Tutorial 11

Swinburne University of Technology

Software Testing and Reliability (SWE30009)

Semester 2, 2023

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Tutor: Dr Hung Q Luu

Student Survey

- Please kindly help **fill in the survey** (10 mins)

2023-HS2-SWE30009-Software Testing ... > Course Evaluations

2023 Semester 2

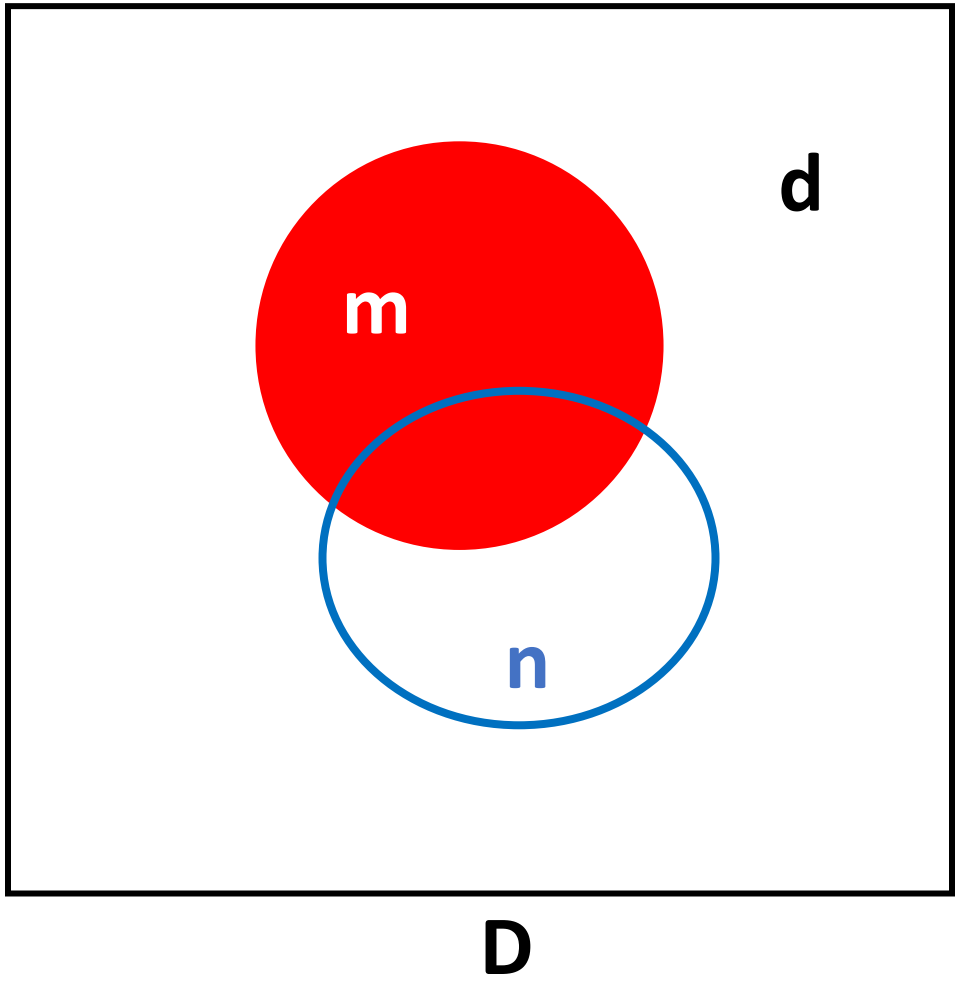
watermark™
Course Evaluations & Surveys | formerly EvaluationKIT

Testing effectiveness

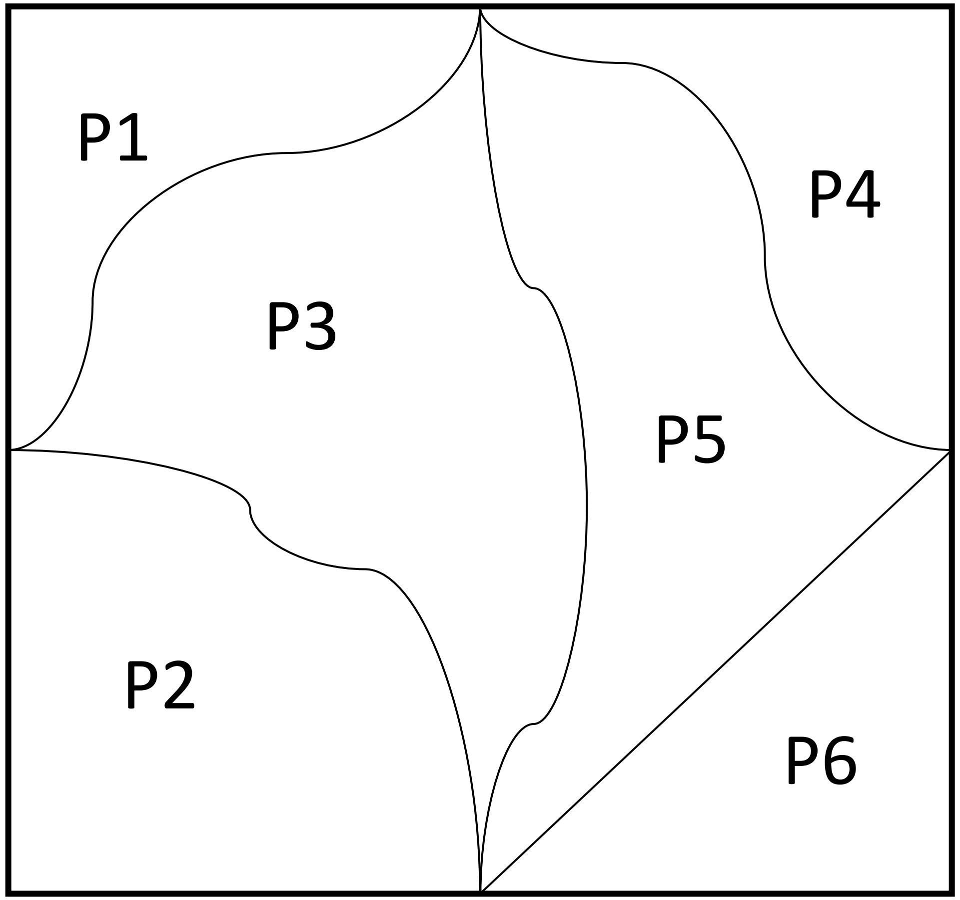
$$\theta = \frac{m}{d}$$

Input domain

- **D**: input domain
- **d**: domain size
- **m**: number of failure-causing inputs
- **n**: number of test cases
- $\boldsymbol{\theta}$ **= m/d**: failure ratio
- **σ = n/d**: sampling rate



Partitions



Effectiveness measures

- **E-measure:** Expected probability of detecting failures
- **P-measure**: Probability of detecting at least one failure
- **F-measure:** Expected number of test cases to detect the first failure

