BLOCKCHAIN ON ARTIFICIAL INTELLIGENCE CLOUD

– AI TRAINING 305

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Product: https://aws.amazon.com/marketplace/pp/B01JJ31R8C

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1. What is Artificial Intelligence (AI)?

Recently human intelligence such as learning and problem solving has been quickly approached by machine computing. The notion of Artificial Intelligence (AI), also known as machine intelligence, may be substantiated by the fast-moving machine learning technologies that have started the next industrial revolution.

2. What is Machine Implicit Learning (MIL)?

Extended from human learning, machine learning technologies include a family of classification algorithms. Human implicit learning refers to a set of classification capabilities acquired without human awareness.

Can one train machines to acquire implicit learning capabilities from studying images based on machine learning?

AI 202 documents the problems and solutions to develop the machine implicit learning capability of image machine learning by using AIHPC cloud that integrates top machine learning technologies.

3. What is AIHPC cloud?

AIHPC (AI and HPC) cloud is a next-generation Amazon cloud product of machine intelligence platforms (including TensorFlow and MXNet), Big Data container platforms, and cloud container computing. With a *unified user interface*, AIHPC cloud supports artificial intelligence (AI) computing and advanced cloud container infrastructure with HPC (high-performance computing) and Big Data workload.

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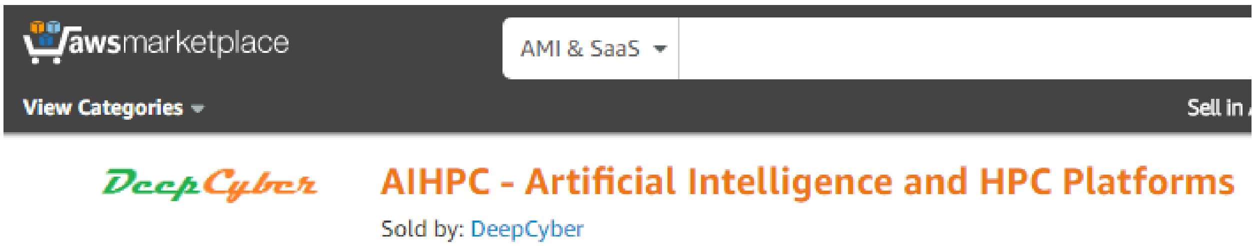
4. How to launch AIHPC servers in GovCloud?

In the EC2 launch site of AWS GovCloud management console, you may search the GovCloud marketplace for “AIHPC” and launch an AIHPC server in the GovCloud (US) region. AIHPC is certified on regulated workload and sensitive data by AWS GovCloud for U.S. persons thus works best for U.S. government users.

For industrial users, you may go to the typical AWS marketplace at https://aws.amazon.com/marketplace/pp/B01JJ31R8C to launch an EC2 instance of the AIHPC cloud.



5. How to provision your AIHPC cloud cluster?

1) Launch the AIHPC AMI from the AWS link to an EC2 instance and obtain {Your IP/DNS}
2) SSH into the new EC2 and verify that "/home/ubuntu/lb.sh" launches 5 docker containers and a container load balancer
3) Open /home/ubuntu/ML_notes for instructions to test ML platforms on a universal user interface

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6. What are the machine learning (ML) platforms integrated in AIHPC?

1) TensorFlow - Google ML platform
2) MXNet – Deep Learning Framework
3) MLR – Machine Learning in R framework
4) Weka for ImageJ
5) OpenCV

7. How are these ML platforms integrated?

These ML platforms are integrated on the R console. They are also accessible from the web client of the RStudio Server of your EC2 instance.

8. How to test integrated ML platforms from R?

SSH into your EC2 instance, then

```
1) sudo R -> source("mnist.R",echo=TRUE)
2) sudo R -> source("mxnet.R",echo=TRUE)
3) sudo R -> source("mlr.R",echo=TRUE)
```

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9. What are the key values of AIHPC cloud?

The integrated AIHPC cloud platforms:

1) Develop new AI capabilities such as implicit machine learning
2) Provide a unified user interface to use popular ML platforms
3) Speed up your AI demo and AI solutions by providing a convenient and powerful starting point
4) Allow quick and handy ML demos from Web
5) Process machine learning and computer vision workload with the integrated AIHPC artificial intelligence platforms (TensorFlow, MXNet, Weka, ImageJ, and OpenCV3)
6) Process Big Data workload with the integrated AIHPC Spark and Hadoop container platforms and HPC cloud clusters
7) Engage container parallel processing for dockerized cloud HPC node 5 times faster than a regular EC2 host; building on the ZDAF AMI with dual-layer security for DOS and ZeroDay defense

10. Who are the users and customers of AIHPC?

1) Users: faculty and students of Cognitive Science, Computer Science and Information Management, Chief Technology Officers (CTO), Solution and Enterprise Architects, Data Scientists, and AI Sales Engineers.
2) Customers: universities, research and training institutes, consulting firms, banks, technology companies, government agencies, and other large/medium/small companies

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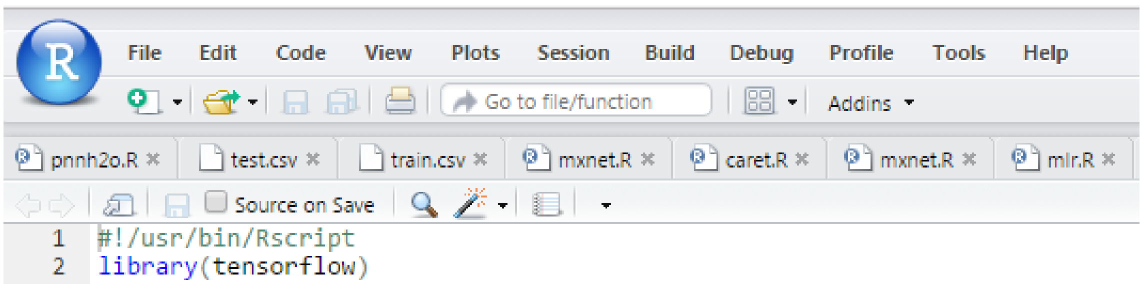
11. How to access AIHPC cloud from Web?

ADC Servers	Protocol	IP Address	Port	Launch/Access
AIHPC RStudio	http	EC2 Public IP	**8787**	**ubuntu**
AIHPC Jupyter	https	EC2 Public IP	**8888**	**./jup_start &**

Note: You many want add incoming rules to the AWS security group for the EC2 instance to open the ports to trusted source IPs.

12. How to use the R Web of AIHPC cloud?

URL: http://{Your Public IP}:8787 -> user=ubuntu; password by "sudo passwd" via SSH



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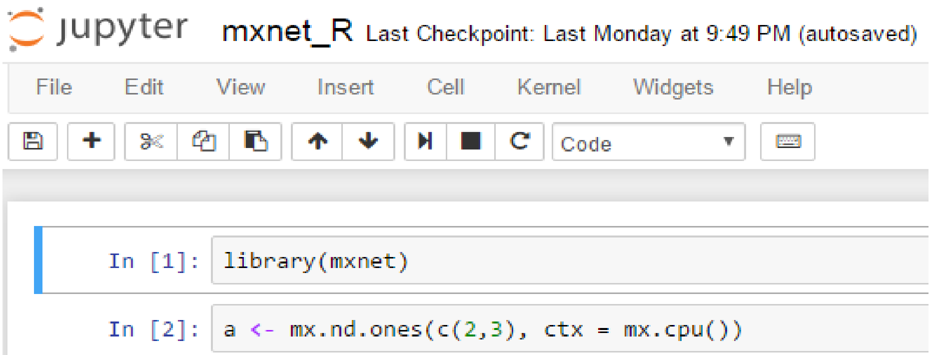
13. How to use the Jupyter Web of AIHPC cloud?

URL: https://{Your Public IP}:8888 -> click “Log in”



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14. How to create HPC clusters with AIHPC AMI?

1) Use AWS CfnCluster {see instruction at https://aws.amazon.com/hpc/cfncluster} custom_ami={AIHPC AMI ID};
2) Use MIT StarCluster {see instruction at http://star.mit.edu/cluster} node_image_id={AIHPC AMI ID}

15. How to locate the {AIHPC AMI ID} for a specific region to build HPC clusters?

AIHPC AWS Product Page -> Continue -> Manual Launch -> AMI IDs for different regions

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16. How to launch 5 Docker containers and a container load balancer?

`/home/ubuntu/lb.sh` {execute this script from SSH command line}

17. Why is your HPC cluster on AIHPC AMI 5 times faster?

With AIHPC cloud, the additional 5 Docker containers are running in parallel to expand the processing power. This makes your HPC cloud 5 times faster than conventional EC2 instances that do not use AIHPC.

18. Can AIHPC reduce the number of EC2 worker nodes?

Yes. With AIHPC cloud, each of the 5 containers of a worker node can process similar workload as an original worker node.

