

Becoming the Expert - Interactive Multi-Class Machine Teaching

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CVPR 2015 Supplementary Material

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1 Dataset Example Images

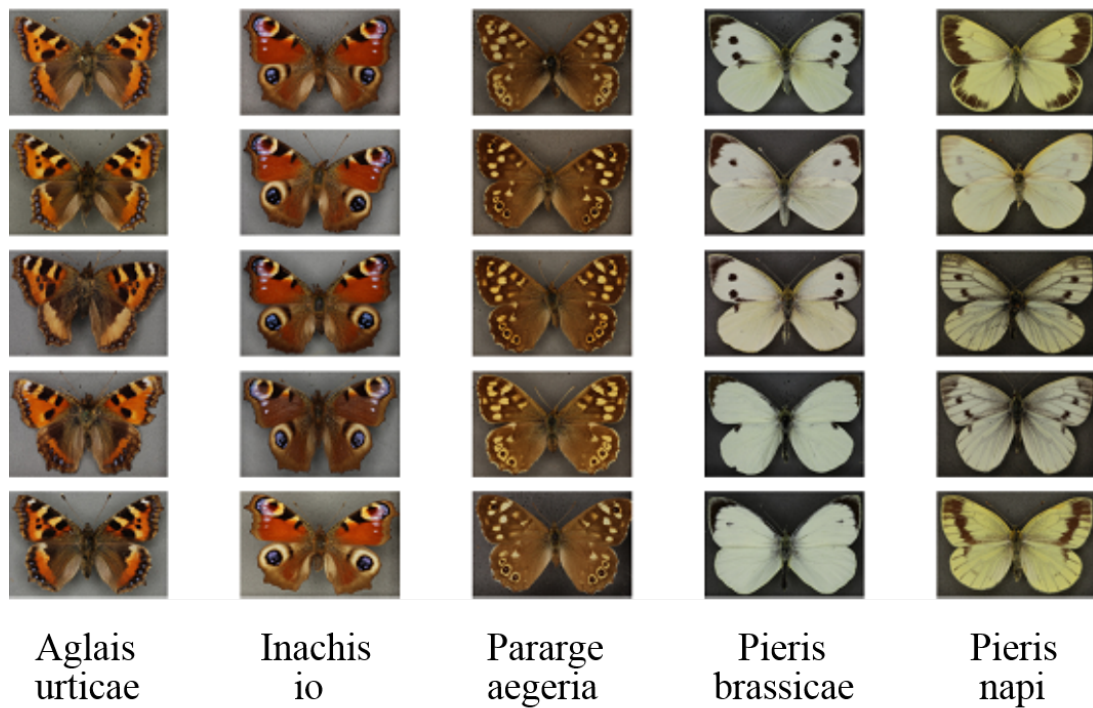


Figure 1: 5 random examples each for the 5 classes in the butterfly dataset. Each column represents one class. In total there are 300 images for each species of butterfly.