Random testing

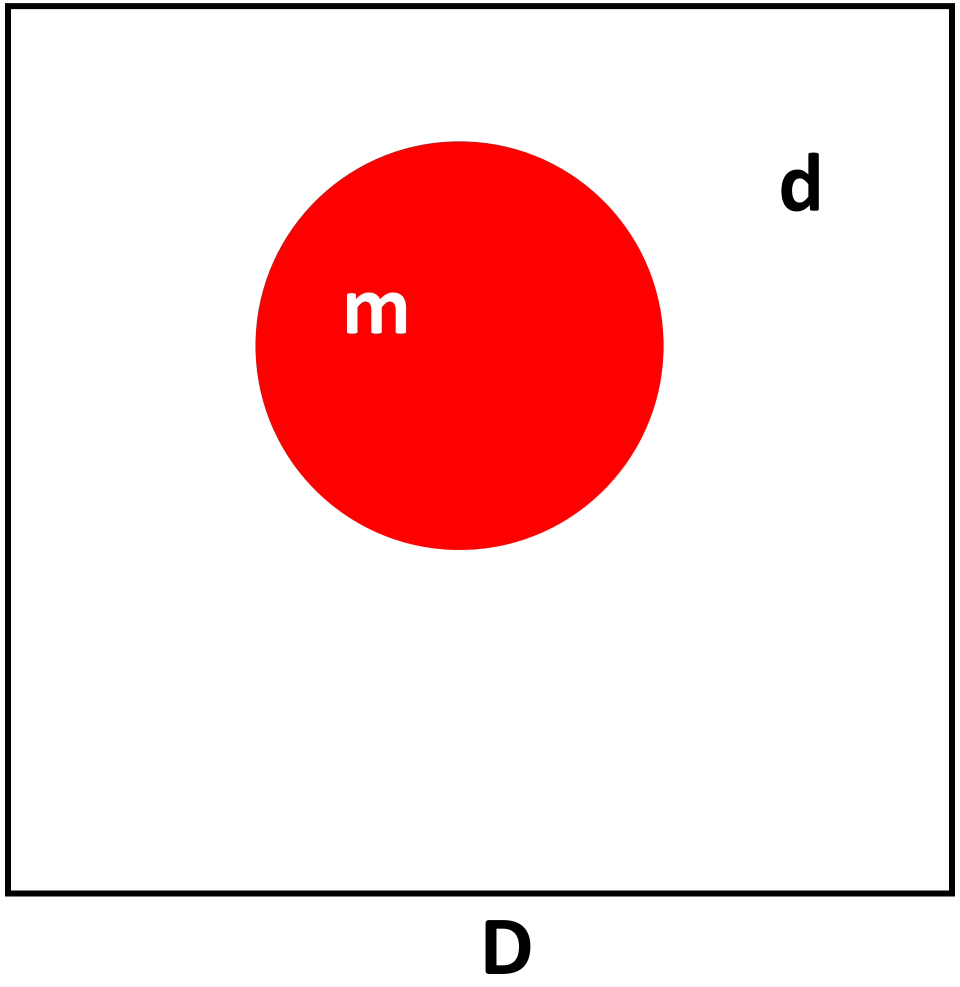
$$\theta = \frac{m}{d}$$

- Expected probability of detected failures
  - One test case

$$E_r = \theta$$

  - Multiple test cases

$$E_r = n\theta$$



$$\theta = \frac{m}{d}$$

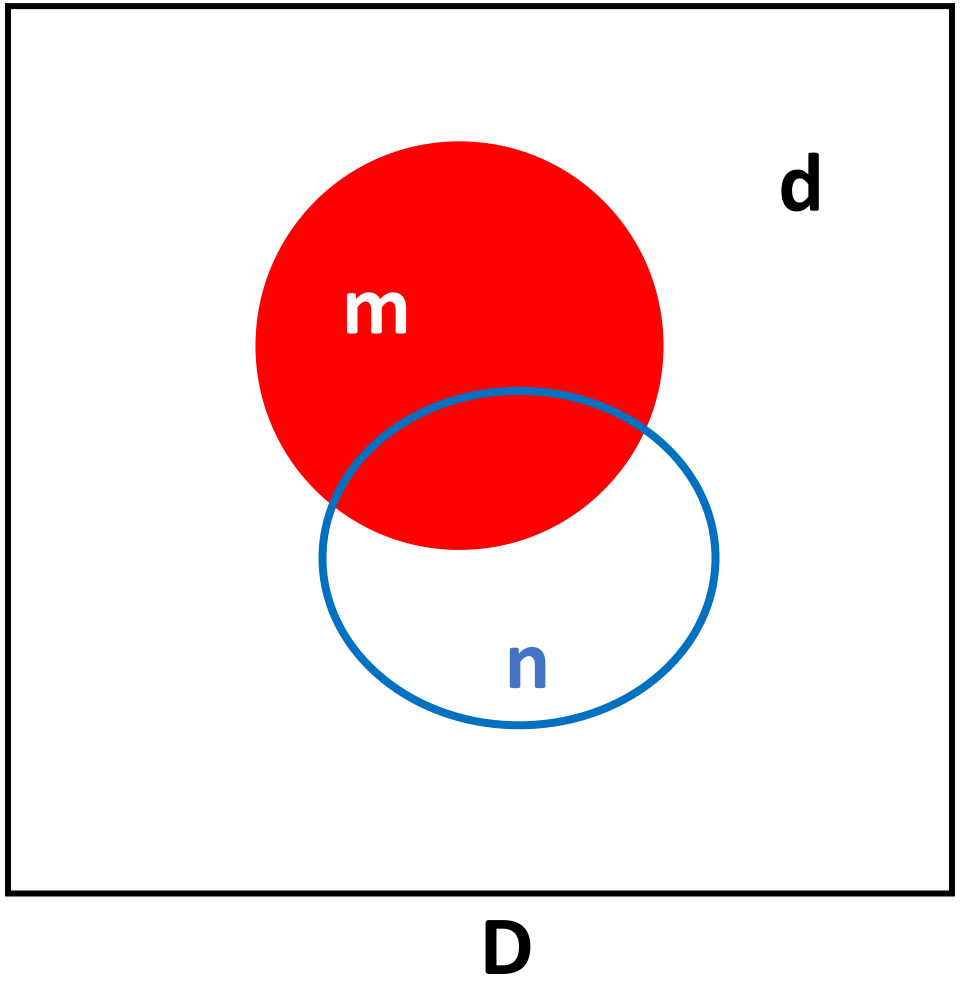
Random testing

- Probability of detecting at least one failure
  - One test case

$$P_r = \theta$$

  - Multiple test cases

$$P_r = 1 - (1 - \theta)^n$$

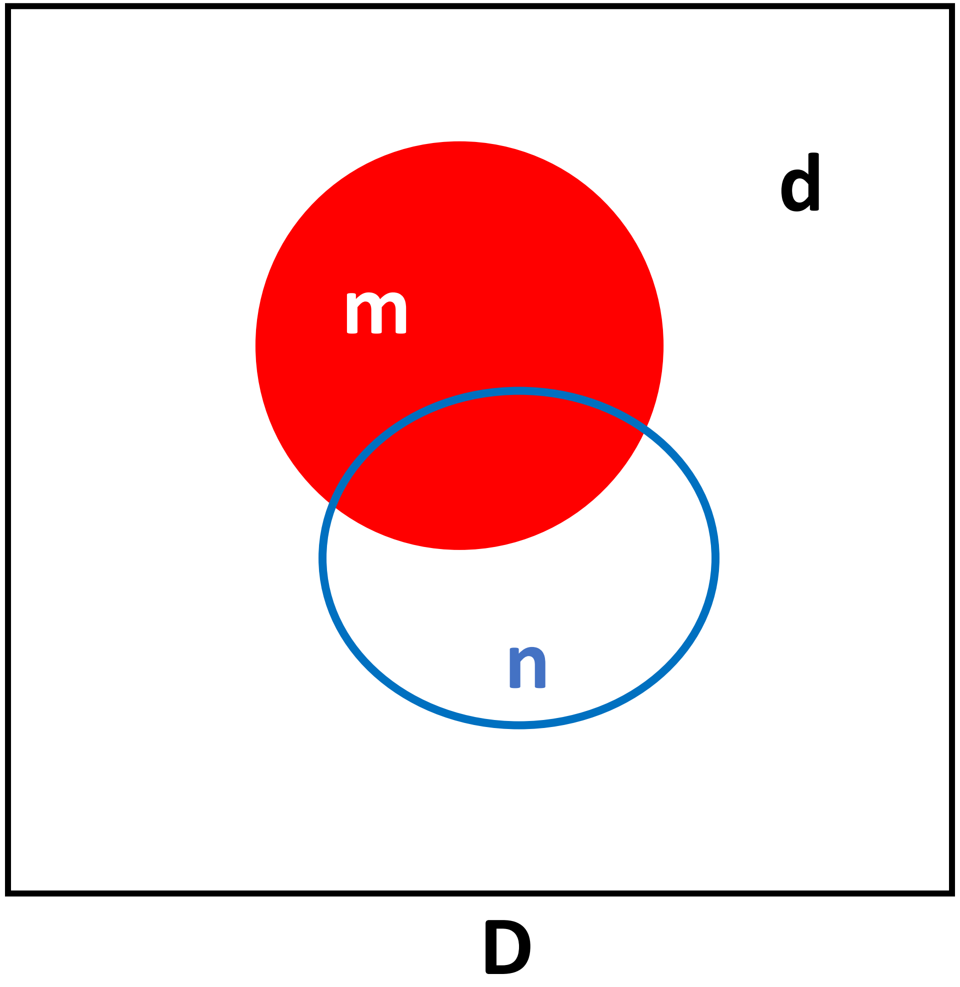


Random testing

- Expected number of test cases to detect the first failure

