Verification of Data Structures
Using Jahob

Feride Çetin
Kremena Diatchka

Outline

- Jahob
- Motivation
- Cyclic list example
- In progess: leaf linked tree
- Conclusions

Verifying data structures

- Developer: provides specifications
  - Loop invariants
  - Procedure contracts (pre- & post-conditions)
  - Class invariants

- Jahob:
  - Specs --> logical constraints --> proved by decision procedures

Motivations

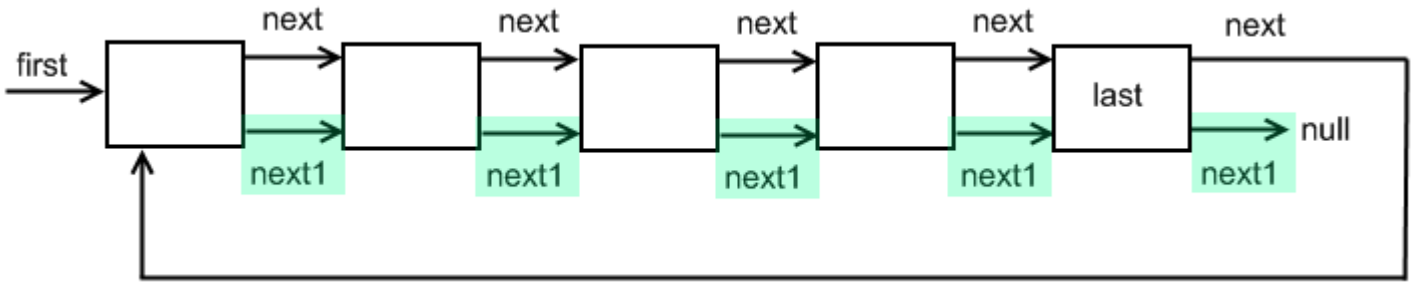
1. We can solve more problems automatically
2. Fast computers --> can use advanced techniques
3. Computers everywhere -> bugs everywhere, bugging everyone
4. Bugs are $$$

Modular verification of data structures

Status

- Verified
  - List with header node
  - Queue
  - Cyclic list
- Tried
  - Instantiable queue
- In progress
  - Leaf-linked tree

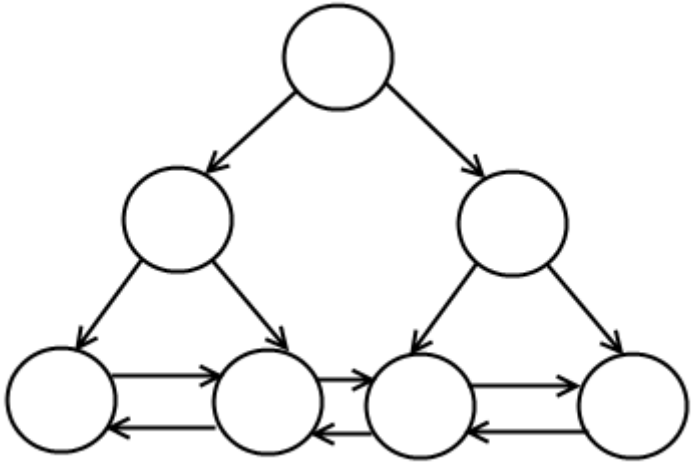
Cyclic list example



Demo (kind of)

Leaf-linked tree

- Motivation: *log(n)* operations on linked list
- Node:
  - Node left, right, next, prev, parent
  - int v



Leaf-linked tree structure

- Binary search tree
- No sort property verification for this project
- Left subtree : values <= parent.v
- Right subtree : values > parent.v
- Each parent node holds the largest left subtree value
- private static Node root;

Insertion method

- Each value is inserted as a leaf
- Two insertion stages:
  - Insertion in the binary search tree
  - Update of the leaf-linked list

Methods

boolean isEmpty() -> verified

boolean isLeaf (Node n) -> verified

void add (int v) -> in progress

void leafUpdate (Node n) -> in progress

Specification variables

- Nodes: all nodes reachable from root using left or right fields
- Content: the values of nodes in Nodes
- Internal nodes: all those nodes for which at least one of the left or right fields is not null

Class invariants

- Tree invariant on left and right fields
- Root Not Pointed: if root is not null then no node exists whose left, right, next, prev fields point to root
- Field constraint on all Node fields of a node: they should point to a node in Nodes (in this tree)
- Field constraint on parent field: if x has a parent, then there exists a node whose left or right field points to x

Conclusions

“The whole problem with the world is that fools and fanatics are always so certain of themselves, but wiser people so full of doubts.”

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Jahob: helping prove fools wrong and wise people correct since 2007

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Motivation
Jahob and decision procedures it uses
    Mona, spass (FOL theorem prover)
What data structures we have done
Cyclic list example – show it verifies
In progess: leaf linked tree
Conclusions

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Software bugs, or errors, are so prevalent and so detrimental that they cost the U.S. economy an estimated $59.5 billion annually, or about 0.6 percent of the gross domestic product, according to a newly released study commissioned by th

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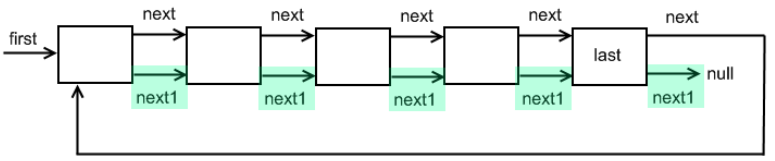

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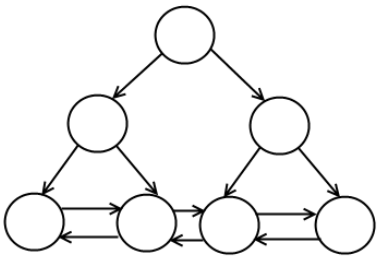

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