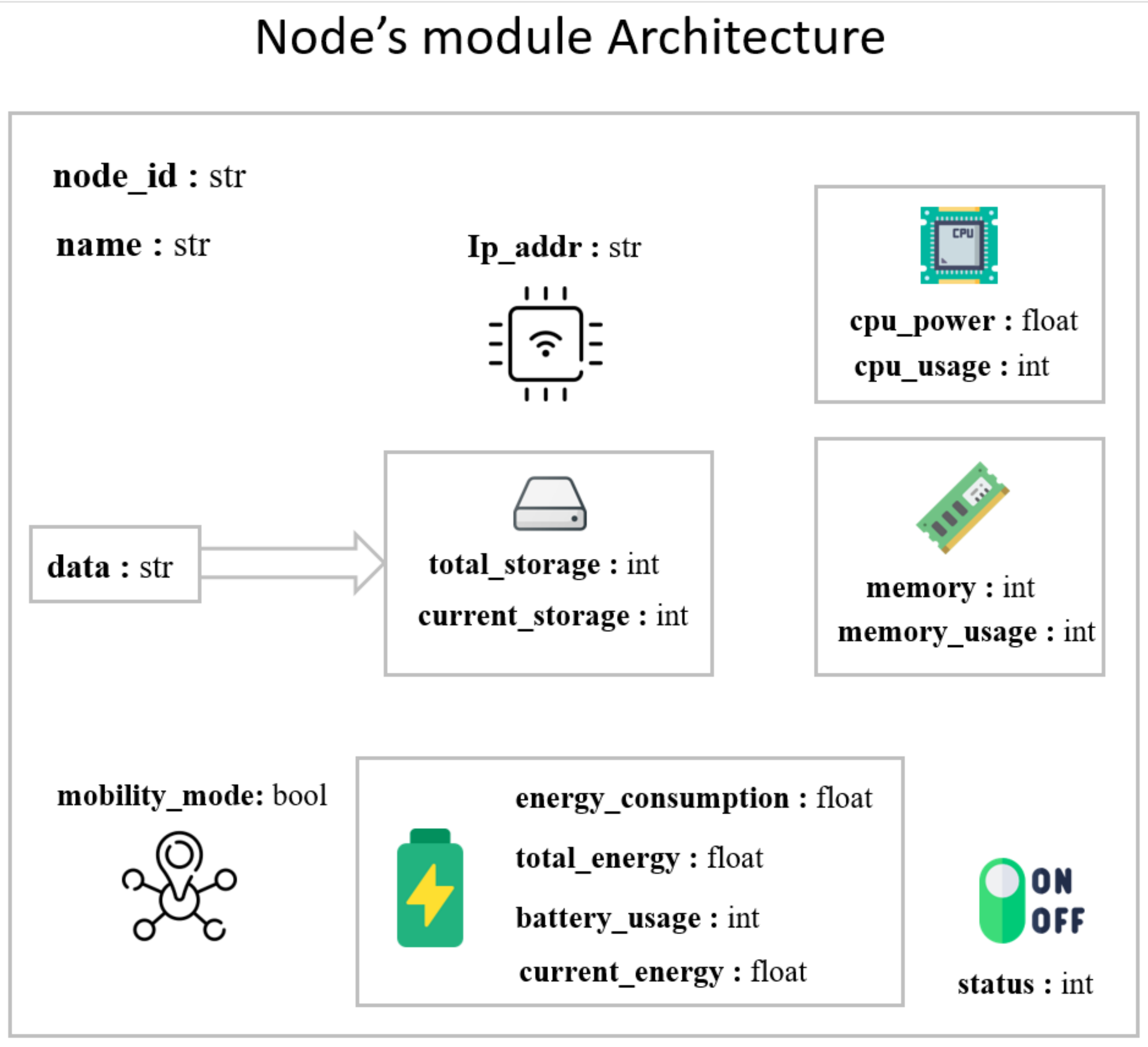
CS_FedSIM's documentation!