$$F_r = \left\lfloor \frac{1}{\theta} \right\rfloor$$

$$\theta = \frac{m}{d}$$



Partition testing

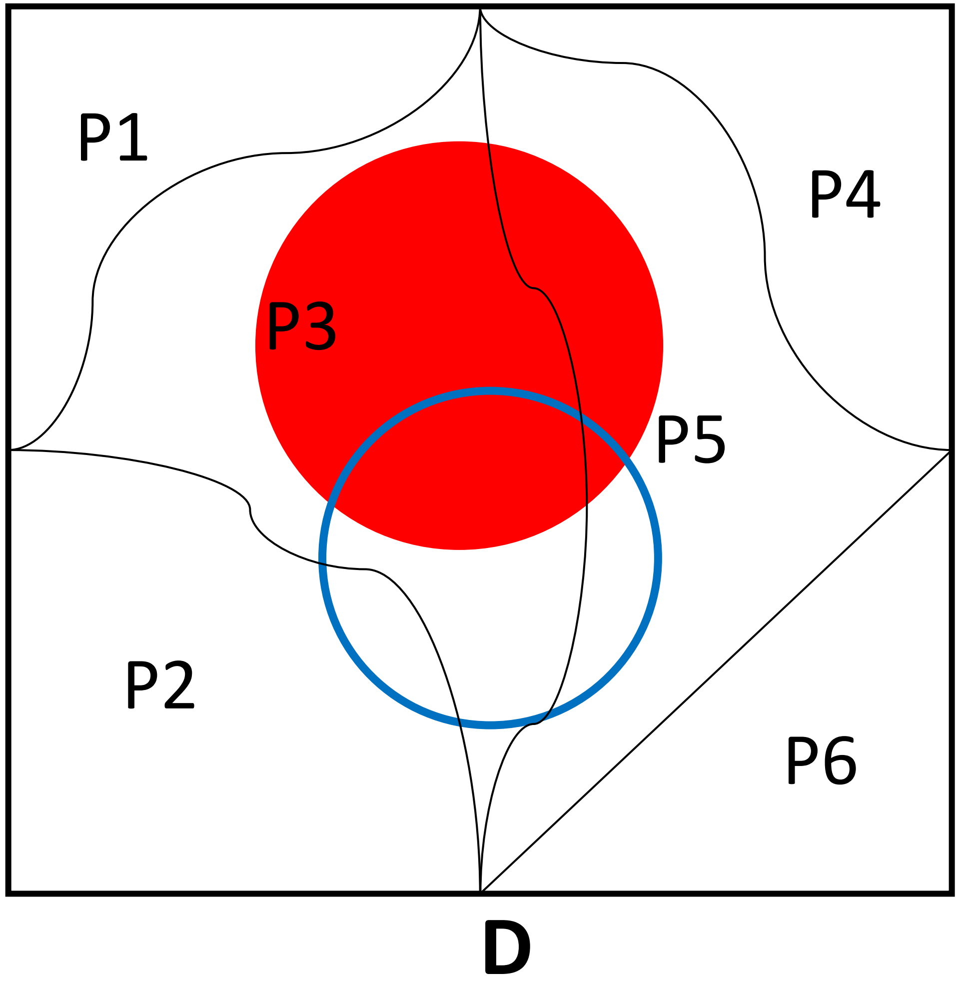
$$\theta_i = \frac{m_i}{d_i}$$

- Expected probability of detected failures
  - One test case for each partition

$$E_p = \sum_{i=1}^{k} \theta_i$$

  - Multiple test cases for each partition

$$E_p = \sum_{i=1}^{k} n_i \theta_i$$



Partition testing

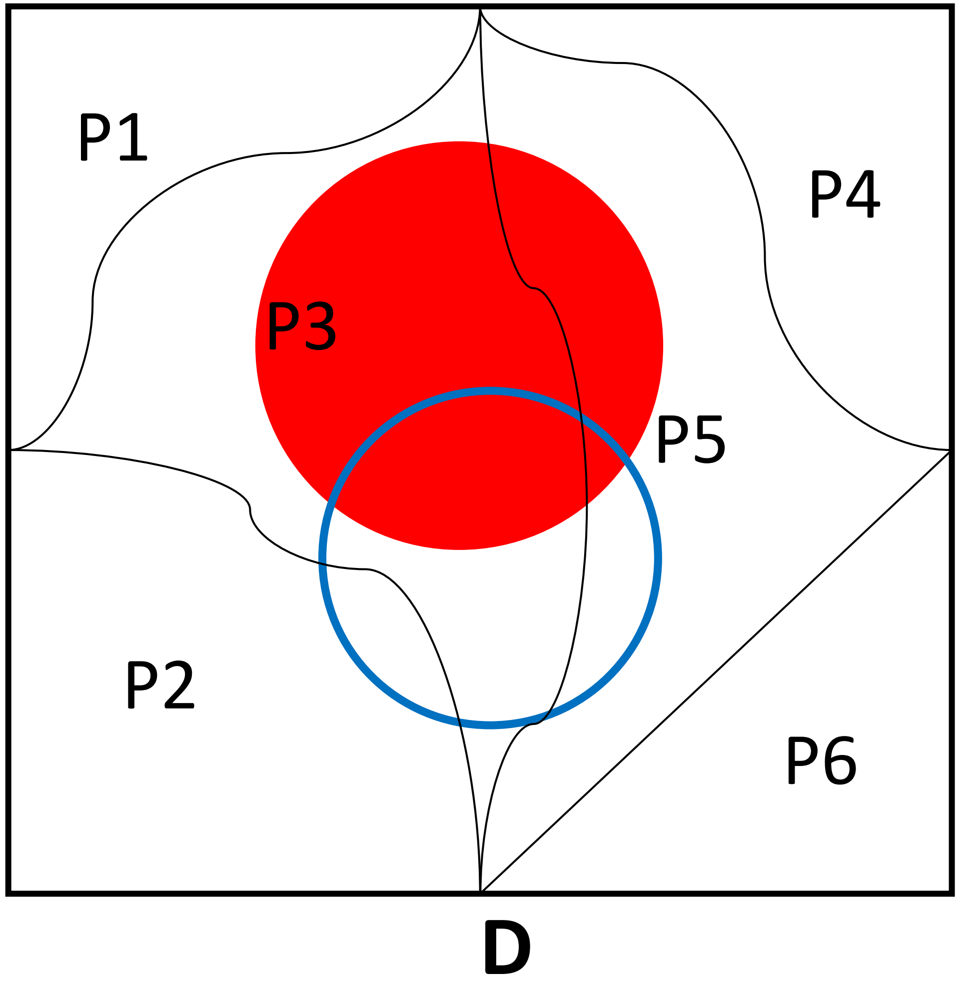
$$\theta_i = \frac{m_i}{d_i}$$

- Probability of detecting at least one failure
  - One test case for each partition