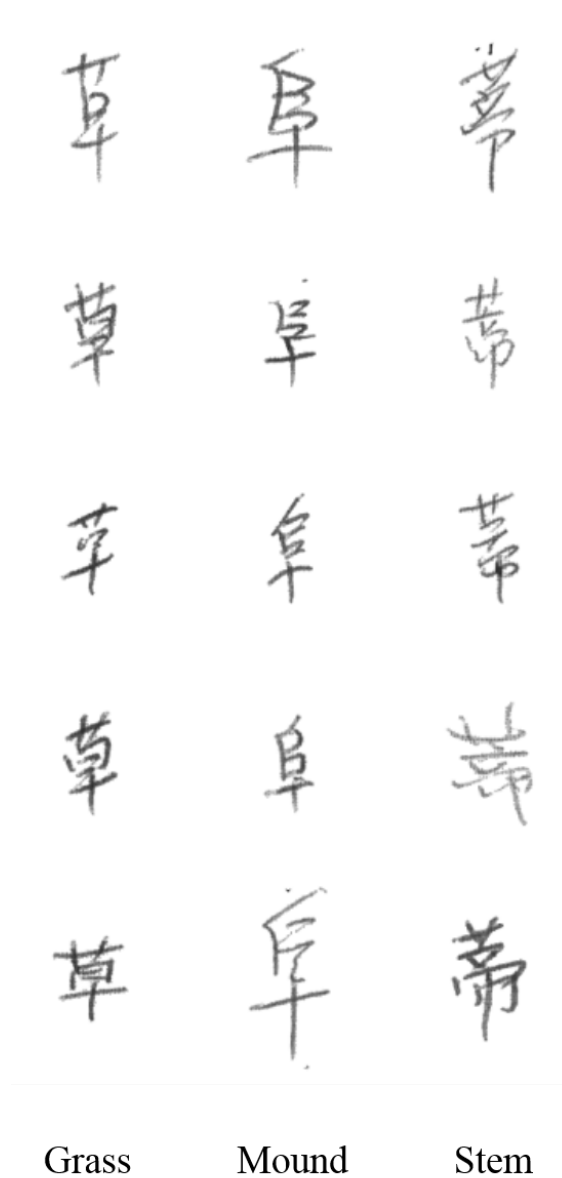
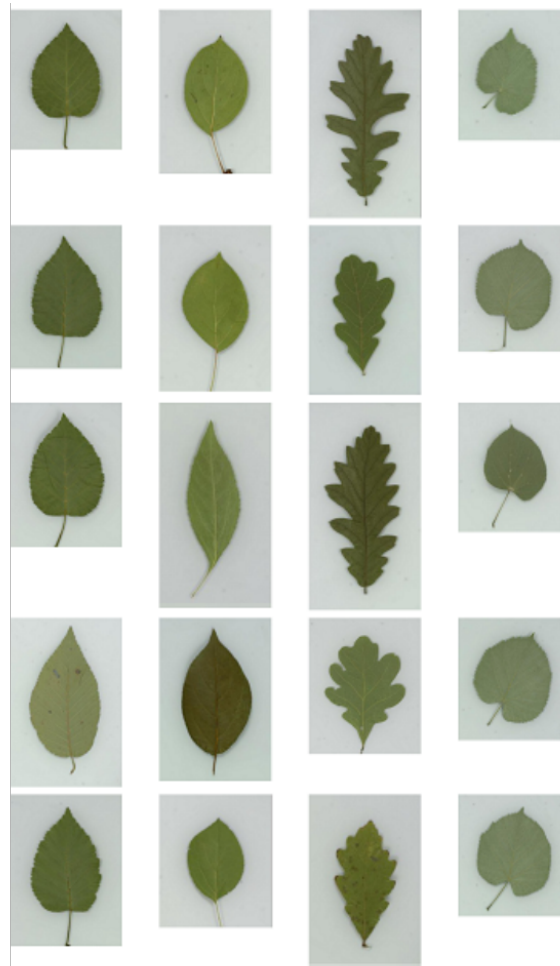
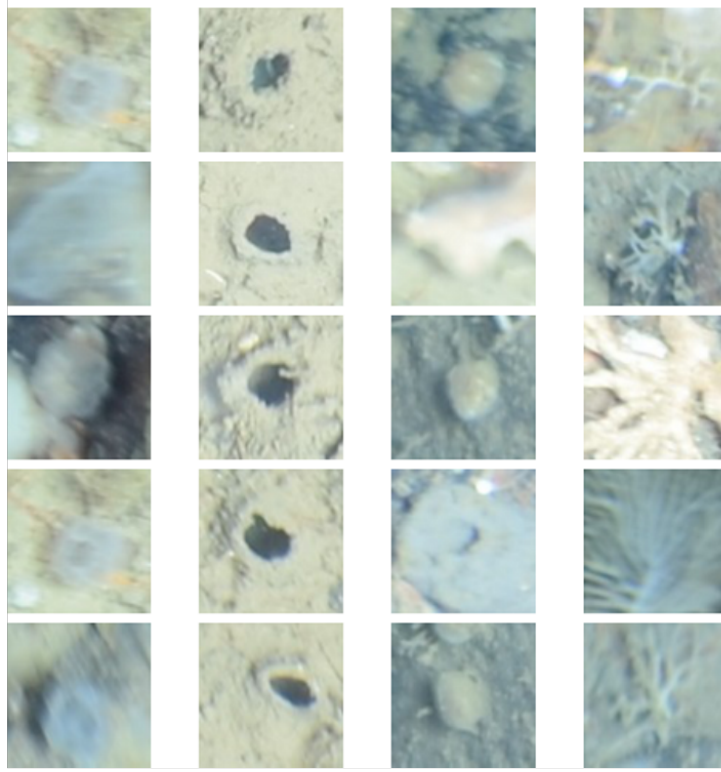


Figure 2: 5 random examples each for the 3 classes in the Chinese dataset. Each column represents one class. In total there are between 237 and 240 images for each class of character.



