: 0.3837208563539752

```

valid_objective: 0.7696045063374202
valid_y_col_norms_max: 2.9565500866272743
valid_y_col_norms_mean: 2.9565500866272743
valid_y_col_norms_min: 2.9565500866272743
valid_y_max_max_class: 0.954072614170507
valid_y_mean_max_class: 0.7400570764784135
valid_y_min_max_class: 0.5075105074361135
valid_y_misclass: 0.2924738219895288
valid_y_nll: 0.5702870191282428
valid_y_row_norms_max: 0.8357983656336915
valid_y_row_norms_mean: 0.1421029346062117
valid_y_row_norms_min: 0.0013194672206367525
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.085000 seconds
Time this epoch: 44.780000 seconds
Monitoring step:
  Epochs seen: 28
  Batches seen: 38528
  Examples seen: 3850224
  learning_rate: 0.07202799999999937
  momentum: 0.39090909090909487
  total_seconds_last_epoch: 82.085000000000075
  train_h0_col_norms_max: 0.7500000000000019
  train_h0_col_norms_mean: 0.7450279349207543
  train_h0_col_norms_min: 0.7053431469466741
  train_h0_max_x_max_u: 1.106628481941089
  train_h0_max_x_mean_u: 0.2527403667533255
  train_h0_max_x_min_u: 0.0
  train_h0_mean_x_max_u: 0.2562380218492528
  train_h0_mean_x_mean_u: 0.023102454812973936
  train_h0_mean_x_min_u: 0.0
  train_h0_min_x_max_u: 0.015091105736545362
  train_h0_min_x_mean_u: 0.00017725354571365855
  train_h0_min_x_min_u: 0.0
  train_h0_range_x_max_u: 1.1043325020733348
  train_h0_range_x_mean_u: 0.25256311320761177
  train_h0_range_x_min_u: 0.0
  train_h0_row_norms_max: 0.6368854195200562
  train_h0_row_norms_mean: 0.4748220959284282
  train_h0_row_norms_min: 0.3976153707820216
  train_h1_col_norms_max: 0.7500000000000019
  train_h1_col_norms_mean: 0.7482073616216096
  train_h1_col_norms_min: 0.7268074610373982
  train_h1_max_x_max_u: 0.6624907145442238
  train_h1_max_x_mean_u: 0.10424913066367515
  train_h1_max_x_min_u: 0.0
  train_h1_mean_x_max_u: 0.2074732135122007
  train_h1_mean_x_mean_u: 0.01645104488047852
  train_h1_mean_x_min_u: 0.0
  train_h1_min_x_max_u: 0.028032184413592447
  train_h1_min_x_mean_u: 0.00041642313932244455
  train_h1_min_x_min_u: 0.0
  train_h1_range_x_max_u: 0.6536295069429525
  train_h1_range_x_mean_u: 0.10383270752435265

```

train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 0.9995371879299707  
train\_h1\_row\_norms\_mean: 0.7434590531951832  
train\_h1\_row\_norms\_min: 0.49494803943759186  
train\_h2\_col\_norms\_max: 0.7500000000000019  
train\_h2\_col\_norms\_mean: 0.7490165392527433  
train\_h2\_col\_norms\_min: 0.7374589106582602  
train\_h2\_max\_x\_max\_u: 0.7117130588882323  
train\_h2\_max\_x\_mean\_u: 0.07376432034183314  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.252491901273383  
train\_h2\_mean\_x\_mean\_u: 0.02108243567549063  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.10464178883377649  
train\_h2\_min\_x\_mean\_u: 0.002400681518906713  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.6818284948760236  
train\_h2\_range\_x\_mean\_u: 0.07136363882292637  
train\_h2\_range\_x\_min\_u: 0.0  
train\_h2\_row\_norms\_max: 1.2008602322351596  
train\_h2\_row\_norms\_mean: 0.7365004171033454  
train\_h2\_row\_norms\_min: 0.38771405946525767  
train\_objective: 0.4300292983356342  
train\_y\_col\_norms\_max: 2.977728055885  
train\_y\_col\_norms\_mean: 2.977728055885  
train\_y\_col\_norms\_min: 2.977728055885  
train\_y\_max\_max\_class: 0.9771735631819078  
train\_y\_mean\_max\_class: 0.8160470890694457  
train\_y\_min\_max\_class: 0.5505949026374226  
train\_y\_misclass: 0.16503039823137564  
train\_y\_nll: 0.3428134585532348  
train\_y\_row\_norms\_max: 0.8397301209486512  
train\_y\_row\_norms\_mean: 0.1429071369420164  
train\_y\_row\_norms\_min: 0.0002897230346059847  
training\_seconds\_this\_epoch: 44.780000000000006  
valid\_h0\_col\_norms\_max: 0.7499999999999996  
valid\_h0\_col\_norms\_mean: 0.7450279349207407  
valid\_h0\_col\_norms\_min: 0.7053431469466871  
valid\_h0\_max\_x\_max\_u: 1.3603896947239615  
valid\_h0\_max\_x\_mean\_u: 0.20669440391356023  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.5443543169524858  
valid\_h0\_mean\_x\_mean\_u: 0.03789370739352229  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.13692222145428987  
valid\_h0\_min\_x\_mean\_u: 0.0016123769147839103  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.3417235501317937  
valid\_h0\_range\_x\_mean\_u: 0.20508202699877626  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0\_row\_norms\_max: 0.6368854195200695  
valid\_h0\_row\_norms\_mean: 0.47482209592841873  
valid\_h0\_row\_norms\_min: 0.3976153707820142  
valid\_h1\_col\_norms\_max: 0.7499999999999996

```
valid_h1.col_norms_mean: 0.7482073616216138
valid_h1.col_norms_min: 0.7268074610374117
valid_h1.max_x_max_u: 0.943322492449595
valid_h1.max_x_mean_u: 0.11792392385884548
valid_h1.max_x_min_u: 0.0
valid_h1.mean_x_max_u: 0.43297166784953534
valid_h1.mean_x_mean_u: 0.03268398434294677
valid_h1.mean_x_min_u: 0.0
valid_h1.min_x_max_u: 0.15584290657891708
valid_h1.min_x_mean_u: 0.0032296796917029246
valid_h1.min_x_min_u: 0.0
valid_h1.range_x_max_u: 0.8596103390408605
valid_h1.range_x_mean_u: 0.11469424416714256
valid_h1.range_x_min_u: 0.0
valid_h1.row_norms_max: 0.9995371879299536
valid_h1.row_norms_mean: 0.7434590531951668
valid_h1.row_norms_min: 0.49494803943760485
valid_h2.col_norms_max: 0.7499999999999996
valid_h2.col_norms_mean: 0.7490165392527307
valid_h2.col_norms_min: 0.7374589106582392
valid_h2.max_x_max_u: 1.1565212273523722
valid_h2.max_x_mean_u: 0.08466347814493874
valid_h2.max_x_min_u: 0.0
valid_h2.mean_x_max_u: 0.40803146203743546
valid_h2.mean_x_mean_u: 0.025101545621961305
valid_h2.mean_x_min_u: 0.0
valid_h2.min_x_max_u: 0.13120759256973538
valid_h2.min_x_mean_u: 0.0023208719309226666
valid_h2.min_x_min_u: 0.0
valid_h2.range_x_max_u: 1.1323792394276853
valid_h2.range_x_mean_u: 0.08234260621401607
valid_h2.range_x_min_u: 0.0
valid_h2.row_norms_max: 1.2008602322351472
valid_h2.row_norms_mean: 0.7365004171033375
valid_h2.row_norms_min: 0.3877140594652628
valid_objective: 0.7373423527809264
valid_y.col_norms_max: 2.9777280558849983
valid_y.col_norms_mean: 2.9777280558849983
valid_y.col_norms_min: 2.9777280558849983
valid_y.max_max_class: 0.9655763057225265
valid_y.mean_max_class: 0.7773413687782061
valid_y.min_max_class: 0.5133522390386048
valid_y.misclass: 0.25634816753926704
valid_y.nll: 0.5285494338287513
valid_y.row_norms_max: 0.8397301209486763
valid_y.row_norms_mean: 0.14290713694201415
valid_y.row_norms_min: 0.0002897230346059851
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.085000 seconds
Time this epoch: 44.820000 seconds
Monitoring step:
  Epochs seen: 29
  Batches seen: 39904
  Examples seen: 3987732
```

