# THE VAN PERSIE PROBLEM

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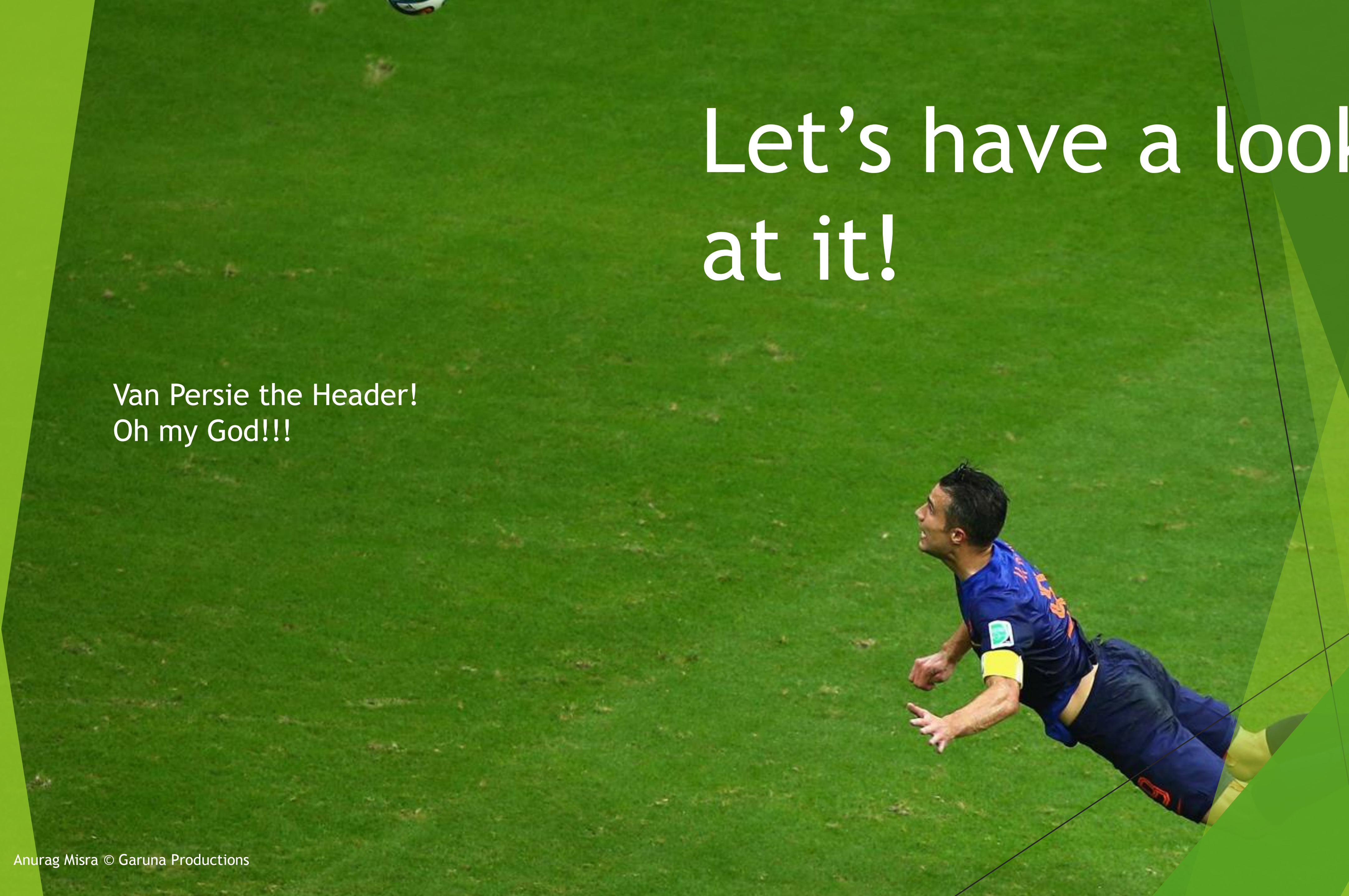
# Let’s have a look at it!



