TreeCalc Virtual Machine

Virtual machines 185.A49 UE

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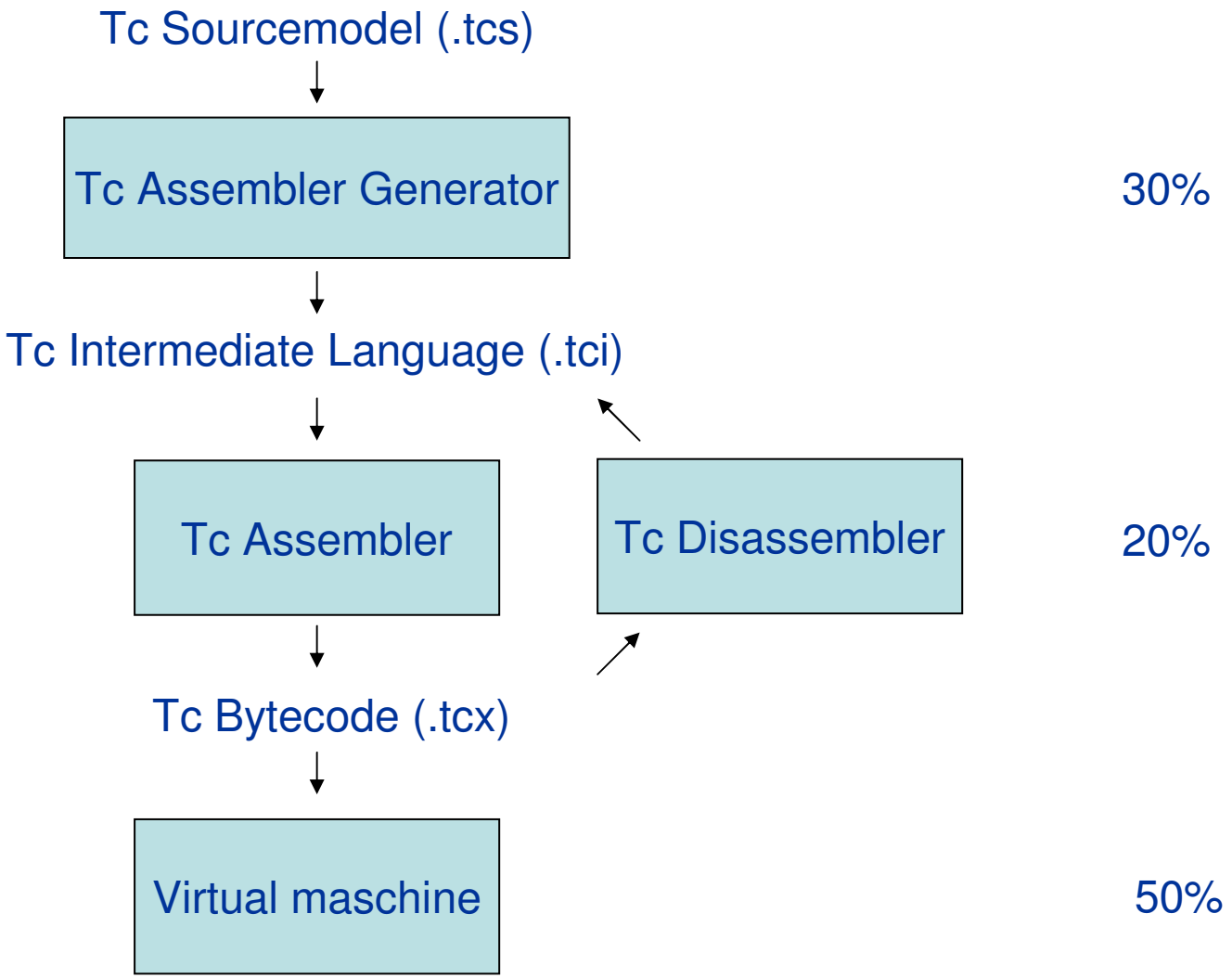
computer languages

Setting

- Starting point
  - TreeCalc language + Java generator
  - Test models and test data (JUnit)
- Goal
  - Virtual Machine with same functionality
  - Implementation in Java

Components


Tc Sourcemodel (.tcs)
Tc Assembler Generator
30%
Tc Intermediate Language (.tci)
Tc Assembler
Tc Disassembler
20%
Tc Bytecode (.tcx)
Virtual maschine
50%

