`pobj`

"objects that last"

Course Project, CS262a, Fall '04

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overview

- Persistent dynamic memory management library
  - memory manager independent
  - support for garbage collector
- Implemented over ARIES storage management (**`lladd`**)
  - but is generally storage independent
- Atomicity through transaction semantics
  - logical consistency in the presence of failure
- Automatic reconstruction and crash recovery
  - physical / binary compatibility of memory blocks (intra-object)
  - topological reconstruction of references (inter-object)
- Emphasis on flexibility and usability
  - support for legacy code / library processing
  - mixed persistent / transient object management
  - logical consistency factored out

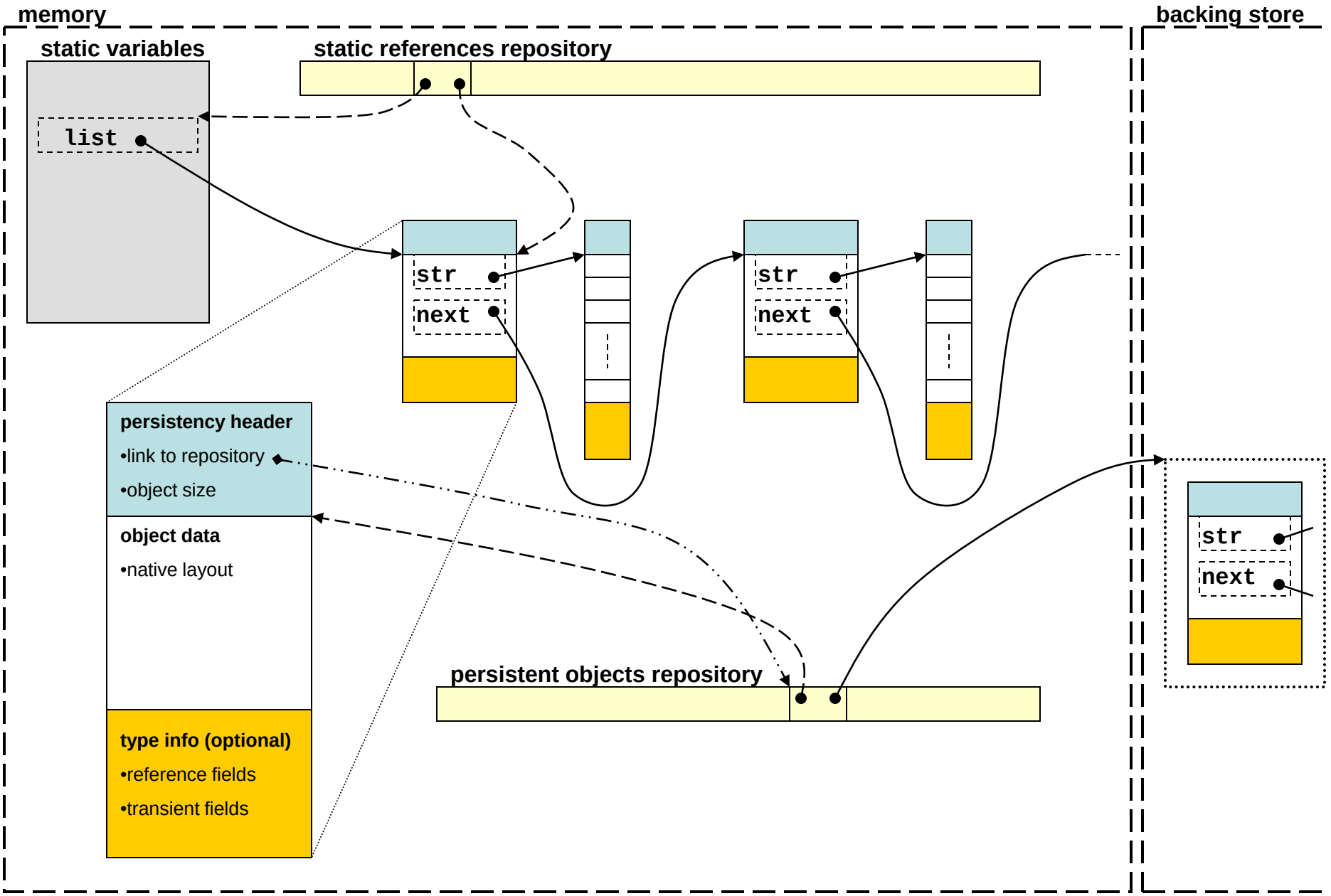
programming with **pobj**

Don’t mess with…

- files and I/O
- representation conversions
- reconstruction
- atomicity and crash recovery
- storage management and garbage collection
- dumping recursive data structures

