به نام خدا

گزارش کار تمرین کامپیوتری ۲

نگین سفاری ۸۱۰۱۹۷۵۲۵

استاد: دکتر نوابی

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توضیحات در مورد الگوریتم پیاده شده:

برای انجام این پروژه از ۲ class به نام های WIRE و GATE استفاده شده است.

ابتدا به WIRE می پردازیم. در WIRE مقادیری را برای هر سیم نگه میداریم که به شرح زیر است:

```
class WIRE {
    string name;
    string type;
    char Faulty_Wire;
    int input_of_gate;
    int output_of_gate;
    vector <char> Fault_simulation_Values;
    vector <char> Good_simulation_values;
    vector <string> possible_stucks;
    vector <int> stuck_checkList;
```

در name ، نام آن سیم نگه داشته می شود که اگر این سیم خروجی یک fan out باشد نام آن اندیسی از ورودی fan out خواهد بود.

در type نوع سیم از لحاظ input یا output و یا wire بودن ذخیره می شود.

Faulty_wire تعیین می کند که یک سیم در شبیه سازی در حال انجام مقدار faulty دارد یا نه. اگر مقدار '1' را داشته باشد به معنای وجود faulty و اگر '0' باشد به معنای نبودن آن است.

از آنجا که برای هر گیت شماره ای را اختصاص میدهیم برای راحتی کار برای هر سیم در input_of_gate شماره ی گیت ای که به آن وارد می شود و در output_of_gate شماره ی گیت ای که از آن خارج می شود را نگه می داریم. در صورت input و یا output بودن سیمی و نداشتن گیت ای که از آن خارج شوند و یا آنکه به آن وارد شوند، مقدار متناظر آن ها 1- خواهد بود.

وکتور Fault_simulation_values برای هر سیم مقادیر به دست آمده به ازای تمامی تست کیس ها در یک بار سیمیولیش با وجود خطا بر روی هر کدام از سیم ها که نوبتشان بوده را نگه می دارد.

وکتور Good_simulation_values برای هر سیم مقادیر به دست آمده به ازای تمامی تست کیس ها را در سیمیولیشن با فرض سالم بودن تمامی سیم ها نگه می دارد.

وکتور possible_stucks مقادیر fault های ممکن که بر روی این سیم می تواند اتفاق بیفتد را نگه می دارد. این وکتور با توجه به گیت ای که این سیم به آن وارد می شود، پر خواهد شد.

وکتور stuck_check_list کاملا به اندازه وکتور possible_stucks است و اگر هر کدام از fault های ممکن شبیه سازی بشوند در وکتور stuck_check_list با یک کردن جایگاه متناظر با آن این fault را تیک می زنیم.

حال به GATE می پردازیم. در GATE مقادیری را برای هر سیم نگه میداریم که به شرح زیر است:

```
class GATE {
    string operation;
    WIRE* first_input;
    WIRE* second_input;
    vector<WIRE*>output;
```

در قسمت operation نام گیت نگه داشته می شود و از آنجا که fan out را هم یک گیت در نظر می گیریم نام "fanout" را برایش انتخاب می کنیم.

با اینکه گیت not و fanout تنها یک ورودی دارند، دو عدد WIRE* برای ورودی تعریف میکنیم تا همه ی گیت ها یک دست باشند و برای این موارد خاص جفتشان را با هما ورودی پر میکنیم که مشکلی را در برنامه ایجاد نخواهد کرد.

وکتور output که از جنس WIRE* است به خروجی های یک گیت اشاره دارد.