Tc Assembler Generator

- Variables
  - Numbers instead of names
  - Enhance symbol tables
- Nice and useful
  - Comments in output (variable names, ...)
  - Constants handled by Assembler
- Short-circuiting and, or
  - label-handling

Tc Intermediate Language

```
A_LI_MainLayers.compute =
  F_LI_Indexation_Perc > 0 ? F_LI_TariffDuration : 1
```

tcs

↓ Tc Assembler Generator

```
.formula formula=506 simple=false ; line 3182
   //start of if statement, line 3182
   : callfunc 65 0 ; F_LI_INDEXATION_PERC
   : pushconst 0
   : cmpbig
   : iffalse L0
   : callfunc 90 0 ; F_LI_TARIFFDURATION
   : goto L1
 L0:
   : pushconst 1
 L1:
   //end of if statement
   : return
.formuladone
```

tci

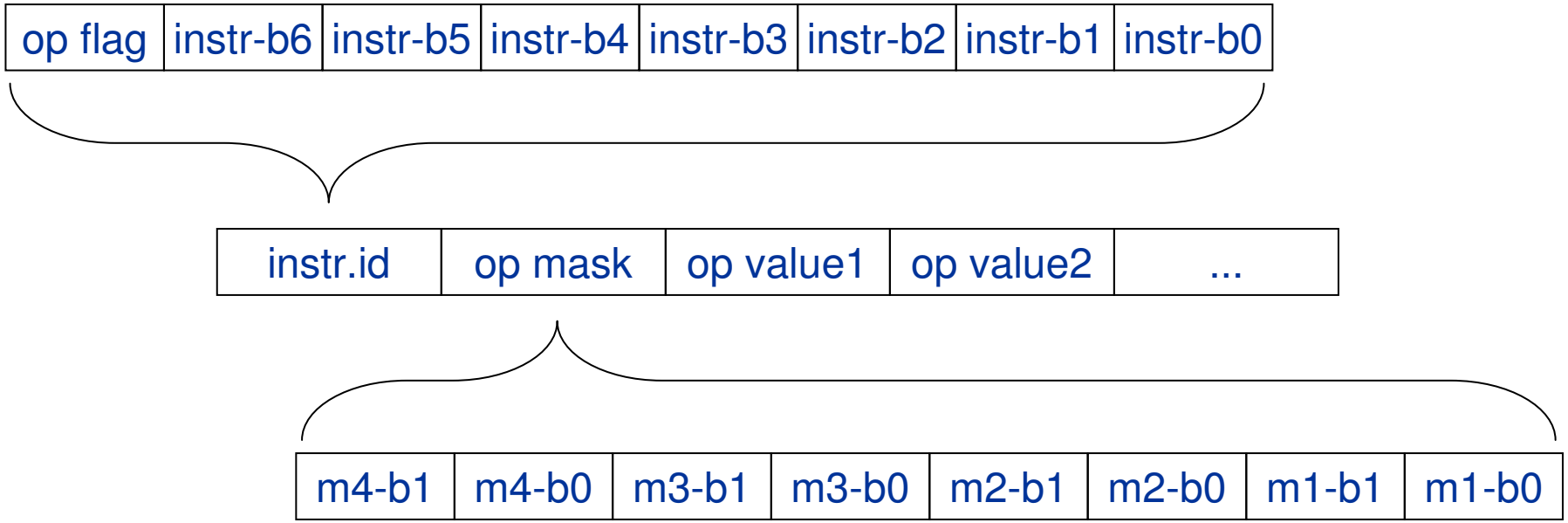
Tc Assembler

- Configuration: Instructions array

```
new Instruction(INSTR_CALLFUNC, "callfunc",
                +1, -2,
                "funcid", OPTYPE_INT,
                "nargs", OPTYPE_BYTE
    ) //arg1 ... arg_nargs -- result
```