learning\_rate: 0.07102900000000051  
momentum: 0.3868686868686799  
total\_seconds\_last\_epoch: 81.95000000000142  
train\_h0\_col\_norms\_max: 0.750000000000019  
train\_h0\_col\_norms\_mean: 0.745321533041024  
train\_h0\_col\_norms\_min: 0.7151222369247011  
train\_h0\_max\_x\_max\_u: 1.130807256696254  
train\_h0\_max\_x\_mean\_u: 0.2538628881508954  
train\_h0\_max\_x\_min\_u: 0.0  
train\_h0\_mean\_x\_max\_u: 0.29371662945077825  
train\_h0\_mean\_x\_mean\_u: 0.022933703895878173  
train\_h0\_mean\_x\_min\_u: 0.0  
train\_h0\_min\_x\_max\_u: 0.01794726137890321  
train\_h0\_min\_x\_mean\_u: 0.0002204680998117382  
train\_h0\_min\_x\_min\_u: 0.0  
train\_h0\_range\_x\_max\_u: 1.124501584405856  
train\_h0\_range\_x\_mean\_u: 0.2536424200510835  
train\_h0\_range\_x\_min\_u: 0.0  
train\_h0\_row\_norms\_max: 0.6395788940485414  
train\_h0\_row\_norms\_mean: 0.4750522810164371  
train\_h0\_row\_norms\_min: 0.40077036507279656  
train\_h1\_col\_norms\_max: 0.750000000000019  
train\_h1\_col\_norms\_mean: 0.7482900120063338  
train\_h1\_col\_norms\_min: 0.7247944177271728  
train\_h1\_max\_x\_max\_u: 0.651339115786698  
train\_h1\_max\_x\_mean\_u: 0.10530755690510862  
train\_h1\_max\_x\_min\_u: 0.0  
train\_h1\_mean\_x\_max\_u: 0.1975688805415476  
train\_h1\_mean\_x\_mean\_u: 0.017287961668382836  
train\_h1\_mean\_x\_min\_u: 0.0  
train\_h1\_min\_x\_max\_u: 0.02295301136106301  
train\_h1\_min\_x\_mean\_u: 0.0004464413300134079  
train\_h1\_min\_x\_min\_u: 0.0  
train\_h1\_range\_x\_max\_u: 0.6457502816017926  
train\_h1\_range\_x\_mean\_u: 0.10486111557509525  
train\_h1\_range\_x\_min\_u: 0.0  
train\_h1\_row\_norms\_max: 1.0061489240807502  
train\_h1\_row\_norms\_mean: 0.7436239587530834  
train\_h1\_row\_norms\_min: 0.4925976253411488  
train\_h2\_col\_norms\_max: 0.750000000000019  
train\_h2\_col\_norms\_mean: 0.7490222637223029  
train\_h2\_col\_norms\_min: 0.7373125888585071  
train\_h2\_max\_x\_max\_u: 0.740344013126818  
train\_h2\_max\_x\_mean\_u: 0.07413574913097452  
train\_h2\_max\_x\_min\_u: 0.0  
train\_h2\_mean\_x\_max\_u: 0.26148333477288016  
train\_h2\_mean\_x\_mean\_u: 0.02103884249261169  
train\_h2\_mean\_x\_min\_u: 0.0  
train\_h2\_min\_x\_max\_u: 0.10059750021441084  
train\_h2\_min\_x\_mean\_u: 0.0025892038732892773  
train\_h2\_min\_x\_min\_u: 0.0  
train\_h2\_range\_x\_max\_u: 0.7124244501679989  
train\_h2\_range\_x\_mean\_u: 0.07154654525768524  
train\_h2\_range\_x\_min\_u: 0.0

train\_h2.row\_norms\_max: 1.2016178230500274  
train\_h2.row\_norms\_mean: 0.7364823256647501  
train\_h2.row\_norms\_min: 0.37960579811773093  
train\_objective: 0.4256967335789694  
train\_y.col\_norms\_max: 3.003954746845179  
train\_y.col\_norms\_mean: 3.003954746845179  
train\_y.col\_norms\_min: 3.003954746845179  
train\_y\_max\_max\_class: 0.9820250226242004  
train\_y\_mean\_max\_class: 0.8317273411756423  
train\_y\_min\_max\_class: 0.553259073026517  
train\_y\_misclass: 0.17815690723448813  
train\_y\_nll: 0.35916659864057965  
train\_y.row\_norms\_max: 0.8441080119509662  
train\_y.row\_norms\_mean: 0.14448775435190944  
train\_y.row\_norms\_min: 0.0016268971302354587  
training\_seconds\_this\_epoch: 44.820000000000082  
valid\_h0.col\_norms\_max: 0.7500000000000003  
valid\_h0.col\_norms\_mean: 0.7453215330410402  
valid\_h0.col\_norms\_min: 0.7151222369246991  
valid\_h0\_max\_x\_max\_u: 1.3526485953421545  
valid\_h0\_max\_x\_mean\_u: 0.21191076421702668  
valid\_h0\_max\_x\_min\_u: 0.0  
valid\_h0\_mean\_x\_max\_u: 0.6235899227076337  
valid\_h0\_mean\_x\_mean\_u: 0.037641720261993666  
valid\_h0\_mean\_x\_min\_u: 0.0  
valid\_h0\_min\_x\_max\_u: 0.17758302037986337  
valid\_h0\_min\_x\_mean\_u: 0.0019914844936375613  
valid\_h0\_min\_x\_min\_u: 0.0  
valid\_h0\_range\_x\_max\_u: 1.3191183030835367  
valid\_h0\_range\_x\_mean\_u: 0.20991927972338925  
valid\_h0\_range\_x\_min\_u: 0.0  
valid\_h0.row\_norms\_max: 0.6395788940485478  
valid\_h0.row\_norms\_mean: 0.4750522810164327  
valid\_h0.row\_norms\_min: 0.40077036507278224  
valid\_h1.col\_norms\_max: 0.7499999999999996  
valid\_h1.col\_norms\_mean: 0.7482900120063435  
valid\_h1.col\_norms\_min: 0.724794417727157  
valid\_h1\_max\_x\_max\_u: 0.8624729060842429  
valid\_h1\_max\_x\_mean\_u: 0.11235227269788028  
valid\_h1\_max\_x\_min\_u: 0.0  
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valid\_h1\_mean\_x\_mean\_u: 0.032357754392385335  
valid\_h1\_mean\_x\_min\_u: 0.0  
valid\_h1\_min\_x\_max\_u: 0.1456853890024264  
valid\_h1\_min\_x\_mean\_u: 0.003563982274668677  
valid\_h1\_min\_x\_min\_u: 0.0  
valid\_h1\_range\_x\_max\_u: 0.8158278759967152  
valid\_h1\_range\_x\_mean\_u: 0.10878829042321163  
valid\_h1\_range\_x\_min\_u: 0.0  
valid\_h1.row\_norms\_max: 1.0061489240807717  
valid\_h1.row\_norms\_mean: 0.7436239587530973  
valid\_h1.row\_norms\_min: 0.4925976253411668  
valid\_h2.col\_norms\_max: 0.7499999999999996  
valid\_h2.col\_norms\_mean: 0.7490222637222912

```

valid_h2.col_norms_min: 0.7373125888585185
valid_h2.max_x_max_u: 1.1546451403663172
valid_h2.max_x_mean_u: 0.07743340587611712
valid_h2.max_x_min_u: 0.0
valid_h2.mean_x_max_u: 0.41443539904501053
valid_h2.mean_x_mean_u: 0.022532123560119462
valid_h2.mean_x_min_u: 0.0
valid_h2.min_x_max_u: 0.08677423636027333
valid_h2.min_x_mean_u: 0.001551222352779785
valid_h2.min_x_min_u: 0.0
valid_h2.range_x_max_u: 1.1269075130342918
valid_h2.range_x_mean_u: 0.07588218352333737
valid_h2.range_x_min_u: 0.0
valid_h2.row_norms_max: 1.2016178230500083
valid_h2.row_norms_mean: 0.7364823256647572
valid_h2.row_norms_min: 0.3796057981177426
valid_objective: 0.650811874073991
valid_y.col_norms_max: 3.0039547468451495
valid_y.col_norms_mean: 3.0039547468451495
valid_y.col_norms_min: 3.0039547468451495
valid_y.max_max_class: 0.9679062056557178
valid_y.mean_max_class: 0.7821364913973372
valid_y.min_max_class: 0.5108930844052895
valid_y.misclass: 0.27061518324607325
valid_y.nll: 0.5508742914575565
valid_y.row_norms_max: 0.8441080119509862
valid_y.row_norms_mean: 0.1444877543519076
valid_y.row_norms_min: 0.0016268971302354968
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.085000 seconds
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl...
Saving to ..\Sean\nn_files_S4C4R20\nn_train.pkl done. Time elapsed: 0.085000 seconds