$$P_p = 1 - \prod_{i=1}^{k} (1 - \theta_i)$$

  - Multiple test cases for each partition

$$P_p = 1 - \prod_{i=1}^{k} (1 - \theta_i)^{n_i}$$



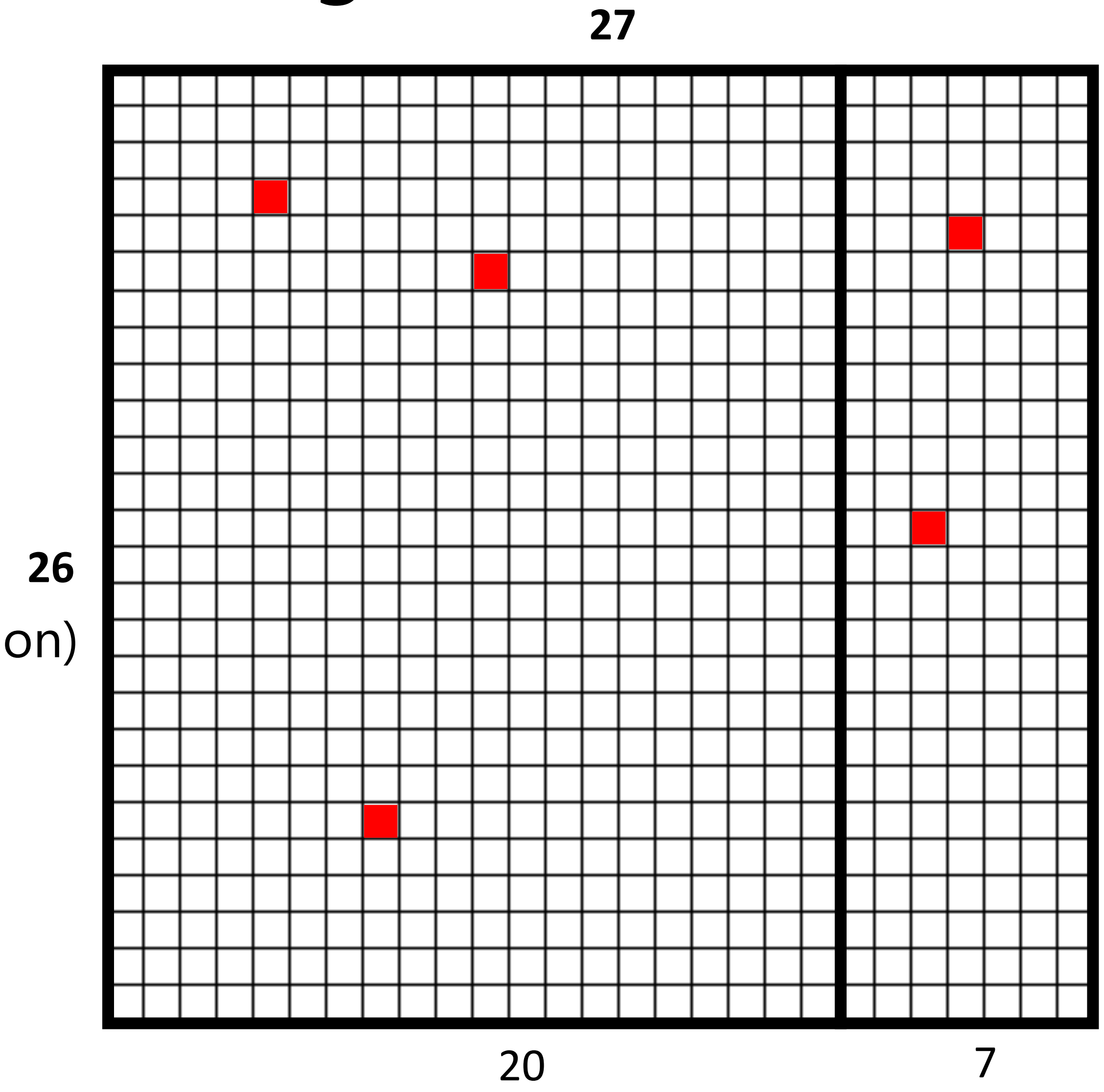
Random testing vs. Partition testing

- P-measure
  - Random testing (4 test cases)

$$P_r = 1 - (1 - \theta)^n$$

  - Partition testing (2 test case in each partition)

$$P_p = 1 - \prod_{i=1}^{k} (1 - \theta_i)^{n_i}$$



Random testing vs. Partition testing

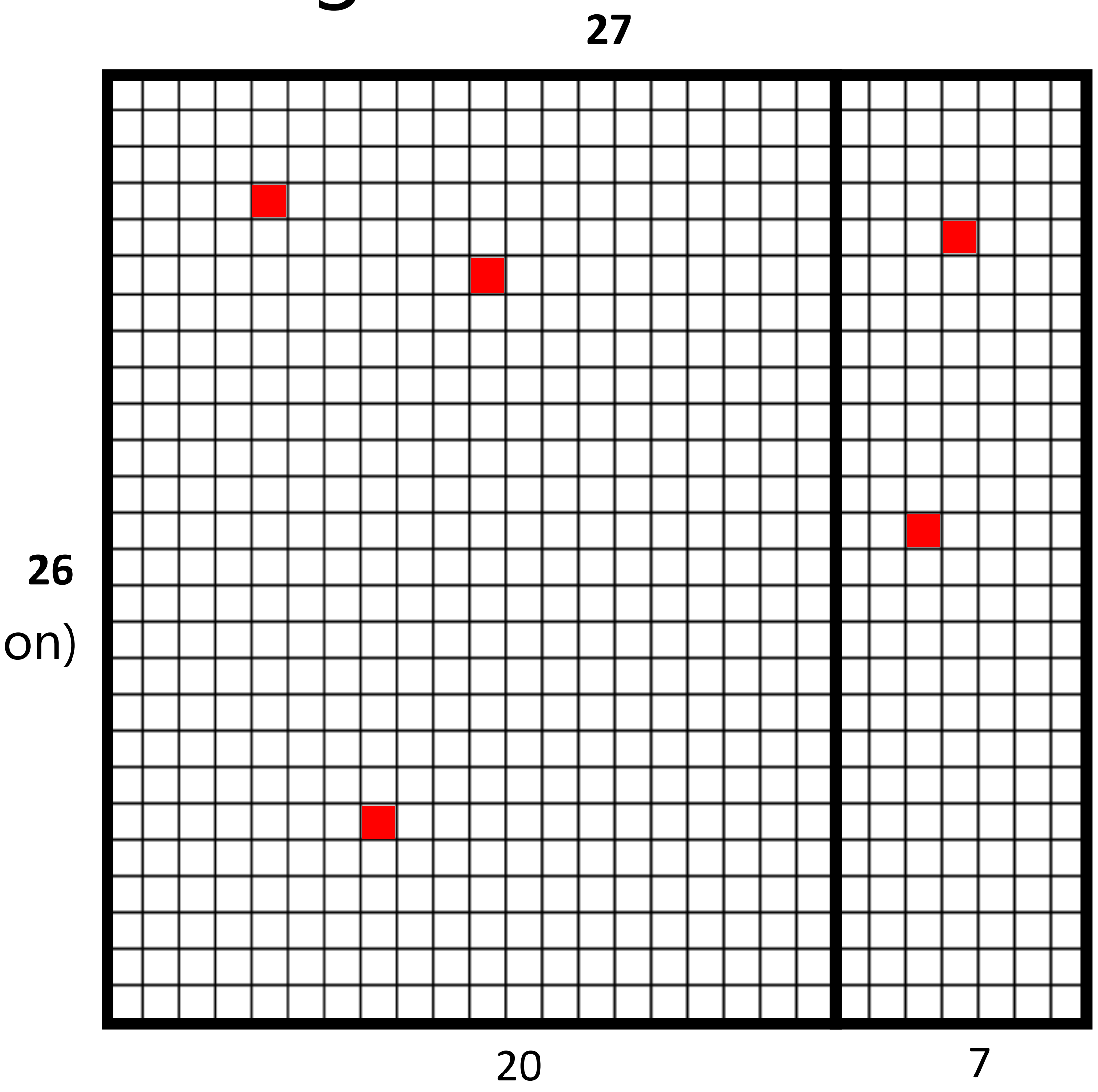
Parition Testing is better than Random Testing

- P-measure
  - Random testing (4 test cases)

$$
\begin{aligned}
P_r &= 1-(1-\theta)^n \\
&= 1-\left(1-\frac{5}{702}\right)^4 \\
&= 0.0281
\end{aligned}
$$