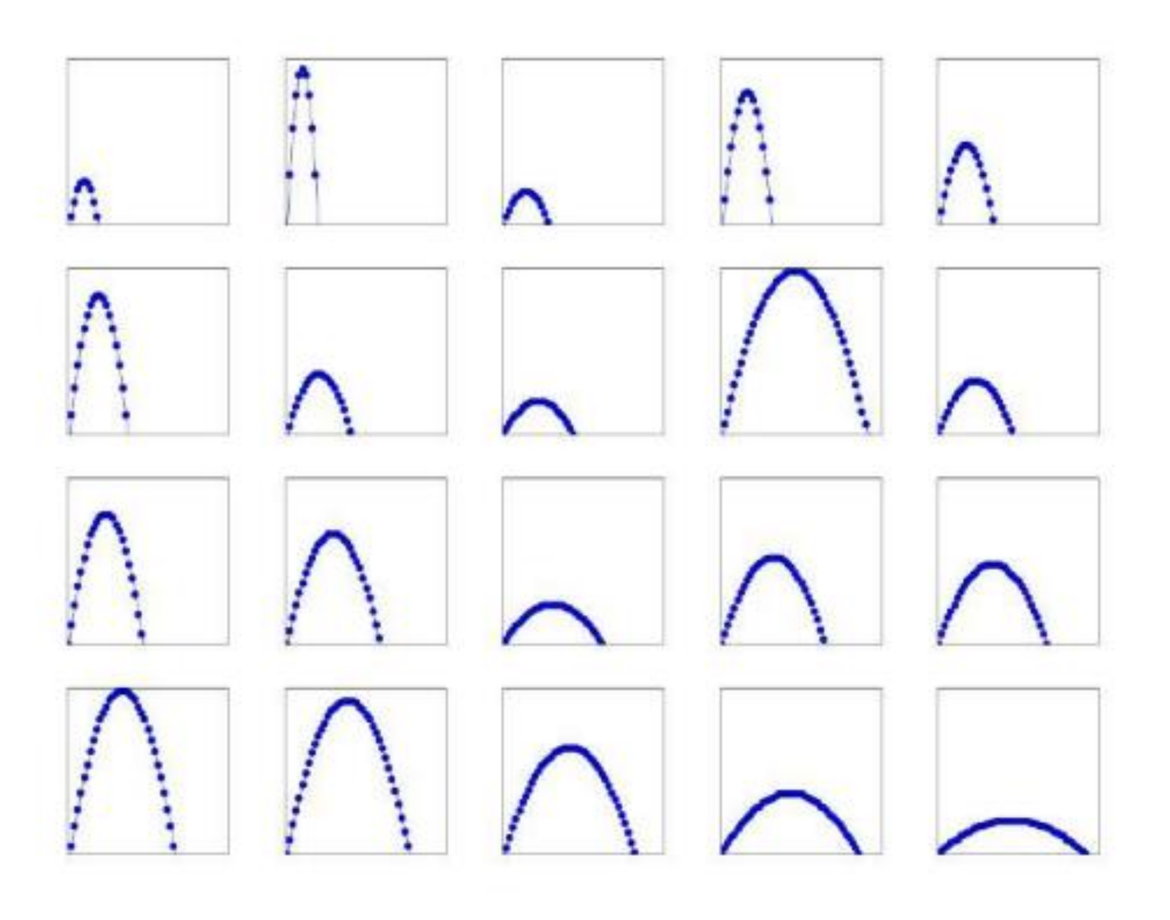
Van Persie the Header!
Oh my God!!!

