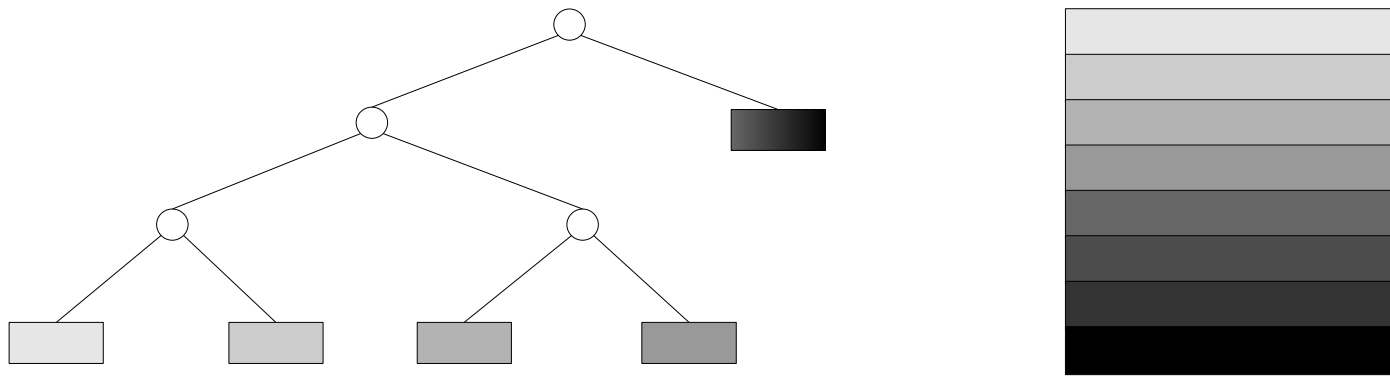


Memories

Array-like Records for ACL2



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ACL2 Workshop 2006
August 15

Introduction to memories

A “memory” is a new kind of record

Fast access to keys $0, 1, \dots, n-1$

Efficient rewrite rules, no stobj's or arrays

Potential applications

RAM in processor models

Heaps in VM models

Random-access structures for algorithms

Existing solutions

Custom macros (defstructure)

Positional lists (nth, update-nth)

Association lists (acons, assoc)

The misc/records book

(g key rec) looks up the value of key in rec

(s key val rec) extends rec by binding key to val

Provides hypothesis free, equality-based rules

Matt Kaufmann and Rob Sumners. *Efficient rewriting of operations on finite data structures in ACL2. ACL2 2002.*

Misc/records rewrite rules

$$(g\ a\ (s\ a\ v\ r)) = v$$

$$a_1 \neq a_2 \rightarrow (g\ a_1\ (s\ a_2\ v\ r)) = (g\ a_1\ r)$$

$$(s\ a\ (g\ a\ r)\ r) = r$$

$$(s\ a\ v_1\ (s\ a\ v_2\ r)) = (s\ a\ v_1\ r)$$

$$a_1 \neq a_2 \rightarrow (s\ a_1\ v_1\ (s\ a_2\ v_2\ r)) = (s\ a_2\ v_2\ (s\ a_1\ v_1\ r))$$

Our hybrid approach

A tree stores array elements

$O(\log_2 n)$ reads and writes

Space is allocated only for used addresses

A misc/record stores other values

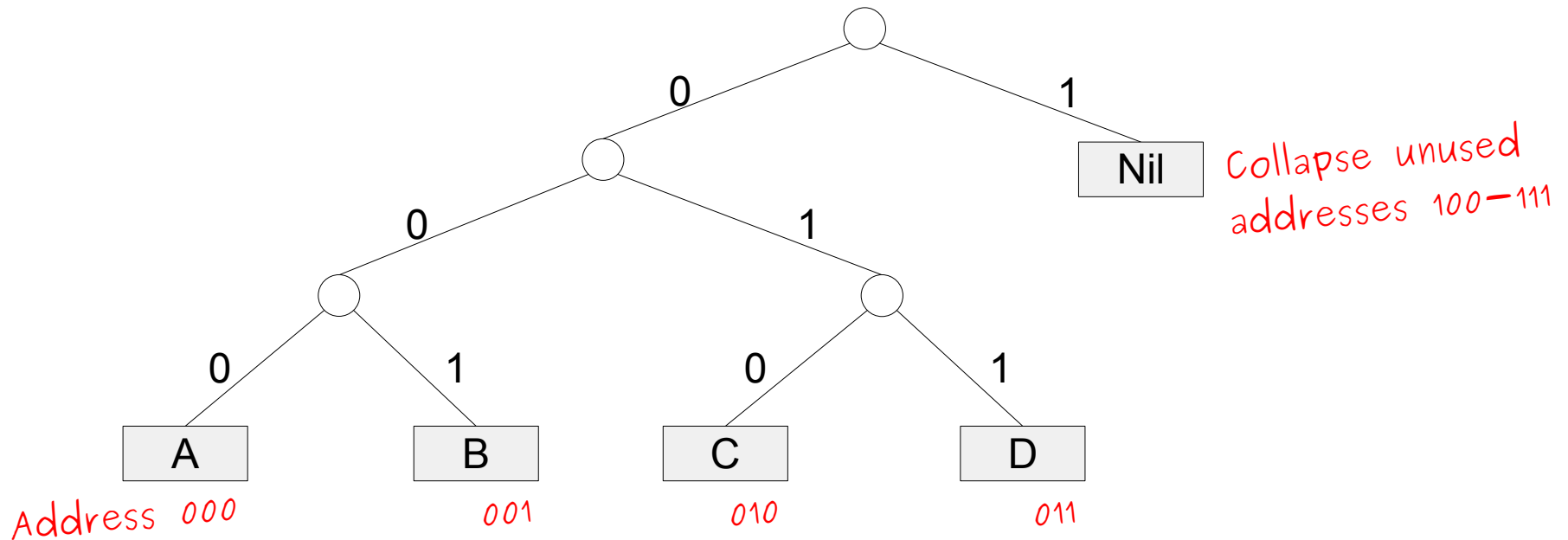
Slow to read/write from these

Enables hypothesis-free, equality-based rules

Our tree structure

Fixed depth, data at the tips

Nils are collapsed for memory efficiency



Performance results

Memory Size	Loads/sec	Stores/sec
2^8	11,000,000	2,200,000
2^{16}	2,500,000	625,000
2^{32}	785,000	300,000
2^{64}	240,000	125,000

Test System

2.8 GHz Pentium 4, GCL 2.6.7, ACL2 3.0

Some caveats

Memories (and records) are a little odd

Great for what they do

Not good at other things (domain, range, nested records, etc.)

There are other approaches

Equivalence-based reasoning is really nice, but sometimes hard to “combine”

Forcing, backchain limits to remove hypotheses

Quick recap

Memories are array-like records

Fast $O(\log_2 n)$ reads and writes

Huge arrays are not a problem

No stobj's or ACL2 arrays

Same rewrites as misc/records

Getting started

```
(include-book "data-structures/memories/memory" :dir :system)
```

```
:doc MEM::memory
```