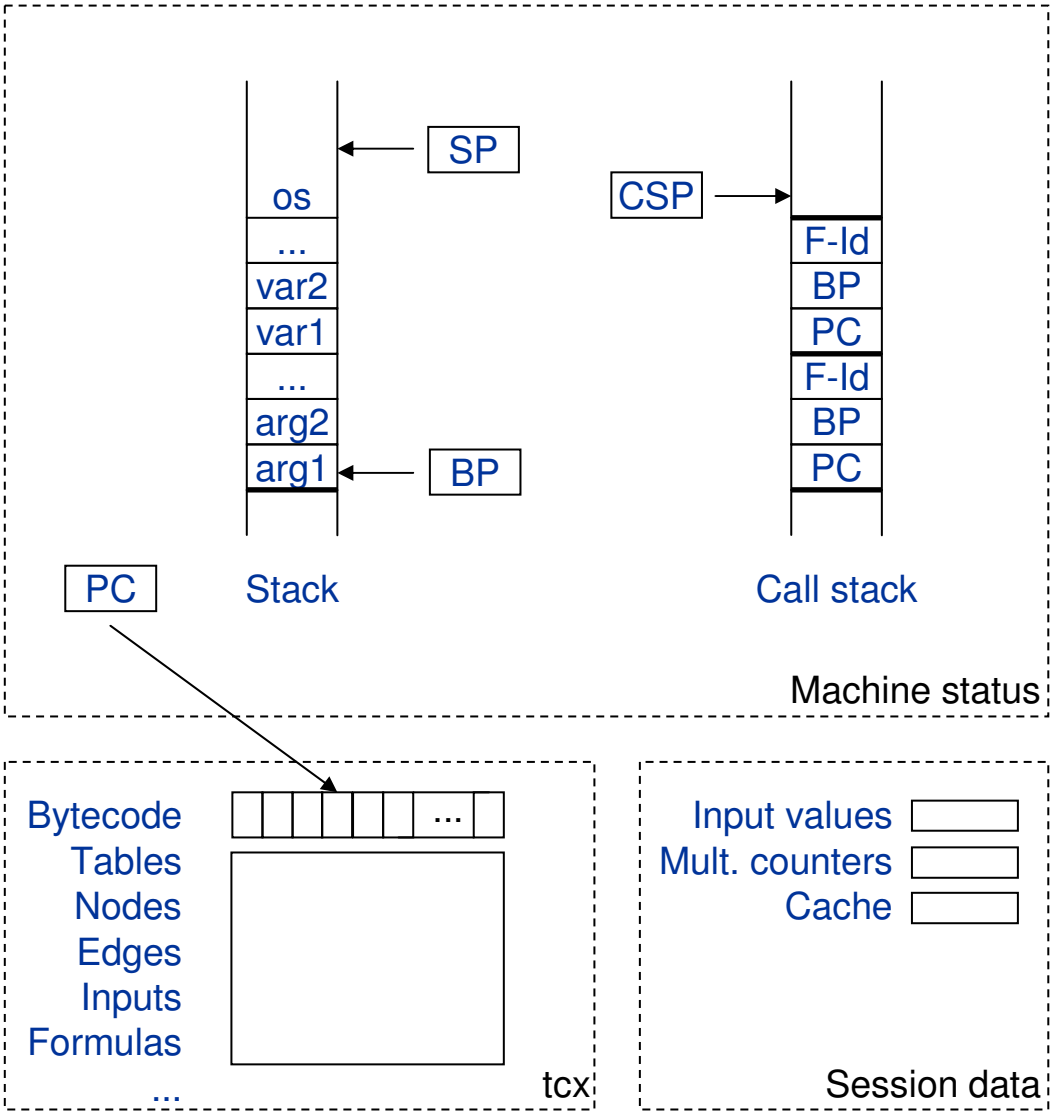
- Main action
  - Parsing (ANTLR) + Error handling
  - Formulas
    - Manage constant pool
    - Resolve labels (backpatching)
    - Encode bytecode

Tc Bytecode - Formulas



b1	b0	operand value
0	0	no operand
0	1	1 byte
1	0	2 bytes, big-endian
1	1	4 bytes, big-endian

Tc Virtual machine - Data



Tc Virtual machine - Execution

- Decode instruction → instrid, op1, op2, op3, op4
- switch(instrid) { ... }
- Operand stack
  - set freed elements to null → automatic GC