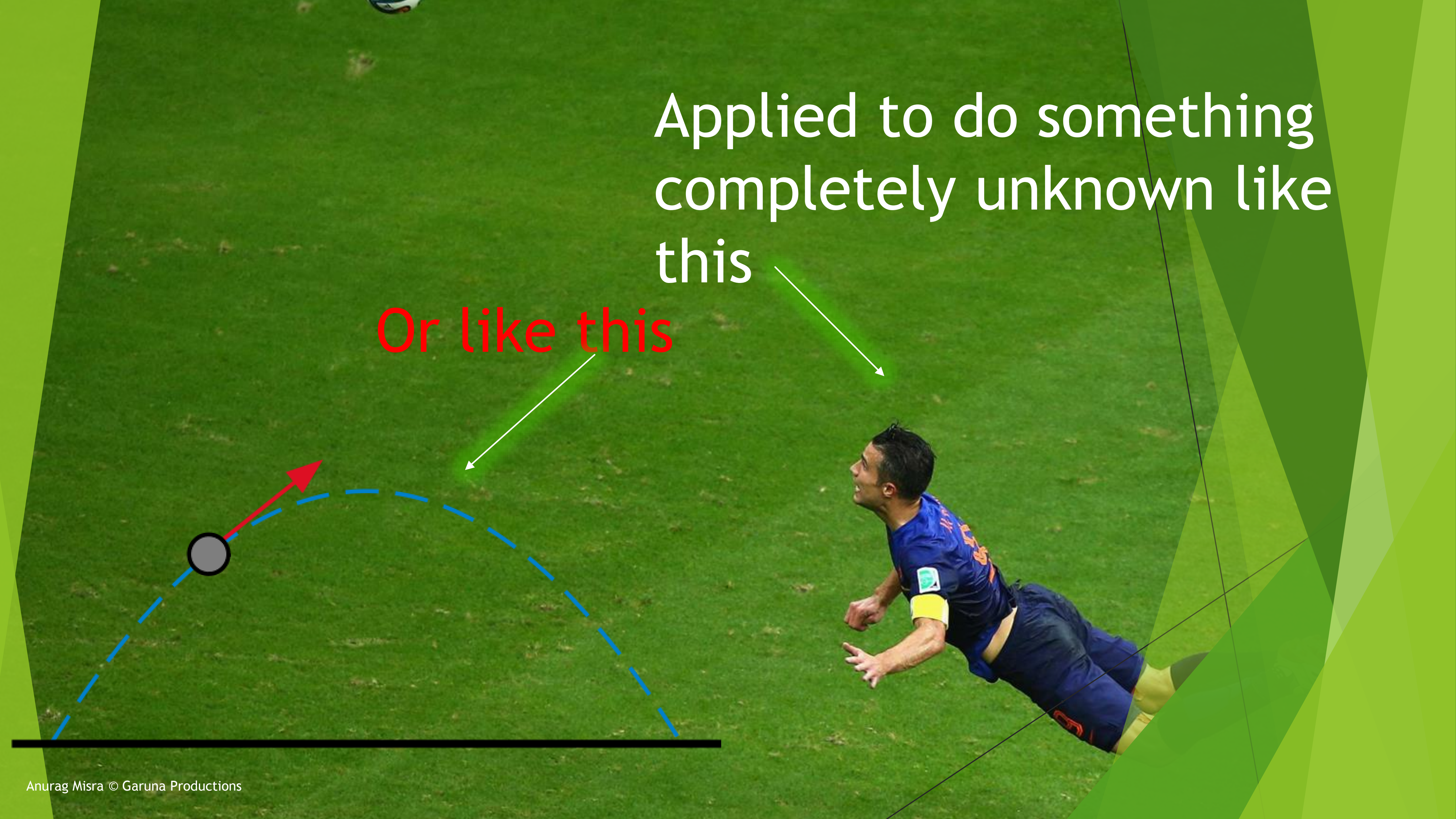

ESP 1 - 0 NED
43:22
FIFA
VISA

# How did Van Persie actually do it?

Humans are basically very complex machines.
Just like machines humans also learn these incredibly difficult tasks by encountering such situations again and again, and applying it using their cognitive model

This is basically this:




Applied to do something completely unknown like this
Or like this

# How will I reproduce the Van Persie Header?

Or basically how to train a machine to perform something similar to the “Incredible Van Persie Goal!”?