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19. What is the URL to verify that the load balancer is working for a worker node?

Browser -> http://{Your IP/DNS}:9000/

20. How to show the 5 containers and the enterprise load balancer on EC2?

`docker ps` {this also verifies that the load balancer are running for the 5 containers}

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21. How to use the computer vision AI platform on AIHPC cloud?

Using an SSH session, go to the folder:

~/opencv-3.0.0/OpenCV_3_KNN_Character_Recognition_Python

1) Use the windows remote desktop client and log in to your EC2 instance.
2) Open file manager -> Tools -> Open Current Folder in Terminal
3) cd ~/opencv-3.0.0/OpenCV_3_KNN_Character_Recognition_Python
4) python TrainAndTest.py {Test 1}
5) python GenData.py {Test 2}

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22. How to run face recognition on a sample Obama image?

1) cd ~/opencv-3.0.0/obama_face;
2) python t1.py haarcascade_frontalface_default.xml obama-phone.jpg;
3) cd /tmp; w3m obama-phone.jpg.faces.jpg
4) You need to use GUI to view the graphic result.

23. How to train new classifiers on images?

1) Use the windows remote desktop client and log in to your EC2 instance.
2) Open file manager -> Tools -> Open Current Folder in Terminal
3) cd ~/Fiji.app
4) ./ImageJ.sh
5) Fiji (ImageJ) menu -> Plugins -> Segmentation -> Trainable Weka Segmentation -> ~/Fiji.app/images -> obama-phone.jpg
6) Select face -> add to class 1 -> select background -> add to class 2 -> click train classifier

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24. How to run the Hadoop container platform?

```
$ docker run --privileged -it -p 50070:50070 -p 8032:8032 dc_hadoop
/etc/bootstrap.sh –bash
```

25. How to verify Hadoop UI?

browser -> http://{Your New IP}:50070/

26. How to use the Spark container platforms?

1) run spark container

```
$ docker run --privileged -it -p 8088:8088 -p 8042:8042 -p 4040:4040 -h
sandbox dc_spark bash
```

2) verify spark UI: browser -> http://{Your New IP}:4040
3) test Spark {inside spark container shell}

run the spark shell

```
pyspark {python spark-shell}
spark-shell
```

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27. How to secure Hadoop container with ADD?

```
$ docker run --privileged -it -p 50070:50070 -p 8032:8032 dc_hadoop
/etc/bootstrap.sh –bash

$ source /root/.bashrc
```

28. How to secure Spark container with ADD?

```
$ docker run --privileged -it -p 50070:50070 -p 8032:8032 dc_hadoop
/etc/bootstrap.sh -bash

$ source /root/.bashrc
```

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29. How to use GUI to view images on EC2 host?

1) make sure lxdm is running from EC2 console {i.e., the SSH session}
2) `sudo start lxdm`
3) make sure you know ubuntu password {use "sudo passwd" to reset}
4) `sudo passwd ubuntu` {in case the password for ubuntu is not set}
5) start the windows remote desktop client and enter the public DNS or the elastic IP of your server instance and hit connect.
6) enter the username (ubuntu) and password (pass) of the server instance and hit ok
7) use GUI file manager to navigate to /tmp, click obama-phone.jpg.faces.jpg

30. How to run license plate code with OpenCV3?

1) cd ~/opencv-3.0.0/OpenCV_3_License_Plate_Recognition_Python
2) Use the windows remote desktop client and log in to your EC2 instance.
3) Open file manager -> Tools -> Open Current Folder in Terminal
4) cd ~/opencv-3.0.0/OpenCV_3_License_Plate_Recognition_Python
5) python Main.py {Test 1}

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31. What is human image implicit learning (HIIL)?

The notion of human intelligence as learning may be extended by human implicit learning research. George Miller and Arthur Reber of Harvard started the field of human implicit learning in Cognitive Science by inventing the human task of artificial grammar learning in 1960s.

There are generally two phases in artificial grammar learning experiments:

Phase 1 - training: subjects study a string of letters, all of which follow the rules of an artificial grammar.

Phase 2 – assessment of classification: the subjects are told to **classify** new strings as either following the rules of the grammar or not. The results usually show that the subjects are able to classify the strings more accurately than chance would predict. However, when asked to **clarify** why they chose to classify particular strings in as grammatical, subjects were typically unable to verbalize how they did it.

Extending the artificial grammar implicit learning research, in a human image implicit learning (HIIL) experiment (Yang and Ye, 1993), subjects are asked to classify face pictures on salient (front vs. leaning faces) and non-salient (pretty vs. not-pretty faces) dimensions after training/studying similar pictures without explicit explanation of the rules to classify the pictures. Results show that the subjects can learn implicit rules (**not able to reason why**) to **classify** new pictures better than others who do not have the implicit training.

References:

Miller, G.A. (1958). "Free recall of redundant strings of letters." Journal of Experimental Psychology. 56 (6): 485–491.

Reber, A.S. (1967). "Implicit learning of artificial grammars." Verbal Learning and Verbal Behavior. 5 (6): 855–863.

Yang, Z. L. and Ye, G. W. (1993), "Characteristics of Implicit Learning: Learning Capability and Density of Transmission and Storage," Psychological Science, 16(3), 138-161.

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32. What is machine image implicit learning?

Machine implicit learning (MIL) falls in the intersection between cognitive science, cognitive computing, AI, machine learning, and computer vision etc.

From human subjects to AI machines as the AIHPC cloud machines, our machine image implicit learning experiment may mimic the ANOVA (analysis of variance) design of the classical human image implicit learning study (Yang and Ye, 1993) as follows:

Material of experiments: face images

Subjects: humans as students

Design: 2x2 ANOVA design

IVs = A and B

A = training factor = implicit learning/training vs. control (no learning)

B = dimension factor = salient vs. non-salient classification of images

DV = classification performance of grouping pictures

Task = image classification: ask students to group pictures to four categories. The pictures are pre-classified by complex rules that are designed to be difficult to reason yet can be learned implicitly through training.

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33. Compare human implicit learning to MIL tasks

Human implicit learning and MIL may be compared to show many similarities except for subjects. We shall demonstrate that machines shall classify pictures implicitly better than chance.

Components	Human Image Implicit Learning (HIIL)	Machine Image Implicit Learning (MIIL)
Notion of learning (same)	Two phases: training and assessment of learning	Two phases: training and assessment of learning phases
Notion of “implicit” (same)	Humans cannot reason the complex rules of grouping	Machines cannot reason the complex rules
Subjects (different)	*Humans* such as students	Machines such as *AIHPC cloud*
Learning Material (same)	Face pictures of different classes	Pictures of different classes (e.g., cats vs. dogs)
Rules of grouping (same)	Grouping by complex rules of the classes	Grouping of pictures by complex rules of the classes
Assumption (same)	Humans can learn implicit rules to classify pictures	AI machines can learn implicit rules to classify pictures
Conclusion (same)	Humans classify pictures implicitly better than chance	*MIIL effect: machines shall classify pictures implicitly better than chance*

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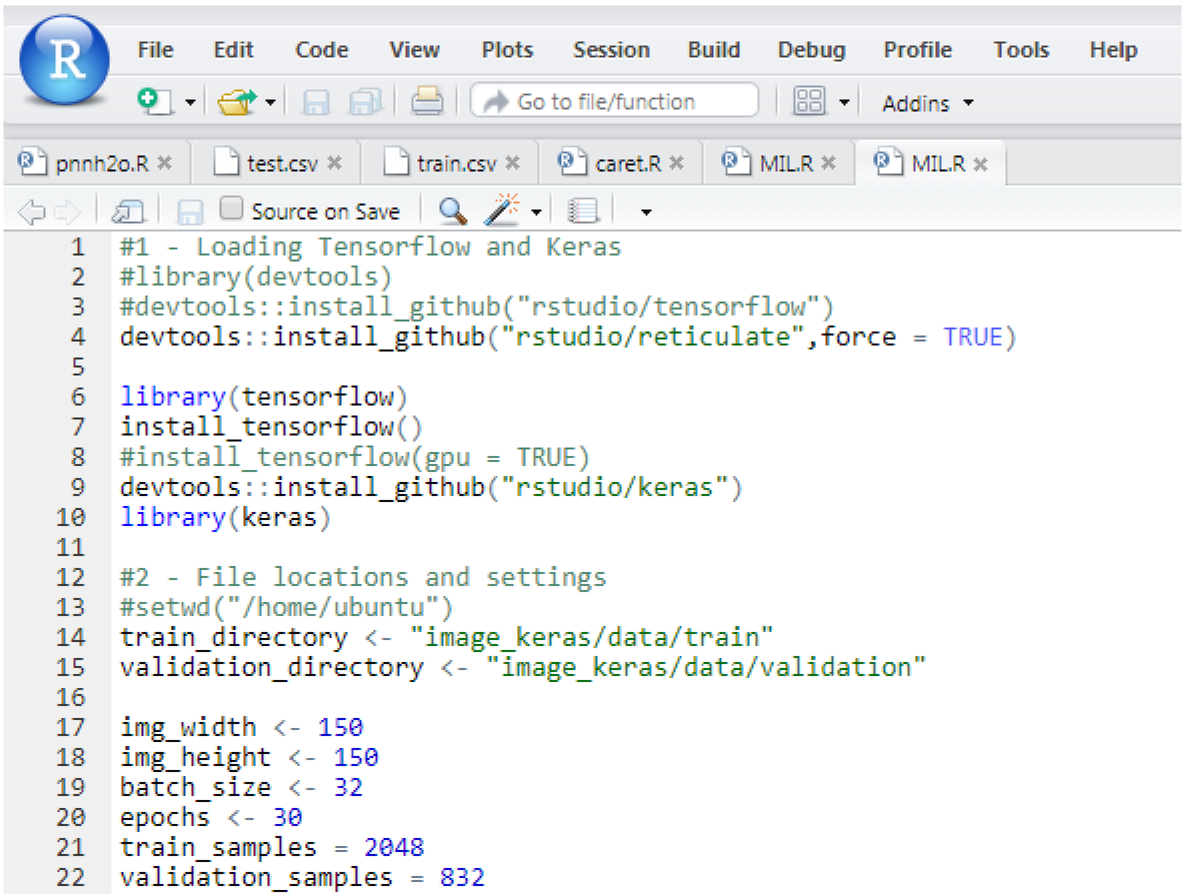
34. How to prepare the MIIL experiment?