```

## 9 Training Results

Here we show the results of each of the training runs, plotting the metrics computed by Pylearn2 during the training.

```

In [46]: def plot_results(scr):
    save_file = os.path.join(output_dir, "nn_train.pkl").format(
        slope=scr.slope, crater=scr.crater, roughness=scr.roughness
    )
    model = serial.load(save_file)
    channels = model.monitor.channels

    arg_min = np.argmin(channels['valid_y_misclass'].val_record)
    x_min = channels['valid_y_misclass'].example_record[arg_min]

    ax = plt.subplot()
    ax.plot(channels['train_y_nll'].example_record, channels['train_y_nll'].val_record,
            label='Train', lw=2)
    ax.plot(channels['valid_y_nll'].example_record, channels['valid_y_nll'].val_record,
            label='Validation', lw=2)
    ax.set_xlabel('Examples Seen')

```

```

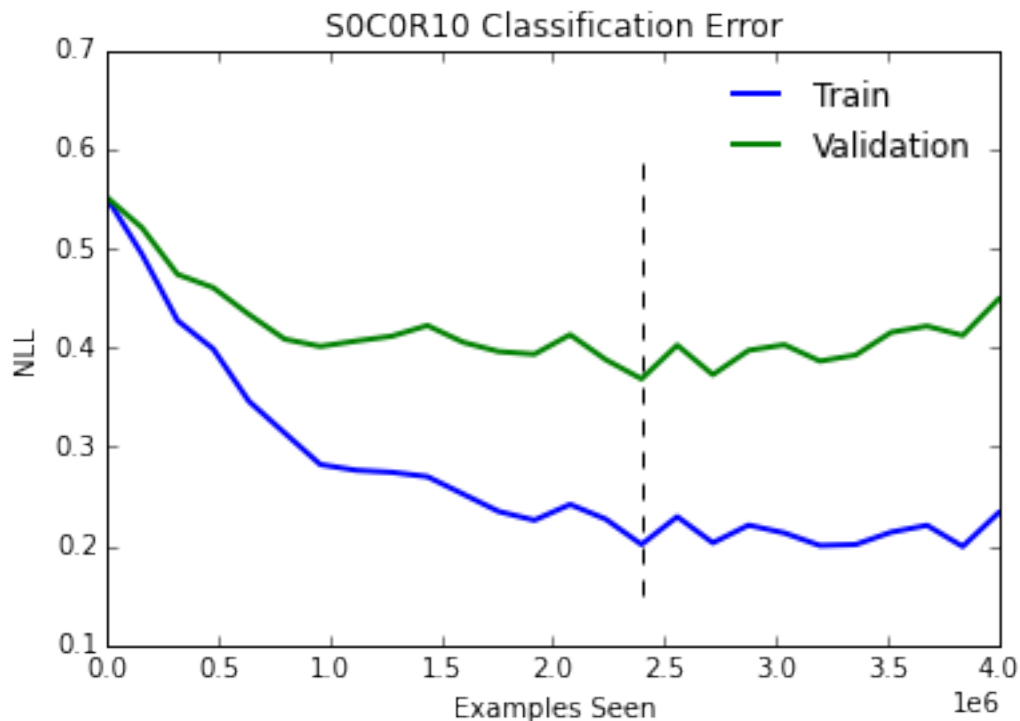
ax.set_ylabel('NLL')
ax.set_title('S{slope}C{crater}R{roughness} Classification Error'.format(
    slope=scr.slope, crater=scr.crater, roughness=scr.roughness
))
plt.legend().draw_frame(False)
plt.ticklabel_format(style='sci', axis='x', scilimits=(0,0))
ax.plot([x_min, x_min], ax.get_ylim(), 'k--')
plt.show()
plt.close()

ax = plt.subplot()
ax.plot(channels['train_y_misclass'].example_record, channels['train_y_misclass'].val_record,
        label='Train', lw=2)
ax.plot(channels['valid_y_misclass'].example_record, channels['valid_y_misclass'].val_record,
        label='Validation', lw=2)
ax.set_xlabel('Examples Seen')
ax.set_ylabel('Misclassification Rate')
ax.set_title('S{slope}C{crater}R{roughness} Misclassification'.format(
    slope=scr.slope, crater=scr.crater, roughness=scr.roughness
))
plt.legend().draw_frame(False)
plt.ticklabel_format(style='sci', axis='x', scilimits=(0,0))
ax.plot([x_min, x_min], ax.get_ylim(), 'k--')
plt.show()
plt.close()

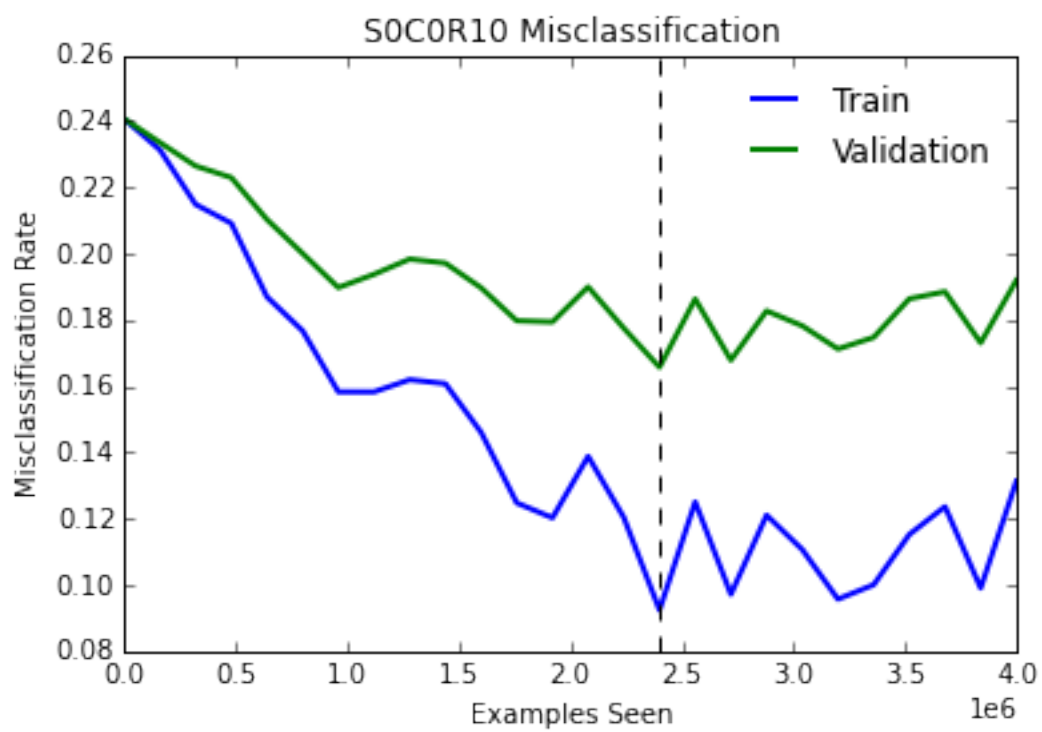
```