Contents

CS_FedSIM is a simulator framework of the client selection step in federated learning written in python language. The simulator also considers the resources used during federated learning with various IoT device categories.

Users have the option to create and test their own client selection techniques using the framework thanks to its modularity. Modifications also can be made to the nodes, their categories, and the resource consumption models.

The goal of this framework is to help researchers to simulate their methods in the federated learning steps, due to the lack of simulators in this field. The framework was developed in a relatively modular manner to provide the researchers complete control.



class node.**Node**(*name: str, data: Optional[str] = None, data_type: Optional[str] = None, mobility_mode: bool = False*)

Bases: `object`

A class that represents the basis of the node's module.

…

`name`

The name of the node to be identified with.

Type: str

`data`

The data available in the node.

Type: str

`data_type`

The type of the data in the node.

Type: str

`mobility_mode`

Indicates if the node is mobile or not.

Type: bool

`node_id`

The node identifier, represented by a hash.

Type: str

`ip_addr`

The IP address of the node in the network.

Type: str

`status`

Indicates the status of the node if it is available and can be contacted. (1 = Yes, 0 = No)

Type: int

`leader`

Indicates whether the node is the leader of its network or not.

Type: bool

`gathered_data`

Data collected from other nodes or the server.

Type: any

`battery_usage`

The percentage of the node's battery usage.

Type: int

`total_energy`

The total energy capacity of the node.

Type: float

`energy_consumption`

Indicates how much energy this node consumes in an operation.

Type: float

`current_energy`

The current energy capacity in mAh.

Type: float

`total_storage`

The total storage capacity of the node.

Type: int

`current_storage`

The current storage capacity of the node.

Type: int

`cpu_power`

The total power of the processor.

Type: float

`cpu_usage`

The percentage of CPU usage.

Type: int

`memory`

The memory capacity of the node.

Type: int

`memory_usage`

The memory usage percentage of the node.

Type: int

`get_resources_information():`

Take all the information about the resources of this node.

Notes

The other methods are a group of getters and setters, so they are not explained for this module.

`__init__`(*name: str, data: Optional[str] = None, data_type: Optional[str] = None, mobility_mode: bool = False*)

Constructs all the necessary attributes for the node object.

Parameters:

- **name** (*str*) – The name of the node to be identified with.
- **data** (*str, optional*) – The data available in the node.
- **data_type** (*str, optional*) – The type of the data in the node.
- **mobility_mode** (*bool, optional*) – Indicates if the node is mobile or not.

Examples

```
>>> node = Node(name='node1')
```

`get_resources_information()`

Take all the information about the resources of this node.

Returns: **information (tuple)**

Return type: All resource information represented by a tuple of 13 information.

Examples

```
>>> node.get_resources_information()
```

class node.**PowNode**(*name: str, mobility_mode: bool = False*)

Bases: `node.Node.Node`

A class that represents the module of a powerful node.

…

name

The node of the node to identify it.

Type: str

mobility_mode

Indicates whether the node is mobile or stationary.

Type: bool, optional

__init__(*name: str, mobility_mode: bool = False*)

Constructs all the necessary attributes for the PowNode object.

Parameters:

- **name** (*str*) – The node of the node to identify it.
- **mobility_mode** (*bool, optional*) – Indicates whether the node is mobile or stationary.

Examples

```
>>> node = PowNode(name='node1')
```

class node.**MidNode**(*name: str, mobility_mode: bool = False*)

Bases: `node.Node.Node`

A class that represents the module of a medium power node.

…

name

The node of the node to identify it.

Type: str

mobility_mode

Indicates whether the node is mobile or stationary.

Type: bool, optional

__init__(*name: str, mobility_mode: bool = False*)

Constructs all the necessary attributes for the MidNode object.

Parameters:

- **name** (*str*) – The node of the node to identify it.
- **mobility_mode** (*bool, optional*) – Indicates whether the node is mobile or stationary.

Examples

```
>>> node = PowNode(name='node1')
```

class node.**LowNode**(*name: str, mobility_mode: bool = False*)

Bases: `node.Node.Node`

A class that represents the module of a low power node.

