

# Particle Swarm Optimisation for Neural Networks

4G4 Group Presentation

Group 8: Kim Barker, Louise Aumont and William Halfpenny

# Presentation Outline

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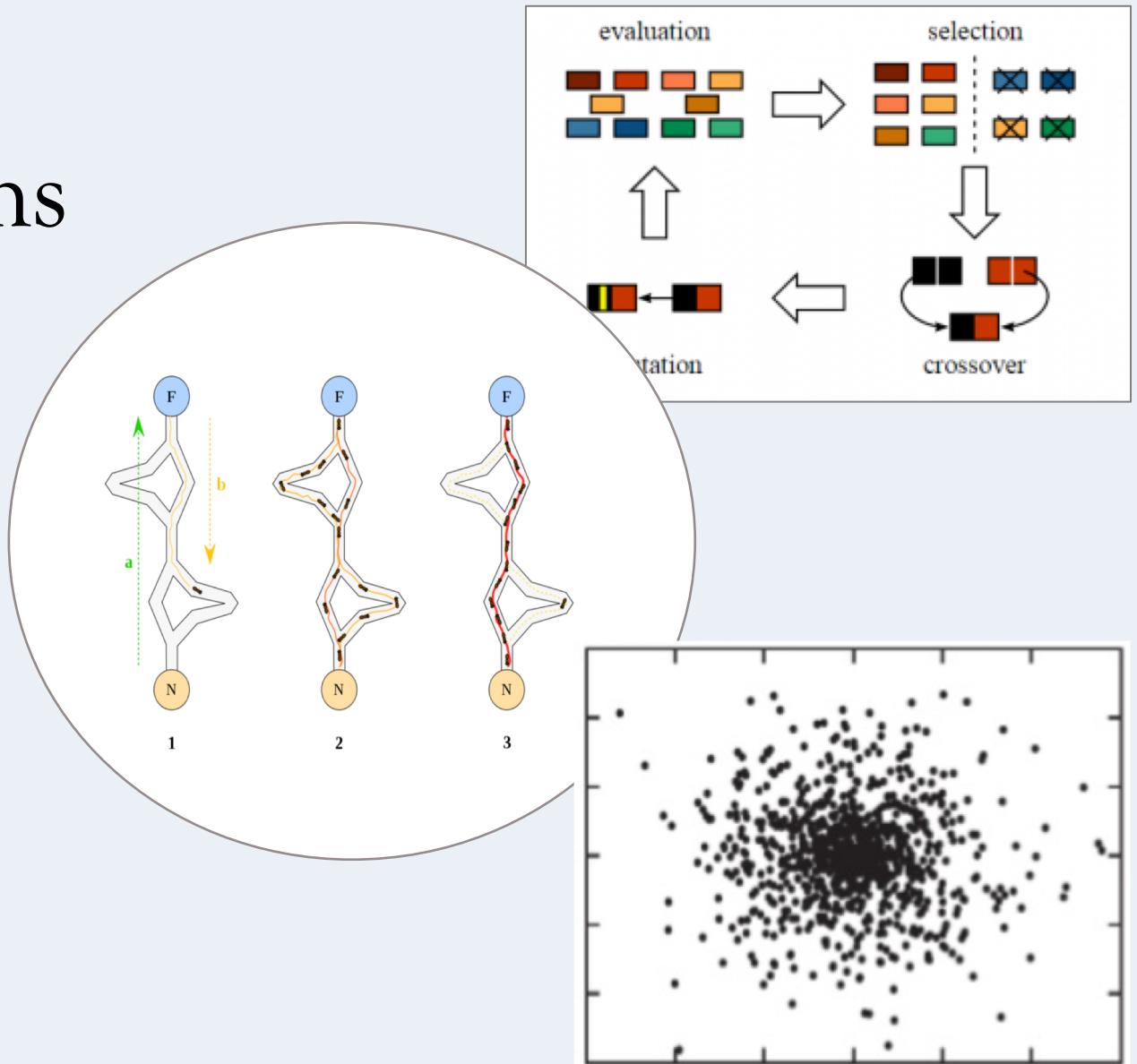
1. Motivation
2. Results
3. Future steps

The background of the slide features a photograph of a vast flock of birds, likely starlings, captured in flight against a backdrop of a sunset or sunrise. The birds are concentrated in the lower half of the frame, forming a dense, dark cloud that tapers off towards the top right. The sky above them is a gradient of warm colors, from deep orange at the horizon to a cooler blue-grey at the top. A single, thin white line, possibly a contrail or a distant aircraft, cuts across the upper left portion of the bird cluster.