به طور کلی می توان گفت که روش کار برنامه ب این صورت است:

ابتدا فایل های ورودی دریافت می شوند و پس از خوانده شدن به کمک تابع decode_svFile تمامی سیم ها و گیت ها تشخیص داده می شوند و وکتور wires و gates پر می شوند. ابتدا به

کمک generate_wire تمامی سیم ها که نامشان در فایل ورودی آمده اند ذخیره می شوند، سپس در تابع generate_gates پس از آنکه ورودی ها و خروجی گیت ها دیده می شوند در صورتی که سیم ورودی به گیت به شماره ی گیت دیگری اشاره داشته باشد fanout تشخیص داده می شود. و یا آنکه اگر هر دو ورودی یک گیت یکسان باشند باز هم fanout تشخیص داده می شود. در تابع execute_fanout عمل اافه کردن گیت fanout به وکتور گیت ها صورت می گیرد. در این تابع اگر برای سیم مورد برسی گیت ای که به آن وارد شده باشد از قبل تعیین نشده باشد به معنای یک fanout جدید با دو عدد خروجی می باشد که به ورودی های یک گیت دیگر قرار است بروند که در این مورد ۲ سیم جدید تولید می شود و محل ورود و خروج آن ها را مشخص میکنیم. یک حالت دیگر آن است که از قبل آن سیم به fanout وارد شده باشد و الان به شاخه جدید تری نیاز است که در این مورد هم سیم جدیدی تولید می شود و محل ورود و خروج آن را مشخص میکنیم. در حالت آخر این مورد بررسی می شود که سیمی به ورودی گیتی قبلا رفته و آن ثبت هم شده است و حال گیت جدیدی یافت شده که همان سیم را به عنوان ورودی می خواهد در اینجا ۲ سیم جدید تولید می شود و محل ورود و خروج آن ها را مشخص میکنیم. به گونه ای که یک شاخه از آن به گیت قدیمی می رود و یک شاخه به گیت جدید وارد می شود. و ورودی به fanout را هم همان سیم اصلی در نظر می گیریم و مشخصاتش را با شرایط جدید به روز رسانی می کنیم. به این روش وکتور های گیت و سیم ها پر می شوند و تمامی fanout ها هم لحاظ شده اند. حال عملیات sort کردن سیم ها با توجه به اولویتی که دارند به کمک تابع sort_wires و sort_path انجام می شود و در نهایت یک وکتور از ایندکس های مرتب شده وکتور wires خواهیم داشت. محاسبات باید از سیم هایی شروع شود که ایندکس آن ها در خانه های انتهایی وکتور ایندکس های سورت شده قرار دارند شروع شود. قبل از شروع سیمیولیشن ها در تابع fault_collapsing تمامی خطا های ممکن بر روی ورودی گیت ها مشخص می شوند. اکنون از فایل متنی که دارای تست وکتور ها هست آن ها را میخوانیم و برای سیمیولیشن با فرض سالم بودن تمامی سیم ها به تمامی سیم ها از نوع input مقدار می دهیم. در تابع simulation ابتدا سیمیولیش با فرض سالم بودن سیم ها را به کمک تابع eval که برای گیت ها زده شده است انجام میدهیم. تابع eval می تواند هم good simulation ها

را انجام دهد و هم fault simulation ها را. برای انجام fault simulation به وضعیت خروجی گیت ها توجه می شود. اگر خروجی همان سیمی باشد که این بار fault بر روی آن افتاده است آن گیت محاسباتی انجام نمیدهد و خروجی مقدار fault خود را حفظ می کند. باید توجه داشت که fanout چندین خروجی دارد و هر کدام از خروجی ها که خطا دارد مقدار خطا را حفظ میکند اما باقی خروجی ها مقدار ورودی را می گیرند.

به ازای تمامی fault های ممکن تست وکتور ها را به مدار می دهیم و خروجی ها را با حالت بدون خطا چک می کنیم و نتایج را چاپ میکنیم. برای آن که خطای دیگری را بر روی سیمی لحاظ کنیم حتما باید نتایج مربوط به fault simulation قبلی را پاک کنیم و تیک مربوط به آن خطا را در وکتور stuck_checkList مربوط به سیم مربوطه بزنیم و سراغ خطای بعدی برویم.