…

name

The node of the node to identify it.

Type: str

mobility_mode

Indicates whether the node is mobile or stationary.

Type: bool, optional

__init__(*name: str, mobility_mode: bool = False*)

Constructs all the necessary attributes for the MidNode object.

Parameters:
- **name** (*str*) – The node of the node to identify it.
- **mobility_mode** (*bool, optional*) – Indicates whether the node is mobile or stationary.

Examples

```
>>> node = LowNode(name='node1')
```

class clientSelection.**ClientSelection**(*nodes: list, debug_mode: bool = False*)

A class that represents the basis of the client selection module.

…

nodes

The list of all nodes in the environment.

Type: list

debug_mode

Indicates if the debug mode is enabled or not.

Type: bool

get_nodes():

Return the list of all nodes.

get_debug_mode():

Return if the debug_mode is enabled.

__init__(*nodes: list, debug_mode: bool = False*)

Constructs all the necessary attributes for the ClientSelection object.

Parameters:
- **nodes** (*list*) – The list of all nodes in the environment.

- **debug_mode** (*bool, optional*) – Indicates if the debug mode is enabled or not.

`get_debug_mode()` → `bool`

Return if the debug_mode is enabled.

Returns:	**debug_mode (bool)**
Return type:	Indicates if the debug mode is enabled or not.

Examples

```
>>> clientSelection.get_debug_mode()
```

`get_nodes()` → `list`

Return the list of the nodes.

Returns:	**nodes (list)**
Return type:	the list of the nodes.

Examples

```
>>> clientSelection.get_nodes()
```

class `clientSelection.RandomClientSelection(`*`nodes: list, K: float = 0.1, debug_mode: bool = False`*`)`

A class that inherits the client selection module, which selects clients randomly.

...

`nodes`

The list of all nodes in the environment.

Type: list

`K`

the percentage of the selection.

Type: float

`debug_mode`

Indicates if the debug mode is enabled or not.

Type: bool

`random_client_selection():`

Returns a randomly selected list of clients with a percentage K.

`__init__(`*`nodes: list, K: float = 0.1, debug_mode: bool = False`*`)`

Constructs all the necessary attributes for the RandomClientSelection object.

Parameters:
- **nodes** (*list*) – The list of all nodes in the environment.
- **K** (*float*) – the percentage of the selection.
- **debug_mode** (*bool, optional*) – Indicates if the debug mode is enabled or not.

`random_client_selection()` → `list`

Return the list of selected nodes randomlu.

Returns: **selected_clients (list)**

Return type: the list of the nodes.

Examples

```
>>> randomClientSelection.random_client_selection()
```

class `clientSelection.`**`ResourceClientSelection`**`(`*`nodes: list, K: float = 0.1, debug_mode: bool = False`*`)`

A class that inherits the client selection module, which selects clients according to the strength of their resources.

…

`nodes`

The list of all nodes in the environment.

Type: list

`K`

the percentage of the selection.

Type: float

`debug_mode`

Indicates if the debug mode is enabled or not.

Type: bool

`resource_client_selection():`

Returns a list of clients selected according to their power ranking.

`__init__``(`*`nodes: list, K: float = 0.1, debug_mode: bool = False`*`)`

Constructs all the necessary attributes for the ResourceClientSelection object.

Parameters:
- **nodes** (*list*) – The list of all nodes in the environment.
- **K** (*float*) – the percentage of the selection.
- **debug_mode** (*bool, optional*) – Indicates if the debug mode is enabled or not.

`resource_client_selection``() → list`

Return the list of the selected nodes according to their power.

Returns: **selected_clients (list)**

Return type: the list of the nodes.

Examples

```
>>> resourceClientSelection.resource_client_selection()
```

class `consumptionModel.`**`CPUModel`**`(`*`node: node.Node.Node`*`)`

A class that represents the module of the processor consumption model of the nodes.

…

`node`

The node assigned to this model.

Type: Node

`get_node(): Node`

Return the node.

`set_node():`

Assign this consumption model to a node.