# 1. Motivation

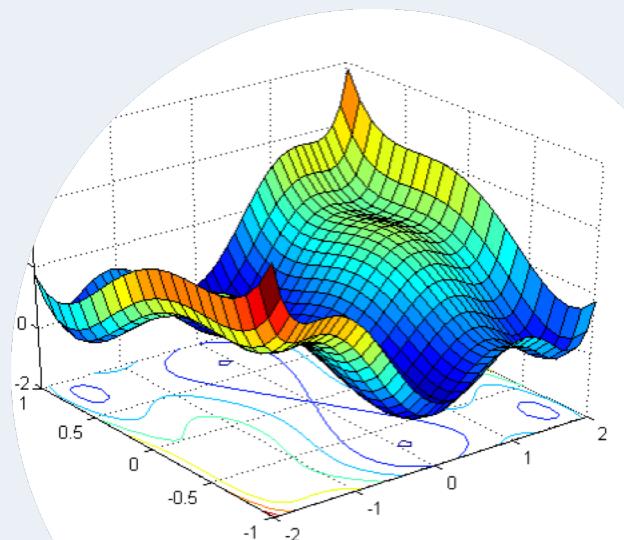
# Biomimetic Algorithms

- Natural metaphors
- More intuitive algorithms



# Particle Swarm Optimisation

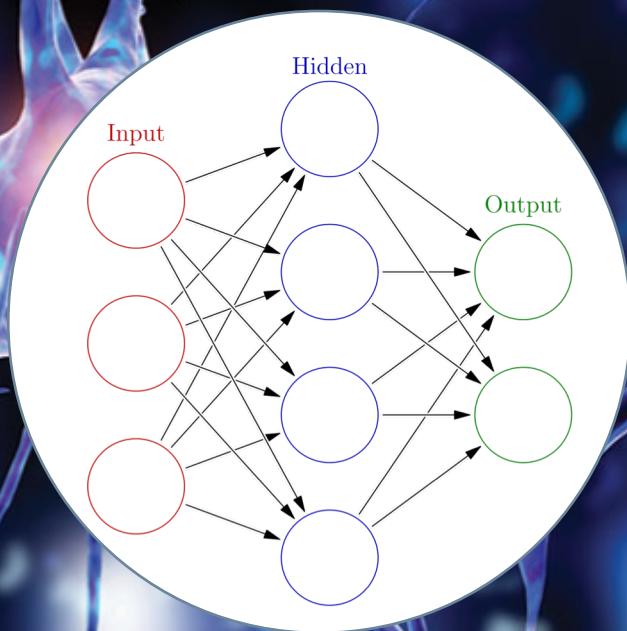
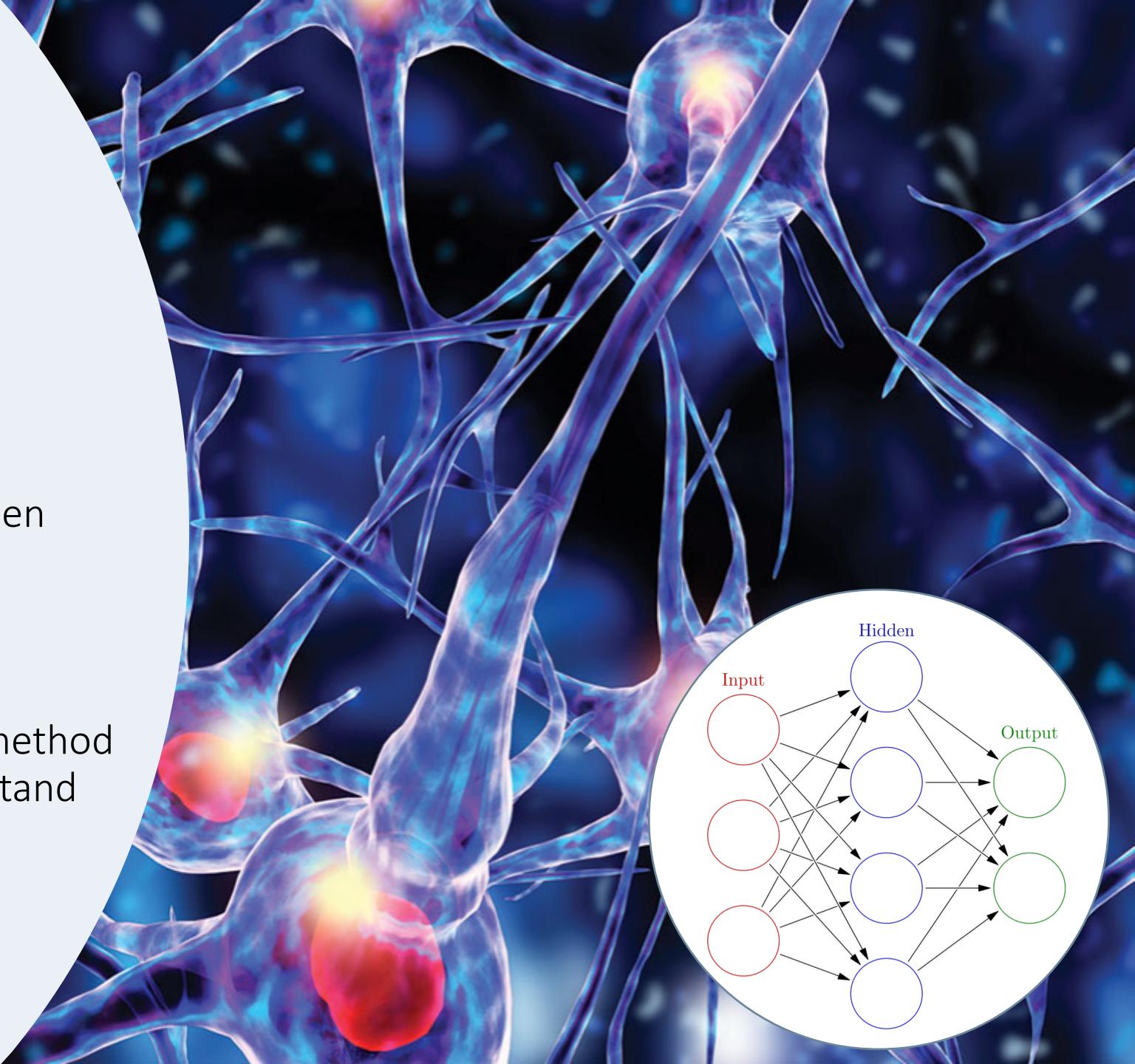
- Particle Swarm Optimisation (PSO)
- Inspired by flocking behaviour of birds
- Updates based on global and personal history