Betula Malus Quercus Tilia

Figure 3: 5 random examples each for the 4 classes in the leaves dataset. Each column represents one class. In total there are between 102 and 150 images for each species of leaf.







Ascidiidae Molgulidae Porifera-M Stylasterida

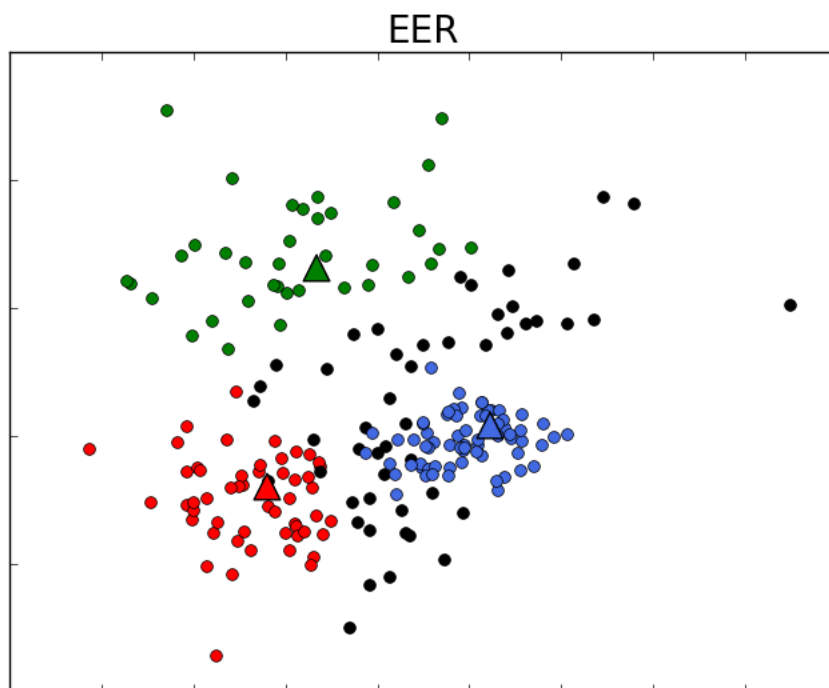
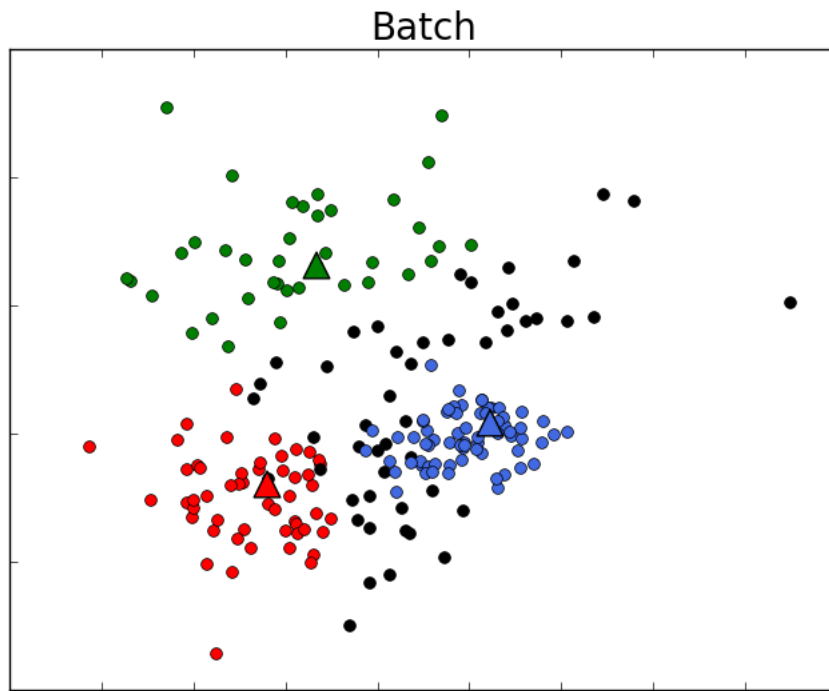
Figure 4: 5 random examples each for the 4 classes in the seabed dataset. Each column represents one class. In total there are 100 images for each underwater species.