  - Partition testing (2 test case in each partition)

$$
\begin{aligned}
P_p &= 1-\prod_{i=1}^{k}(1-\theta_i)^{n_i} \\
&= 1-\left(1-\frac{3}{520}\right)^2\left(1-\frac{2}{182}\right)^2 \\
&= 0.0332
\end{aligned}
$$



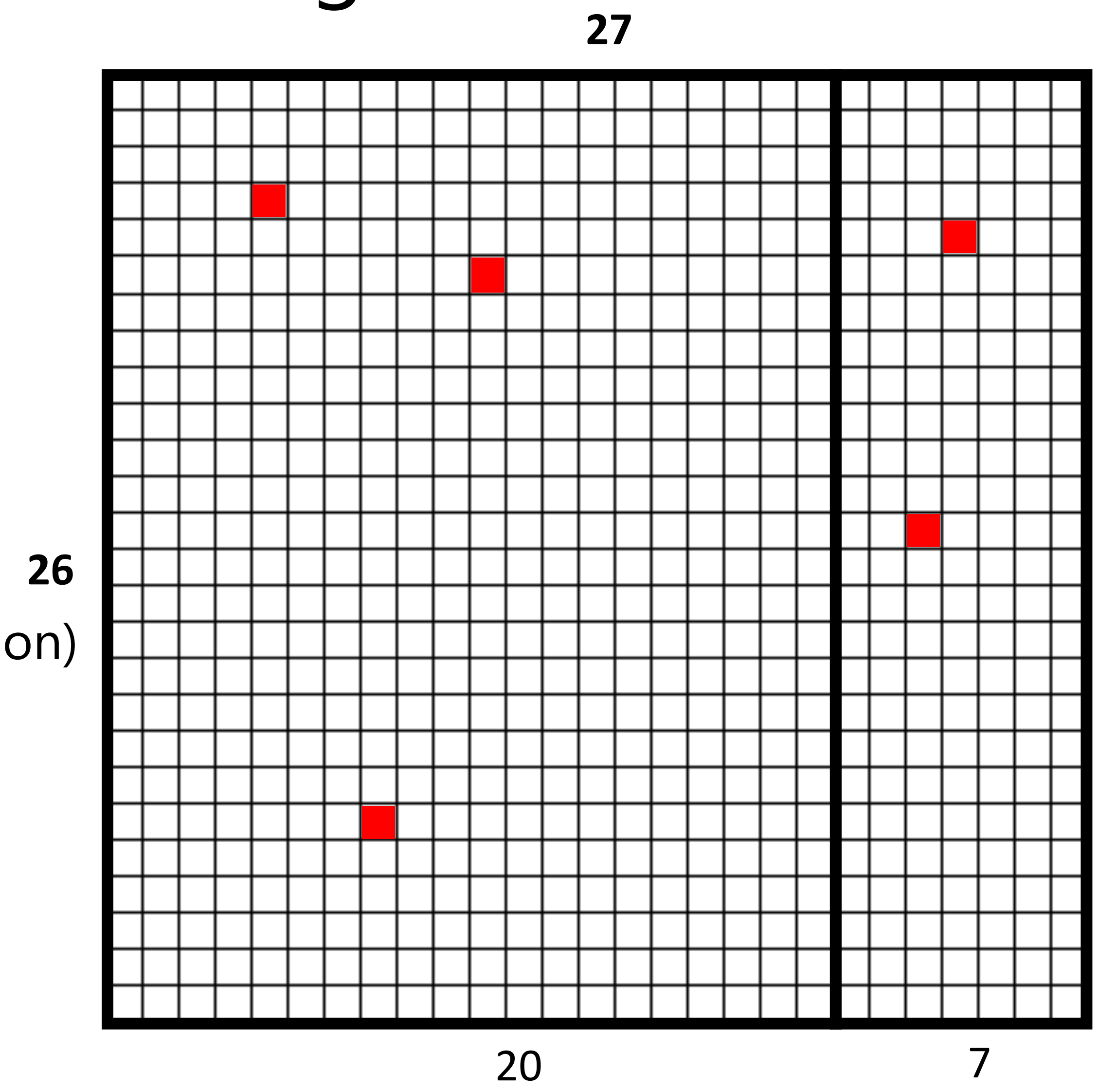
Random testing vs. Partition testing

- E-measure
  - Random testing (4 test cases)

$$E_r = n\,\theta$$

  - Partition testing (2 test case in each partition)

$$E_p = \sum_{i=1}^{k} n_i \theta_i$$



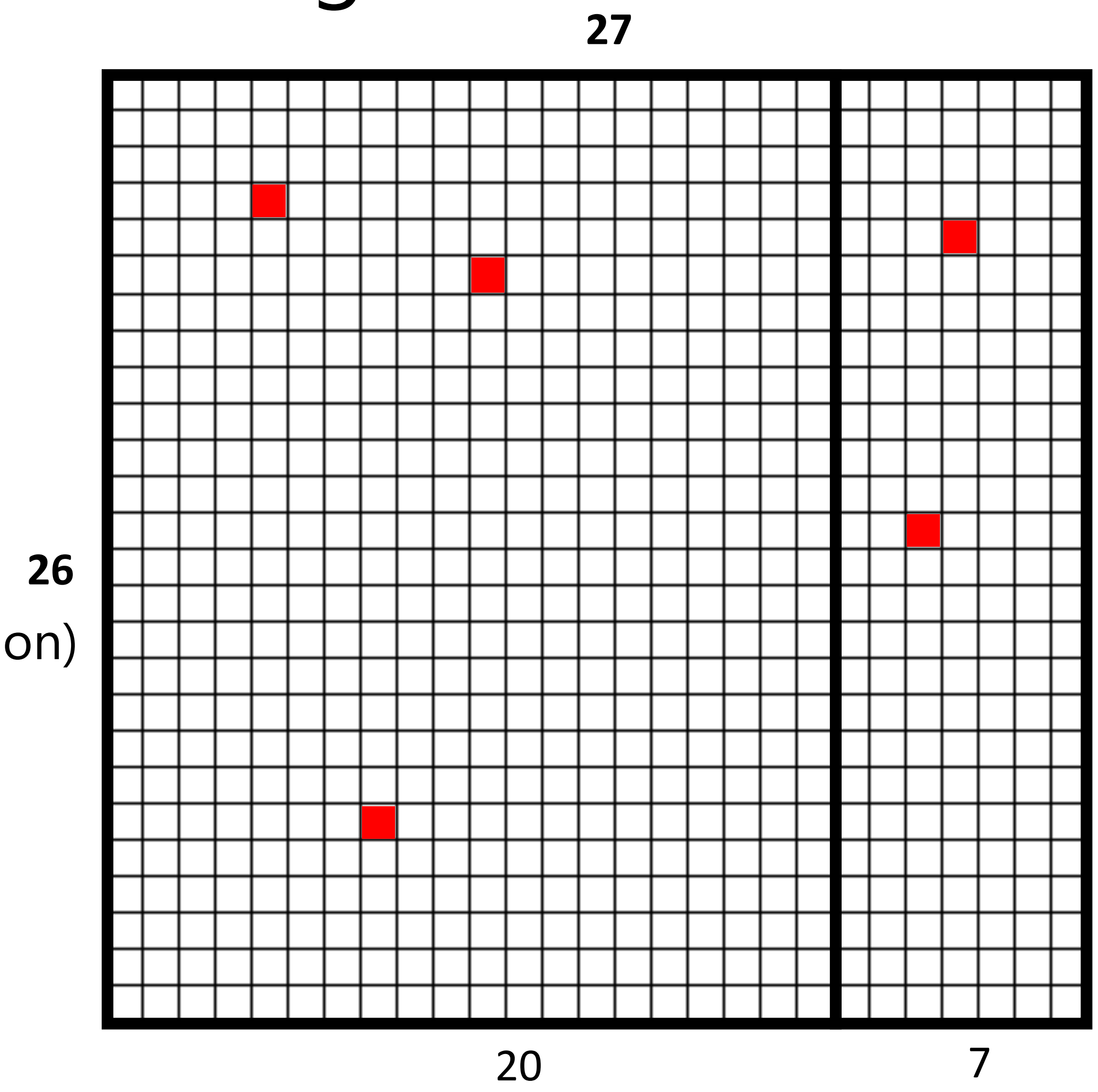
Random testing vs. Partition testing

- E-measure
  - Random testing (4 test cases)

$$
\begin{aligned}
E_r &= n\,\theta \\
&= 4\frac{5}{702} \\
&= 0.0285
\end{aligned}
$$

