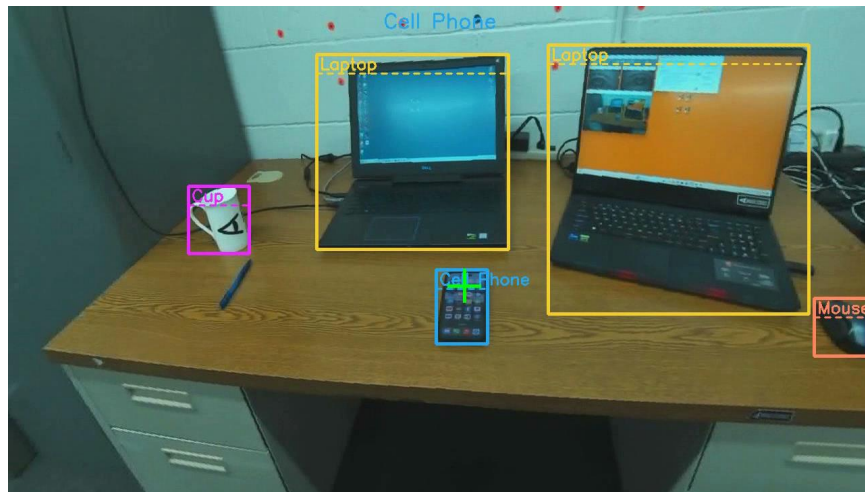


ETVision AI Training Manual

TRAINING ARTIFICIAL INTELLIGENCE SCENE OBJECT RECOGNITION FOR
ETVISION

MANUAL VERSION 1.4
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techsupport@argusscience.com
Web site: www.argusscience.com

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1 Introduction and Overview

The *ETVision* application (version 1.0.7.2 and above) can use an artificial intelligence (AI) model to recognize objects that appear in the head mounted scene camera image. To do this, *ETVision* requires a set of two specially prepared files: an “AImodel” file and a companion “AInames” file. This two-file set constitutes an “ArgusAIModel”.

With every new *ETVision* system, Argus Science provides an “ArgusAIModel” trained to recognize a set of common objects. An optional add-on to the Argus Science *ETAnalysis* program, called *AIOBJECTTraining*, allows users to create custom “ArgusAIModels” for objects that are specific to the user’s application and environment.

Creation of AI models for image object recognition requires “training”, using a very large number of images in which the identity and location of the objects of interest are specified. Manually designating these objects in hundreds or thousands of images is normally a very labor-intensive task. The *AIOBJECTTraining* module uses the Moving Area of Interest (MAOI) feature within *ETAnalysis* to automate creation of AI training and verification image sets.

This manual describes procedures for creating a custom ArgusAIModel (section 3.1), enhancing an existing ArgusAIModel with additional “training” (section 3.3), and using the resulting ArgusAIModel with *ETVision* (section 3.2). These procedures require the use of the *ETAnalysis* application equipped with the optional *AIOBJECTTraining* module. It also requires that the PC being used is equipped with an appropriate GPU (section 2.1), and requires that the PC has Internet access and has been “set-up” using an install program provided by Argus Science as described in this manual (section 2.3).

Once the AI training environment is installed and set-up as described in section 2.3, no further internet access is required to use the AI model training feature. The AI Model and Object List is created on the local PC with no access to any external programs or material. This training is dependent upon the customer’s identification of objects to be tracked, and the name associated with these objects is under the sole control of the user. The resulting AI model is exclusively limited to recognizing these user-defined objects in *ETVision* scene video images, and to reporting gaze interaction with the objects.

2 Equipment requirements & Set-up

2.1 Hardware

In order to use AI model object recognition the PC running the *ETVision* application should have at least 16 GB RAM and must be equipped with an Nvidia GPU, model 3060 or above. The GPU driver must be version 31.xxx or above (must support Cuda). To support AI training, as described in this manual, there should also be at least 200 GB of free space available on the C:\ drive. If a different PC will be used to run *ETAnalysis* and create custom AI models, the above requirements also apply to that PC.

2.2 Software

AI feature recognition is supported by *ETVision*, version 1.0.7.2 or above. The AI training procedure is supported by *ETAnalysis* version 1.1.0.3 or above with the *AIOBJECTTRAINING* option included.


2.3 AI training environment set-up

The PC that will be used to train new AI models (or augment existing models) must be set-up as follows. Note that an Internet Connection is required for this procedure, and the user must have “Administrator Privileges”.

- Consult Argus Science for ArgusAI.zip download link. Download ArgusAI.zip and extract 3 files (Install.bat, iPython.exe, and Uninstall.bat) to a local directory.
- Be sure Internet connection is “on-line”.
- Run Install.bat.

3 Create and use an ArgusAIModel

3.1 Train AI to create an ArgusAIModel for image objects

- Use *ETVision* headgear to make a training video containing objects to be recognized by AI.
 - It is important that a superimposed gaze cursor and AI object bounding boxes from an existing ArgusAIModel not appear on the training video; so be sure that the “Record LAOI / AI”, the “Record Gaze” and the “Record Fix” check boxes, on the Video Source dialog (*ETVision* manual, section 9.4.2), are unchecked.
 - It is not necessary to measure gaze or even to have a person wear the *ETVision* optics when making a training video.
 - Be sure “Auto Record Scene Video with Data File” is checked on the *Eye Data* dialog, and begin recording an *ETVision* data file.
 - Try to move the scene camera so that it views the object (or objects) to be trained from various angles and distances.
 - Close the data file.
- Open the recorded scene video as an “environment video” in *ETAnalysis* (*ETAnalysis* manual, section 16.3).
 - Create MAOIs that track objects of interest (*ETAnalysis* manual, section 16.7).
 - Save MAOIs (click “Save and Close” button near top right of Display Area).
 - It is usually sufficient to use rectangular MAOI bounding boxes to track objects rather than tracking the exact object outlines.
 - Right click Environment Video node, and select “View MAOIs”; click “save video” icon  near bottom left of Display Area, and select “Save AI data set”. The resulting “Saving AI Dataset” dialog includes a “Browse” button. To use default parameters, just use the browser to select a dataset file name and location that we will refer to as AI project folder, then click “OK”.
 - Creates dataset bat file and dataset folder in AI project folder.
 - Creates ArgusAINames.txt and dataset.yaml files in dataset folder.
 - Copies standard “pretraining” file (yolov8n.pt) to dataset folder.

- Creates “images” and “labels” subdirectories in dataset folder.
- Run dataset bat file in AI project folder.
 - Adds cache files to “labels” subdirectory.
 - Creates “Runs” folder, with associated subfolders and files, in data set folder.
 - Creates ArgusAIModel.onnx files in data set folder.
- The ArgusAIModel.onnx and ArgusAINames.txt file constitute the new ArgusAIModel.
 - To be used, the AImodel file and corresponding AInames file must remain in the same directory folder.
 - The files can be copied to other folders and renamed as long as following convention is observed. The AImodel and AInames files must have names of the form: *nnnModelmmm.onnx* and *nnnNamesmmm.txt*, respectively. *nnn* and *mmm* can be any number of characters as long as they form a legal Windows file name, and are exactly the same on both files.
 - To enable the future addition of training data to the model, it is important that the original ArgusAIModel.onnx and ArgusAINames.txt files remain in the dataset folder even if copies of these files are moved and/or renamed.

3.2 Use newly created ArgusAIModel in *ETVision*

- If the newly created ArgusAIModel files are not already on the ETVision PC, copy them to a folder of the user’s choice. (If the folder already contains files of the same name, the files can be renamed as long as the naming convention previously described is maintained.)
- Run *ETVision*. On the *Advanced Configuration* dialog, under “AI Settings”, click the “Model” button. Use the resulting browser to select the “.onnx” AImodel file for the newly created ArgusAIModel. Assuming that the previously described naming convention has been followed, this will also automatically select the corresponding AInames file. Check “Enable AI Auto Detection” checkbox. (Note: if PC, GPU driver does not support Cuda, this check box will be grayed out).

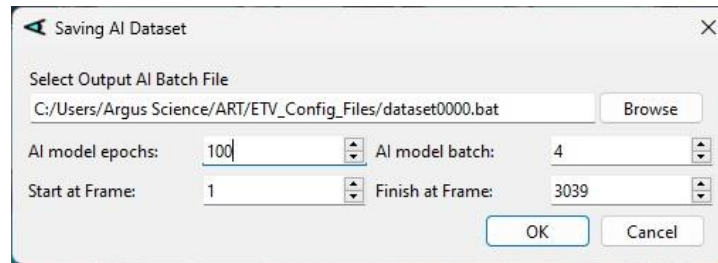
3.3 Add training material to existing ArgusAImodel

- Use *ETVision* headgear to make a video containing additional objects to be recognized by AI or to add views of existing objects. Be sure *ETVision* is set to not record LAOI/AI, gaze, or fixations on the scene video.
- Open video in *ETAnalysis* and create MAOIs that track objects of interest. If an object of interest is the same as one already included in model be sure to give it the same name.
- Save MAOIs. View MAOIs and click “save video” icon to save “AI data set”.
- Use the browser to select the same dataset bat file (in the same AIproject folder) created for the original model. When prompted to “overwrite?”, click “Yes”. (Note both previous and new material will be included in new files).
- Run the dataset bat file as before. (Both previous and new training material will be included in the new model).
- Subfolders under the dataset folder will be updated with additional images, labels and associated material. “ArgusAIModel.onnx” and “ArgusAINames.txt” files will be created in the data set folder, overwriting any previous files with these names in the data set folder, and constituting a new ArgusAIModel. The new model will incorporate both the previous and new training material. As previously explained, copies of the AImodel and AInames files can be renamed as long as the proper naming convention is followed, and copies can be placed in a different directory folder if desired.
- Follow directions in the previous section to select the new AImodel and AInames files in *ETVision*.
- When adding new training material to an ArgusAImodel, be careful not to include anything that will degrade the previous training.
 - If the objective is to “teach” the AI about a new object that was visible in the original “training video” but was not tracked in that training video, it is usually best to start fresh by tracking all objects of interest in the video with MAOIs, and create a new AI model. The reason is that the existing AI model will already have learned that the new object is not in images like those in the original video.
 - If the objective is to “teach” the AI model about a new object that was not visible in the original training video, training material can be added to the previous model; but either be sure that none of the previous objects are visible in the new training video or, if they are visible, be sure to track these objects in the new training video as well as the new object. If

previous objects are visible in the new training video but not tracked, the AI model will start to learn that these objects are not present when seen in images like those in the new video.

3.4 AI model training parameters

The “Saving AI Dataset” dialog, in *ETAnalysis*, includes several parameters in addition to the “Output AI Batch file” path and name, as shown below.



The start and finish frame parameters default to the first and last frame of the training video file. The other two parameters are “AI model epochs” and “AI model batch”. The default values for these parameters are “100” and “4”, respectively.

“AI model epochs” specifies the number of times each training image will be used. Increasing this number will tend to improve the model, but with diminishing returns and at the expense of additional time required to complete the training.

“AI model batch” specifies the number of processes attempted in parallel and has a maximum number that depends on the capabilities and resources available to the PC, especially the GPU capability. Larger “batch” values will speed up the training process if the system has the required capability, but if the system capability is exceeded, the process will fail when the dataset bat is executed. Failure is sometimes indicated with an “Out of Memory Error”; but some times with less obvious errors indicated during the bat process.

The default value “AI model batch=4” is a safe setting for systems with at least the minimum hardware requirements as previously specified.

The training process was successfully tested with “AI model batch=32” using a computer with the following specs.

Processor: i7; 12700H 2.7 GHz

GPU: Nvidia RTX 3060

RAM: 16 GB

Hard Disk: 932 GB

OS: Win 11

Although systems may be able to handle higher values (as illustrated by above example), the maximum value for any specific system configuration needs to be determined by trial and error, and there are too many possible system configurations to test all possibilities. It will be up to the user to decide whether to simply use the safe default value of 4 or experiment with higher values for the “batch” parameter.

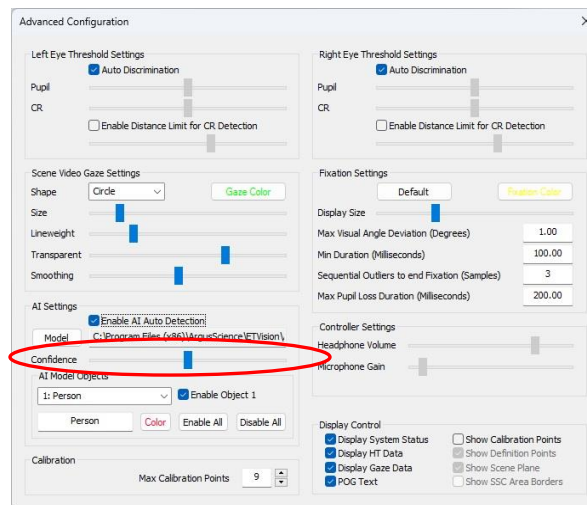
3.5 Using an AI model in *ETVision*

3.5.1 Load and enable AI model

On the *ETVision*, *Advanced Configuration* dialog, under “AI Settings”, click the “Model” button. Use the resulting browser to select the “.onnx” AI model file for the newly created ArgusAIModel. Assuming that the previously described naming convention has been followed, this will also automatically select the corresponding AI names file. Check “Enable AI Auto Detection” checkbox. (Note: if PC, GPU driver does not support Cuda, this check box will be grayed out).

3.5.2 Adjust AI detection confidence threshold

The AI model assigns a confidence level to each detected object. *ETVision* accepts the AI object designation and displays an object bounding box only if the confidence level is above a threshold level specified by the “Confidence” slider on the *Advanced Configuration* dialog. The default level is 50% (center of slider range).

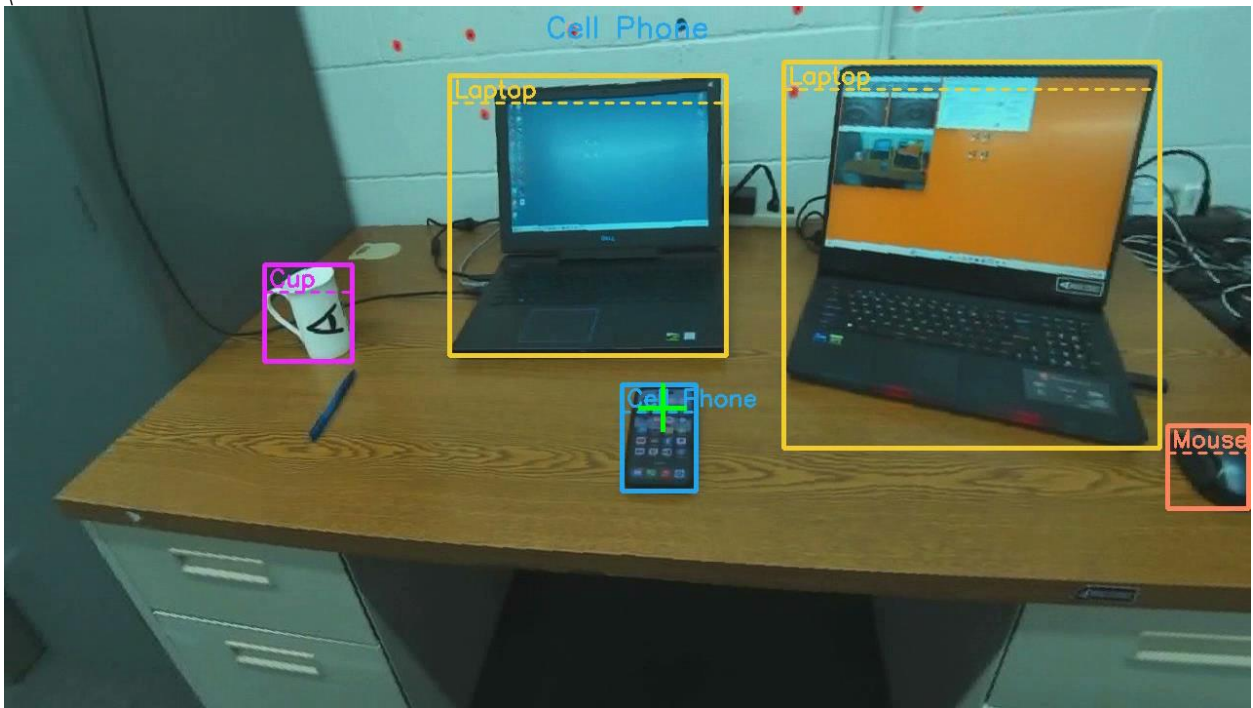


If some visible objects are being detected correctly but intermittently (bounding box is flashing on and off), increasing the “Confidence” setting (moving slider to the right) may result in more stable detection. However, setting too high a “Confidence” threshold may result in false detections (detection of objects that are not really in the image). The “Confidence” slider setting applies to all AI model objects.

3.5.3 AI object detection display

When “AI Auto Detection” is enabled, objects recognized in the scene image by the AI model will be enclosed by a labeled rectangular outline, or “bounding box”. If the POG cursor is within one of the bounding boxes, text at the top center of the scene camera image will display the object name.

In the scene camera image below the AI model is recognizing two “Laptop” computers, a “Cup”, a “Cell Phone”, and a “Mouse”. The POG cursor is within the “Cell Phone” bounding box, and this is indicated by the text at top center of the image.



3.5.4 Modify object properties

Use the “AI Model Objects” drop down menu, on the *Advanced Configuration* dialog, to see a list of object numbers and names for the AI model currently loaded. Names will be truncated if too long to fit in the pull down menu box. Select an object from the list to see the properties of that object. Properties include an “Enable” check box for the object, as well as the full name of the object and color of the object bounding box that will be superimposed on the scene camera video image.

Once an object is selected, as described above, the name can be changed by typing in the name field, and the color can be changed by clicking the “Color” button and selecting from the resulting color dialog.

Unchecking the “Enable” box will prevent ETVision from displaying or recording detection of that object. Properties of other objects will be unchanged. The entire set of objects can be enabled or disabled by clicking the “Enable All” or “Disable All” buttons. If the model has a large number of objects (for example the 80 object model provided by Argus Science) a quick way to enable only a small subset of the objects is to first click “Disable All”, and then select and enable each object from the subset to be used.

As long as the same model remains loaded in ETVision, the property modifications described above will be remembered, even if ETVision is closed and reopened. The property modifications do not affect to the actual AI model and name files. When a model is loaded to ETVision (click “Model” button and browse to desired *.onnx model file), original properties are restored. To restore the original properties of the currently loaded model, simply click the “Model” button and re-select it from the browser).

3.5.5 AI object detection data

If the “Gaze_AI” data item is checked on the *Data Selection* dialog (section 7.8.1.1), a “Gaze_AI” column on data files recorded by *ETVision* will indicate when gaze falls within the bounding box of a detected object. If real-time data is being streamed to an external device (section 7.9) the “Gaze_AI” data item will be included in the data stream.

The Gaze_AI data item will be zero when gaze is not within any AI bounding box. When gaze is within an AI object bounding box, the Gaze_AI data item will be the integer value corresponding to the object number in the AI model being used. Object numbers for the default AI model supplied by Argus Science are listed below, in section 3.5.6, and can also be viewed on the “AI Model Objects” pull down menu when the model is loaded. For example, if the default model is being used and gaze is within a bounding box labeled “Car”, the Gaze_AI data item will be 3. If gaze is within a “Chair” bounding box, Gaze_AI will be 57.

AI bounding boxes may overlap on the scene image. If gaze is within more than one overlapping AI bounding box, gaze will be reported to be on the one for which gaze is closest to the center of the bounding box. If the fix_duration data item indicates that a fixation is in progress (see ETVision manual, sections 7.4.1 and 9.12) the “Gaze_AI” data item will indicate which object, if any, is being fixated. Note that if more than one object of the same type is detected (for example, the two laptops in the screenshot on the previous page) the data will not distinguish between them.

3.5.6 Items included in default ArgusAIModel

Object number	Object name
1	Person
2	Bicycle
3	Car
4	Motorbike
5	Aeroplane

6	Bus
7	Train
8	Truck
9	Boat
10	Traffic Light
11	Fire Hydrant
12	Stop Sign
13	Parking Meter
14	Bench
15	Bird
16	Cat
17	Dog
18	Horse
19	Sheep
20	Cow
21	Elephant
22	Bear
23	Zebra
24	Giraffe
25	Backpack
26	Umbrella
27	Handbag
28	Tie
29	Suitcase
30	Frisbee
31	Skis
32	Snowboard
33	Sports Ball
34	Kite
35	Baseball Bat
36	Baseball Glove
37	Skateboard
38	Surfboard
39	Tennis Racket
40	Bottle
41	Wine Glass
42	Cup
43	Fork
44	Knife
45	Spoon
46	Bowl
47	Banana
48	Apple
49	Sandwich

50	Orange
51	Broccoli
52	Carrot
53	Hot Dog
54	Pizza
55	Donut
56	Cake
57	Chair
58	Sofa
59	Potted Plant
60	Bed
61	Dining Table
62	Toilet
63	TV Monitor
64	Laptop
65	Mouse
66	Remote
67	Keyboard
68	Cell Phone
69	Microwave
70	Oven
71	Toaster
72	Sink
73	Refrigerator
74	Book
75	Clock
76	Vase
77	Scissors
78	Teddy Bear
79	Hair Drier
80	Toothbrush

4 Commonly asked Questions

Q: How long should my video for training objects be?

A: In general, ETAnalysis does not require lengthy videos for training objects. Somewhere on the order of 2 to 5 minutes should be acceptable.

Q: What would be the best approach when making a video for performing AI Training?

A: Eye tracking is not required for an AI training video. Be sure ETVision is set to not record LAOI/AI, gaze, or fixations on the scene video. Try to use the Scene camera to get different view angles and distances to the object you want to train.

Q: My object tracks okay, but can we make it better?

A: Yes. Create an additional training video with the object in different lighting conditions or in an area with different surroundings if possible. Track the object with an MAOI on the new video and “Save AI data set” to the same Batch file you already used to train the existing model. When prompted to “overwrite?”, click “Yes”. This will add the new images to the training material used when you run the batch file (effectively adding more visual content for training). Run the batch file again to train the new object file.

Q: Occasionally I get a false recognition of an object that is not the actual object I trained for. How do I correct this?

A: Record a short section of video where these false indications occur. If there are any objects previously trained for in the new video, be sure to make MAOI’s for these, but best case is to have the area of false detection in the video with no other valid objects of interest. In this case, you don’t need to create any MAOIs. “Save AI data set” to the same Batch file you already used to train the existing model, and run the Batch file again. This is “addition by subtraction”. You will be teaching the model that the objects that were falsely detected are not one of the objects it should recognize.

Q: How do I add an object to an already completed AI Model file?

A: If you are using the same training video and adding an object, reload the MAOI collection in ETAnalysis and add a new MAOI to existing collection. From this point on, treat it as though making a new AI Model. Save “Save AI data set” to new batch file and folder. Run the new batch file to train a new AI model.

If the new object was not in the original video, then you can add a new training video to the AI Model file as described for the previous two questions. If the new training video also contains images of the previously defined objects, be sure to also track those objects with MAOIs using the same names as in the original training video.

Q: When making my MAOI file for training, should I use Rectangle or multi-vertice bounding box?

A: It is faster and easier to use the rectangle MAOI bounding box since we only need to have the object we are training within the bounding box.