

AI in Schools – Unplugged Activity

Forward Propagation

| Instructions |
|---|
| Arrange the class as shown in figure 1 |
| Explain that there is the input layer, the hidden layers in the middle and the output layer. Each neuron looks for a particular feature, a fixed shape or pattern. Each layer is going to be looking for more complex patterns of features. Such neurons are called feature detectors. |
| Program/train each pupil (neuron) in each layer with their features to detect (I.e. Nose, Eyes etc). Do this by giving all the pupils the appropriate cards as per figure 2 - these cards are provided in the unplugged folder. |
| We input the data to the network – layer 1. The teacher (layer 1) stands at the front and shows the input image(s) (only pupils/neurons in layer 2 are to act upon what they are shown and they turn their card over/show their card and shout “fire or bingo” if they have been “programmed”/“trained” with any of the features from the teacher’s image. (This stage means the input image features are separated, broken down and each is now a picture somewhere on layer 2). |
| After the pupils in layer 2 have identified the feature they are looking for they turn around in turn one at a time and show their cards to layer 3 pupils/neurons |
| Layer three pupils then identify which of the individual features shown by the layer 2 pupils they are looking for and if they have them they turn the cards over and shout “fire/bingo”. For example, layer 2 pupils show a card of two open eyes and a nose, and the layer 3 pupil is detecting two open eyes and a nose, the layer 3 pupil shouts “fire/bingo” |
| After each pupil in layer 3 has identified all the features they are looking for, layer 3 pupils turn around in turn and show their cards of their detected features to layer 4 pupils/neurons |
| Layer 4 pupils then identify which features they are looking for if they are a happy face they will shout “fire/bingo – Happy Face” and if they are a “Sad face” they will shout “fire/bingo – Sad Face” |
| Layer 4 pupils will then have either a Sad face, Happy Face or No Face. If they have Happy Face or a Sad face they are to pass these to Layer 5 which is the output layer. The process that the pupils would have completed is forward propagation through the network. |

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Figure 1:

** The yellow shaded columns are included here as a guide to remind the teacher what each layer is called. This naming needs to be pointed out to pupils as they are arranged. If your class is larger than 17 pupils, then have other pupils, stand around and observe what is going on through the neural network, their job will be to feedback what they have seen. Use the supporting notes in the teacher's PowerPoint for questions to ask the pupils during the unplugged activity.



| | |
|------------------------|---|
| Layer 1 Input Layer | <ul style="list-style-type: none"> Teacher or another pupil is to show layer 2 pupils each card individually |
|------------------------|---|

| | | | | | |
|-------------------------|-----------|-----------|-----------|------------------|---------------|
| Layer 2 Hidden Layer | Eyes E | Nose N | Hair H | Smiley Face U | Sad Face S |
|-------------------------|-----------|-----------|-----------|------------------|---------------|

Layer 1 is looking for 1 feature

| | | | | | | |
|-------------------------|------------------------|---------------------------|-------------------|-------------------|--|---------------------------|
| Layer 3 Hidden Layer | Hair + Sad mouth HS | Eyes + Smiley mouth EU | Hair + Eyes HE | Eyes + Nose EN | Sad Mouth + Smiley Mouth + Nose SUN | Nose + Smiley Mouth NU |
|-------------------------|------------------------|---------------------------|-------------------|-------------------|--|---------------------------|

Layer 3 is looking for up to 3 features

| | | | | |
|-------------------------|--|---|--|--|
| Layer 4 Hidden Layer | Hair + Eyes + Nose + Sad Mouth HENS | Hair + Eyes + Nose + Smiley Mouth HENU | Hair + Eyes + Smiley Mouth + Sad Mouth HEUS | Eyes + Nose + Smiley Mouth + Sad Mouth ENUS |
|-------------------------|--|---|--|--|

SAD FACE

HAPPY FACE

NO FACE

NO FACE

Layer 4 is looking for 4+ features

| | | |
|-------------------------|------------------------|------------------------|
| Layer 5 Output Layer | Smiley/Happy Face U | Sad/Frowning Face S |
|-------------------------|------------------------|------------------------|

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Figure 2:

** In the activity each of these squares will represent a card (excluded the yellow squares, the yellow is purely to remind the teacher which layers are being worked with so that this can be explained to the pupils).

| | |
|------------------------|---|
| Layer 1 Input Layer | Input Layer <ul style="list-style-type: none"> Teacher or another pupil is to show layer 2 pupils each card individually |
|------------------------|---|

| | | | | | |
|-------------------------|----------|-----------|-----------|------------------|---------------|
| Layer 2 Hidden Layer | Eye E | Nose N | Hair H | Smiley Face U | Sad Face S |
|-------------------------|----------|-----------|-----------|------------------|---------------|

Layer 1 is looking for 1 feature

| | | | | | | |
|-------------------------|-----------------------|--------------------------|-------------------|-------------------|--------------------------------------|--------------------------|
| Layer 3 Hidden Layer | Hair + Sad Face HS | Eyes + Smiley Face EU | Hair + Eyes HE | Eyes + Nose EN | Sad Face + Smiley Face + Nose SUN | Nose + Smiley Face NU |
|-------------------------|-----------------------|--------------------------|-------------------|-------------------|--------------------------------------|--------------------------|

Layer 3 is looking for up to 3 features

| | | | | |
|-------------------------|--------------------------------------|--|--|--|
| Layer 4 Hidden Layer | Hair + Eyes+ Nose + Sad Face HENS | Hair + Eyes + Nose + Smiley Face HENU | Hair + Eyes + Smiley Face + Sad Face HEUS | Eyes + Nose + Smiley Face + Sad Face ENUS |
| | SAD FACE | HAPPY FACE | NO FACE | NO FACE |

Layer 4 is looking for 4+ features

| | | |
|-------------------------|------------------------|------------------------|
| Layer 5 Output Layer | Smiley/Happy Face U | Sad/Frowning Face S |
|-------------------------|------------------------|------------------------|