# The solution lies in:

## Visuomotor Learning Using Image Manifolds:

**Developing a neural network by taking numerous trials throw trajectories as inputs and using that neural network to predict the right trajectory**

Humans like footballers basically learn by doing actions and then observing the result: the trajectory caused. They do and learn. So do machines! This is what is called Machine Learning!

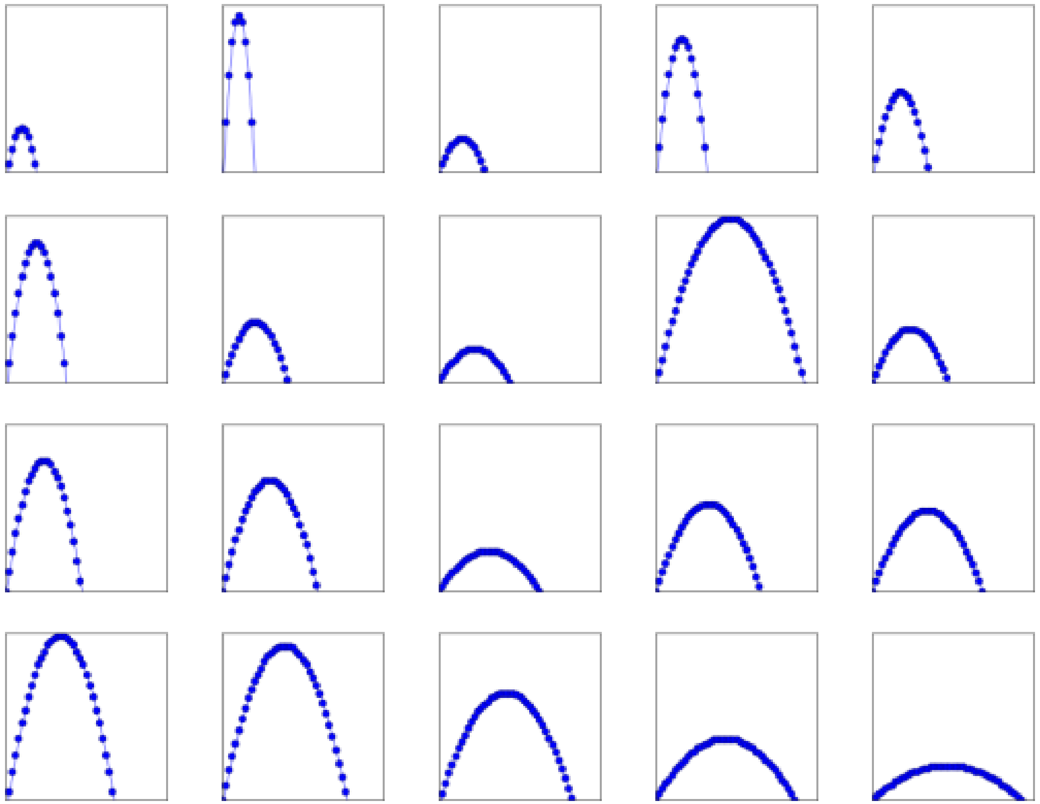
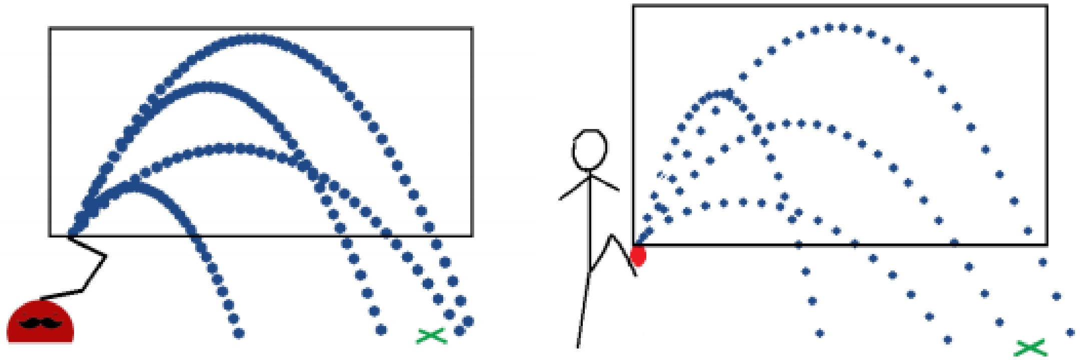


Figure 2.16: Sample Images from Dataset for Ball Projectile problem.