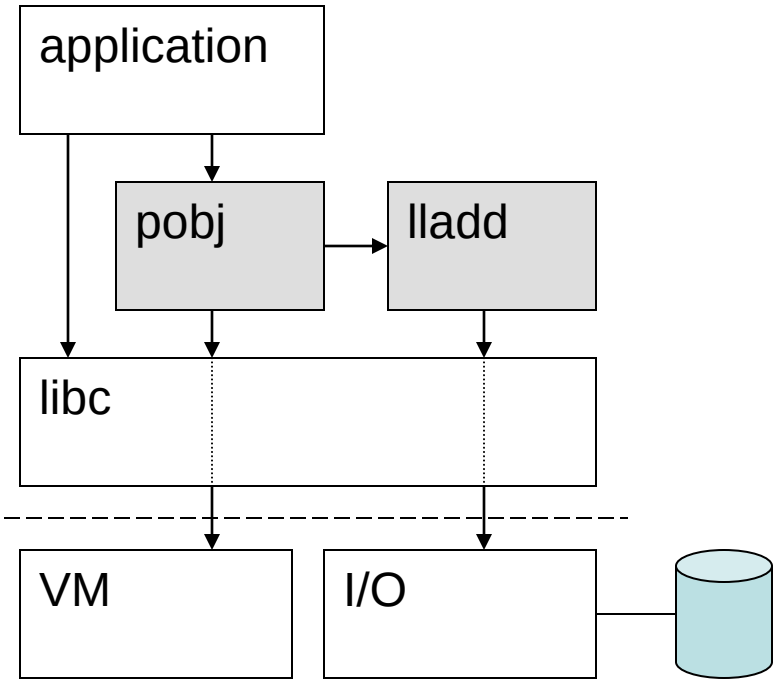
```
Node *list = NULL;
void add_line (char *line) {
  int len = strlen (line);
  pobj_start ();
  Node *node = (Node *)
    pobj_malloc (sizeof (Node));
  char *str = (char *)
    pobj_malloc (sizeof (char) * (len + 1));
  pobj_ref_typify (node, node_ref_fields);
  strcpy (str, line);
  pobj_update (str);
  POBJ_SET_REF (node, str, str);
  POBJ_SET_REF (node, next, list);
  pobj_static_set_ref (&list, node);
  pobj_end ();
}
int main (int argc, char **argv) {
  pobj_init ();
  while (get_line (line, sizeof (line)))
    add_line (line);
  print_list ();
}
```