یک نمونه ورودی به برنامه(۱):

```
module mux (a, b, s, y, w);
input a;
input b;
input s;
output y;

wire sbar;
wire aa;
wire bb;
nand #(3,5) U1 (sbar, s, s);
nand #(3,5) U2 (aa, a, sbar);
nand #(3,5) U3 (bb, b, s);
nand #(3,5) U4 (y, aa, bb);

endmodule
```

```
#00 1110
#21 1100
#31 1010
#19 0110
```

خروجی متناظر با ورودی بالا:

stucked wire name: a

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 0 current value: 0

test case 3 at time 71 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: b

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : fault was detected expected value: 0 current value: 1

test case 3 at time 71 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: s

*** stuck value: SA0 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : fault was detected expected value: 0 current value: 1

test case 3 at time 71 : fault was detected expected value: 1 current value: 0

---

stucked wire name: s

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 0 current value: 0

test case 3 at time 71 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: y

*** stuck value: SA0 ***

test case 0 at time 0 : fault was detected expected value: 1 current value: 0

test case 1 at time 21 : fault was detected expected value: 1 current value: 0

test case 2 at time 52 : no fault was detected expected value: 0 current value: 0

test case 3 at time 71 : fault was detected expected value: 1 current value: 0

---

stucked wire name: y

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : fault was detected expected value: 0 current value: 1

test case 3 at time 71 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: sbar

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : fault was detected expected value: 0 current value: 1

test case 3 at time 71 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: aa

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : fault was detected expected value: 1 current value: 0

test case 2 at time 52 : no fault was detected expected value: 0 current value: 0

test case 3 at time 71 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: bb

*** stuck value: SA1 ***

test case 0 at time 0 : fault was detected expected value: 1 current value: 0

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 0 current value: 0

test case 3 at time 71 : fault was detected expected value: 1 current value: 0

---

stucked wire name: s0

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 0 current value: 0

test case 3 at time 71 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: s1

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 0 current value: 0

test case 3 at time 71 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: s2

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

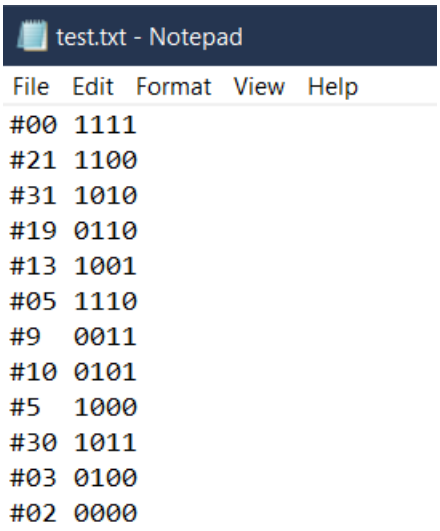
test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 0 current value: 0

test case 3 at time 71 : no fault was detected expected value: 1 current value: 1

یک نمونه ورودی به برنامه(۲):

```
module TEST (a, b, c, d, y);

input a;
input b;
input d;
output y;

input c;

wire x;

wire xbar;
wire aa;
wire bb;

nand U1 (y,aa, bb);

nand #(3,5) U2 (aa, xbar, a);

nor #(3,5) U3 (bb, x, c);
not #(3,5) U4 (xbar, x);

nor #(3,5) U5 (x, b, d);


endmodule
```



خروجی متناظر با ورودی بالا:

stucked wire name: a

***** stuck value: SA1 *****

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 1 current value: 1

test case 3 at time 71 : fault was detected expected value: 0 current value: 1

test case 4 at time 84 : no fault was detected expected value: 1 current value: 1

test case 5 at time 89 : no fault was detected expected value: 1 current value: 1

test case 6 at time 98 : no fault was detected expected value: 1 current value: 1

test case 7 at time 108 : no fault was detected expected value: 1 current value: 1

test case 8 at time 113 : no fault was detected expected value: 1 current value: 1