1) MIIL stands for Machine Image Implicit Learning
2) Launch AIHPC cloud and establish an SSH session
3) Download the code from the github repo

```
git clone https://github.com/yeswici/image_keras
```

4) RStudio URL: http://{Your Public IP}:8787 -> user=ubuntu; password by "sudo passwd ubuntu" via SSH
5) Use RStudio Web to open ~/image_keras/R/MIL.R



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35. How are images trained with AIHPC CPUs?

The MIL.R code runs on AIHPC cloud with either CPU or GPU configurations. By default, CPU is used to train the MIL AI model machine with hundreds of training images.

```
#4 - Small Conv Net - 2) training
model %>% fit_generator(
  train_generator,
  steps_per_epoch = as.integer(train_samples/batch_size),
  epochs = epochs,
  validation_data = validation_generator,
  validation_steps = as.integer(validation_samples/batch_size),
  verbose=2
)
```

```
2017-07-03 17:28:03.577623: W tensorflow/core/platform/cpu_feature_guard.cc
structions, but these are available on your machine and could speed up CPU
86s - loss: 7.8716 - acc: 0.4946 - val_loss: 7.9353 - val_acc: 0.5000
Epoch 2/30
80s - loss: 7.6510 - acc: 0.5034 - val_loss: 6.6104 - val_acc: 0.4904
Epoch 3/30
80s - loss: 7.2396 - acc: 0.5029 - val_loss: 7.0901 - val_acc: 0.5024
Epoch 4/30
80s - loss: 2.4306 - acc: 0.5337 - val_loss: 0.6863 - val_acc: 0.5505
Epoch 5/30
80s - loss: 0.7084 - acc: 0.6006 - val_loss: 0.6586 - val_acc: 0.6178
```

References:

Relevant work to MIIL by AIHPC cloud - Azure face emotions:

https://azure.microsoft.com/en-us/services/cognitive-services/emotion/

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36. How to measure the MIIL training effect?

After the AI model machine is trained, the loss and accuracy of using the trained model to classify new test (validation) pictures shall be the metrics to measure the training effect.

```
#4 - Small Conv Net - 3)Evaluating on validation set
evaluate_generator(model,validation_generator, validation_samples)

> evaluate_generator(model,validation_generator, validation_samples)
[[1]]
[1] 1.341891

[[2]]
[1] 0.6887019
```

Here is the training effect by the accuracy metric. The neural network reaches ~69% accuracy. Hence, the implicit image learning through training by the machines has resulted in ~69% accuracy for using the trained AI model to classify new pictures, 19% better than the chance of 50%. The AI machines do not need to specify and reason the complex rules of the trained AI model to achieve the significant MIIL training effect.

References:

@misc{chollet2015keras, title={Keras}, author={Chollet, Fran\c{c}ois and others}, year={2015}, publisher={GitHub}, howpublished={\url{https://github.com/fchollet/keras}},}

Rajiv Shah, https://github.com/rajshah4/image_keras

DeepCyber of Maryland, https://github.com/yeswici/image_keras

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37. Google TSA MIIL competition

To further illustrate the details of MIIL training and computing, we introduce a practical MIIL research and study use case by a Google TSA completion on image machine learning.

Kaggle, a company owned by Google, collaborated with TSA (a federal agency responsible for airport security) to host a competition to predict the probability that a given body zone (out of 17 total body zones) has a threat present. There are more than three terabytes image files that may be analyzed for the predictions.

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38. Real-world MIIL use case: Preparations

The objective of the real-world use-case (nicknamed as *Catch Cats* or *CC* experiment) is to detect threats in scanned TSA images. The *CC* preparations are:

1) Code tsa_read_images.R (under */home/ubuntu/image_keras/R*) to extract the first *a3saps* zip file (*00360f79fd6e02781457eda48f85da90.a3daps*) to PNG images files
2) Transfer the image files to the AIHPC cloud
3) Code *rename,php* (under /home/ubuntu/image_keras/data_tsa) to rename and reorder the image files in the AIHPC cloud
4) Create a new folder *data_tsa* to hold TSA image files in a pre-set folder structure (*threats* in the TSA images are nicknamed as *cats*):

   /home/ubuntu/image_keras/data_tsa –> *train* -> *cats*

   -> *dogs*

   -> *validation* -> *cats*

   -> *dogs*

References:

TSA = Transportation Security Administration

TSA image files:

1) https://www.kaggle.com/c/passenger-screening-algorithm-challenge/data
2) https://console.cloud.google.com/storage/browser/kaggle-tsa-stage1/stage1/a3daps/?authuser=0

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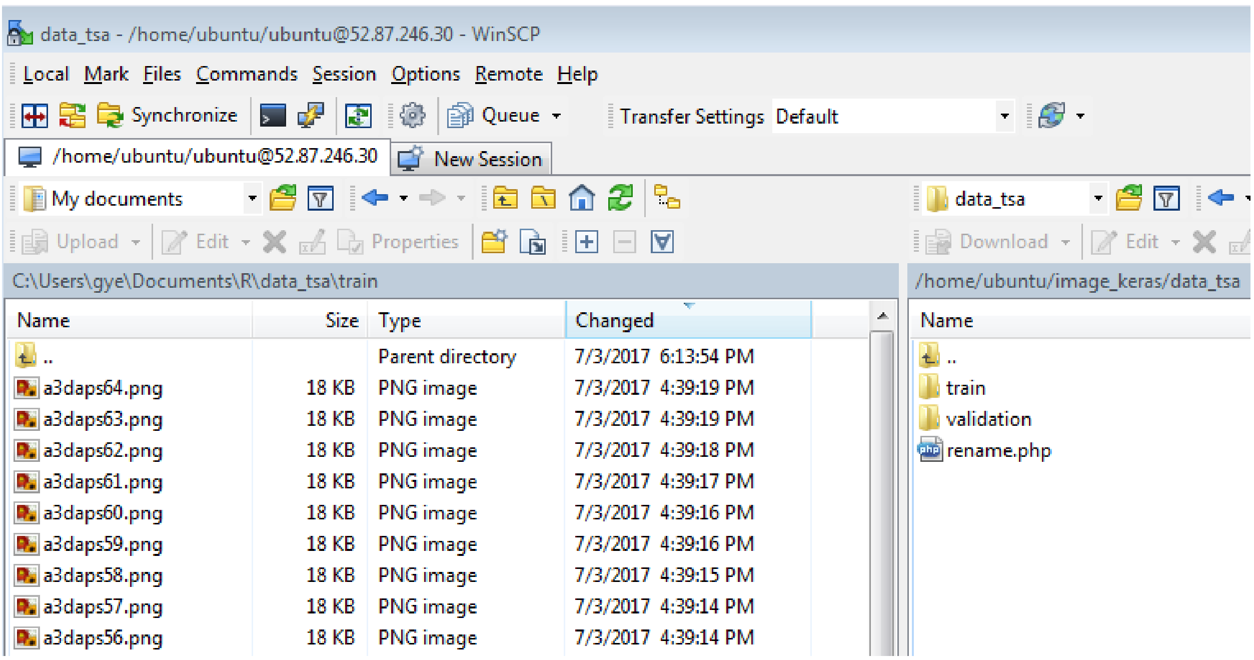
39. How to transfer image files to AIHPC cloud?