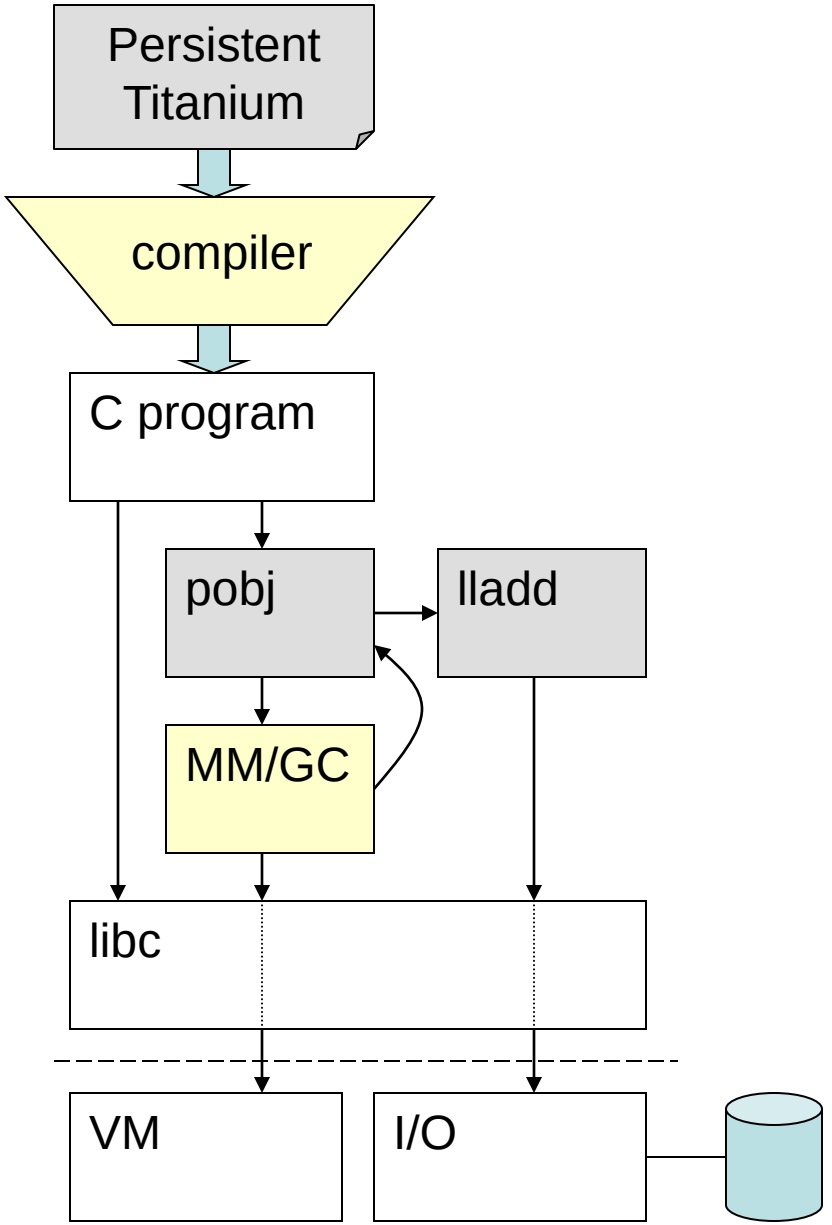
persistent memory objects



architecture

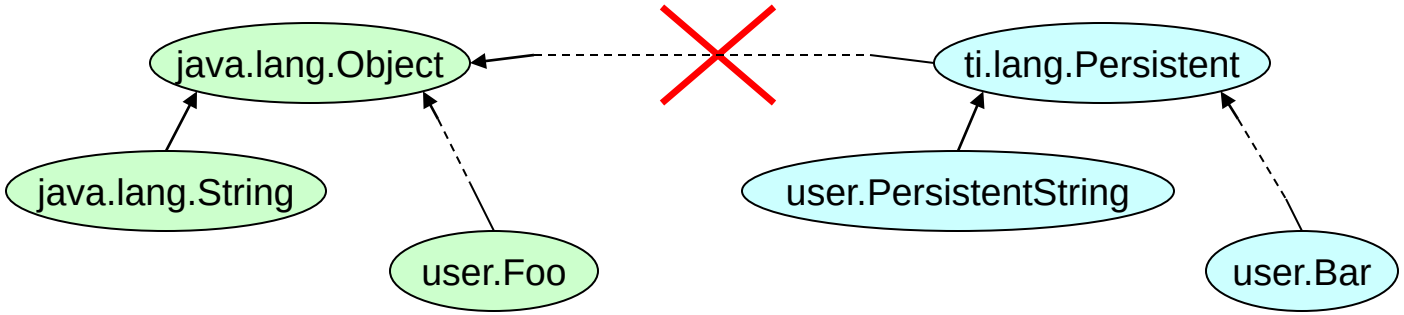
The obvious case (below) but also more interesting ones (right)…





language supported persistency

- Persistent objects implemented in *Titanium*, an SPMD Java dialect
- Persistency statically known through separate type hierarchy



- Persistent operations compiled to use **`pobj`** functions

```
Persistent p = new PersistentString();
```

tcbuild

```
temp_6 = (T11nc_2R74ac *)
        pobj_calloc(1, sizeof (T11nc_2R74ac));
```

- Safe operation aggregation through **`transaction`** blocks
- Support for persistent arrays through qualifiers

```
int[] persistent x = new int[4] persistent;
```

- **`pobj`** integrated with Titanium's Boehm-Weiser garbage collector

Persistent Titanium

Use…

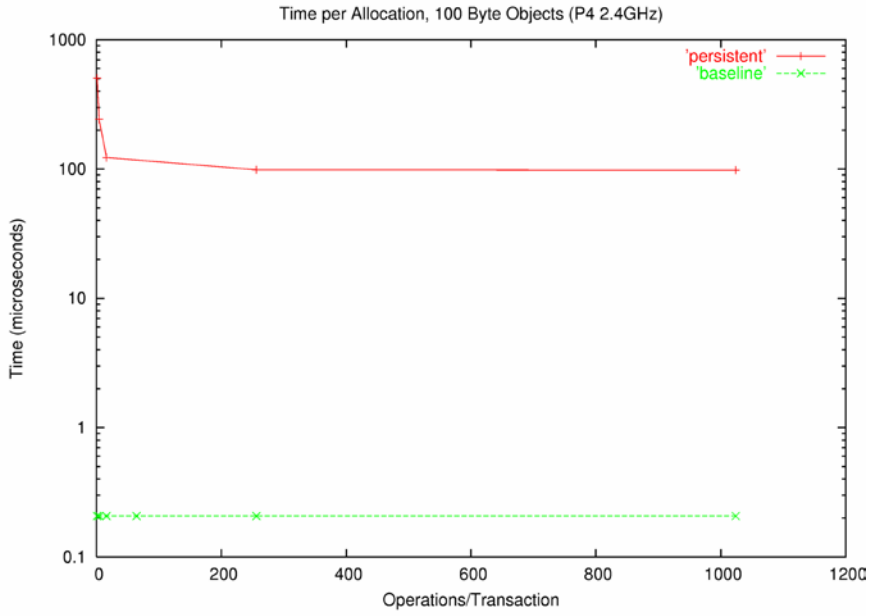
- persistent objects that extend `Persistent`
- static variables to point to roots of data structures
- `transaction` blocks to maintain consistency

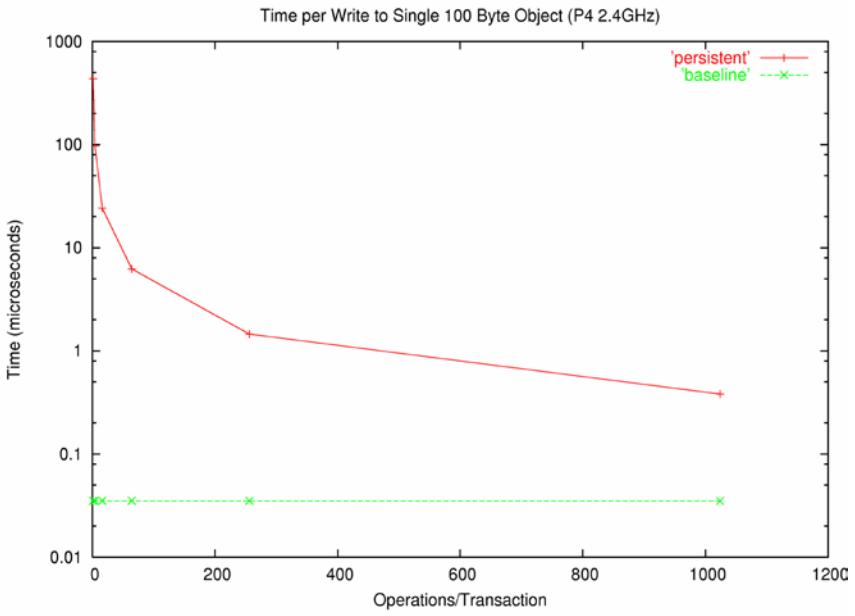
Program execution results		
input	run #1 output	run #2+ output
line1 line2 line3 line4	(crash)	line1 line2 line3

```
static class Node extends Persistent { ... }
static Node head, tail;
static void addLine (String s) {
  transaction {
    Node node = new Node(s);
    if (head == null)
      head = tail = node;
    else {
      tail.next = node;
      // Crash in the middle of a transaction.
      if (node.num == 4) throw new Error();
      tail = node;
    }
  }
}
// List only built on first run.
public static void main (String[] args) {
  String line;
  if (head == null) // Check if first run.
    while ((line = getLine ()) != null)
      addLine (line);
  printList ();
}
```

evaluation

- Different approach than RDS/RVM
  - topological storage and reconstruction
    - nice abstraction for objects
    - recursive operations: update, mark-and-sweep
  - independent of memory and store managers
  - persistent / transient allocated on a single region
    - possibly improves spatial cache locality
  - but probably not as efficient (benchmarks are future work!)
- Some numbers…





future work

Short term

- dynamic persistency
- type descriptors
- generalized statics
- transient fields
- fast checksum comparison

Long term

- flexible pointers
- on-the-fly rollback
- delayed recovery (static initializers)

Sci-Fi

- object synchronization
- automatic lock management (deadlock resolution)
- persistency semantics for Titanium/Java
  - persistify predefined types through qualifiers
  - runtime detection of persistent operations
  - `transaction` block optimization (reduce number of updates)