# Neural Network Training

- Maps complex relationships between inputs and outputs
- Training the weights of a NN is an optimisation problem
- Back propagation is the standard method but it can be challenging to understand

⇒ PSO-NN



# Problem Statement

“How does PSO compare to conventional methods for training NNs?”

Is it as accurate?

Is it robust?

Is it as efficient?

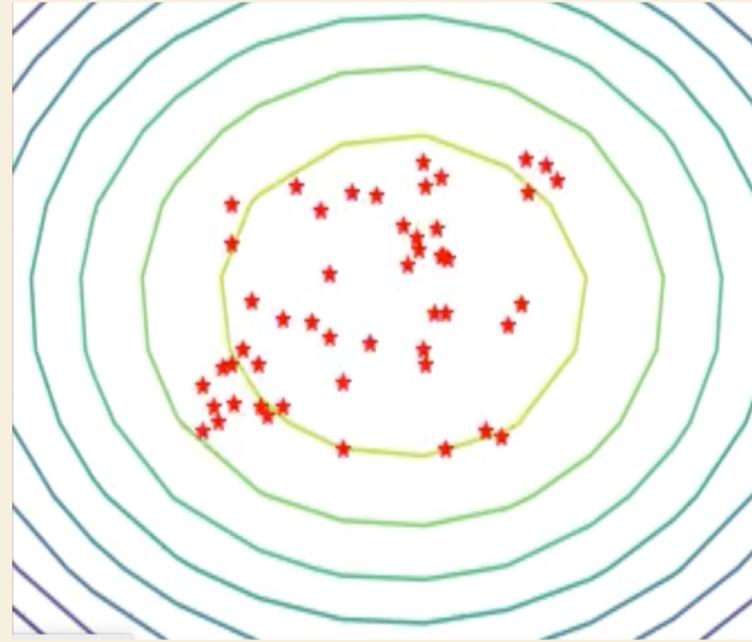
Will it work on complex datasets?