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : fault was detected expected value: 0 current value: 1

test case 11 at time 148 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: b

***** stuck value: SA0 *****

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 1 current value: 1

test case 3 at time 71 : no fault was detected expected value: 0 current value: 0

test case 4 at time 84 : no fault was detected expected value: 1 current value: 1

test case 5 at time 89 : no fault was detected expected value: 1 current value: 1

test case 6 at time 98 : no fault was detected expected value: 1 current value: 1

test case 7 at time 108 : no fault was detected expected value: 1 current value: 1

test case 8 at time 113 : no fault was detected expected value: 1 current value: 1

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : fault was detected expected value: 0 current value: 1

test case 11 at time 148 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: d

*** stuck value: SA0 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 1 current value: 1

test case 3 at time 71 : no fault was detected expected value: 0 current value: 0

test case 4 at time 84 : no fault was detected expected value: 1 current value: 1

test case 5 at time 89 : no fault was detected expected value: 1 current value: 1

test case 6 at time 98 : no fault was detected expected value: 1 current value: 1

test case 7 at time 108 : no fault was detected expected value: 1 current value: 1

test case 8 at time 113 : no fault was detected expected value: 1 current value: 1

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : no fault was detected expected value: 0 current value: 0

test case 11 at time 148 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: y

*** stuck value: SA0 ***

test case 0 at time 0 : fault was detected expected value: 1 current value: 0

test case 1 at time 21 : fault was detected expected value: 1 current value: 0

test case 2 at time 52 : fault was detected expected value: 1 current value: 0

test case 3 at time 71 : no fault was detected expected value: 0 current value: 0

test case 4 at time 84 : fault was detected expected value: 1 current value: 0

test case 5 at time 89 : fault was detected expected value: 1 current value: 0

test case 6 at time 98 : fault was detected expected value: 1 current value: 0

test case 7 at time 108 : fault was detected expected value: 1 current value: 0

test case 8 at time 113 : fault was detected expected value: 1 current value: 0

test case 9 at time 143 : fault was detected expected value: 1 current value: 0

test case 10 at time 146 : no fault was detected expected value: 0 current value: 0

test case 11 at time 148 : fault was detected expected value: 1 current value: 0

---

stucked wire name: y

***** stuck value: SA1 *****

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 1 current value: 1

test case 3 at time 71 : fault was detected expected value: 0 current value: 1

test case 4 at time 84 : no fault was detected expected value: 1 current value: 1

test case 5 at time 89 : no fault was detected expected value: 1 current value: 1

test case 6 at time 98 : no fault was detected expected value: 1 current value: 1

test case 7 at time 108 : no fault was detected expected value: 1 current value: 1

test case 8 at time 113 : no fault was detected expected value: 1 current value: 1

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : fault was detected expected value: 0 current value: 1

test case 11 at time 148 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: c

***** stuck value: SA0 *****

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 1 current value: 1

test case 3 at time 71 : no fault was detected expected value: 0 current value: 0

test case 4 at time 84 : no fault was detected expected value: 1 current value: 1

test case 5 at time 89 : no fault was detected expected value: 1 current value: 1

test case 6 at time 98 : fault was detected expected value: 1 current value: 0

test case 7 at time 108 : fault was detected expected value: 1 current value: 0

test case 8 at time 113 : no fault was detected expected value: 1 current value: 1

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : no fault was detected expected value: 0 current value: 0

test case 11 at time 148 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: x

*** stuck value: SA0 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 1 current value: 1

test case 3 at time 71 : no fault was detected expected value: 0 current value: 0

test case 4 at time 84 : no fault was detected expected value: 1 current value: 1

test case 5 at time 89 : no fault was detected expected value: 1 current value: 1

test case 6 at time 98 : no fault was detected expected value: 1 current value: 1

test case 7 at time 108 : no fault was detected expected value: 1 current value: 1

test case 8 at time 113 : no fault was detected expected value: 1 current value: 1

