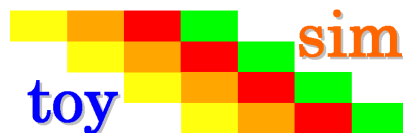


# toysim user manual



<b>Title</b>	toysim (ArchC functional simulator for the Princeton TOY machine)
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<b>v0.0.4</b>	2014-12-02 Added project logo in README.
<b>v0.0.3</b>	2014-11-02 Documentation corrections.
<b>v0.0.2</b>	2014-10-30 Project cleaned-up and updated for Github.
<b>v0.0.1</b>	2010-12-11 First public version.

## 1. Introduction

This is the ArchC (<http://www.archc.org>) functional simulator model for the Princeton TOY processor. The Princeton TOY machine is a 16-bit educational RISC processor with only two orthogonal encodings. A description of the basic ISA is available in the form of the [TOY reference card](#).

This model has the system call emulation functions implemented, so it is a good idea to turn on the ABI option. It should be noted that this capability is currently untested.

## 2. File listing

The `toysim` distribution includes the following files:

<code>/toysim</code>	Top-level directory
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AUTHORS	List of <code>toysim</code> authors.
LICENSE	The modified BSD license governs <code>toysim</code> .
README.html	HTML version of README.
README.pdf	PDF version of README.
README.rst	This file.
VERSION	Current version of the project sources.
defines_gdb	Macro definitions for GDB integration.
modifiers	Instruction encoding and decoding modifiers.
rst2docs.sh	Bash script for generating the HTML and PDF versions of the documentation (README).
run_tools.sh	Script for automating the build of the simulator and the associated binary utilities ( <code>binutils</code> ) port.
toy.ac	Register, memory and cache model for TOY.
toy_gdb_funcs.cpp	GDB support for the TOY simulator.
toy_isa.ac	Instruction encodings and assembly formats.
toy_isa.cpp	Instruction behaviors.
toy_syscall.cpp	OS call emulation support for TOY (untested).
toysim.png	PNG image for the <code>toysim</code> project logo.
/tests	Tests subdirectory
run-tests.sh	Run a selected benchmark.
/fibo	Fibonacci series benchmark directory
Makefile	Makefile for building the benchmark.
ac_start.s	Startup file (prior <code>main()</code> ) for TOY.
fibo.asm	Fibonacci benchmark using the alternative Princeton TOY assembly syntax (defined for the ArchC model).
/popcount	Population count benchmark directory
Makefile	Makefile for building the benchmark.
popcount.asm	Population count benchmark using the original assembly syntax (needs to be converted).

### 3. Usage

To generate the interpreted simulator, the `acsim` executable is ran:

```
$ acsim toy.ac [-g -abi -gdb]           # (create the simulator)
$ make -f Makefile.archc               # (compile)
$ ./toy.x --load=<file-path> [args]    # (run an application)
```

To generate the compiled application simulator, the `accsim` executable is ran:

```
$ accsim toy.ac <file-path>           # (create specialized simulator)
$ make -f Makefile.archc               # (compile)
$ ./toy.x [args]                       # (run the application)
```

The `[args]` are optional arguments for the application.  
There are two formats recognized for application `<file-path>`:

- ELF binary matching ArchC specifications
- hexadecimal text file for ArchC

In order to generate the binary utilities port (binutils port), the `acbingen.sh` driver script must be used. This should be called as follows:

```
$ acbingen.sh -atoy -i `pwd`/../../toysim-tools/ toy.ac
```

for generating the binutils port executables. This includes the following tools:

- `addr2line`
- `ar`
- `as`
- `c++filt`
- `gdb` (the GDB port is also generated in the same directory)
- `gdbtui`
- `ld`
- `nm`
- `objcopy`
- `objdump`
- `ranlib`
- `readelf`
- `size`
- `strings`
- `strip`

## 4. Notes

The assembly instruction syntax followed by the ArchC-based simulator for TOY is quite different than the original syntax. The following table summarizes the differences of the two syntax variations.

Original syntax	ArchC-compatible syntax
<code>R[d] &lt;- imm8</code>	<code>lda rd, imm8</code>
<code>R[d] &lt;- mem[imm8]</code>	<code>ld rd, imm8</code>
<code>R[d] -&gt; mem[imm8]</code>	<code>st rd, imm8</code>
<code>R[d] &lt;- mem[R[t]]</code>	<code>ldi rd, rt</code>

<code>mem[R[t]] &lt;- R[d]</code>	<code>sti rd, rt</code>
<code>R[d] &lt;- R[s] + R[t]</code>	<code>add rd, rs, rt</code>
<code>R[d] &lt;- R[s] - R[t]</code>	<code>sub rd, rs, rt</code>
<code>R[d] &lt;- R[s] &amp; R[t]</code>	<code>and rd, rs, rt</code>
<code>R[d] &lt;- R[s] ^ R[t]</code>	<code>xor rd, rs, rt</code>
<code>R[d] &lt;- R[s] &lt;&lt; R[t]</code>	<code>shl rd, rs, rt</code>
<code>R[d] &lt;- R[s] &gt;&gt; R[t]</code>	<code>shr rd, rs, rt</code>
<code>R[d] &lt;- pc; pc &lt;- imm8</code>	<code>jal rd, imm8</code>
<code>pc &lt;- R[d]</code>	<code>jr rd</code>
<code>if (R[d] == 0) pc &lt;- imm8</code>	<code>jz rd, imm8</code>
<code>if (R[d] &gt; 0) pc &lt;- imm8</code>	<code>jp rd, imm8</code>
<code>pc &lt;- pc</code>	<code>halt</code>

Supported pseudo-instructions include:

- `nop` (no operation)
- `move` (move register)
- `neg` (negate)
- `li` (load immediate)
- `la` (load address)

## 5. Prerequisites

- ArchC installation (tested on Cygwin/Win7-64bit and Linux)
- Standard UNIX-based tools: `make`, `gcc`.

## 6. Contact

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