

CLAIMS

1. A computer-implemented method for performing a map iteration by a network node of a blockchain network, the method comprising:

receiving a request to obtain a plurality of keys included in a map by the network node, the map storing a plurality of key-value pairs that comprise the plurality of keys and a plurality of values corresponding to the plurality of keys;

maintaining data representing a forest that stores the plurality of keys that are stored in the map, the forest comprising a plurality of trees, each tree comprising up to a respective plurality of storage nodes, each storage node storing a subset of the plurality of keys;

traversing the forest to retrieve the plurality of keys stored in the forest; and

returning the plurality of keys.

2. The method of claim 1, wherein the traversing the forest to retrieve the plurality of keys stored in the forest comprises:

iterating each storage node of the forest; and

retrieving one or more keys that are stored in the each storage node of the forest.

3. The method of any preceding claim, wherein the traversing the forest comprises at least one of the following:

performing a depth-first search on the forest; or

performing a breadth-first search on the forest.

4. The method of any preceding claim, wherein each tree of the plurality of trees comprises a respective plurality of levels, and wherein each level comprises one or more storage nodes.

5. The method of any preceding claim, wherein the plurality of levels correspond to a plurality of different hash functions, and wherein each key is stored in the forest based on one or more hash values of the key that are computed using one or more hash functions of the plurality of different hash functions.

6. The method of claim 5, wherein the method further comprises:
 - receiving a request to add a key of a key-value pair to the forest in response to the key-value pair being stored in the map;
 - determining a storage node of the forest to insert the key based on one or more hash values of the key that are computed using one or more hash functions of the plurality of different hash functions; and
 - storing the key to the storage node.
7. The method of claim 5, wherein the method further comprises:
 - receiving a request to delete a key of a key-value pair from the forest in response to the key-value pair being deleted from the map;
 - determining a storage nodes of the forest that stores the key based on one or more hash values of the key that are computed using one or more hash functions of the plurality of different hash functions; and
 - deleting the key from the storage node.
8. The method of claim 5, wherein the method further comprises:
 - receiving more than one request to add respective keys of key-value pairs to the forest in response to the key-value pairs being stored in the map;
 - determining different storage nodes of the forest to insert the keys based on one or more hash values of the keys that are computed using one or more hash functions of the plurality of different hash functions; and
 - storing the respective keys to the different storage nodes concurrently.
9. The method of any preceding claim, wherein each tree of the plurality of trees comprises a plurality of leaf storage nodes and one or more non-leaf storage nodes, and wherein each of the one or more non-leaf storage nodes corresponds to a configurable number of child nodes.
10. The method of any preceding claim, wherein each storage node of the forest stores a configurable number of keys.

11. The method of any preceding claim, wherein the maintaining data representing a forest that stores the plurality of keys that are stored in the map comprises one or more of:

generating a forest data structure to store the plurality of keys;

adding a new key into the forest in response to a corresponding key-value pair is stored in the map;

deleting an existing key from the forest in response to a corresponding key-value pair is removed from the map; or

modifying an existing key in the forest in response to a corresponding key-value pair is changed in the map.

12. An apparatus for implementing a blockchain-based map iteration system, the apparatus comprising a plurality of modules for performing the computer-implemented method of any one of claims 1 to 11.

13. A blockchain-based map iteration system, comprising:

one or more processors; and

one or more computer-readable memories coupled to the one or more processors and having instructions stored thereon that are executable by the one or more processors to perform the computer-implemented method of any one of claims 1 to 11.