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : no fault was detected expected value: 0 current value: 0

test case 11 at time 148 : fault was detected expected value: 1 current value: 0

---

stucked wire name: x

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 1 current value: 1

test case 3 at time 71 : fault was detected expected value: 0 current value: 1

test case 4 at time 84 : no fault was detected expected value: 1 current value: 1

test case 5 at time 89 : no fault was detected expected value: 1 current value: 1

test case 6 at time 98 : no fault was detected expected value: 1 current value: 1

test case 7 at time 108 : no fault was detected expected value: 1 current value: 1

test case 8 at time 113 : no fault was detected expected value: 1 current value: 1

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : fault was detected expected value: 0 current value: 1

test case 11 at time 148 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: xbar

***** stuck value: SA1 *****

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 1 current value: 1

test case 3 at time 71 : no fault was detected expected value: 0 current value: 0

test case 4 at time 84 : no fault was detected expected value: 1 current value: 1

test case 5 at time 89 : no fault was detected expected value: 1 current value: 1

test case 6 at time 98 : no fault was detected expected value: 1 current value: 1

test case 7 at time 108 : no fault was detected expected value: 1 current value: 1

test case 8 at time 113 : no fault was detected expected value: 1 current value: 1

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : no fault was detected expected value: 0 current value: 0

test case 11 at time 148 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: aa

***** stuck value: SA1 *****

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : fault was detected expected value: 1 current value: 0

test case 2 at time 52 : fault was detected expected value: 1 current value: 0

test case 3 at time 71 : no fault was detected expected value: 0 current value: 0

test case 4 at time 84 : no fault was detected expected value: 1 current value: 1

test case 5 at time 89 : fault was detected expected value: 1 current value: 0

test case 6 at time 98 : no fault was detected expected value: 1 current value: 1

test case 7 at time 108 : no fault was detected expected value: 1 current value: 1

test case 8 at time 113 : no fault was detected expected value: 1 current value: 1

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : no fault was detected expected value: 0 current value: 0

test case 11 at time 148 : no fault was detected expected value: 1 current value: 1

---

stucked wire name: bb

*** stuck value: SA1 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 1 current value: 1

test case 3 at time 71 : no fault was detected expected value: 0 current value: 0

test case 4 at time 84 : fault was detected expected value: 1 current value: 0

test case 5 at time 89 : no fault was detected expected value: 1 current value: 1

test case 6 at time 98 : fault was detected expected value: 1 current value: 0

test case 7 at time 108 : fault was detected expected value: 1 current value: 0

test case 8 at time 113 : fault was detected expected value: 1 current value: 0

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : no fault was detected expected value: 0 current value: 0

test case 11 at time 148 : fault was detected expected value: 1 current value: 0

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stucked wire name: x0

*** stuck value: SA0 ***

test case 0 at time 0 : no fault was detected expected value: 1 current value: 1

test case 1 at time 21 : no fault was detected expected value: 1 current value: 1

test case 2 at time 52 : no fault was detected expected value: 1 current value: 1

test case 3 at time 71 : no fault was detected expected value: 0 current value: 0

test case 4 at time 84 : no fault was detected expected value: 1 current value: 1

test case 5 at time 89 : no fault was detected expected value: 1 current value: 1

test case 6 at time 98 : no fault was detected expected value: 1 current value: 1

test case 7 at time 108 : no fault was detected expected value: 1 current value: 1

test case 8 at time 113 : fault was detected expected value: 1 current value: 0

test case 9 at time 143 : no fault was detected expected value: 1 current value: 1

test case 10 at time 146 : no fault was detected expected value: 0 current value: 0

test case 11 at time 148 : fault was detected expected value: 1 current value: 0

این خروجی در فایل Results.txt ذخیره شده است که تمامی نتایج را به دقت مشخص کرده و می توان جمله fault was detected را در مقابل مواردی که اختلاف در خروجی بوده یافت.