A photograph of a massive flock of birds, likely starlings, captured in flight against a backdrop of a sunset or sunrise. The birds are concentrated in the lower half of the frame, forming a dense, dark cloud that tapers off towards the top right. The sky above is a gradient of warm orange and yellow, transitioning into a cooler blue and purple at the top. A single, thin white line, possibly a contrail, cuts across the upper left portion of the image.

## 2. Results and Insights

# Simulating PSO

- 2D simulation: visual and intuitive
- Set the initial position and velocity
- Update them at each iteration:

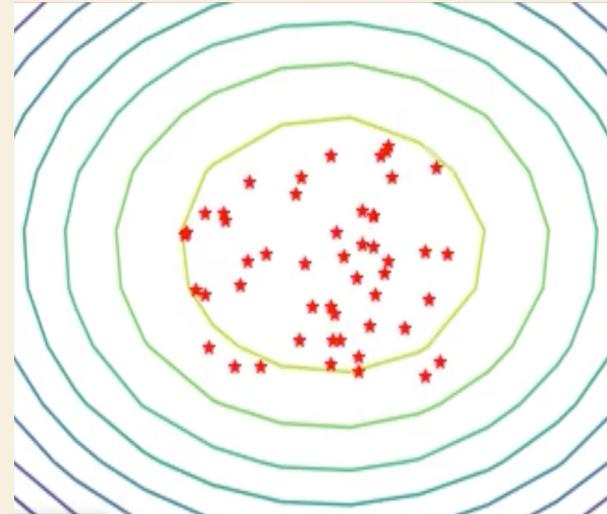


| Cognitive term  | Social term |
|---|-------------|
| $\mathbf{v}_i(t+1) = \mathbf{v}_i(t) + c_1 \mathbf{R}_1 (\mathbf{p}_i(t) - \mathbf{x}_i(t)) + c_2 \mathbf{R}_2 (\mathbf{p}_g(t) - \mathbf{x}_i(t))$ |             |

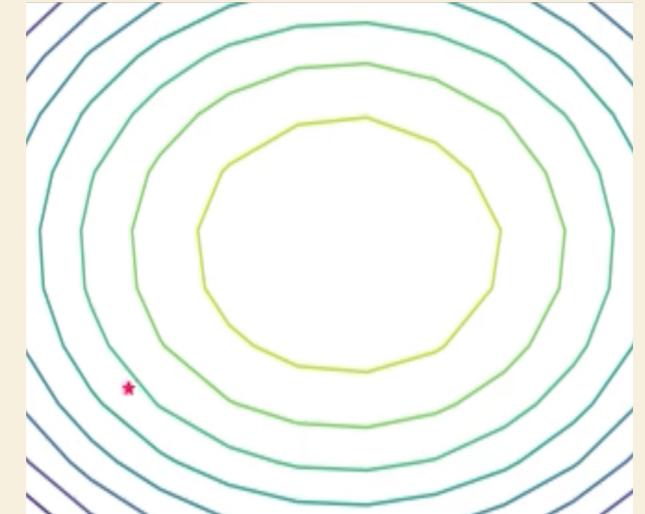
$$\mathbf{x}_i(t+1) = \mathbf{x}_i(t) + \mathbf{v}_i(t+1)$$

# Experimenting with Parameters

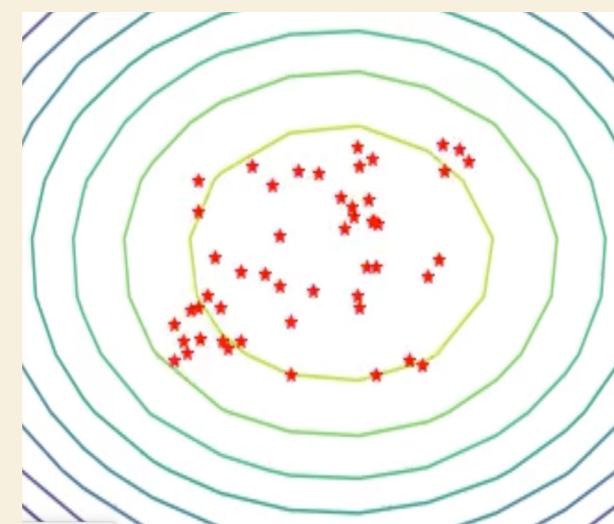
- Velocity range
- Accuracy vs efficiency



