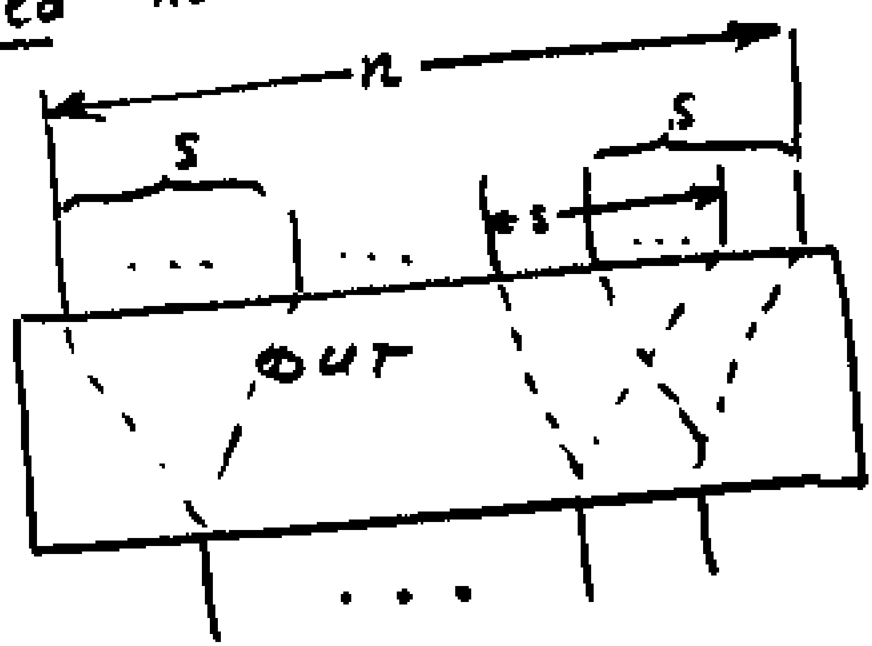
Pseudoexhaustive Testing

Exhaustive testing for devices with outputs depending on a limited number of inputs



Every output depends on at most S out of n inputs

(A. K. Chandra et. al., IBM Res. Repor RC 8936, July 1981;
Tang, Chen, IBM Research Report RC 10064, July 1983)

2.

Let $T(n,s)$ is a min test for these devices

<u>Examples</u>

1. $$T(4,3) = \begin{pmatrix} 0&0&0&0 \\ 0&0&1&1 \\ 0&1&0&1 \\ 0&1&1&0 \\ 1&0&0&1 \\ 1&0&1&0 \\ 1&1&0&0 \\ 1&1&1&1 \end{pmatrix}$$

2. $$T(8,2) = \begin{pmatrix} 0&0&0&0&0&0&0&0 \\ 0&0&1&1&1&0&0&1 \\ 0&1&0&1&0&1&1&1 \\ 1&0&0&0&1&1&1&0 \\ 1&1&1&0&0&0&1&1 \\ 1&1&1&1&1&1&0&0 \end{pmatrix}$$

$\therefore$ In every s-tuple of columnes of $T(n,s)$ all 2^s binary s-tuples appearing at least once

Constructions and estimations for pseudoexhaustive tests

Denote $f(n,s)$ a min number of test patterns in a pseudo-exhaustive test $T(n,s)$

1. $f(n,1)=2$, $T(n,1)=\begin{pmatrix} 0 0 \dots 0 \\ 1 1 \dots 1 \end{pmatrix}$

2. $f(n,2) \simeq \log_2 n$,
   Columns in $T(n,2)$ are vectors with exactly $\frac{1}{2} f(n,2)$ ones; for every column negated vector cannot appear as a column in $T(n,2)$

3. For $s=3$

$$T(n,3) = \left(\begin{array}{c|c} T(n/2,3) & T(n/2,3) \\ \hline T(n/2,2) & \overline{\overline{T}}(n/2,2) \end{array}\right)$$

$\overline{\overline{T}}(n/2,2)$ is a pseudoexhaustive test $T(n/2,2)$ with all test patterns negated

$$f(n,3) = f(n/2,3) + f(n/2,2)$$

4. for $s=n$, $f(n,n)=2^{n}$.

5. For $s=n-1$, $f(n,n-1)=2^{n-1}$.

$T(n,n-1)$ consists of all vectors of even parity

6. For $s=n-2$, $f(n, n-2) = \left\lfloor \frac{1}{3} 2^n \right\rfloor$

$T(n, n-2)$ consists of all vectors of weights $0, 3, 6, 9, \dots$ (weight is a number of ones) or weights $1, 4, 7, 10, \dots$ or $2, 5, 8, 11, \dots$

Exact values of $f(n,s)$ <u>are unknown</u> for $2 < s < n-2$

<u>Bounds</u>:

$$2^{s-3} \log_2 (n-s) \le f(n,s) \le 2^s \cdot s \log_2 n$$

Constructions for $T(n,s)$

1. All vectors of weights $0, n-s+1,$
$2(n-s+1), 3(n-s+1), \ldots$

Optimal for $s = n, n-1, n-2$.

$$f(n,s) \le \left\lfloor \frac{1}{n-s+1} 2^n \right\rfloor$$

2. All vectors of ~~a~~ weight $\left\lfloor \frac{s}{2} \right\rfloor$ and their negations

<u>not</u>optimal

$$f(n,s) \le 2 \binom{n}{\lfloor s/2 \rfloor}$$

<u>Example</u>: $n=5,\ s=3$

$$\left\lfloor \frac{5}{2} \right\rfloor = 1$$

$$T(5,3) = \begin{pmatrix} 1&0&0&0&0 \\ 0&1&0&0&0 \\ 0&0&1&0&0 \\ 0&0&0&1&0 \\ 0&0&0&0&1 \\ 0&1&1&1&1 \\ 1&0&1&1&1 \\ 1&1&0&1&1 \\ 1&1&1&0&1 \end{pmatrix}$$