`check_cpu():`

Check if the node has reached the maximum CPU consumption level.

`update_cpu():`

Update the CPU consumption percentage of the node.

`__init__(node: node.Node.Node)`

Constructs all the necessary attributes for the CPUModel object.

Parameters: **node** (*Node*) – The node assigned to this model.

Examples

```
>>> cpuModel = CPUModel(node=node1)
```

`check_cpu() → bool`

Check if the node has reached the maximum CPU consumption level.

Returns: **status (bool)**

Return type: If the maximum level of consumption is reached or not.

Examples

```
>>> cpuModel.check_cpu()
```

`get_node() → node.Node.Node`

Return the instance of the node.

Returns: **nodes (Node)**

Return type: The node's instance.

Examples

```
>>> cpuModel.get_node()
```

`set_node(node: node.Node.Node)`

Assign this consumption model to a node.

Parameters: **node** (*Node*) – the node's instance.

Examples

```
>>> cpuModel.set_node(node1)
```

`update_cpu(cpu_usage)`

Update the CPU consumption percentage of the node.

Parameters: **cpu_usage** (*float*) – the new level of processor consumption.

Examples

```
>>> cpuModel.update_cpu(65)
```

class consumptionModel.**EnergyModel**(*node: node.Node.Node*)

A class that represents the module of the energy consumption model of the nodes.

…

node

The node assigned to this model.

Type: Node

get_node(): Node

Return the node.

set_node():

Assign this consumption model to a node.

consume_energy():

Consume a certain level of energy from the node according to its category.

check_battery():

Update the CPU consumption percentage of the node.

__init__(*node: node.Node.Node*)

Constructs all the necessary attributes for the EnergyModel object.

Parameters: **node** (*Node*) – The node assigned to this model.

Examples

```
>>> energyModel = EnergyModel(node=node1)
```

check_battery()

Check that the node 's battery is not depleted.

Examples

```
>>> cpuModel.check_battery()
```

consume_energy() → float

Consume a certain level of energy from the node according to its category.

Returns: **new_energy (float)**

Return type: The new energy level of the node.

Examples

```
>>> energyModel.consume_energy()
```

get_node() → node.Node.Node

Return the instance of the node.

Returns: **nodes (Node)**

Return type: The node's instance.

Examples

```
>>> energyModel.get_node()
```

set_node(*node: node.Node.Node*)

Assign this consumption model to a node.

Parameters: **node** (*Node*) – the node's instance.

Examples

```
>>> energyModel.set_node(node1)
```

class consumptionModel.**MemoryModel**(*node: node.Node.Node*)

A class that represents the module of the memory consumption model of the nodes.

…

node

The node assigned to this model.

Type: Node

get_node(): Node

Return the node.

set_node():

Assign this consumption model to a node.

check_memory():

Check if the node has reached the maximum Memory consumption level.

update_memory():

Update the Memory consumption percentage of the node.

__init__(*node: node.Node.Node*)

Constructs all the necessary attributes for the MemoryModel object.

Parameters: **node** (*Node*) – The node assigned to this model.

Examples

```
>>> memoryModel = MemoryModel(node=node1)
```

check_memory() → bool

Check if the node has reached the maximum Memory consumption level.

Returns: **status (bool)**
Return type: If the maximum level of consumption is reached or not.

Examples

```
>>> memoryModel.check_memory()
```

get_node() → node.Node.Node

Return the instance of the node.

Returns: **nodes (Node)**

Return type: The node's instance.

Examples

```
>>> memoryModel.get_node()
```

`set_node(node: node.Node.Node)`

Assign this consumption model to a node.

Parameters: **node** (*Node*) – the node's instance.

Examples

```
>>> memoryModel.set_node(node1)
```

`update_memory(memory_usage)`

Update the Memory consumption percentage of the node.

Parameters: **memory_usage** (*float*) – the new level of processor consumption.

Examples

```
>>> memoryModel.update_cpu(57)
```

class `consumptionModel.StorageModel(node: node.Node.Node)`

A class that represents the module of the storage consumption model of the nodes.

…

`node`

The node assigned to this model.

Type: Node

`get_node(): Node`

Return the node.

`set_node():`

Assign this consumption model to a node.

`check_storage():`

Check if the node has reached the maximum storage consumption level.

`add_to_storage():`

Add files to the node and thus fill the storage.

`__init__(node: node.Node.Node)`

Constructs all the necessary attributes for the StorageModel object.

Parameters: **node** (*Node*) – The node assigned to this model.

Examples

```
>>> storageModel = StorageModel(node=node1)
```

`add_to_storage(number_of_mega_bytes: float) → float`

Add files to the node and thus fill the storage.

Parameters: **number_of_mega_bytes** (*float*) – The size of the files added to the storage.

Examples

```
>>> storageModel.add_to_storage(658)
```

`check_storage() → bool`

Check if the node has reached the maximum Storage consumption level.

Returns: **status (bool)**
Return type: If the maximum level of consumption is reached or not.

Examples

```
>>> storageModel.check_storage()
```

`get_node() → node.Node.Node`

Return the instance of the node.

Returns: **nodes (Node)**
Return type: The node's instance.

Examples

```
>>> storageModel.get_node()
```

`set_node(node: node.Node.Node)`

Assign this consumption model to a node.

Parameters: **node** (*Node*) – the node's instance.

Examples

```
>>> storageModel.set_node(node1)
```

`class network.Network(nodes: list, network_number: int, debug_mode: bool = False)`

A class that represents the module of a network of nodes.

…

`nodes`

The list of all nodes in the environment.

Type: list

`network_number`

The network number.

Type: int

`debug_mode`

Indicates if the debug mode is enabled or not.

Type: bool

`assign_ip_addresses():`

Give an ip address to all nodes assigned to this network.

`get_network_number():`

Return the number of the network.

`get_nodes():`

Return the list of all nodes.

`get_network_leader():`

Return the leader of the network.

`set_network_leader():`

Assign a leader to the network.

`__init__(nodes: list, network_number: int, debug_mode: bool = False)`

Constructs all the necessary attributes for the Network object.

Parameters:
- **nodes** (*list*) – The list of all nodes in the environment.
- **network_number** (*int*) – The network number.
- **debug_mode** (*bool, optional*) – Indicates if the debug mode is enabled or not.

`get_network_leader()`

Return the leader of the network.

Returns: **network_leader (Node)**

Return type: the instance of the leader node of the network.

Examples

```
>>> network.get_network_leader()
```

`get_network_number()`

Return the number of the network.

Returns: **network_number (int)**

Return type: The network number.

Examples

```
>>> network.get_network_number()
```

`get_nodes() → list`

Return the list of the nodes.

Returns: **nodes (list)**

Return type: the list of the nodes.

Examples

```
>>> network.get_nodes()
```

`set_network_leader(network_leader)`

Assign a leader to the network.

Parameters: **network_leader** (*Node*) – The new node leader for the network.

Returns: **network_leader (Node)**

Return type: the instance of the leader node of the network.

Examples

```
>>> network.set_network_leader(node1)
```

distributedLearning.**dist_learning**(*train_dataset, selected_clients: list, global_model, global_round: int) -> (<class 'float'>, <class 'list'>, <class 'dict'>, <class 'float'>*)

The function of distributed learning of nodes.

Parameters:

- **train_dataset** (*any*) – The training dataset used for distributed learning.
- **selected_clients** (*list*) – The selected clients.
- **global_model** (*any*) – The model global.
- **global_round** (*int*) – The current global round.

Returns:

- **loss_avg (float)** (*the avereage loss.*)
- **list_acc (list)** (*the full list of all accuracy.*)
- **clients_acc (dict)** (*the full list of clients accuracy as dict format.*)
- **energy (float)** (*The total energy consumed during distributed learning.*)

Examples

```
>>> loss_avg, list_acc, clients_acc, energy =
dist_learning(train_dataset=train_dataset,
selected_clients=selected_clients, global_model=global_model,
global_round=epoch)
```

By AICHE Mohamed