Small  $v_{\max}$

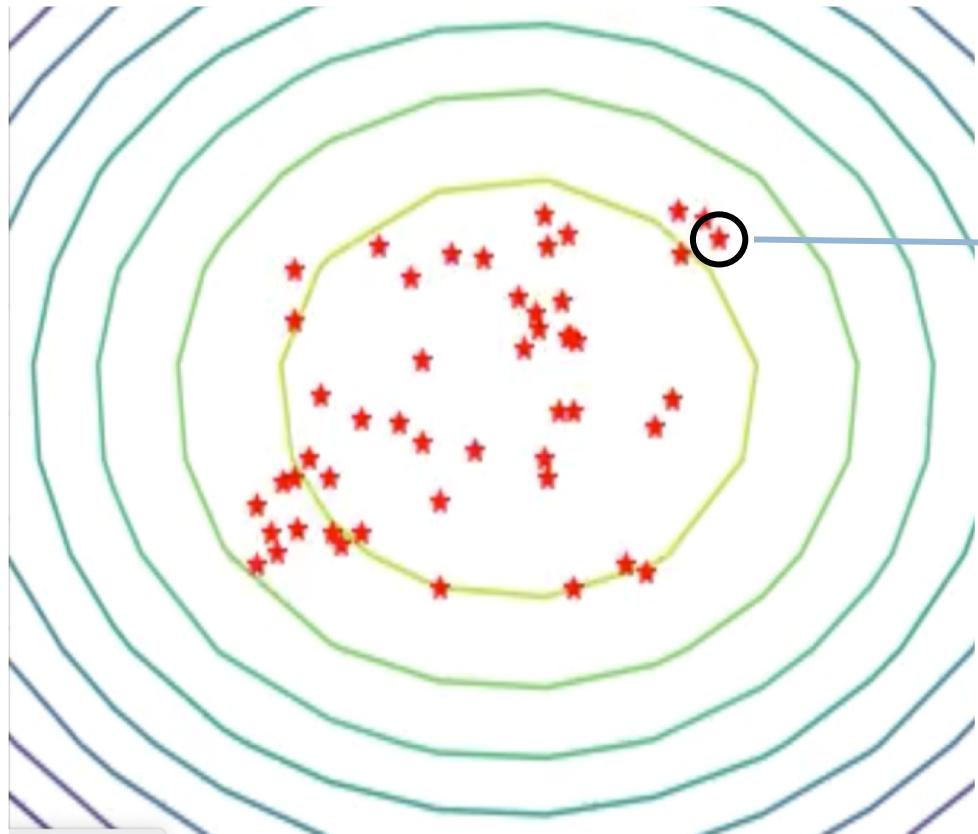


Large  $v_{\max}$



Well chosen  $v_{\max}$

# PSO-NN



How do we find  $f(x)$ ?