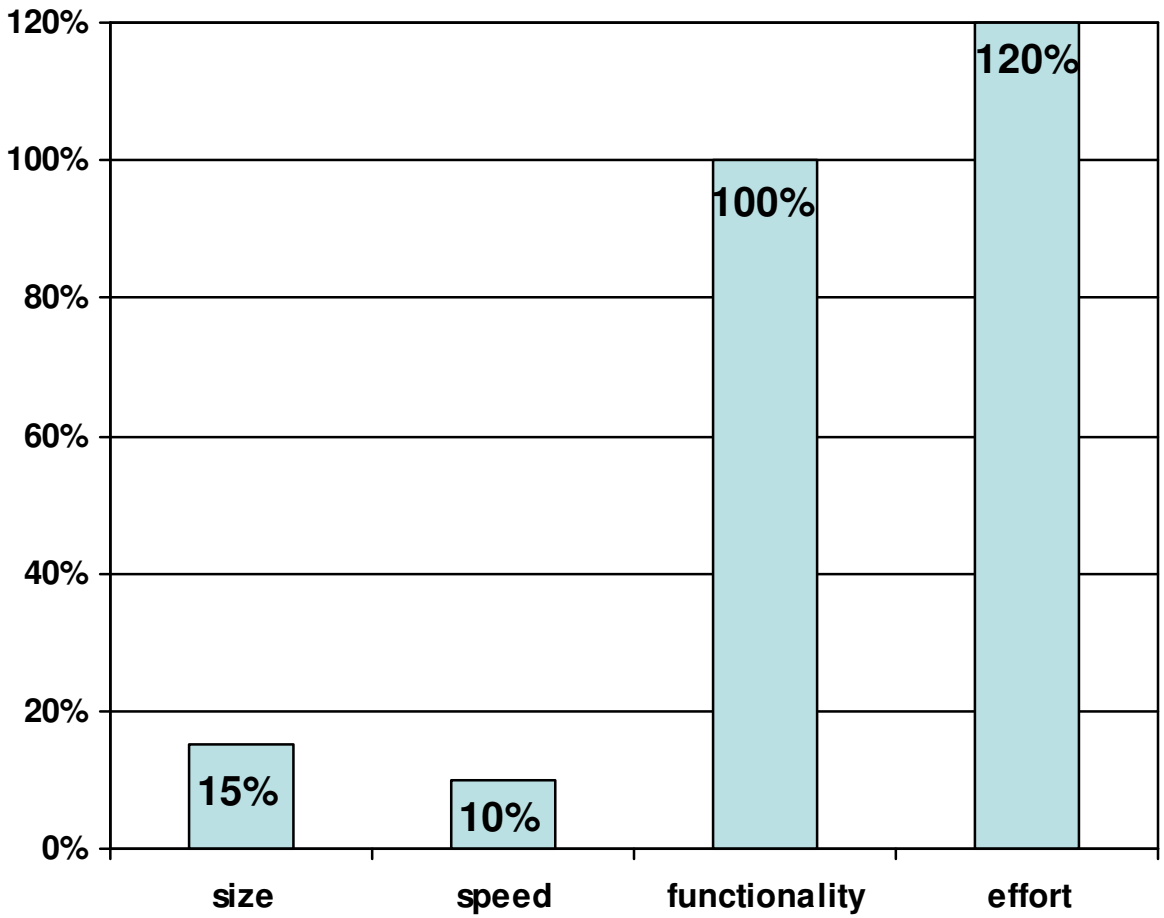
```
case INSTR_ADD: //a b -- a+b
   stack[sp-1] = V.getInstance(stack[sp-1].doubleValue() + stack[sp].doubleValue());
   stack[sp--] = null;
   break;
```

- Trace
  - PC, instruction, operands
  - status before+after instruction execution
- Base classes
  - Values: V, VString, VDouble, VList, ...
  - TreeCalc standard functions
  - Table access functions

TcVM – Tree access

- Macro programs for tree access
  - need special instructions
    - dynamic call of formula
    - get children / linked nodes
    - check if result is defined (own/subnodes)
    - ...
  - quite long (~2 x 200 instructions)
  - hard to debug
- Alternatives
  - recursive call to TcVM machine
  - tree actions / results in extra stacks

Results


120%
100%
80%
60%
40%
20%
0%
15%
10%
100%
120%
size
speed
functionality
effort

Lessons learned

- Assembler
  - very useful layer
  - easy to implement
- Bytecode
  - compact vs. easy to handle
- Assembler generator
  - locatability of instruction names important
  - simpler than Java source code generator
- Virtual machine
  - for prototype: optimize later
  - trace output essential
  - tree handling: macro programming not best solution

Source and Contact

https://github.com/sneubauer/TreeCalc

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