  - Partition testing (2 test case in each partition)

$$
\begin{aligned}
E_p &= \sum_{i=1}^{k} n_i \theta_i \\
&= 2\frac{3}{520} + 2\frac{2}{182} \\
&= 0.0335
\end{aligned}
$$



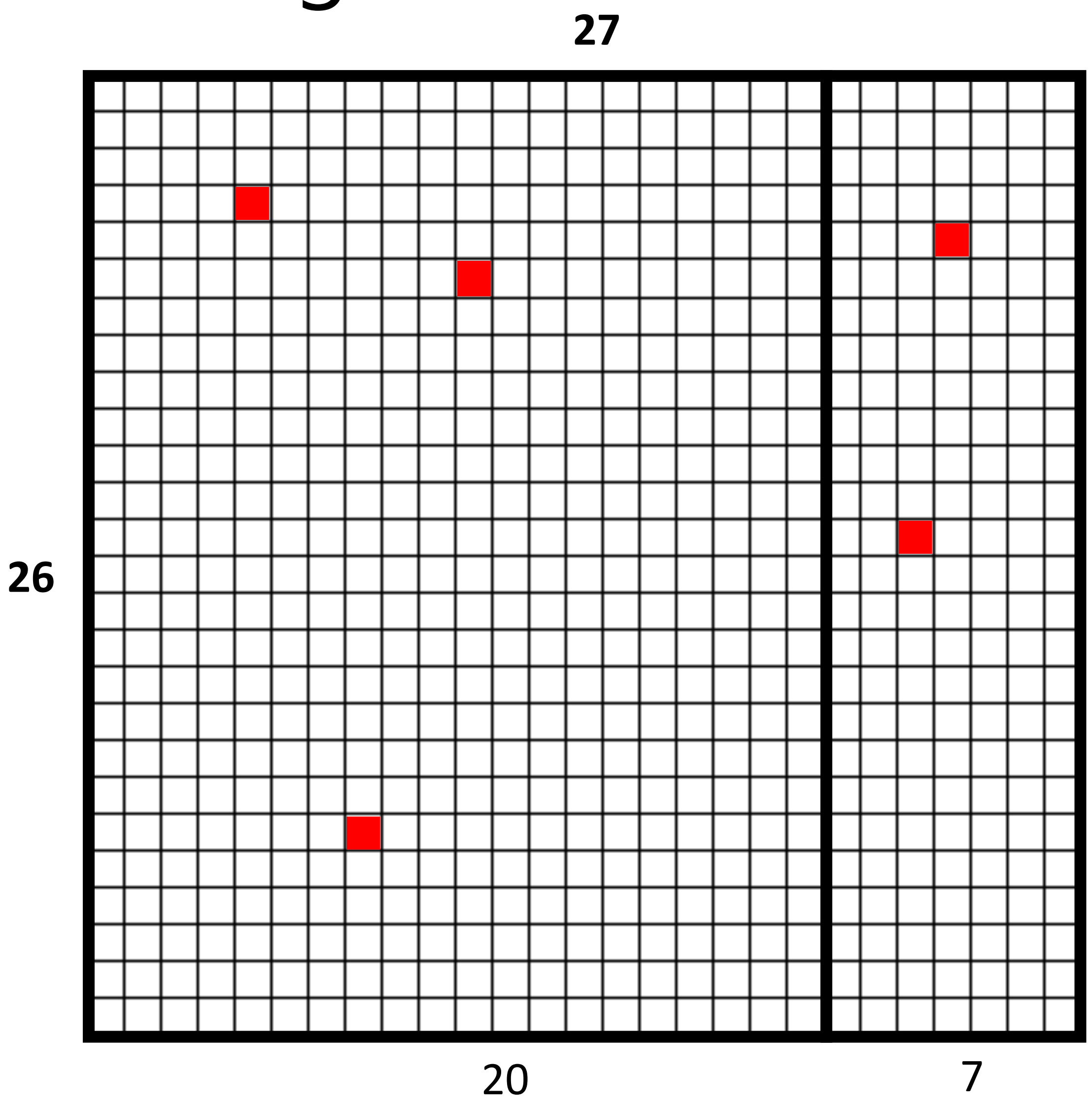
Random testing vs. Partition testing

- P-measure
  - Random testing (4 test cases)

$$
\begin{aligned}
P_r &= 1-(1-\theta)^n \\
&= 1-\left(1-\frac{5}{702}\right)^4 \\
&= 0.0281
\end{aligned}
$$

  - Partition testing (test cases ratio 3:1)

$$P_p = 1-\prod_{i=1}^{k}(1-\theta_i)^{n_i}$$



Random testing vs. Partition testing

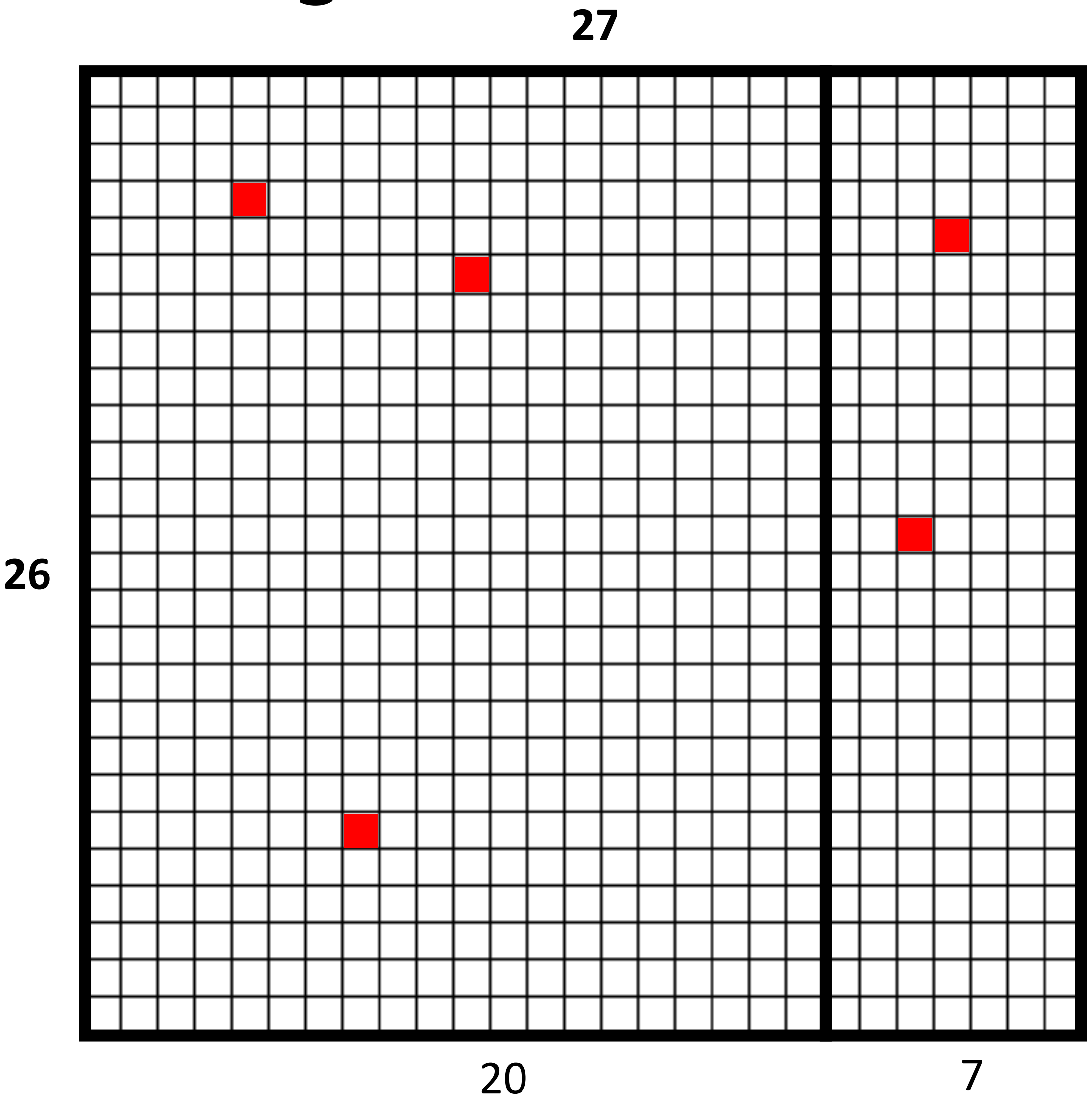
Parition Testing is worse
than Random Testing