## 9.1 S0 C0 R10

In [47]: plot\_results(diffs[0])

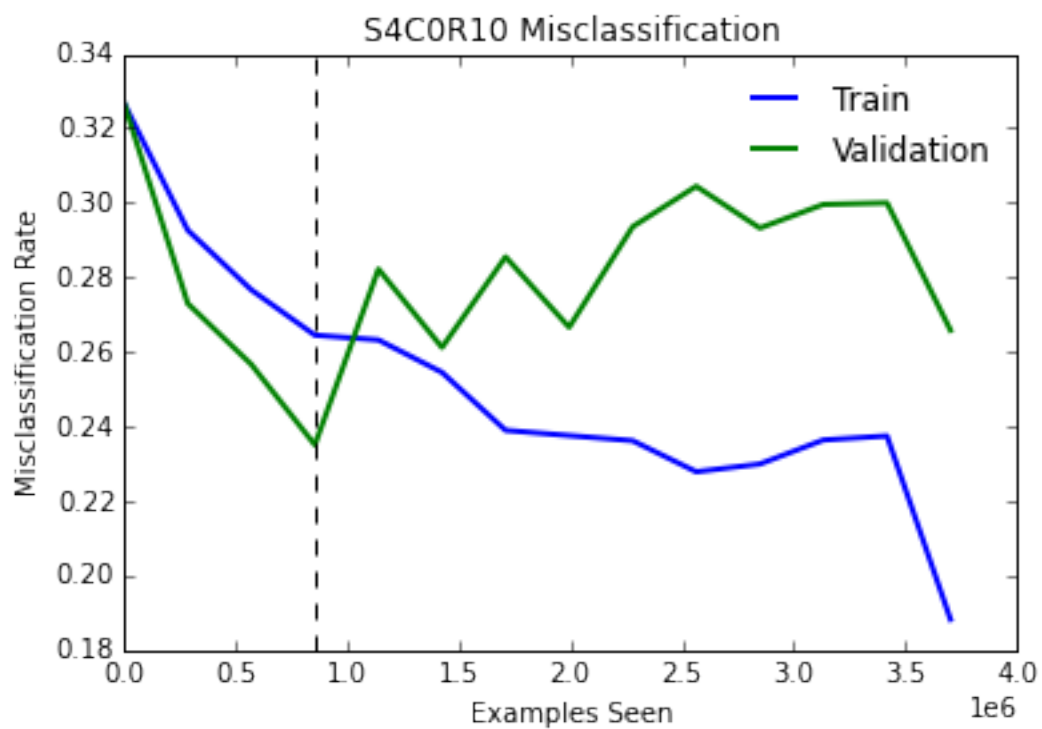
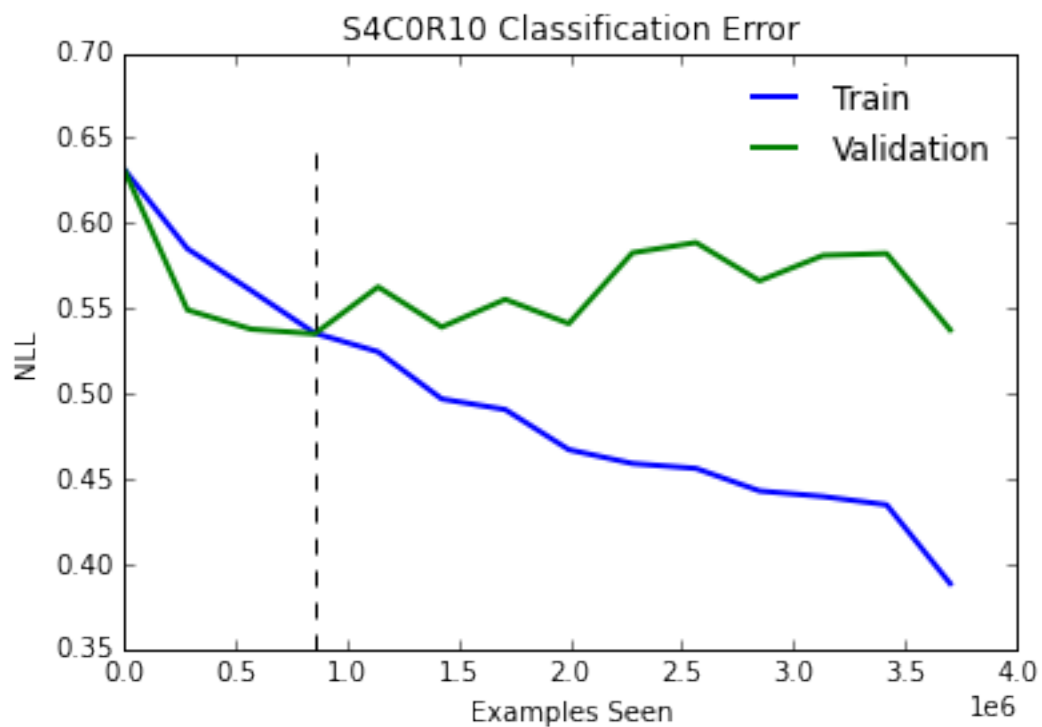