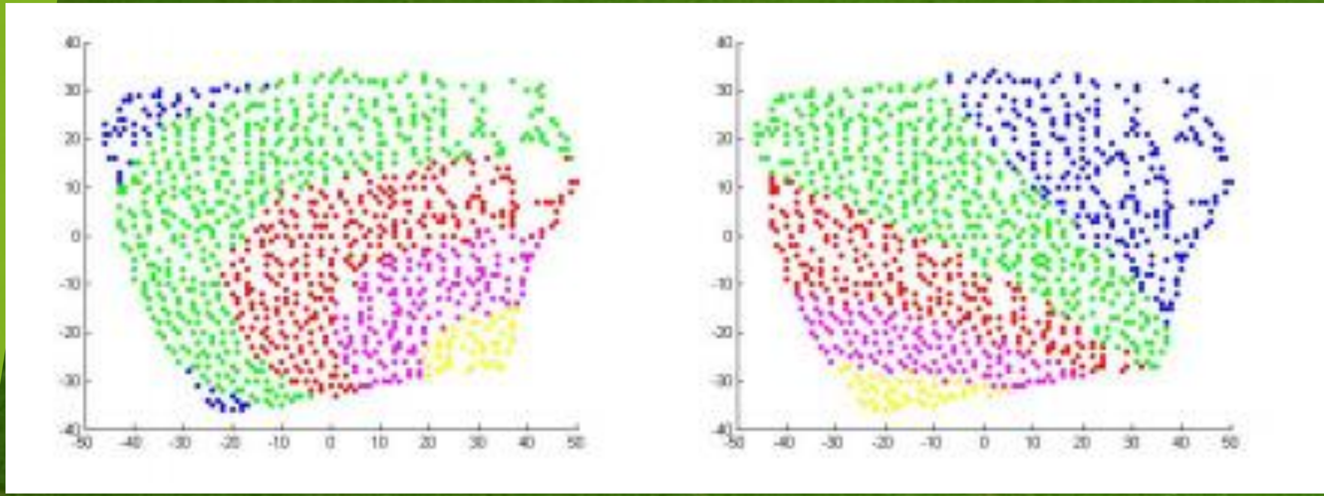
(a) Action of Throwing ball

(b) Action of kicking ball

Since each throw varies only on the parameters ($\theta$,$v$), there are only two ways in which we can modify the images while remaining locally within the subspace of throw images

The structure of this image manifold exactly mimics the structure of the motor parameters (the motor manifold).

They can be mapped to a single joint manifold, which can be discovered using standard non-linear dimensionality reduction algorithms such as ISOMAP.




Resulting manifold obtained using a Hausdorff distance metric (Huttenlocher, Klanderman, and Rucklidge 1993):
$(h(A, B) = max\ a \in A\ min\ b \in B\ ||a - b||)$.