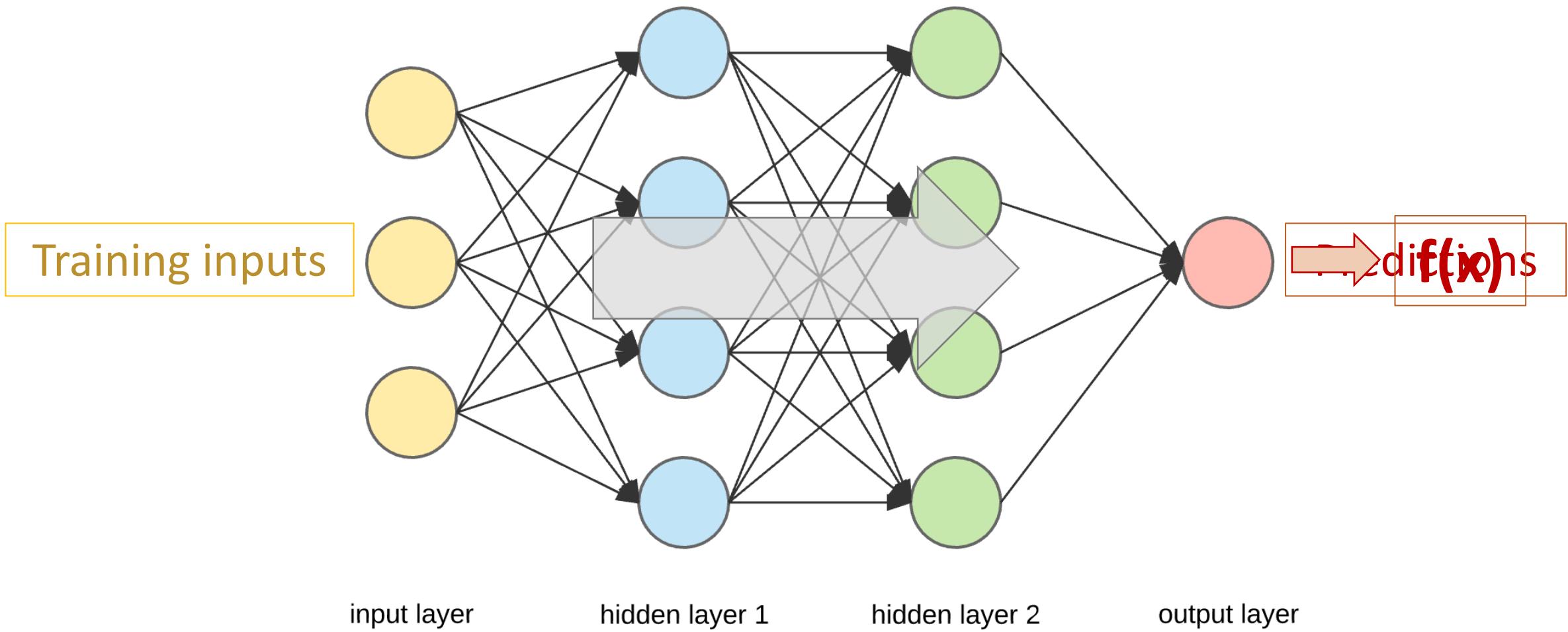
$$\mathbf{x} = [ \boxed{3.7} \quad \boxed{2.3} ]$$

Often:

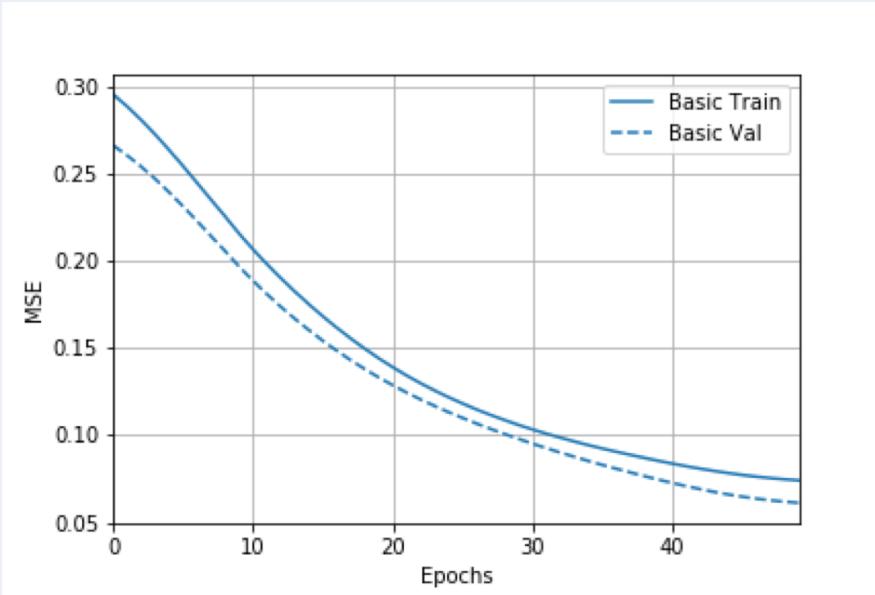
$$\mathbf{x} = [ \boxed{2} \quad \boxed{3} \quad \boxed{1} \quad \boxed{0} \quad \boxed{3} \quad \boxed{2} \quad \boxed{5} \quad \boxed{7} \quad \boxed{4} \quad \boxed{\dots} ]$$

$$\mathbf{X} = \left[ \begin{array}{cccccccccccccccccccccc} 2 & 3 & 1 & 0 & 3 & 2 & 5 & 7 & 4 & 3 & 9 & 5 & 5 & 4 & 6 & 3 & 2 & 4 & 7 & 8 & 9 & 8 & 0 & 0 & 1 & 3 & 2 & 5 & 3 & 4 & 7 & 5 \end{array} \right]$$