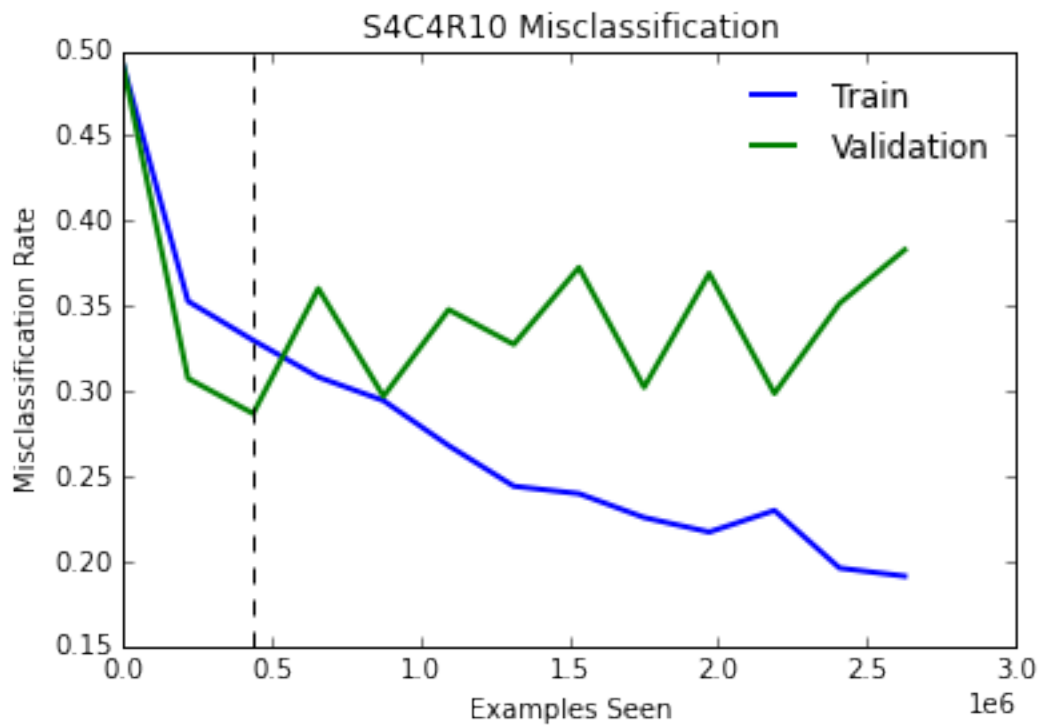
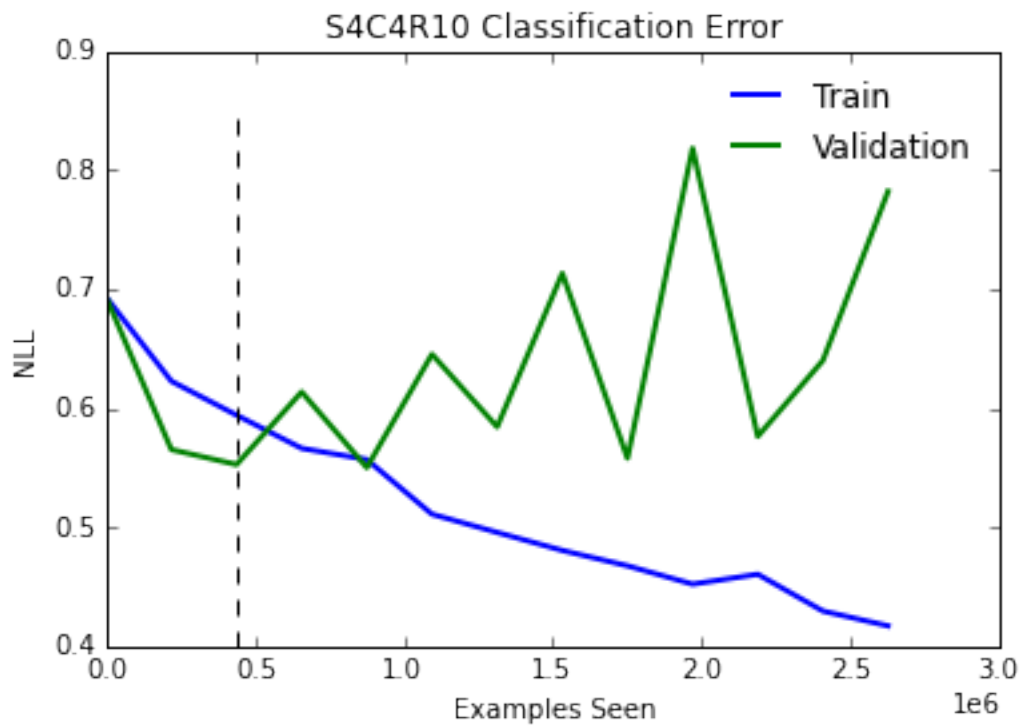
## 9.2 S4 C0 R10