Variations in Manifolds: according to a) angle of projection, and b) velocity.
(low values in yellow)

i.e. Obtain a low dimensional embedding for the
images using ISOMAP

We solve our Van Persie Header problem by solving an easier problem known as Dart Throwing Problem, where you hit a dart at a target board

The Dart Throwing Problem is a simple problem which we solve by the Algorithm we named as “Dart Throwing Algorithm”

**Algorithm 2** Dart Throwing Algorithm

**Input:** Image containing the dart.

**Output:** Series of trajectories $I_1, I_2..I_p$ that will hit the dart in the most optimal position.

**Step1:** Calculate the errors e for all sets of trajectories and select the ones with error $< \epsilon$.

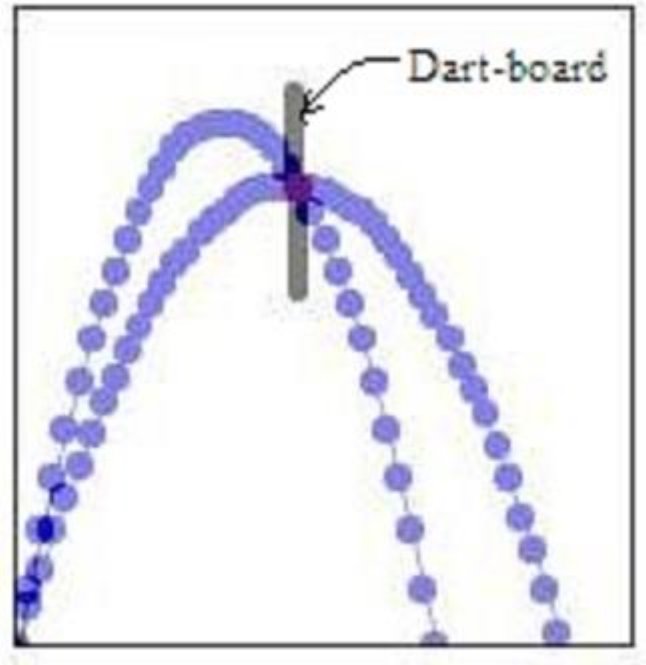
**Step2:** Fit a quadratic through the embedding points of the selected trajectories and their corresponding errors such that
$\hat{q}^T S\hat{q} + b^T\hat{q} = e$.

**Step3:** Use the values of S and b computed in Step 2 to compute the q-coordinates for which the error is minimised i.e. $\hat{q}^T S\hat{q} + b^T\hat{q} = 0$.

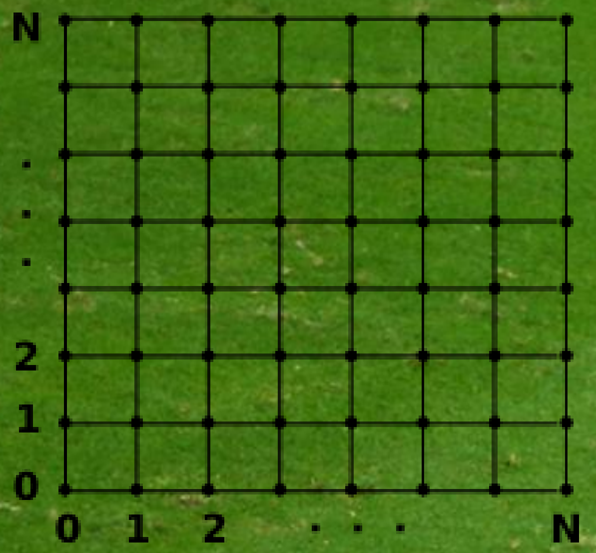
**Step4:** Plot the embedding points on the manifold to find the region of accurate trajectories (Figure 3.5).

**Step5:** Use the mapping learnt in Chapter 2 to generate more throws in the accurate region. Re-calculate errors.

**Step6:** Analyse the accurate region on the manifold to select the trajectories with motor parameters that optimise one's effort in throwing.




Remodeling the goal as (n+1)*(n+1) Dart Problem



And assuming a static goalkeeper at some distance from the goal

# REFERENCES:


1) **From visuo-motor to language**
   **Deepali Semwal, Sunakshi Gupta, Amitabha Mukerjee**
   Department of Computer Science and Engineering
   Indian Institute of Technology, Kanpur
2) Huttenlocher, D. P.; Klanderman, G. A.; and Rucklidge, W. J. 1993. Comparing images using the hausdorff distance. *IEEE PAMI* 15(9):850–863.