



**#ASLI ENGINEERING**

# EIG Algorithm for Byzantine Agreement



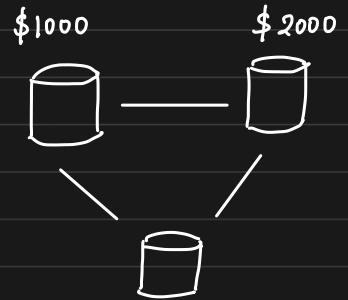
**BY**

**ARPIT BHAYANI**

## Exponential Information Gathering for Byzantine Agreement

Reaching consensus is extremely important in any distributed network.

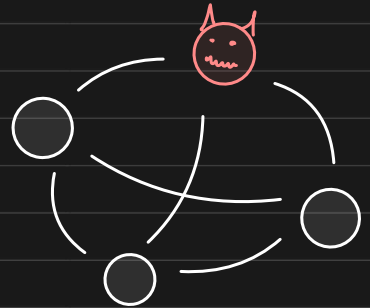
eg: we cannot have two datanodes in a cluster such that one thinks price = \$1000 while the other thinks price = \$2000



Depending on which node the request hits, the user would see the corresponding value, giving an inconsistent view. Somehow, the nodes need to agree on one value.

### Byzantine Agreement

Byzantine agreement is a problem of reaching a consensus even when one or many nodes / processes are malicious / corrupt



### Exponential Information Gathering

Core Idea: Relay the values across rounds, record the communication path, and decide.

## EIG Data Structure

EIG data structure is a tree that grows exponentially. The paths from the root of the tree represent the communication path from which the message is received (propagated)

The tree is constructed level by level and is designed to hold all possible permutations of length  $k$ . (distinct paths)

At each level  $k$ , every node has

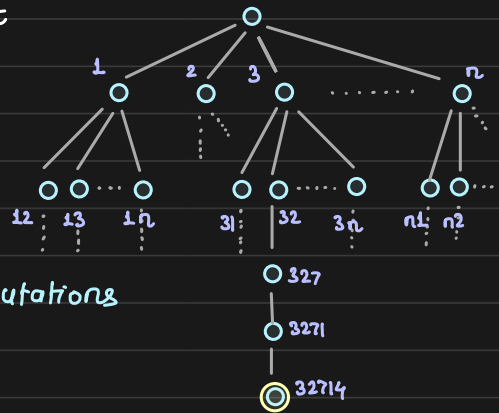
$n-k$  children to maintain uniqueness of the path

Root node is labelled as ""

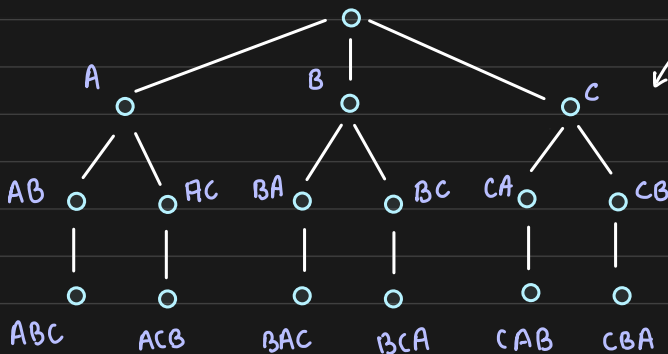
If a node received a message labelled  $[3, 2, 7, 1, 4]$

it holds the message in the tree along that path

Hence the data structure is like a tree



3-level deep EIG  
constructed over 3  
nodes A, B and C



## The algorithm

\* construction of EIG Tree is covered in previous topics

we assume EIG Tree is independently constructed at each node

The algorithm is tolerant to  $f$  faulty processes so long as  $n > 3f$

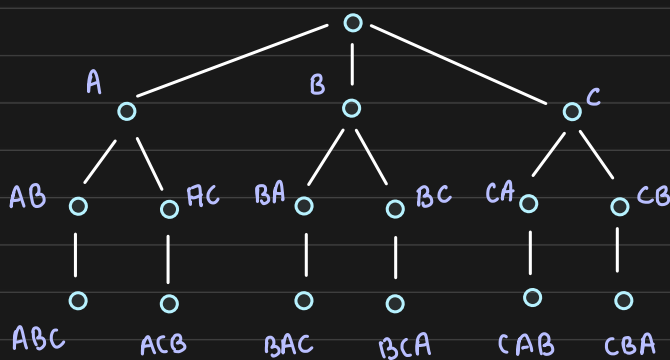
i.e. number of nodes are much larger than the faults

When a process sends "ill-formed" (junk/garbage) value to other nodes participating in the consensus, the consensus should not be prone to that.

## The flow

The processes propagate values for  $f+1$  rounds

and each node/process builds its own EIG Tree



Every node constructs its own EIG of depth

$f+1$  levels

It holds values it receives from other nodes through the specific comm<sup>n</sup> paths

if a node receives garbage value, the node ignores it

eg: value should be int, but string received

value should be in range  $[0-100]$ , but 5000 received

Once the ELG is constructed,

to make the decision, a node traverses the tree bottom-up

The value from the leaves, is propagated up

for non-leaf node,

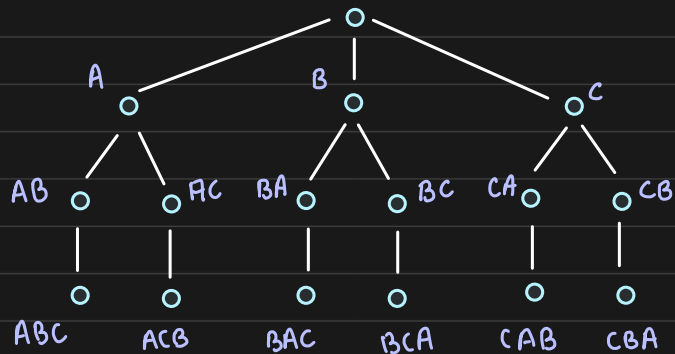
value = majority of values  
of its children

if majority,  $v_x = \text{maj}(v)$

else,  $v_x = v_0$



the default value



The final consensus value will be value converged at root.

1. if no faulty nodes, no corrupt nodes, all nodes would converge to the same  $v_x = v$
2. few corrupt nodes, sending corrupt values will be absorbed and not propagated up.