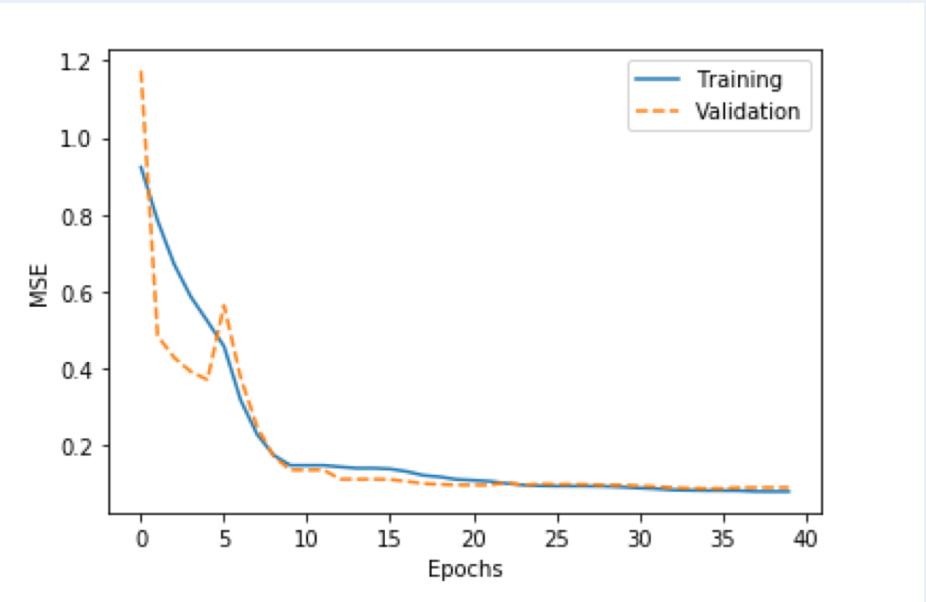
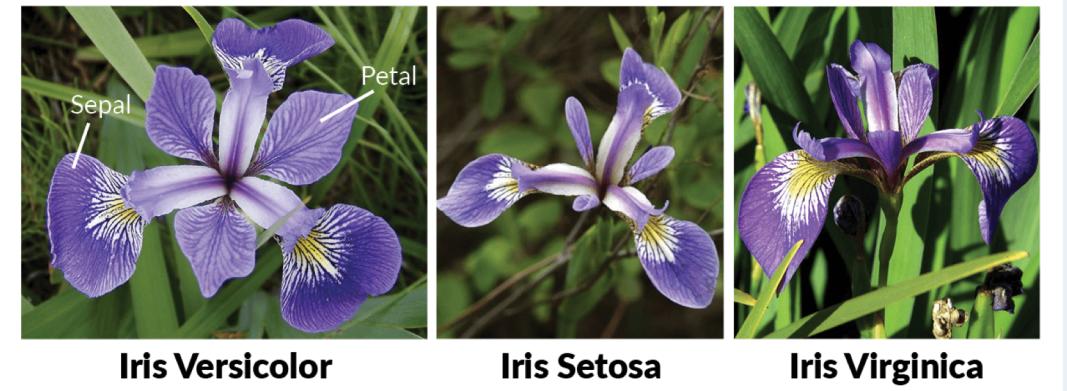
$$X = [2 \ 3 \ 1 \ 0 \ 3 \ 2 \ 5 \ 7 \ 4 \ 3 \ 9 \ 5 \ 5 \ 4 \ 6 \ 3 \ 2 \ 4 \ 7 \ 8 \ 9 \ 8 \ 0 \ 0 \ 1 \ 3 \ 2 \ 5 \ 3 \ 4 \ 7 \ 5]$$