In [120]: `plot_results(diffs[1])`



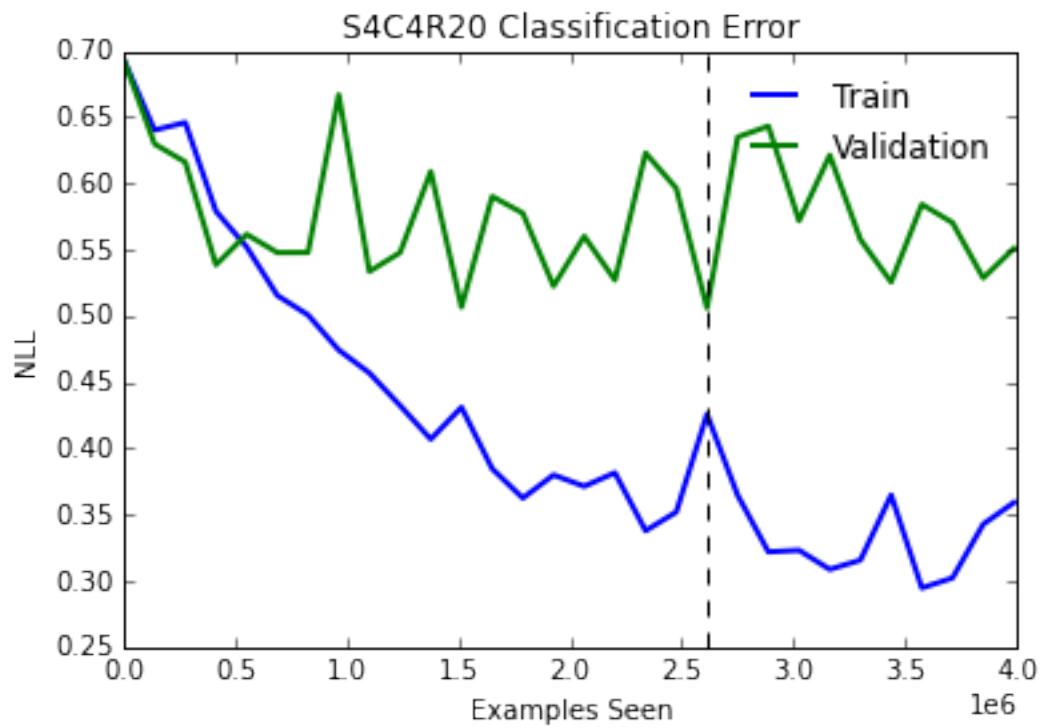
### 9.3 S4 C4 R10

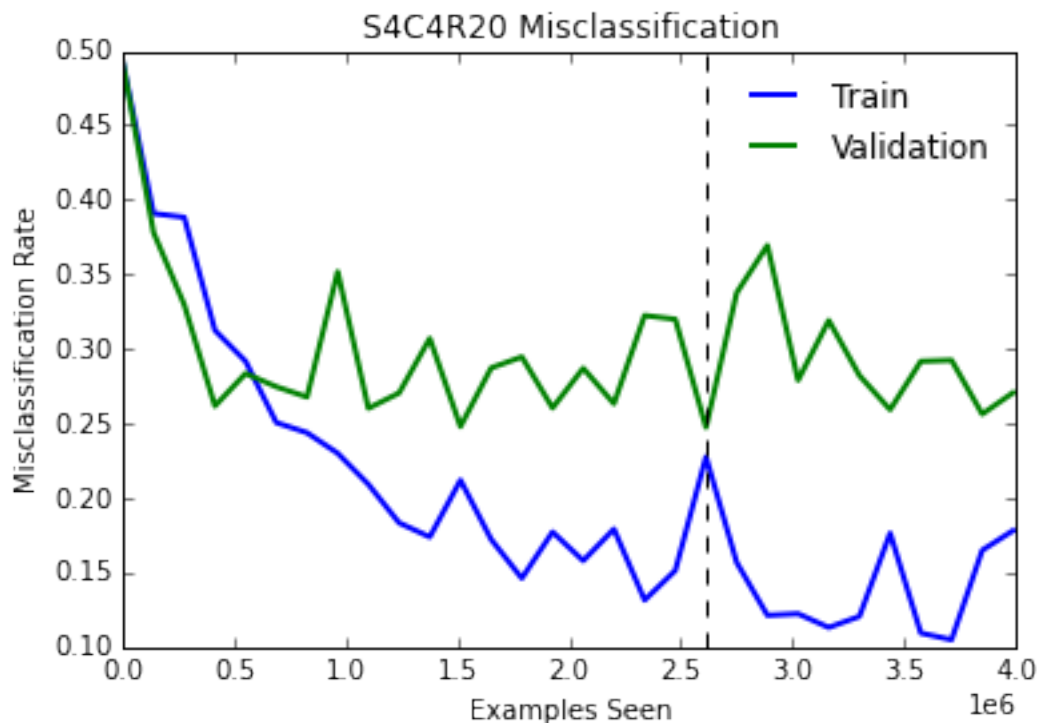
In [121]: plot\_results(diffs[2])



## 9.4 S4 C4 R20

In [122]: plot\_results(diffs[3])





## 10 Training performance

Here, we give the output for each of the different examples that are provided, and analyze the performance of the algorithm to predict the correct locations. Unfortunately, we don't have a separate set of labeled test data to check our algorithm against.

```
In [128]: def fwd_nn(scr, X):
    save_file = os.path.join(output_dir, "nn_train_best.pkl").format(**scr._asdict())
    model = serial.load(save_file)

    b = []
    w = []
    for i, layer in enumerate(model.layers):
        bias = layer.b.get_value().astype(np.float32)
        try:
            # RectifiedLinear uses transformer
            weights = layer.transformer.get_params()[0].get_value().astype(np.float32)
        except AttributeError:
            # Softmax uses W
            weights = layer.W.get_value().astype(np.float32)
        b.append(bias)
        w.append(weights)

    # Run through the net

    # RegularizedLinear 1
```

```

X = np.dot(X, w[0])
X += b[0]
X[X < 0] = 0

# RegularizedLinear 2
X = np.dot(X, w[1])
X += b[1]
X[X < 0] = 0

# RegularizedLinear 3
X = np.dot(X, w[2])
X += b[2]
X[X < 0] = 0

# Softmax
X = np.dot(X, w[3])
X += b[3]
X = X.argmax(axis=1)

return X

def solve(scr):
    # Read in the data and make a value for outputs
    #height = read_raw(raw_file.format(**scr._asdict()), height_rows, height_cols)
    # Read in the image (needed for input to NN)
    image = read_pgm(pgm_file.format(**scr._asdict()))
    # Read in the solution
    soln = read_pgm(soln_file.format(**scr._asdict()))
    # Read in the preprocessed input
    preproc = read_pgm(preprocessing_pgm.format(**scr._asdict()))

    # Determine number that need to feed into net
    n_input = np.sum(preproc == UNKNOWN)
    # and allocate an array for it
    df_input = np.empty((n_input, nn_feat), dtype=np.float32)

    row, col = np.indices((soln.shape))
    # Populate each array
    sel = (preproc == UNKNOWN)
    rows, cols = row[sel].flatten(), col[sel].flatten()
    for n, (i, j) in enumerate(zip(rows, cols)):
        df_input[n, :] = image[i-nn_window//2-1:i+nn_window//2,
                               j-nn_window//2-1:j+nn_window//2].flatten()

    # Normalize output
    df_input = (df_input - 159) / 256

    # Run it through the net
    df_output = ffwd_nn(scr, df_input)
    # and put the solution in for the unknown values
    preproc[sel] = df_output * 0xff

    # Determine how well the net did
    perf = np.sum(df_output * 0xff == soln[sel]) / df_output.shape[0]

```

```

print("Net Accuracy:      {:.1%}".format(perf))

# write out the solved pgm
write_pgm(preproc, final_pgm.format(**scr._asdict()))

# write out the comparison png file
cmp_file = os.path.join(output_dir, "final.png").format(**scr._asdict())
compare_output(preproc, soln, cmp_file)

```

## 10.1 S0 C0 R10

In [129]: solve(diffs[0])

```

Net Accuracy:      90.0%
Accuracy:          98.2%
F1 (safe):         0.99
F1 (unsafe):       0.95

```

Safe classification accuracy: 100.0% (805592 / 805896)

Unsafe classification accuracy: 91.0% (176683 / 194104)

Compare to winning team:

```

Accuracy:          98.28%
F1:                0.99

```

## 10.2 S4 C0 R10

In [130]: solve(diffs[1])

```

Net Accuracy:      73.8%
Accuracy:          91.2%
F1 (safe):         0.83
F1 (unsafe):       0.94

```

Safe classification accuracy: 96.6% (210748 / 218182)

Unsafe classification accuracy: 89.7% (701380 / 781818)

Compare to winning team:

```

Accuracy:          96.74%
F1:                0.94

```

## 10.3 S4 C4 R10

In [131]: solve(diffs[2])

```

Net Accuracy:      67.4%
Accuracy:          91.6%
F1 (safe):         0.70
F1 (unsafe):       0.95

```

Safe classification accuracy: 77.7% (96636 / 124352)

Unsafe classification accuracy: 93.6% (819547 / 875648)