2 Teaching Strategy Visualization

The following pages depict a 2D simulation of a typical teaching path taken by our EER strategy, compared with the batch strategy. Each page represents one time step, and shows the machine’s model of the learner at that moment in time for both strategies. Samples are drawn in colored circles, where the color represents the learner’s prediction of that sample, according to the machine’s model. Samples whose prediction is incorrect are colored in black. Triangles then show samples which the teaching strategy chooses to show to the learner, and the color of the triangle represents the learner’s response when asked to identify that sample. Upwards-pointing triangles represent correct answers, and downwards-pointing triangles represent incorrect answers. The sample most-recently shown to the learner is the largest triangle.

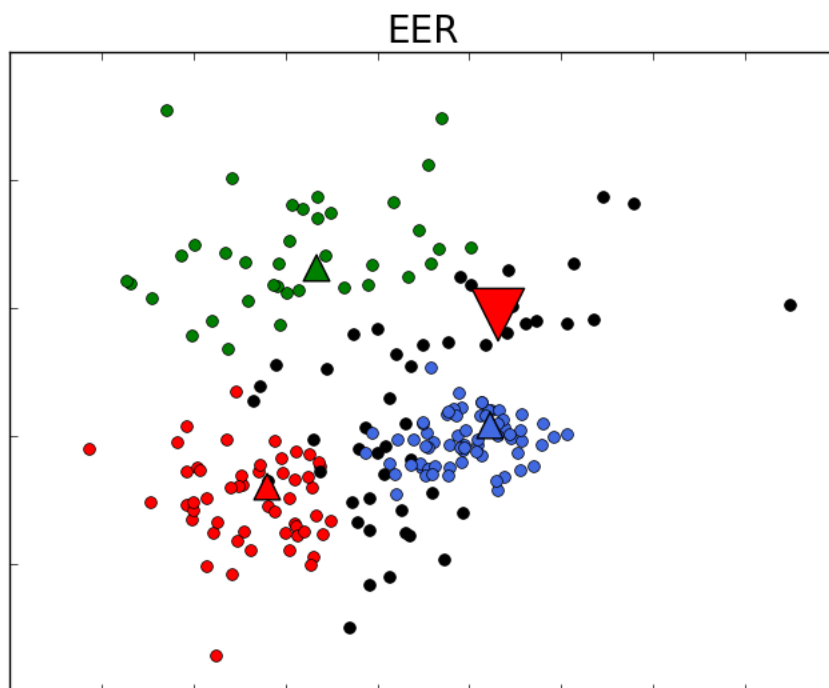
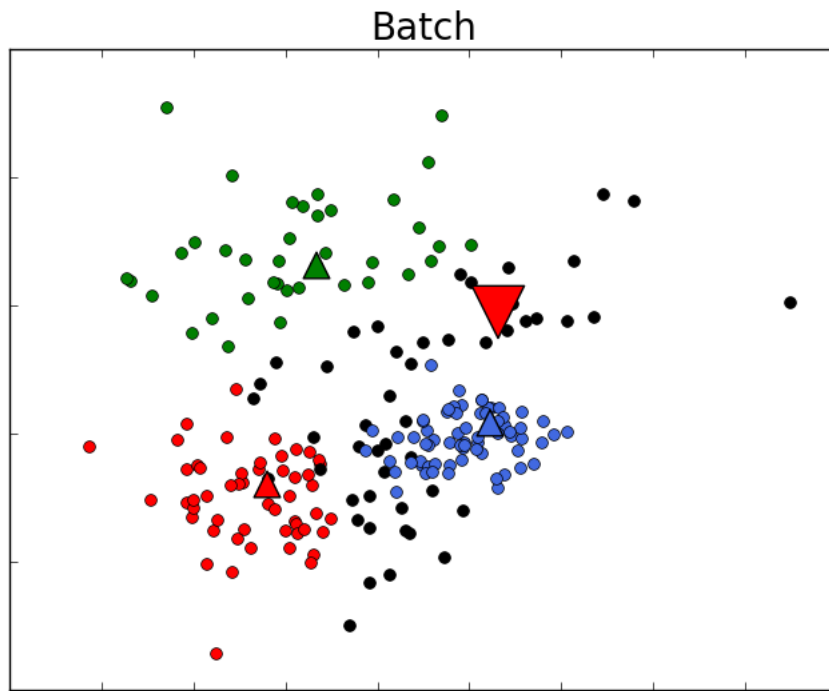
-  Unobserved sample, predicted to be correctly classified as “blue”
-  Unobserved sample, predicted to be incorrectly classified
-  Observed sample, correctly classified as “red”
-  Observed sample, incorrectly classified as “green”