- P-measure
  - Random testing (4 test cases)

$$
\begin{aligned}
P_r &= 1-(1-\theta)^n \\
&= 1-\left(1-\frac{5}{702}\right)^4 \\
&= 0.0281
\end{aligned}
$$

  - Partition testing (test cases ratio 3:1)

$$
\begin{aligned}
P_p &= 1-\prod_{i=1}^{k}(1-\theta_i)^{n_i} \\
&= 1-\left(1-\frac{3}{520}\right)^3\left(1-\frac{2}{182}\right)^1 \\
&= 0.0280
\end{aligned}
$$



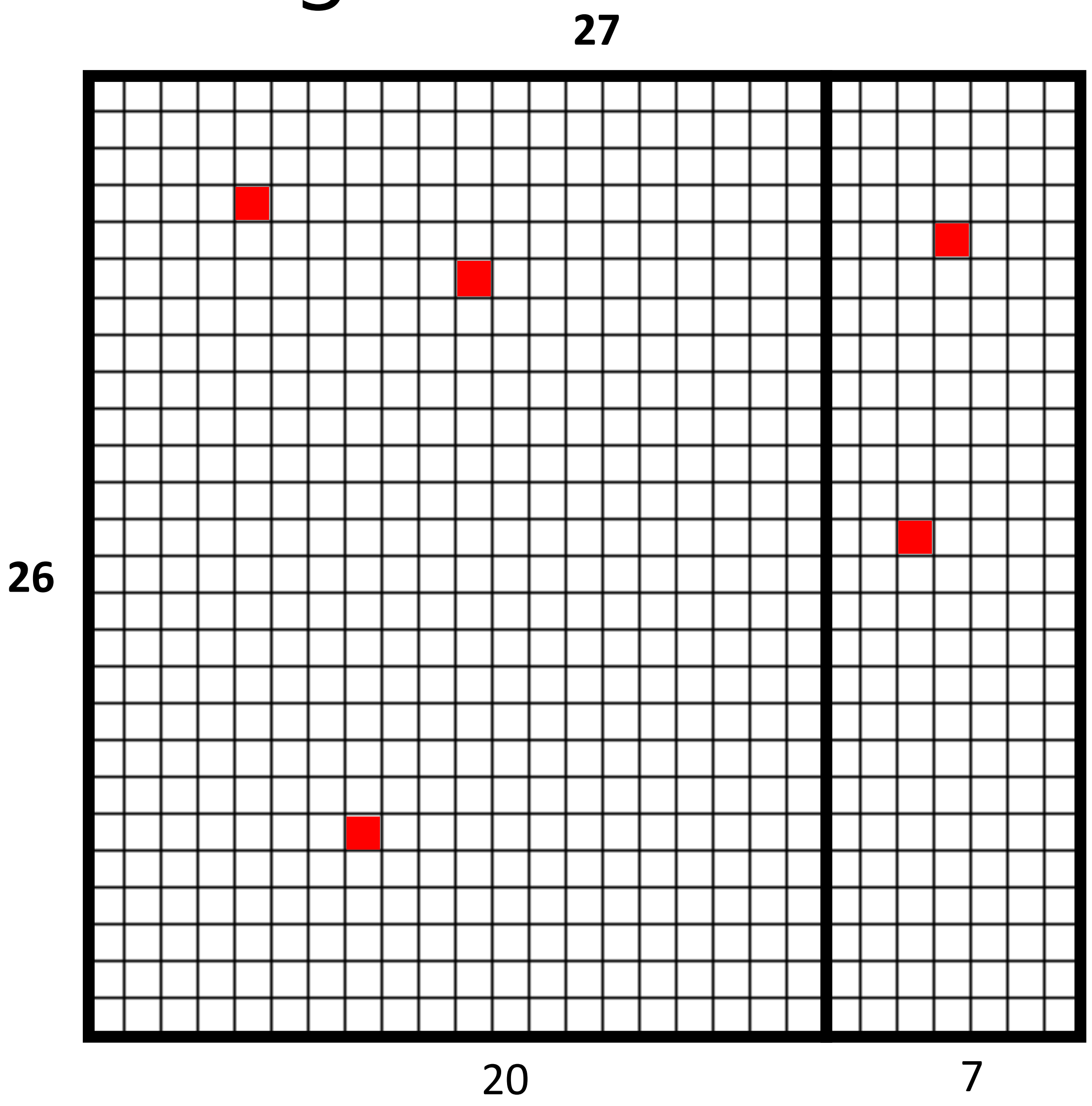
Random testing vs. Partition testing

- E-measure
  - Random testing (4 test cases)

$$
\begin{aligned}
E_r &= n\,\theta \\
&= 4\frac{5}{702} \\
&= 0.0285
\end{aligned}
$$

  - Partition testing (test cases ratio is 3:1)

$$E_p = \sum_{i=1}^{k} n_i \theta_i$$



Random testing vs. Partition testing

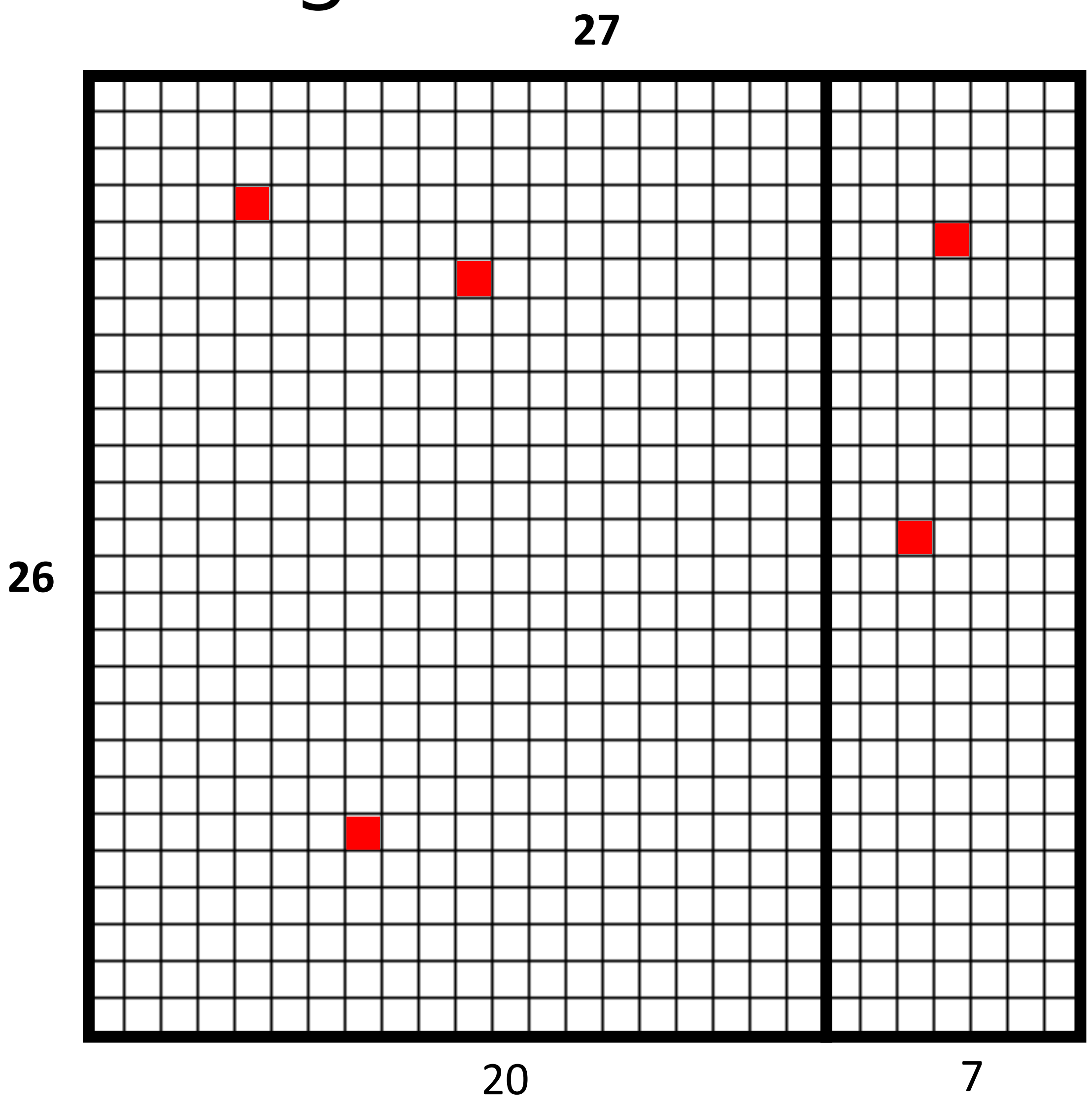
Parition Testing is worse
than Random Testing

- E-measure
  - Random testing (4 test cases)

$$E_r = n\,\theta = 4\frac{5}{702} = 0.0285$$

  - Partition testing (test cases ratio is 3:1)

$$E_p = \sum_{i=1}^{k} n_i\theta_i = 3\frac{3}{520} + 1\frac{2}{182} = 0.0282$$



Proportional Sampling Strategy (PSS)

- All partitions have the same sampling rates

  $\sigma_1 = \sigma_2 = \cdots = \sigma_k$, that is,

  $$\frac{n_1}{d_1} = \frac{n_2}{d_2} = \cdots = \frac{n_k}{d_k}$$

- Test cases are selected randomly from each partition

Proportional Sampling Strategy (PSS)

- A simple method
- Can be applied to almost any partitioning scheme – given relative size ratios of the partitions
- May not be followed strictly in practice

Basic Maximin Algorithm

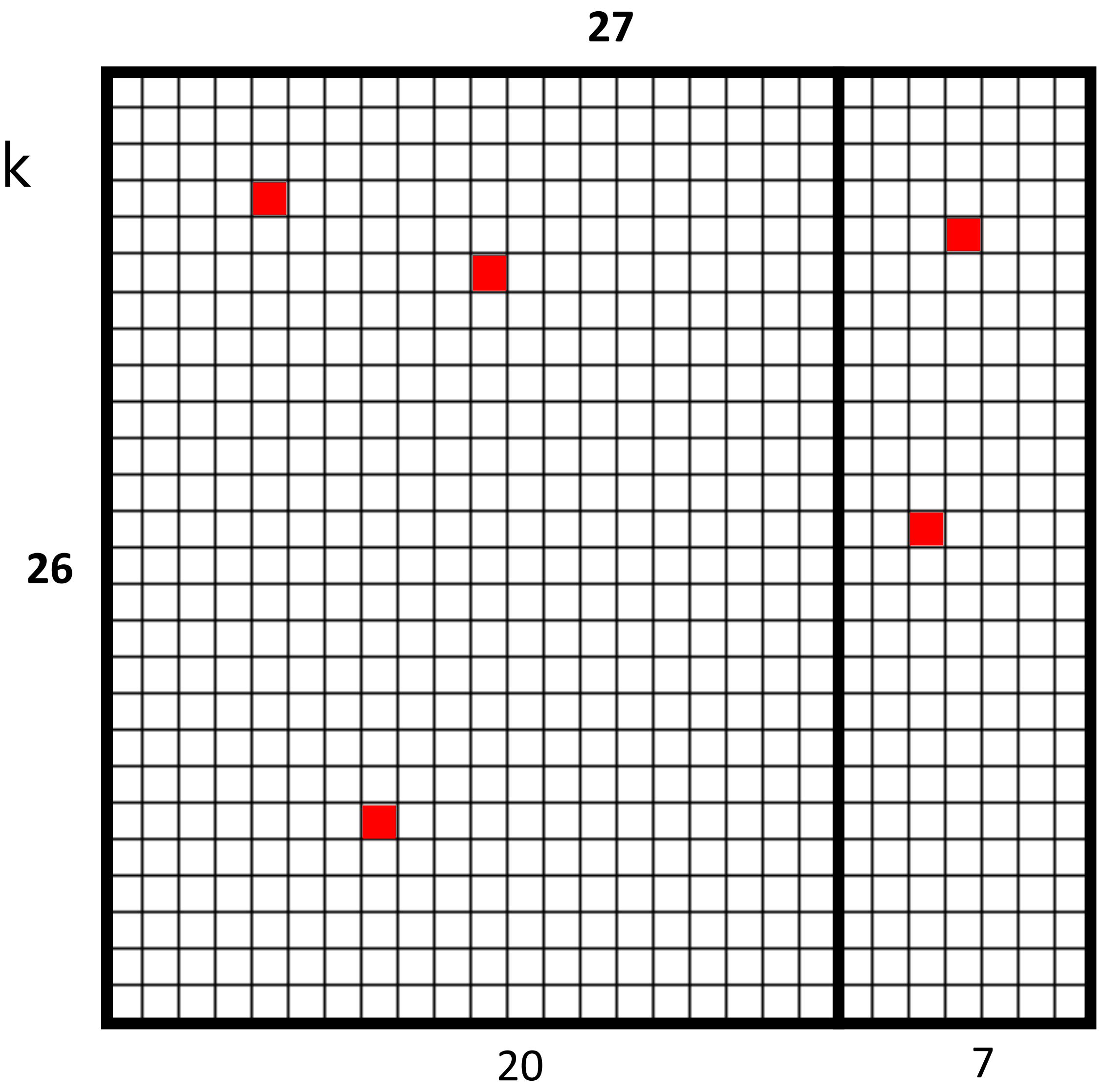
- Set $n_i = 1$ and $\sigma_i = 1/d_i$ for $i = 1, 2, \ldots, k$
- Set $q = n - k$
- While $q > 0$, repeat:

  (a) Find j such that $\sigma_j = \min \sigma_i$

  (b) Set $n_j = n_j + 1$

  (c) Set $\sigma_j = \sigma_j + 1/d_j$

  (d) Set $q = q - 1$



Basic Maximin Algorithm (n = 4)

Result: $n_1 = 3$, $n_2 = 1$

- Set $n_1 = 1$, $n_2 = 1$, $\sigma_1 = 1/520$, $\sigma_2 = 1/182$
- Set q = n – k = 4 – 2 = 2
- Since q = 2 > 0, repeat:

  (a) Since $\min\{\sigma_1, \sigma_2\} = \min\left\{\frac{1}{520}, \frac{1}{182}\right\} = \frac{1}{520}$ then j = 1 (first partition)

  (b) Set $n_1 = n_1 + 1 = 2$

  (c) Set $\sigma_1 = \sigma_1 + 1/520 = 2/520$

  (d) Set q = q – 1 = 1
- Since q = 1 > 0, repeat

  (a) Since $\min\left\{\frac{2}{520}; \frac{1}{182}\right\} = \frac{2}{520} = \sigma_1$ then j=1 (first partition)

  (b) Set $n_1 = n_1 + 1 = 2 + 1 = 3$

  (c) Set $\sigma_1 = \sigma_1 + 1/520 = 3/520$

  (d) Set q = q – 1 = 0