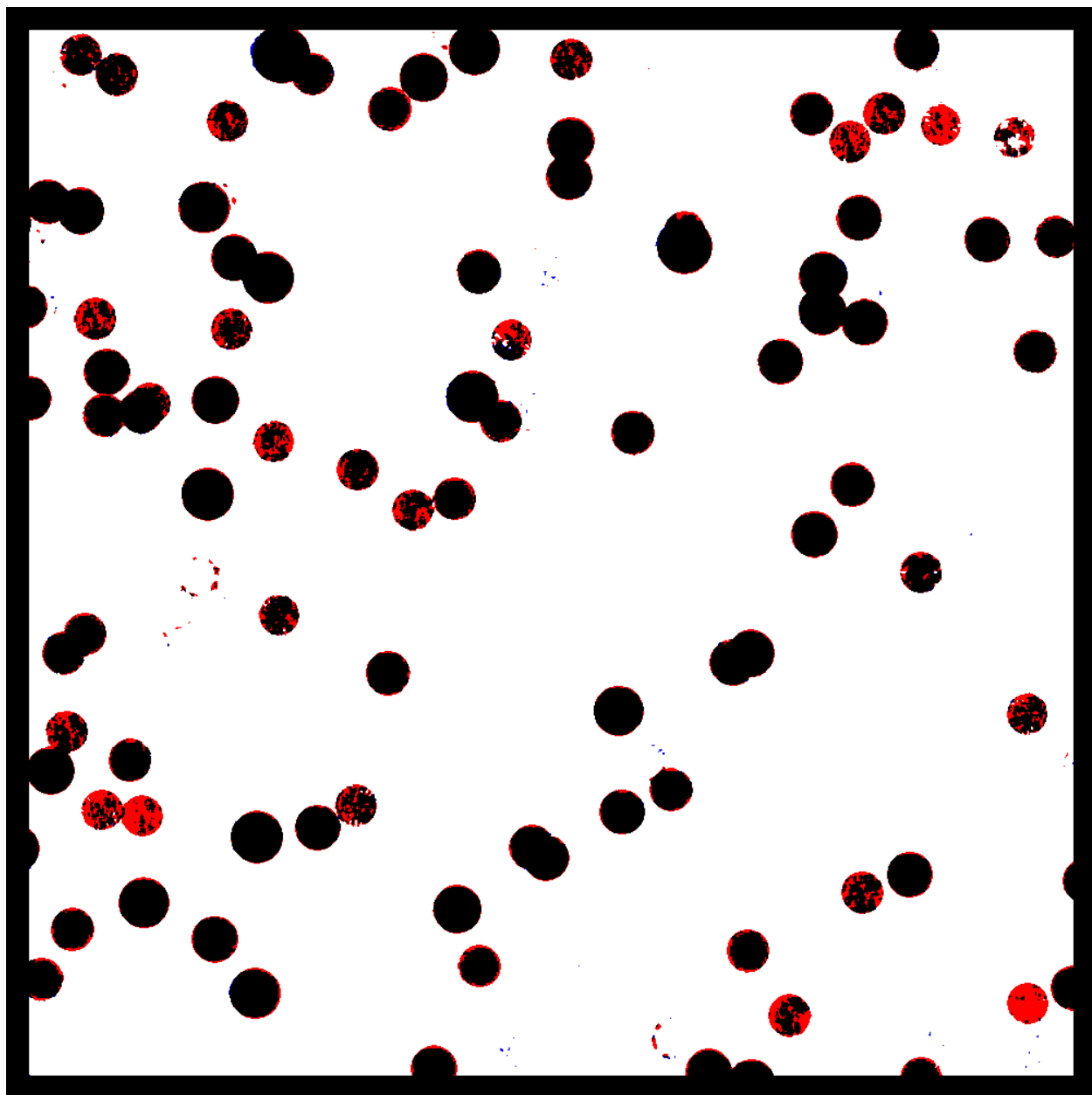


Figure 9:



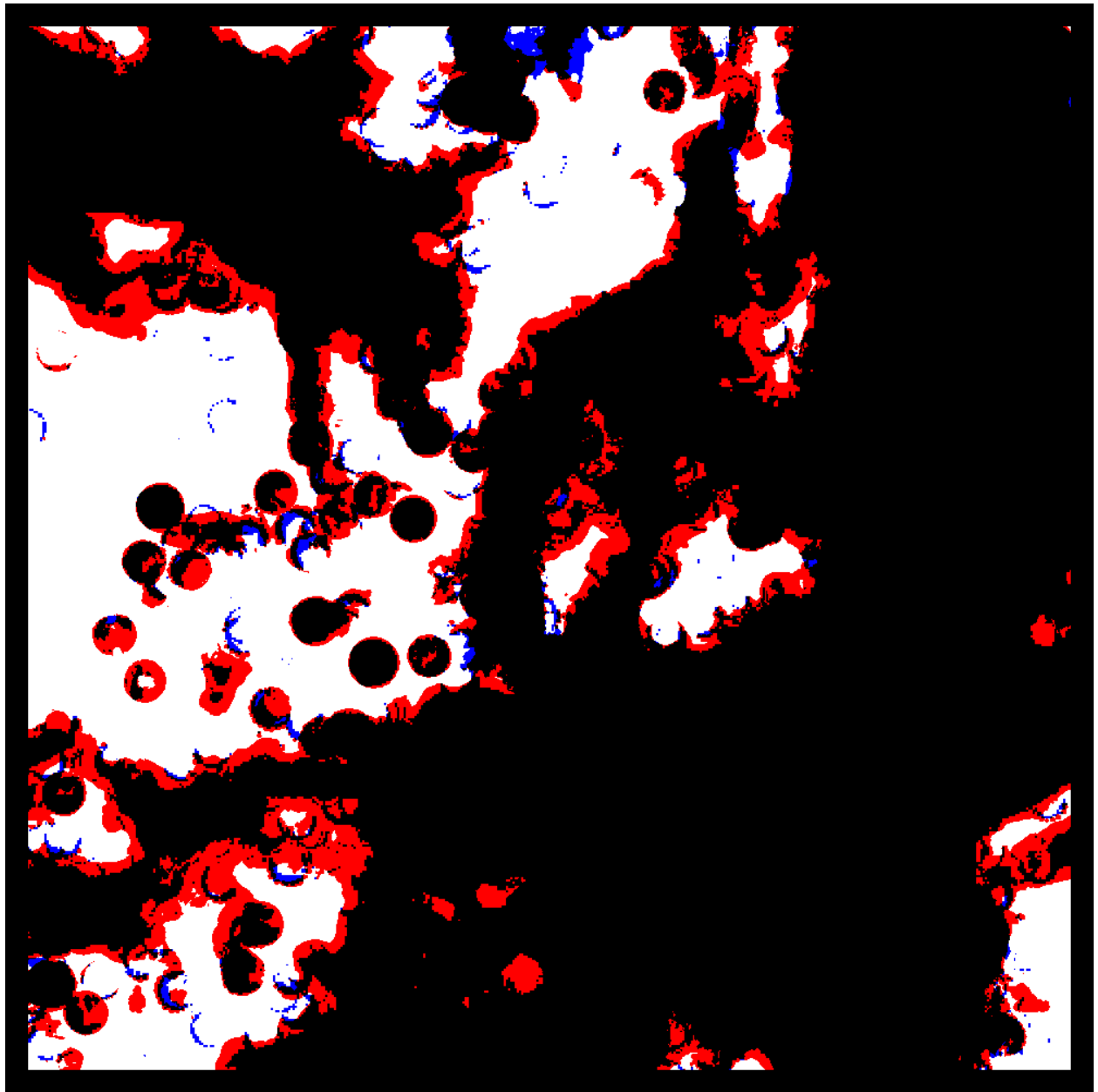


Figure 10:

Compare to winning team:

Accuracy:	96.78%
F1:	0.8819

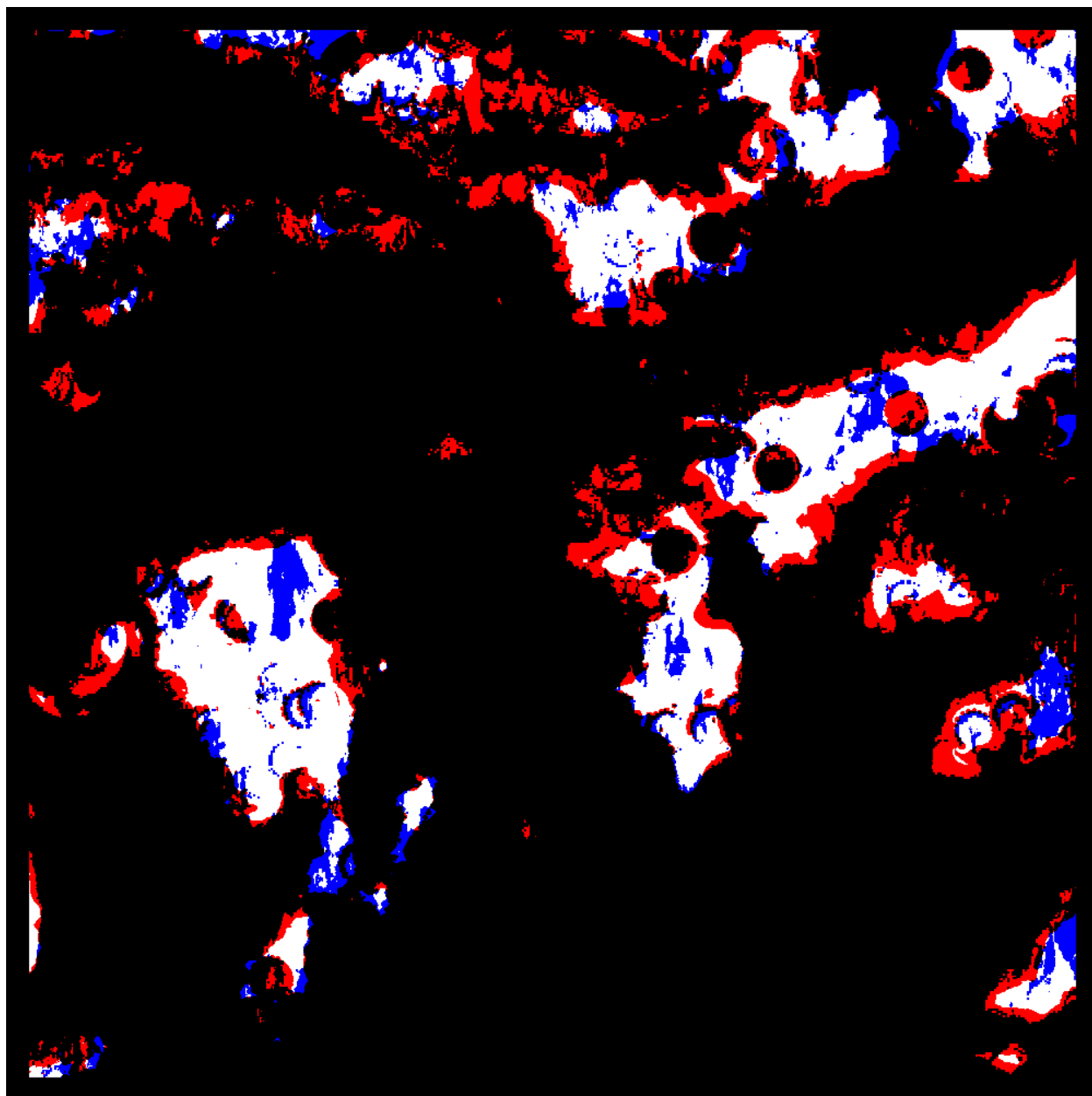


Figure 11:

## 10.4 S4 C4 R20

```
In [132]: solve(diffs[3])
```

Net Accuracy:	77.0%
Accuracy:	95.6%

F1 (safe): 0.77  
F1 (unsafe): 0.98

Safe classification accuracy: 87.1% (75313 / 86465)  
Unsafe classification accuracy: 96.4% (880783 / 913535)

**Compare to winning team:**

Accuracy: 96.50%  
F1: 0.81

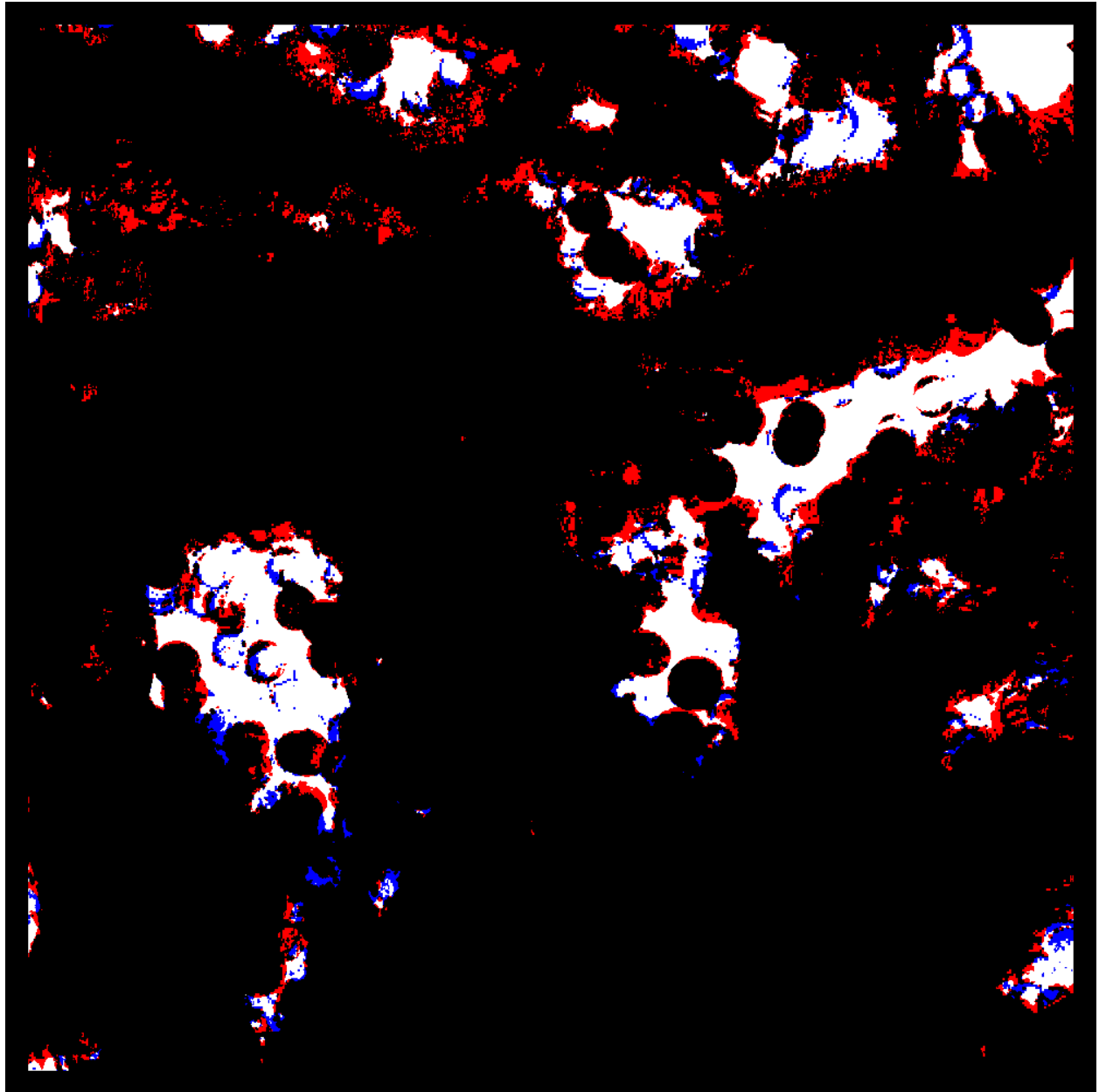


Figure 12: