

# AIGEN tool user manual

April 19, 2021

AIGEN is an open source tool for the generation of transition systems in a symbolic representation "AIGER". To ensure diversity, it employs a uniform random sampling over the space of all Boolean functions with a given number of variables. AIGEN relies on reduced ordered binary decision diagrams (ROBDDs) and canonical disjunctive normal form (CDNF) as canonical representations that allow us to enumerate Boolean functions, in the former case with an encoding that is inspired by data structures used to implement ROBDDs. Several parameters allow the user to restrict generation to Boolean functions or transition systems with certain properties, which are then output in AIGER format.

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## 1 Testing the Tool

The following is a sample command to run the tool:

```
python3 aigen.py -bdd -output FileName.aag -c 1 -u 1 -l 10 -o 9 -noABC
```

where:

- **FileName.aag** is the file name to be generated.
- **-bdd** means that use a bdd based random generation. When replaced by **-dnf** the tool will use canonical DNF based random generation.
- **-c 1** means 1 controllable input

- **-u 1** means 1 uncontrollable inputs
- **-l 10** means 10 latches (i.e. the tool will generate 12 boolean functions over 15 variables)
- **-o 9** means that 9 latches variable influences the output function (i.e. the output function will assign true to (l - o) variables and in this case (10-9)).
- **-noABC** is an optional parameter. A user has to omit it if he wants to run the ABC tool minimization procedure that reduces the size of the generated AIGER file.

To replicate an existing file (an AIGER file that was generated previously by AIGEN tool), use as arguments the same model (bdd or dnf), number of uncontrollable inputs, number of controllable inputs, number of latches, the same number of output variables, and the same seeds. All these info can be found as comments at the end of the file. Note that the number of seeds must be equal to  $l + 1$ .

The following is a sample command to regenerate an existing AIGER file tool:

```
python3 aigen.py -bdd -output random_14.4.3_7_6.aag -c 4 -u 3 -l 7 -o 6 -seeds
1589315720245050 1589315720836518 1589315721306326 1589315721746553
1589315722185292 1589315722596544 1589315722995663 1589315723406943
-oseed 1589315723415047 -noABC
```

Note that **-oseed** is the seed for the random 6 variables chosen out of 7 latches.

## 2 Tables and figures replication

### 2.1 Table 2 Replication

Unfortunately, Table 2 cannot be replicated as it was generated by the competition chairs, however these results can be found at the following URL:  
<https://www.starexec.org/starexec/secure/details/job.jsp?id=35621>

### 2.2 Figures Replication

We provide a command to generate Figures 2 and 3, and another command to generate Figures 2,3, and 4. The first command will take around 20 minutes, however the command to generate Figures 2,3, and 4 will take tens of hours.

- To replicate Figures 2 and 3:
  1. Run the command: `chmod +x experiment-noABC.sh`
  2. Run the command: `./experiment-noABC.sh`

- To replicate Figures 2, 3, and 4:

1. Run the command: `chmod +x experiment.sh`
2. Run the command: `./experiment.sh` (WARNING: this will take tens of hours...)

These commands will generate aiger files in folder "experiments" and generate the "plots.pdf" file.

### 3 Installation

This guide assumes that python is installed on the user machine. If it is not the case, use the following command:

- `sudo apt install python3.8`

To install the tool automatically run the following commands: (this will take around 15 minutes due to the abc tool compiling time)

- `chmod +x setup.sh`
- `./setup.sh`

#### 3.1 Manual Installation

To install it manually:

1. Unzip AIGEN Tool
2. Open to mpmath-1.1.0 Folder
3. run the command: `sudo python setup.py install` **or** `sudo python3 setup.py install`
4. Open aiger-1.9.9 Folder
5. run the command `./configure.sh && make`
6. copy the executable "aigtoaig" to parent folder i.e. in the same location of "Convert-Int-To-Bdd.out.py"
7. run the command: `sudo apt-get install libtinfo-dev`
8. run the command: `sudo dpkg -i libreadline-dev_8.0 - 4_amd64.deb`
9. Open abc-master folder
10. run the command: `make`
11. copy the executable "abc" to parent folder i.e. in the same location of "aigen.py"

12. run the command: `sudo apt install python-pip`
13. run the command: `sudo apt-get install libgmp-dev`
14. run the command: `sudo apt-get install libmpfr-dev`
15. run the command: `sudo apt-get install libmpc-dev`
16. run the command: `pip3 install gmpy2`

```
***** Tool Link *****  
https://github.com/mhdsakr/AIGEN-Tool/raw/master/AIGEN.zip  
***** Tool Permanent Link *****  
https://github.com/mhdsakr/AIGEN-Tool
```