# Results



- Backpropagation results
  - Accuracy = 93.333%

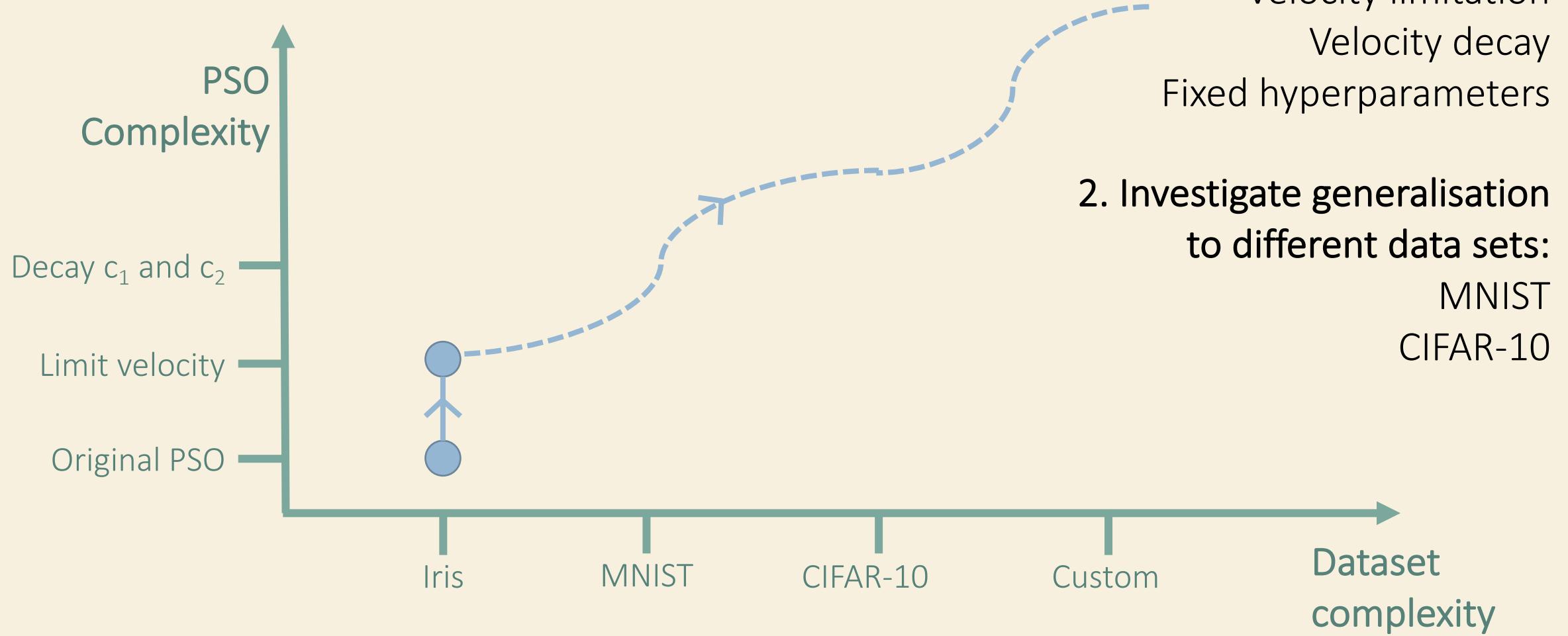


- PSO Results
  - Accuracy = 90.000%

The background of the image shows a vast sky at sunset or sunrise. A massive, dense flock of birds is captured in flight, appearing as a dark, swirling mass that dominates the center-left of the frame. The sky transitions from a deep blue at the top to warm orange and yellow hues near the horizon. A single, thin white contrail is visible on the left side.

### 3. Conclusion and future steps

# Future Steps



# References

- <https://www.howitworksdaily.com/wp-content/uploads/2015/07/wallpaper-of-a-flock-of-flying-birds-hd-bird-wallpapers.jpg>
- [https://www.wired.com/wp-content/uploads/images\\_blogs/wiredscience/2013/03/ff\\_collectives2\\_large.jpg](https://www.wired.com/wp-content/uploads/images_blogs/wiredscience/2013/03/ff_collectives2_large.jpg)
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- <https://www.analyticsvidhya.com/blog/2017/07/introduction-to-genetic-algorithm/>
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- [https://mag.uchicago.edu/sites/default/files/1508\\_Kelly\\_Neural-network.jpg](https://mag.uchicago.edu/sites/default/files/1508_Kelly_Neural-network.jpg)
- <http://slideplayer.com/slide/9347431/28/images/1/Artificial+Neural+Network.j pg>
- [https://upload.wikimedia.org/wikipedia/commons/thumb/9/9e/Iris\\_sanguinea.JPG/1200px-Iris\\_sanguinea.JPG](https://upload.wikimedia.org/wikipedia/commons/thumb/9/9e/Iris_sanguinea.JPG/1200px-Iris_sanguinea.JPG)

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