1) sudo apt-get install vsftpd
2) sudo vi /etc/vsftpd.conf
3) uncomment *#write_enable=YES* to *write_enable=YES*
4) sudo service vsftpd restart
5) WinSCP to connect with AIHPC cloud user *ubuntu*



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40. TSA MIIL execution and training effect

The R program *tsa_mil.R* (under */home/ubuntu/image_keras/R*) runs neural-network (NN) training and predictions to the TSA image files on the AIHPC cloud.

Using the trained neural-network model to test images in the validation or assessment phase, the result for the first *a3saps* file shows that it is possible to achieve above **97% accuracy** (i.e., the MIIL training effect) in detecting threats from the first set of TSA scanned images. Note that the testing/validation images are the same as the training images. Both come from the first *a3saps* file: *00360f79fd6e02781457eda48f85da90.a3daps*.

```
Epoch 1/30
4s - loss: 0.3269 - acc: 0.9688 - val_loss: 1.0000e-07 - val_acc: 1.0000
Epoch 2/30
3s - loss: 1.0000e-07 - acc: 1.0000 - val_loss: 1.0000e-07 - val_acc: 1.0000
Epoch 3/30
3s - loss: 1.0000e-07 - acc: 1.0000 - val_loss: 1.0000e-07 - val_acc: 1.0000
Epoch 4/30
3s - loss: 1.0745e-07 - acc: 1.0000 - val_loss: 1.0000e-07 - val_acc: 1.0000
Epoch 5/30
3s - loss: 1.0000e-07 - acc: 1.0000 - val_loss: 1.0000e-07 - val_acc: 1.0000
Epoch 6/30
3s - loss: 1.0000e-07 - acc: 1.0000 - val_loss: 1.0000e-07 - val_acc: 1.0000
Epoch 7/30
3s - loss: 1.0000e-07 - acc: 1.0000 - val_loss: 1.0000e-07 - val_acc: 1.0000
```

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41. Testing new TSA images

The objective is to use the images of the second *a3daps* file as validation images to test the trained model from the first *a3daps* file:

The first file = *00360f79fd6e02781457eda48f85da90.a3daps*

The second file = *0043db5e8c819bffc15261b1f1ac5e42.a3daps*

1) download the second *a3daps* file from Google cloud storage
2) upload the second *a3daps* file to the AIHPC cloud
3) extract the *a3daps* file to */home/ubuntu/images* by running *tsa_read_image.R* (under */home/ubuntu/image_keras/R*)
4) rename and add the extracted PNG files (from */home/ubuntu/images*) to */home/ubuntu/image_keras/data_tsa1/validation/cats*
5) run *tsa_mil.R* (under */home/ubuntu/image_keras/R*) for the new test/validation image files

Compared to testing the NN model with the same training images, the accuracy drops to *89%* from *97%* for the first iteration/epoch. The MIIL training effect comes to *100%* after several iterations of fitting the model.

```
> model %>% fit_generator(
+   train_generator,
+   steps_per_epoch = as.integer(train_samples/batch_size),
+   epochs = epochs,
+   validation_data = validation_generator,
+   validation_steps = as.integer(validation_samples/batch_size),
+   verbose=2
+ )
Epoch 1/30
4s - loss: 1.4342 - acc: 0.8906 - val_loss: 1.0000e-07 - val_acc: 1.0000
Epoch 2/30
3s - loss: 1.0000e-07 - acc: 1.0000 - val_loss: 1.0000e-07 - val_acc: 1.0000
Epoch 3/30
3s - loss: 1.0000e-07 - acc: 1.0000 - val_loss: 1.0000e-07 - val_acc: 1.0000
Epoch 4/30
```

```
> evaluate_generator(model,validation_generator, validation_samples)
[[1]]
[1] 1e-07

[[2]]
[1] 1
```


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42. Deep diving into body zones?

1) Approach 1: 64 images – a single *a3daps* file to produce 64 images per ID of 3D scans
2) Approach 2: 17 zones per image (select from the 64 images) per ID and then aggregate the training/testing metrics by averages.

We think Approach 1 is better than 2 to create a better trained neural-network model for the MIIL experiment with more accuracy. Why?

Approach 1 treats *threats* as a whole in whole body scans. This is in sync with developing an image classifies for cats and dogs that does not split cats/dogs images into pieces or zones.

Approach 2 splits *threats* into pieces (possibly in the 17 body zones). This may mislead the neural-network trainer to develop a less-accurate image classifier because of implement *threat* information per body zone.

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43. Automating file downloads

We may want to consider Approach 2 in a later stage. Yet at first, we implement Approach 1. Instead of detecting pieces of *threats* in 17 body zones of a single image per scan, we train and test 64 images per 3D-scan ID for 17 rounds to collect the accuracy probabilities for each round of training. The implementation steps are:

1) Install Google Cloud SDK

```
https://cloud.google.com/sdk/docs/#deb
gcloud auth application-default login
```

2) Install Google cloud library:

```
sudo apt-get update
sudo apt-get install composer
composer require google/cloud
```

3) Develop and run the main program:

```
Develop tsa_miil_main.php
Run: php tsa_miil_main.php (under ~/tsa)
First, this shall download an a3dasp file programmatically
```

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44. Automating R/PHP code for one a3daps file

The objective of *tsa_miil_main.php* is to connect *tsa_read_image.R*, *tsa_mil.R*, *rename.php*, and other programs to automate the steps to process a new *a3daps* file. The output file contains the new *a3daps* file id and the MIIL probability as the accuracy metric of testing/validating the new *a3daps* images.

```
function process_single_id($id)
{
    get_3d_file($id);
    extract_3d_runR($id);
    CopyRenameImageFiles($id);
    run_miil_R($id);
    write_submission($id);
    reset_tsa($id);
}
```

References:

PHP library to access Google cloud storage:

https://github.com/GoogleCloudPlatform/google-cloud-php

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45. How to process all the *a3daps* files?

The objective of the MIIL *CC* project is to produce and report the accuracy probability metrics for all the TSA *a3daps* files.

```
$arr_ids = get_id_list();
function process_all_ids($arr)
{
   for($i=0; $i<=sizeof($arr); $i++)
   {
           process_single_id ($arr[$i]);
   }
}
```

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46. How to run/monitor TSA MIIL on AIHPC EC2?

1) Run TSA MIIL and save screen output to *log*

```
~/tsa$ php tsa_miil_main.php | tee log
```

2) Count number of a3dasp files processed in real-time

```
~/tsa$ grep round_1, stage1_submission.txt |wc
```

3) Check submission output in real-time

```
~/tsa$ tail -f stage1_submission.txt
```

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47. Sample submission output

Below is part of a sample submission with accuracy probability as the prediction metric. Alternatively, loss probability (1 - accuracy) may be used as the prediction metric.

```
Id, Accuracy Probability of Aggregated Body Zones for 17 Training Rounds
00360f79fd6e02781457eda48f85da90_round_0,0.5625
00360f79fd6e02781457eda48f85da90_round_1,1.0000
00360f79fd6e02781457eda48f85da90_round_2,1.0000
00360f79fd6e02781457eda48f85da90_round_3,1.0000
00360f79fd6e02781457eda48f85da90_round_4,1.0000
00360f79fd6e02781457eda48f85da90_round_5,1.0000
00360f79fd6e02781457eda48f85da90_round_6,1.0000
00360f79fd6e02781457eda48f85da90_round_7,1.0000
00360f79fd6e02781457eda48f85da90_round_8,0.9844
00360f79fd6e02781457eda48f85da90_round_9,1.0000
00360f79fd6e02781457eda48f85da90_round_10,1.0000
00360f79fd6e02781457eda48f85da90_round_11,1.0000
00360f79fd6e02781457eda48f85da90_round_12,1.0000
00360f79fd6e02781457eda48f85da90_round_13,1.0000
00360f79fd6e02781457eda48f85da90_round_14,1.0000
00360f79fd6e02781457eda48f85da90_round_15,1.0000
00360f79fd6e02781457eda48f85da90_round_16,1.0000
```

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48. Machine Memories Framework

Machine memories are part of machine intelligence that resembles human memory, which is part of human intelligence including learning, memory, choice and decision making. Machine memories use AI algorithms and machine learning technologies on top of computer memory and storage to make machines operate as how human memory works.

Due to aging and drug abuse, one's memories may degrade over time. How to restore the memories that are useful yet fading away? Biologists and psychologists suggest brain regions such as Hippocampus (for memory formation and restoration), Barca (for storage of memories of words), and Visual Cortex (for image processing) are relevant to restore useful memories (see MacKay, The Engine of Memory, Scientific American Summer 2017).

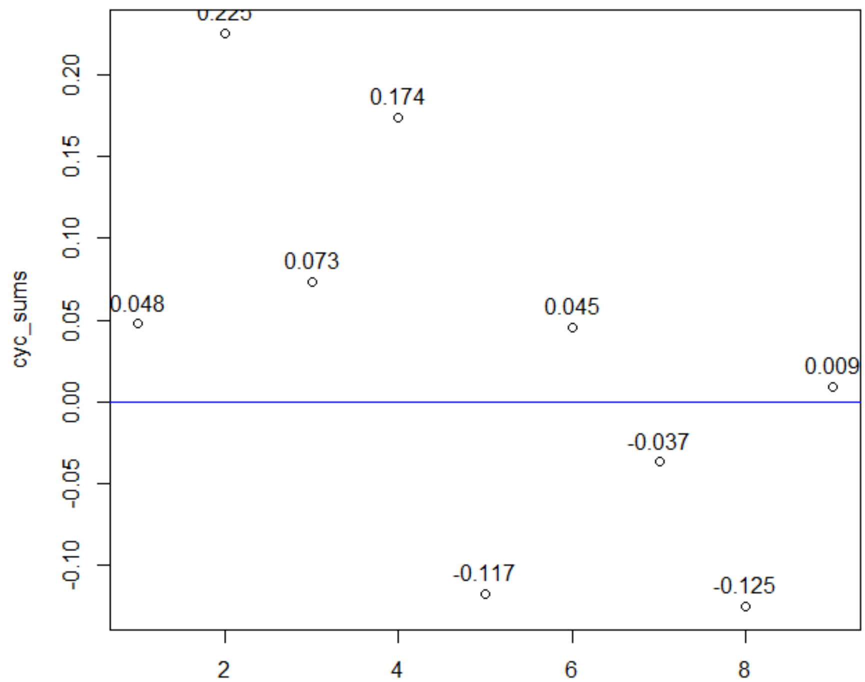
We propose that a machine memories framework (MMF) may function similarly or better in some areas than how human memories work. The MMF may use the AIHPC cloud as the machine computing infrastructure: for processing images (as Visual Cortex), the MMF uses the artificial intelligence platforms of AIHPC cloud such as TensorFlow, MXNet, Weka, ImageJ, and OpenCV3; for storing memories (as Barca), the MMF uses SSD and disk storages of AIHPC cloud or its on-premise storage mechanism; for restoring memories (as Hippocampus), the MMF uses the HPC and Big Data computing capabilities of the AIHPC cloud.

TRAINING NOTES

49. PNN Earnings Cycles (PEC) App for Stocks

AIHPC cloud has served as the backend engines for PNN AI applications. PNN stands for predictive neural nets, which is a trademarked and patented financial AI product for investment management as the first trend-spotting AI machine. PNN helps asset managers rank and optimize portfolios for better returns. See https://yeswici.com for a brief introduction.

PNN Earnings Cycles (PEC) app refers to one of the PNN AI applications that are running on the AIHPC cloud platforms. It builds on the new finding of an AI pattern called PNN Earnings Cycles (PEC): PNN selects a group of stocks that operate responsively to earnings calls in a predictable pattern. As a result, the PEC app has successfully advised actions and no-actions for practical asset management. The plot below shows the returns of the PNN earnings cycles for one of the PNN stocks. For the recent five earnings cycles, the stock returns 4% to 22% per cycle.



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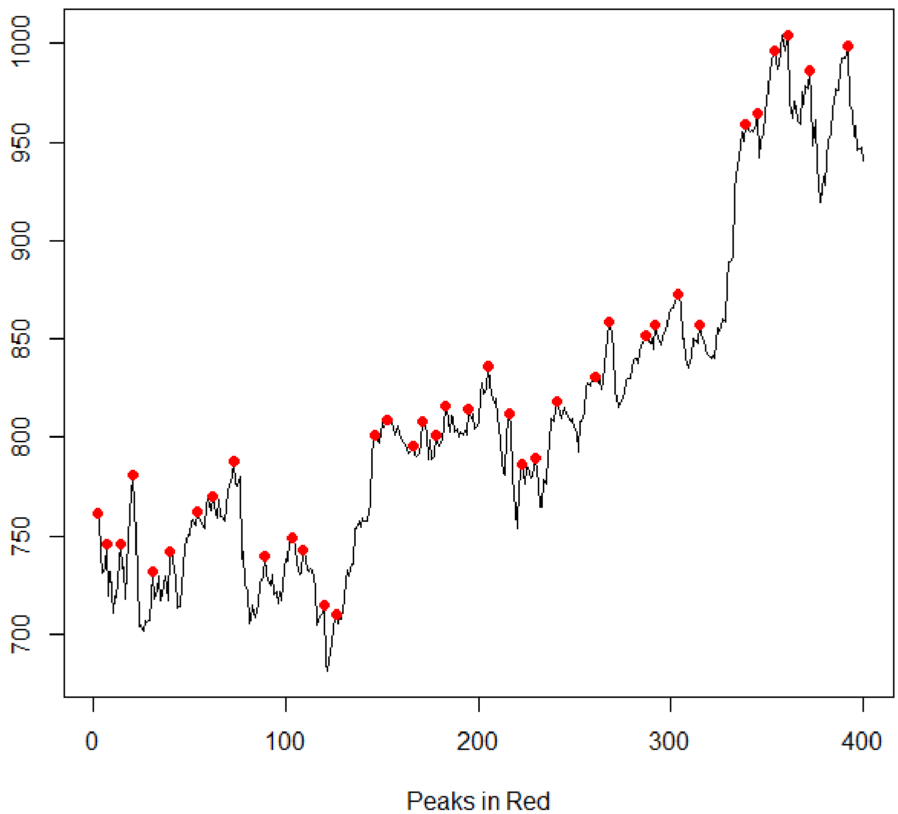
50. PNN Peaks (PP) App for Stocks

When will share prices peak? The PNN Peaks app on the AIHPC cloud computerizes the algorithmic pattern that captures the peak times and values of PNN stocks. The chart below shows the peak times and values in red dots for a PNN stock.

The new AI algorithm of the PP app discovered that the peaks of PNN stocks follow a pattern to appear. Along with the PEC app, this PP pattern has been applied to practical asset risk management to avoid huge investment losses.



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51. PNN Buyback (PBB) App for Stocks

Both AAPL and BABA have established strong shares buyback programs to reward investors. Can the buyback programs also improve its share performance? How to smarten the buyback programs to maximize the share performance over time? We understand that a CEO's performance is primarily assessed by the board and investors on the company's share performance.

The PNN Buyback (PBB) app on AIHPC cloud is designed for CEOs to use PNN Table app (see a sample below) and PNN Earnings Cycles (PEC) app to plan the buyback dates and amounts in order to hold up the desirable trends of share performance.

PNN Table for Asset Managers to Optimize Portfolios/ETF Funds - Trendspotting AI® Nightly Report

Rank	Ticker	cPrice	fAvgTrend	fRisk	Grade	GradeChange	LatestGradeChangeDate
1	AAPL	146.58	30.88%	28.75	★★★★★	No Change	Upgraded on 2017-04-15
2	NKE	54.99	20%	5.31	★★★	Downgraded	Downgraded on 2017-05-02
3	BP	34.32	12.16%	0.94	★★★★	No Change	Upgraded on 2017-04-20
4	TGT	55.77	7.3%	1	★★★	No Change	Downgraded on 2017-04-06
5	XOM	82.06	4.12%	1.26	★★★	No Change	Benchmark Grade on 2017-03-07
6	FB	152.46	-0.92%	0.8	★★★	No Change	Benchmark Grade on 2017-03-07
7	DAL	45.4	-5.05%	0.55	★★★	No Change	Benchmark Grade on 2017-04-05
8	GE	28.99	-6.79%	1.21	★★★	No Change	Upgraded on 2017-05-01
9	GS	224.85	-8.81%	5.94	★★★	No Change	Upgraded on 2017-04-22
10	BAC	23.61	-9.5%	1.28	★★★	No Change	Upgraded on 2017-04-14
11	JNJ	123.34	-15.59%	4.81	★★	No Change	Upgraded on 2017-04-16
12	JPM	87.06	-18%	4.9	★★	No Change	Upgraded on 2017-04-24
13	MS	43.74	-21.17%	2.35	★	No Change	Downgraded on 2017-05-02
14	MSFT	68.46	-21.71%	4	★	No Change	Downgraded on 2017-04-21
15	COST	177.86	-22.29%	9.21	★	No Change	Downgraded on 2017-04-29

TRAINING NOTES

52. How to install Blockchain Bootstrap on AIHPC?

To jumpstart the technical understanding of blockchain concepts, you may follow the steps to install the blockchain bootstrap app on your AIHPC cloud:

1) Launch an AIHPC cloud instance; see Topic 4 - How to launch AIHPC cloud instances.
2) SSH into EC2 console and download the app repo from *yeswici*'s github

```
$ git clone https://github.com/yeswici/blockchain-demo.git
```

3) Go to the app folder and install dependencies

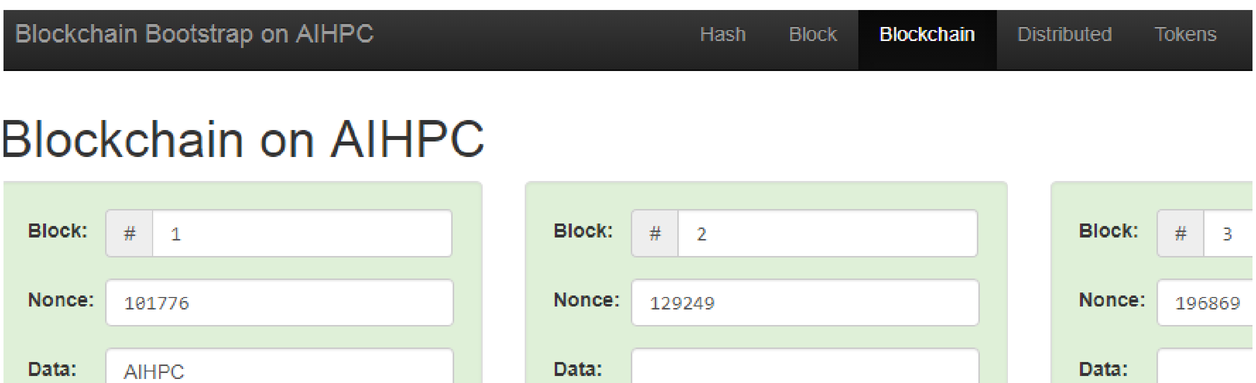
```
$ cd blockchain-demo/
$ sudo apt-get update
$ sudo apt-get install npm
$ sudo apt-get install nodejs
$ sudo ln -s /usr/bin/nodejs /usr/bin/node
$ npm install
```

4) Start the Web server and app

```
$ ./bin/www
```

5) Point a Web browser at the blockchain bootstrap app with this URL

```
http://{IP Address of the AIHPC EC2 Instance}:3000
```



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53. How to Make Changes to the Blockchain Repo?

You may fork the github repo (https://github.com/yeswici/blockchain-demo) and use it as a code base to develop your own blockchain app on the AIHPC cloud server. To commit the code changes to your own repo, follow the steps:

1) Fork the github repo (https://github.com/yeswici/blockchain-demo)
2) SSH into AIHPC EC2 and download the app repo from {your own repo}

```
$ git clone https://github.com/{your own repo}/blockchain-demo.git
```

3) Make code changes to your local repo copy
4) Add, commit, and push the code changes to your remote (github) repo

`$ git add *` {enter your github username and password}

```
$ git commit -m "Customized for AIHPC"
$ git push origin master
```

yeswici Customized for AIHPC	
bin	initial import
locales	Customized for AIHPC
public	Add donation image
routes	initial import
views	Customized for AIHPC

(Credit goes to Anders Brownworth who created the original github repo)

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54. Why Build Blockchain Apps on AIHPC Cloud?

First, the blockchain bootstrap app on AIHPC provides a decent foundation for you to build your own blockchain apps with AI and HPC capabilities. Similar to bitcoin and ethereum, your innovative blockchain app could be created if you find a meaningful connection between the blockchain capabilities and the AIHPC capabilities.

Second, running the blockchain bootstrap app on the AIHPC cloud enables the potential for you to stand on giant shoulders to leap forward by bridging the two hottest technologies: blockchain and artificial intelligence.

Third, the blockchain bootstrap app is open sourced thus you may extend the code and the capabilities of the app on the AIHPC cloud. The capabilities of the blockchain bootstrap app on the AIHPC cloud include hash crypto, block, blockchain, distributed blockchain and tokens. Topic 56 to Topic 60 shall elaborate these capabilities.

For example, you may use both the bootstrap app and the AIHPC AI platforms to create new blockchain apps such as 1) securing TensorFlow datasets of the AIHPC platform with SHA-256 hash functions of the blockchain technology; 2) analyzing blockchain transactions (tokens) of bootstrap-powered apps on neural nets with the MXNet platform of the AIHPC cloud.

Blockchain apps are expected to make significant contributions in many industries and businesses including payment, smart contracts, settlement, supply chain, digital identity, voting, healthcare, and insurance contracts, etc. We are developing a new blockchain app with the bootstrap code repo on the AIHPC cloud.

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55. Famous Blockchain Apps: Bitcoin and Ethereum

Building on the blockchain technology, bitcoin and ethereum have made significant impact to the financial world. Bitcoin is the first digital currency based on the blockchain technology. As of September 4th 2017, the bitcoin unit price has risen 622.99% since last year (see coinbase charts: https://www.coinbase.com/charts).

Ethereum is considered as bitcoin 2.0. It is a prominent next-generation blockchain platform that can issue new digital currency and crowd-sale the new digital currency.

Normally startup companies face challenges to raise funds to create and substantiate novel business models. The ethereum platform offers an automated approach and large audience to connect investors with innovations through new digital currencies.

Similar to IPO (Initial Public Offering) to raise public funds through exchanges, ICO (Initial Coin Offering) may use the ethereum platform to raise funds from the blockchain network,

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56. Blockchain Capability 1: SHA-256 Hash

SHA-256 Hash is one of the fundamental capabilities of the blockchain bootstrap app on the AIHPC cloud. SHA stands for Secure Hash Algorithm: a set of cryptographic hash functions designed by the United States National Security Agency (NSA). The SHA-2 family consists of six hash functions with hash values of 224, 256, 384 or 512 bits. SHA-256 hash uses the hash function with the hash value of 256 bits.

You may get instant hash values for the data entered in the blockchain app on the AIHPC cloud. Given that you have followed the steps of Topic 52, you may access the page below by clicking the “Hash” link from the home page of the blockchain app on the AIHPC cloud (http://{IP Address of the AIHPC EC2 Instance}:3000). Type some text such as “AIHPC” in the Text box; then the SHA-256 hash value for the text shall show up automatically below the Text box. The hash value is calculated by the JavaScript code of the blockchain bootstrap app available in the github repo.


```
function sha256(block, chain) {
  // calculate a SHA256 hash of the contents of the block
  return CryptoJS.SHA256(getText(block, chain));
}
```

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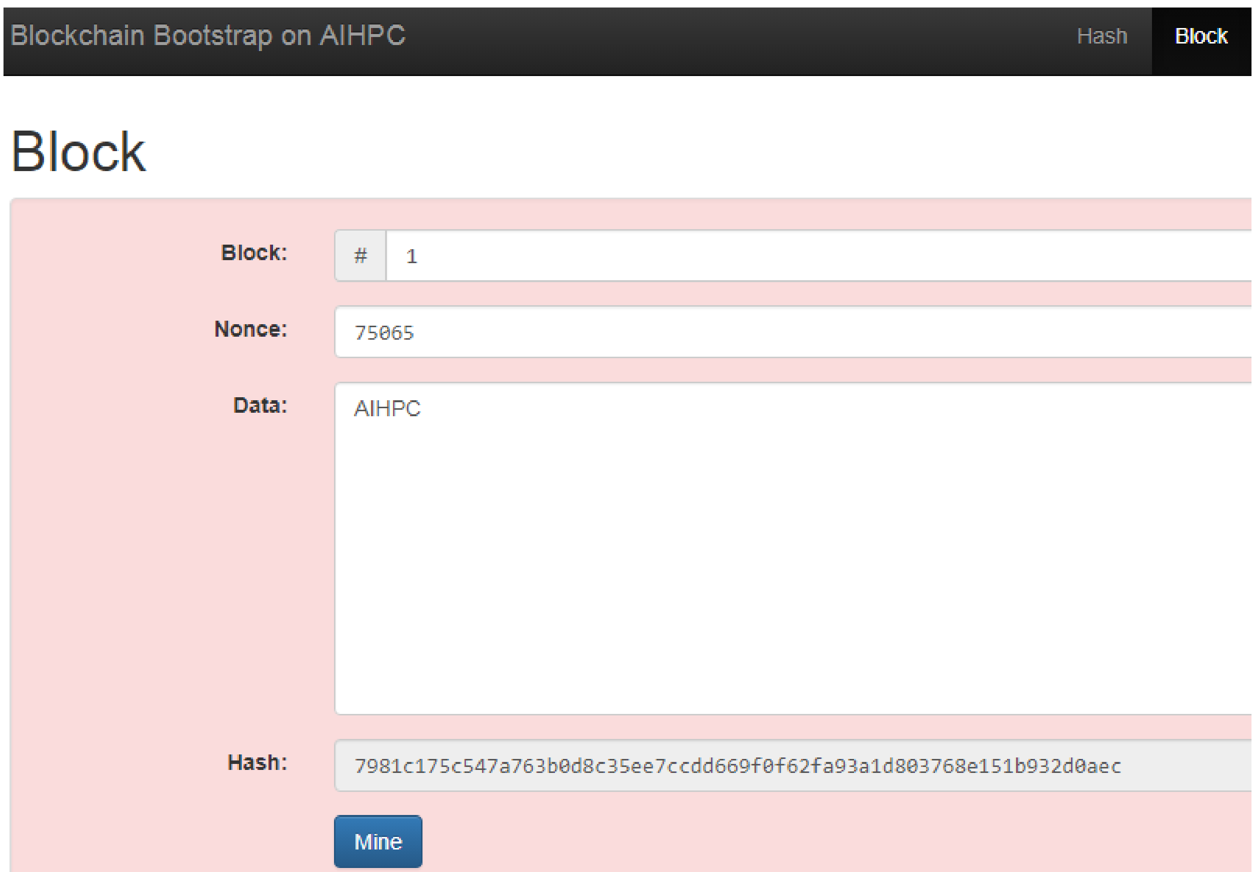
57. Blockchain Capability 2: Block

A block adds two new sections to Data and Hash; block number and Nonce. Block numbers are ordered to label the blocks. Nonces are arbitrary numbers that may only be used once. Blocks are building blocks of a blockchain.

Clicking on the “Block” link of the blockchain bootstrap app on the AIHPC cloud would show a block with Block number, Nonce, Data, and Hash sections. You may add or change the values in any of the three sections of Block number, Nonce, and Data. This would turn the background color to *pink* from *green* as the hash value would automatically change to four non-zeros at the beginning. Clicking on the “Mine” button below the Text box would change the hash value to a new one starting with four zeros, followed by the background color changing to *green* from *pink*.



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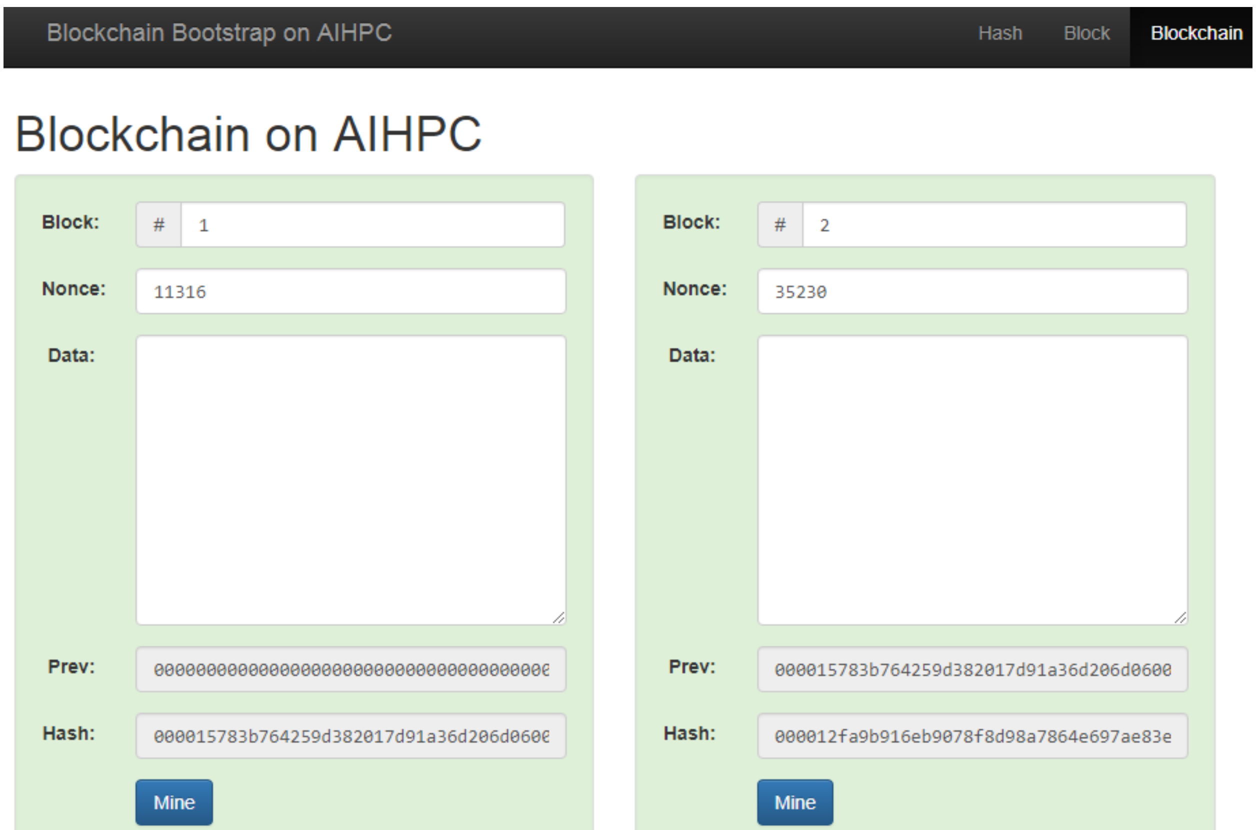
58. Blockchain Capability 3: Blockchain

Building on blocks, a blockchain connects multiple blocks. A "Prev" section is added to each of the member blocks to indicate the hash value of previous block that the current block is connected to. Any change to a block section could break the integrity of the blockchain and result in *pink* background for all subsequent blocks. You need to "Mine" the affected blocks of the blockchain to make the background *green* again.

You may access the "Blockchain" page as seen below by clicking the "Blockchain" link of the blockchain bootstrap app on the AIHPC cloud.



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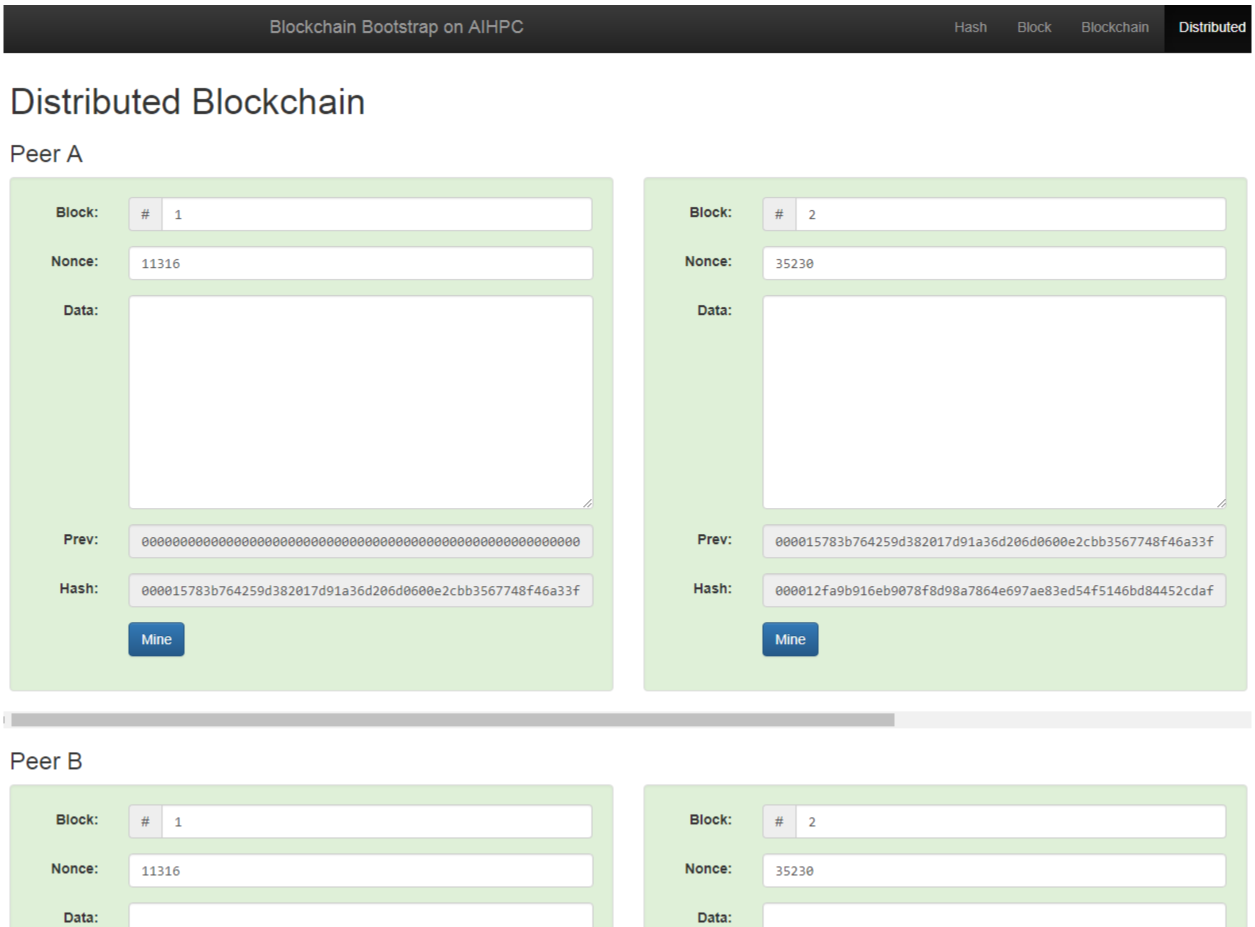
59. Blockchain Capability 4: Distributed Blockchain

A distributed blockchain is a network of multiple blockchains labeled as Peers. For example, Peer A and Peer B blockchain form a distributed blockchain as shown below. You may access the “Distributed Blockchain” page as seen below by clicking the “Distributed” link of the blockchain bootstrap app on the AIHPC cloud.



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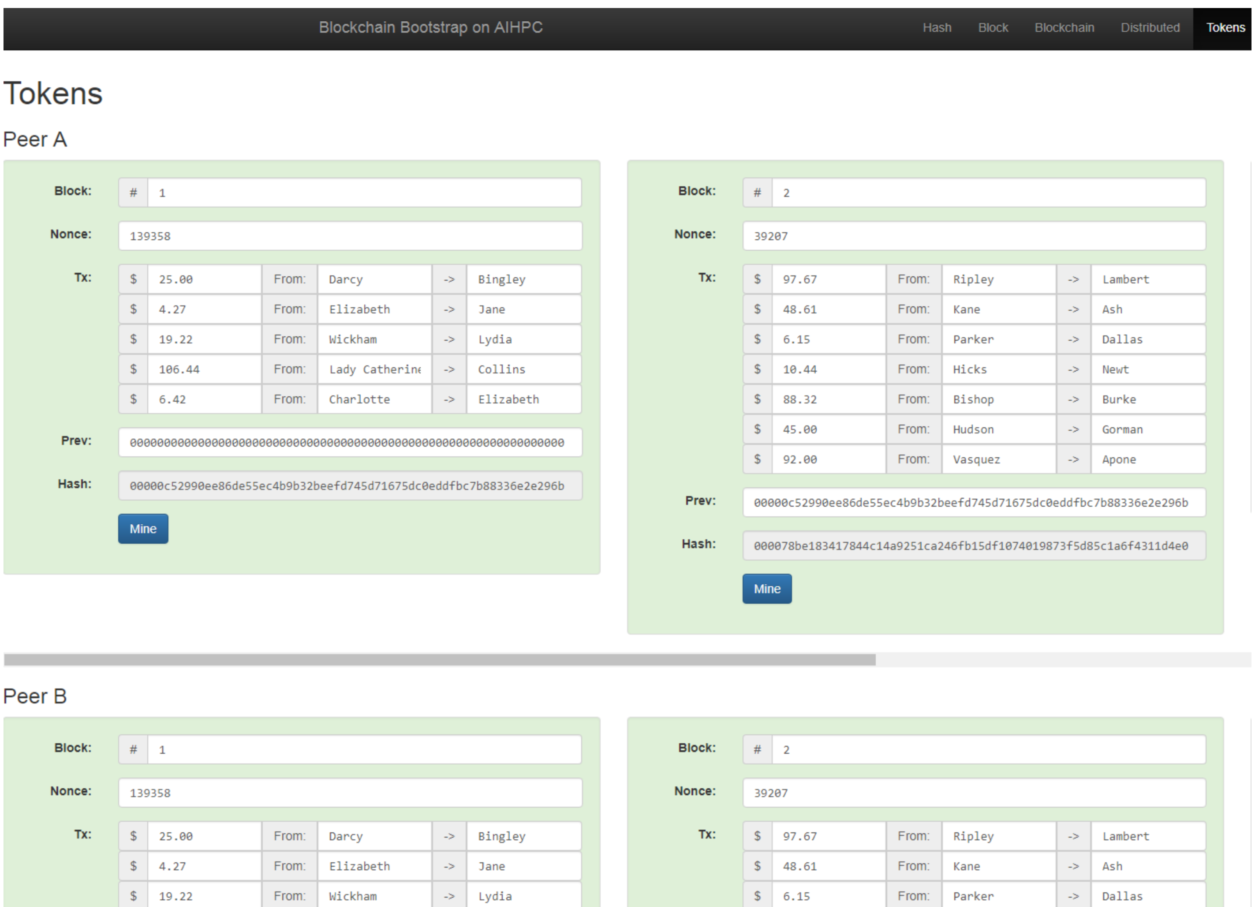
60. Blockchain Capability 5: Tokens

Tokens make distributed blockchains useful for financial transactions in crypto by extending the “Data” section with all-or-nothing transactions (i.e., from “Data” to “Tx”). The “Tx” section of a block of a token could be filled with records of financial activities.

For example, the first transaction of the “Tx” section of Block #1 of Peer A blockchain records the financial activity of transferring $25 from Darcy to Bingley. You may access the Tokens page as seen below by clicking the “Tokens” link of the blockchain bootstrap app on the AIHPC cloud.



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61. How to Secure AI Data by Blockchain Hash/Salt?

AI data such as TensorFlow datasets on the AIHPC cloud may be secured by the Hash and Salt function of the blockchain bootstrap app. *Salt* is a random number added to the data for the one-way SHA-256 hashing in order to prevent reverse-hashing such as using rainbow tables to crack the data. Nonce (see the image for Topic 57) is the *Salt* for the blockchain bootstrap app for the AIHPC cloud.

Below are the source code locations on the AIHPC cloud server and the code snippets for constructing and hashing the data plus salt/nonce. A REST API and a console utility to hash the data and salt are also available on the AIHPC cloud.

```
~/blockchain-demo/views $ vi block.jade
function getText(block, chain) {
        return $('#block'+block+'chain'+chain+'number').val() +
        $('#block'+block+'chain'+chain+'nonce').val() +
        $('#block'+block+'chain'+chain+'data').val();
}
```

```
~/blockchain-demo/public/javascripts $ vi blockchain.js
function sha256(block, chain) {
        // calculate a SHA256 hash/salt of the contents of the block
        return CryptoJS.SHA256(getText(block, chain));
}

~/blockchain-demo/public/javascripts $ vi www_hashsalt.js
//REST API Usage:
//1 start API REST server: node www_hashsalt.js
//2 web: http://localhost:3001/?data=123&salt=456

~/blockchain-demo/public/javascripts $ vi call_hashsalt_api.js
//Console Usage: node call_hashsalt_api.js data salt
```

TRAINING NOTES

62. What is behind Bitcoin Mining?

Bitcoin is a payment token (see Topic 60) secured by blockchain hash and salt (Topic 61). For the blockchain bootstrap app on the AIHPC cloud, bitcoin mining is the sequence of operations to discover new hash values for any *Tx* data that are changed in the chain of blocks.

This bitcoin mining is behind the bitcoin mining businesses in which special bitcoin mining hardware (e.g., AntMiner and Avalon units) are engaged to find new hash values. Cloud mining such as those offered by Hashflare is an alternative to the on-premise mining with the special mining hardware. Regardless of the types of bitcoin mining businesses, the core of the operations is similar to what happens after clicking the *Mine* button of the blockchain bootstrap app for the AIHPC cloud.

Below is the code snippet for the algorithm to mine a payment token and the location of the code file in the AIHPC cloud server. It shows the process to fix the blocks of the chain with new hash values (starting from four zeros) after clicking the *Mine* button.

```
~/blockchain-demo/public/javascripts $ vi blockchain.js
function mine(block, chain, isChain) {
  for (var x = 0; x <= 500000; x++) {
    $('#block'+block+'chain'+chain+'nonce').val(x);
    $('#block'+block+'chain'+chain+'hash').val(sha256(block, chain));
    if ($('#block'+block+'chain'+chain+'hash').val().substr(0, 4) === '0000') {
      if (isChain) {
        updateChain(block, chain);
      }
      else {
        updateState(block, chain);
      }
      break;
    }
  }
}
```

TRAINING NOTES

63. Summary

To summarize the new topics of this training book, AI 305 extends AI 303 with the following blockchain topics:

1. Topic 52 describes the steps to install and access the blockchain bootstrap app on the AIHPC cloud.
2. Topic 53 describes the steps to make code changes to your github repo of the blockchain bootstrap app for the AIHPC cloud.
3. Topic 54 explains the reasons to develop new blockchain apps on the AIHPC cloud.
4. Topic 55 introduces two famous blockchain apps: bitcoin and ethereum.
5. Topic 56 to Topic 60 introduces the 5 capabilities of the blockchain bootstrap app on the AIHPC cloud that you may build on to develop new blockchain apps.
6. Topic 61 provides a solution to secure AI data with the blockchain hash and salt capability by the bootstrap code snippet for the AIHPC cloud.
7. Topic 62 provides an algorithmic solution to fix broken chains through token (bitcoin) mining with new hashing values by the code snippet for the AIHPC cloud.
8. The AIHPC cloud has been certified for global listing on the AWS marketplace; and now is also available on the AWS GovCloud (US) marketplace for regulated workload for U.S. government users (see Topic 4).

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