Time Step 1



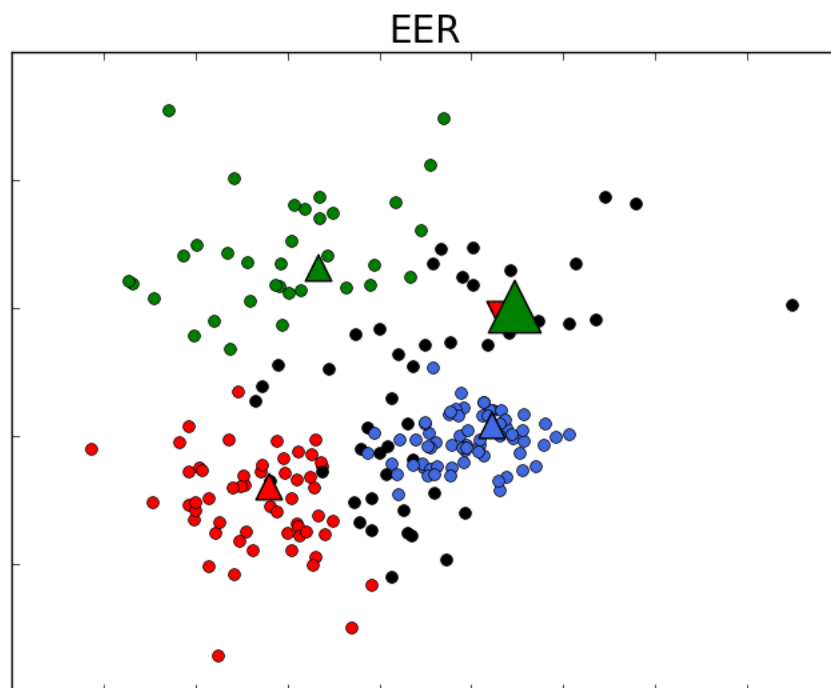
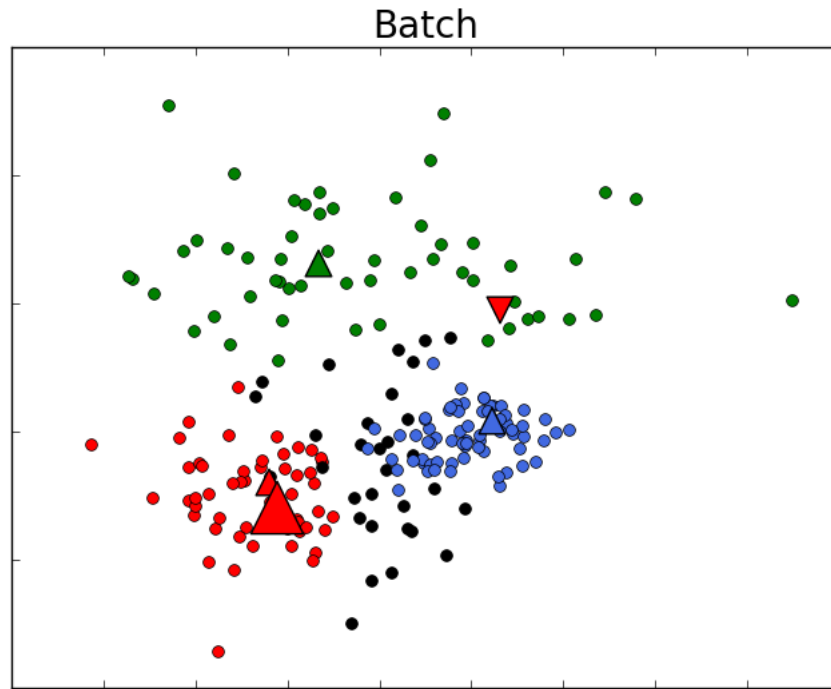
To begin, let us assume that the learner has seen one sample for each of three classes, and answered each correctly, such that both strategies begin with the same initial conditions. Here, these three samples enable the machine to make an estimate of the learner's state, and both methods have several black dots representing samples that are predicted to be incorrect if the learner was asked to label them.

Time Step 2



Here, due to the identical initial conditions, both strategies show an image that lies among the black dots in order to improve the learner's recognition ability in this region. In this case, the learner answers incorrectly for both strategies.

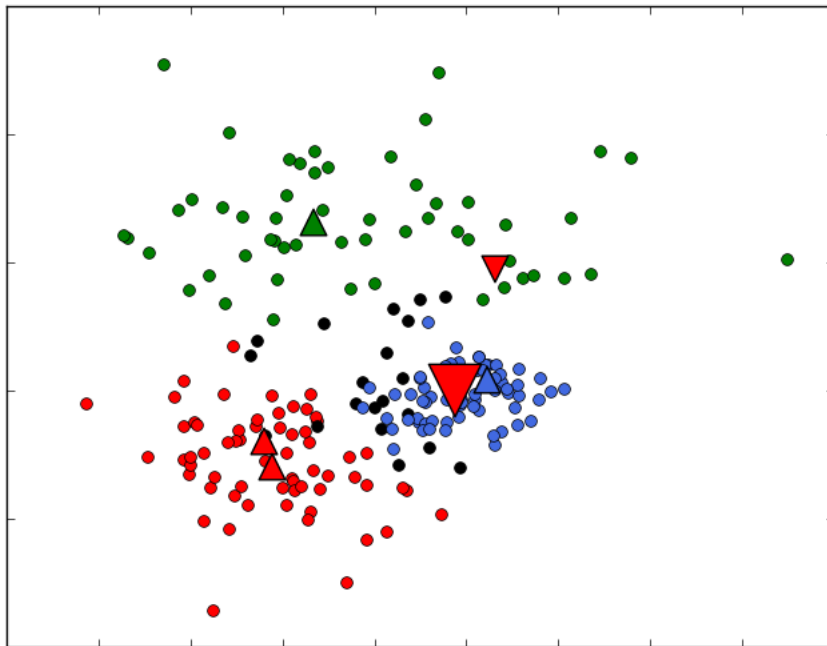
Time Step 3



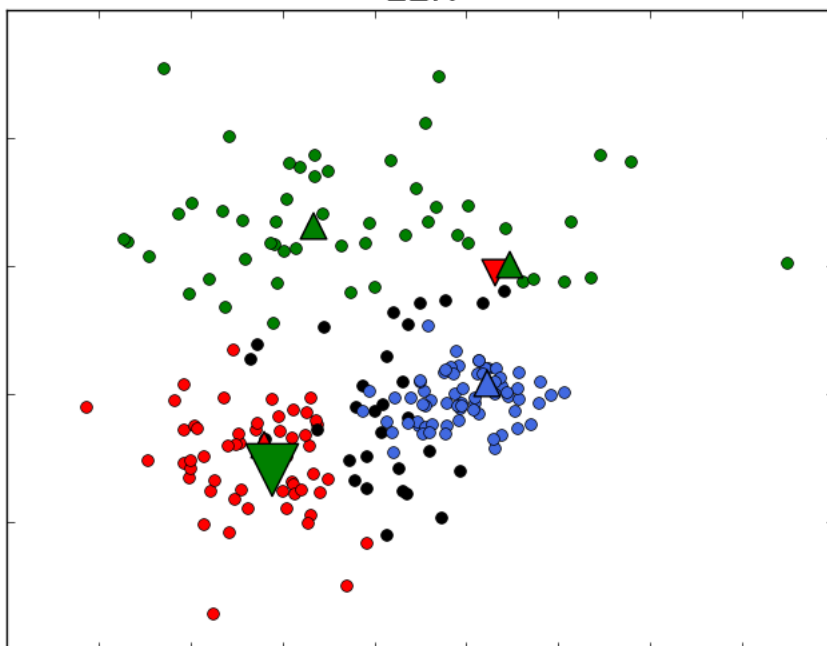
Now, the two strategies differ in their approach. The batch strategy makes the assumption that having now seen the ground truth of the first triangle, the learner remembers this correctly. However, our EER strategy does not make this assumption, and basis its model only on what the learner has actually told the machine he knows. As such, whilst the batch strategy proceeds to sample from another region altogether, our EER strategy returns to this region of uncertainty and displays another sample from here. In this way, our EER strategy ensures that the learner has proved that a particular region in feature space has been correctly learned, before it moves on to teaching the learner about another region. It is this ability to adapt to the specific learner's needs that makes our strategy more powerful than the batch strategy and the other baselines. The remaining pages continue to demonstrate this principle as the teaching progresses.

Time Step 4

Batch

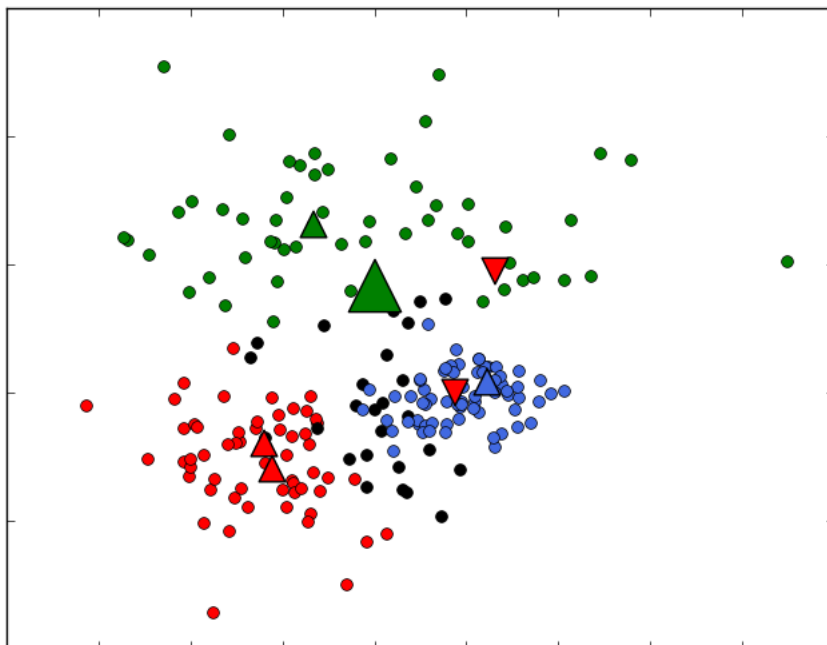


EER

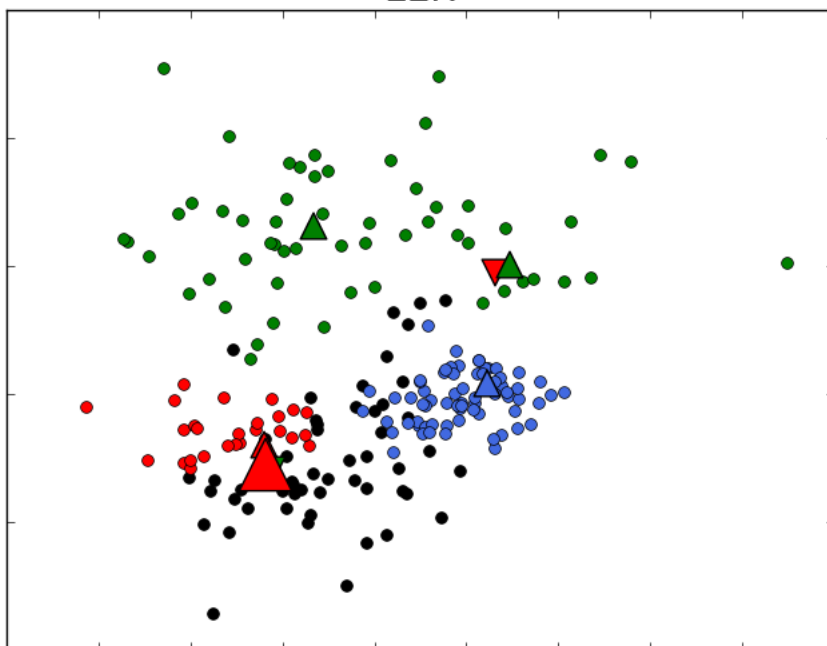


Time Step 5

Batch

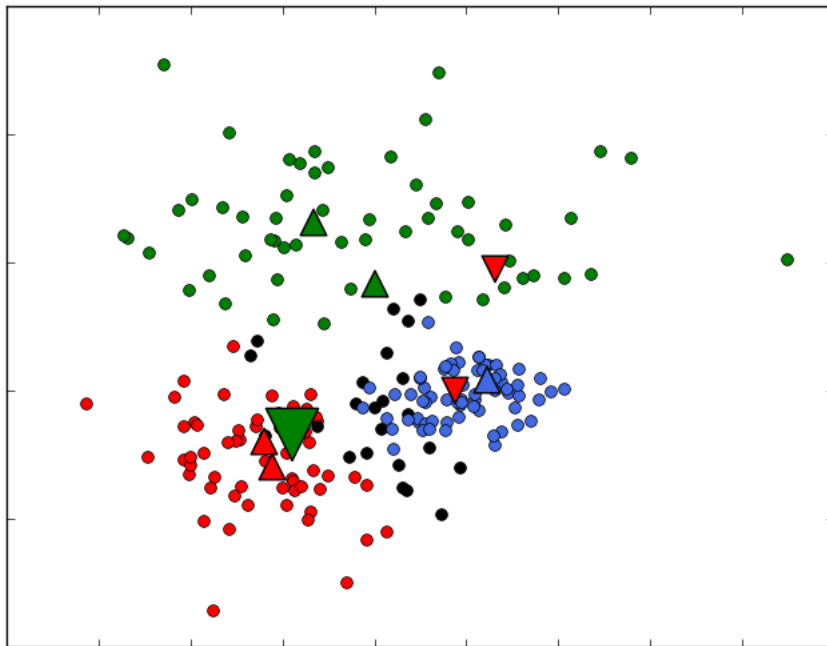


EER

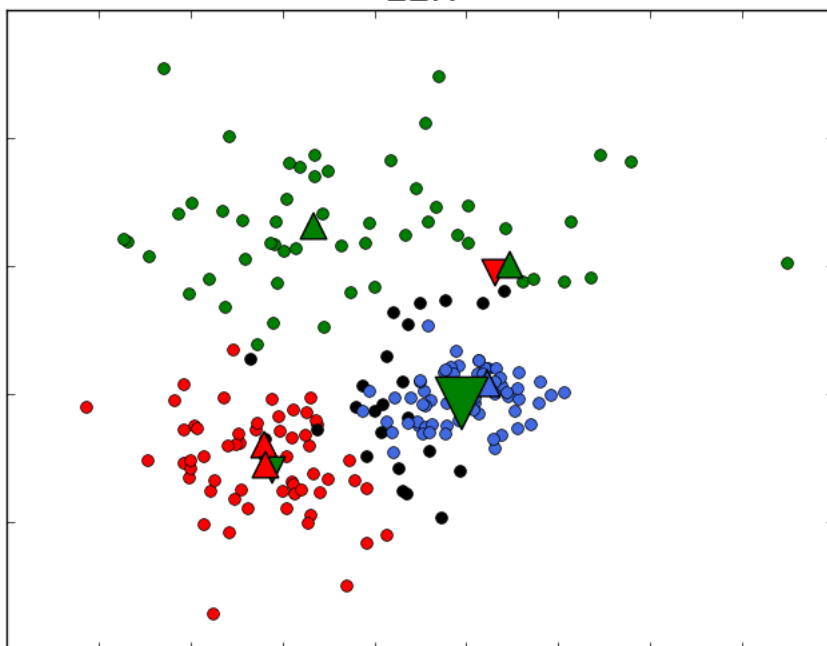


Time Step 6

Batch

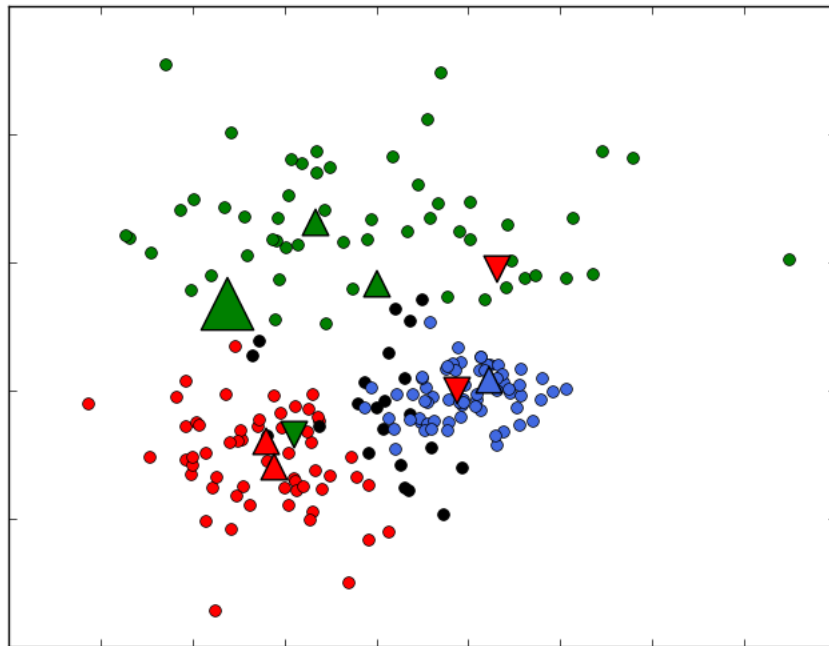


EER



Time Step 7

Batch



EER

