DETEKSI API BERBASIS SENSOR VISUAL MENGGUNAKAN METODE SUPPORT VECTOR MACHINES

Penyusun Tugas Akhir :

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PENDAHULUAN

RANCANGAN & IMPLEMENTASI

SKENARIO UJI COBA

KESIMPULAN & SARAN

LATAR BELAKANG

- Sensor api biasa yang sering digunakan lambat dalam mendeteksi api, menunggu partikel menyentuh sensor
- Sensor biasa sulit untuk mendeteksi api diluar ruangan
- Pemanfaatan kamera CCTV pada gedung-gedung, sehingga tidak perlu memasang alat pendeteksi api

RUMUSAN MASALAH

- Bagaimana melakukan deteksi gerak setiap frame ?
- Bagaimana melakukan deteksi warna api setiap piksel ?
- Bagaimana menghilangkan noise setiap region ?
- Bagaimana meakukan verifikasi piksel api ?

BATASAN MASALAH

- Implementasi dilakukan dengan bahasa pemrograman Python
- Jumlah piksel objek api yang dideteksi lebih besar dari 1% dari luas piksel frame
- Data yang digunakan adalah data video dengan panjang video 6-16 detik
- Data video memiliki ukuran 240 x 320 piksel dengan *channel* R,G,B

BATASAN MASALAH

- Warna api yang didefinisikan adalah *range* warna kuning hingga merah
- Pergerakan dari kamera tidak terlalu besar
- Pantulan objek api termasuk kedalam objek api
- Data video berasal dari KMU *Fire & Smoke Database*, video *open source*, MIVIA *fire dataset*, dan video rekaman

TUJUAN

- Merancang dan membangun perangkat lunak deteksi api menggunakan data video secara *real time*

PENDAHULUAN

RANCANGAN & IMPLEMENTASI

SKENARIO UJI COBA

KESIMPULAN & SARAN

DIAGRAM ALIR PROSES UTAMA

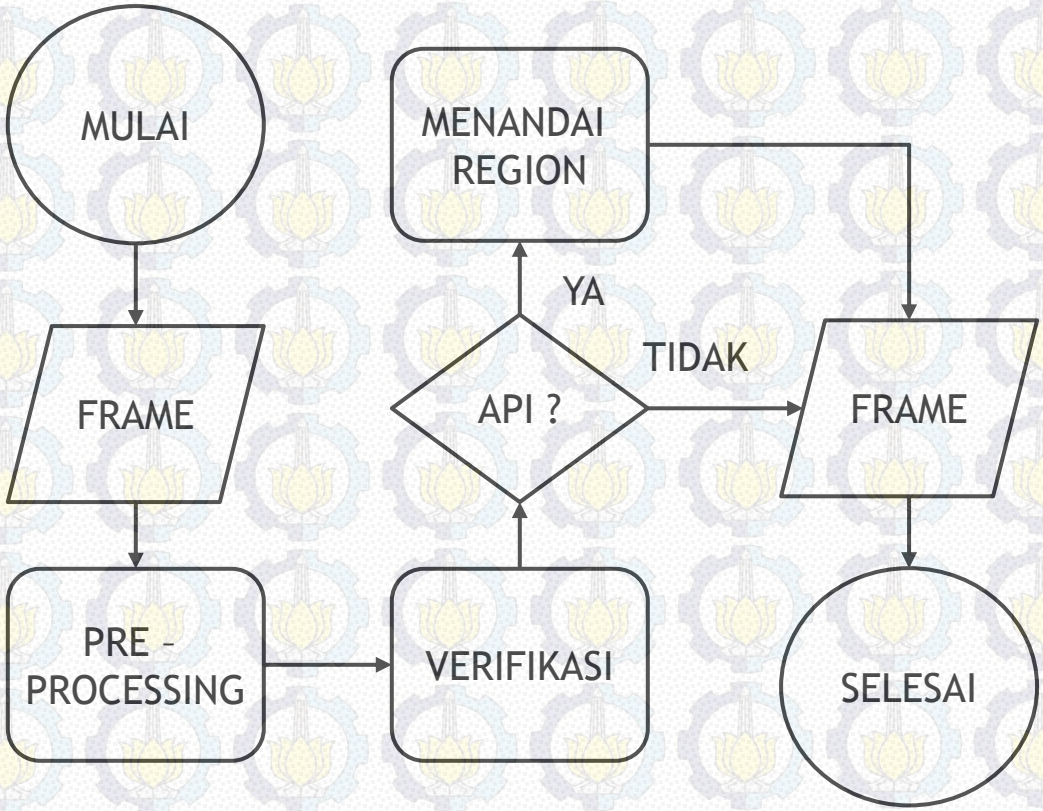


DIAGRAM ALIR PROSES UTAMA

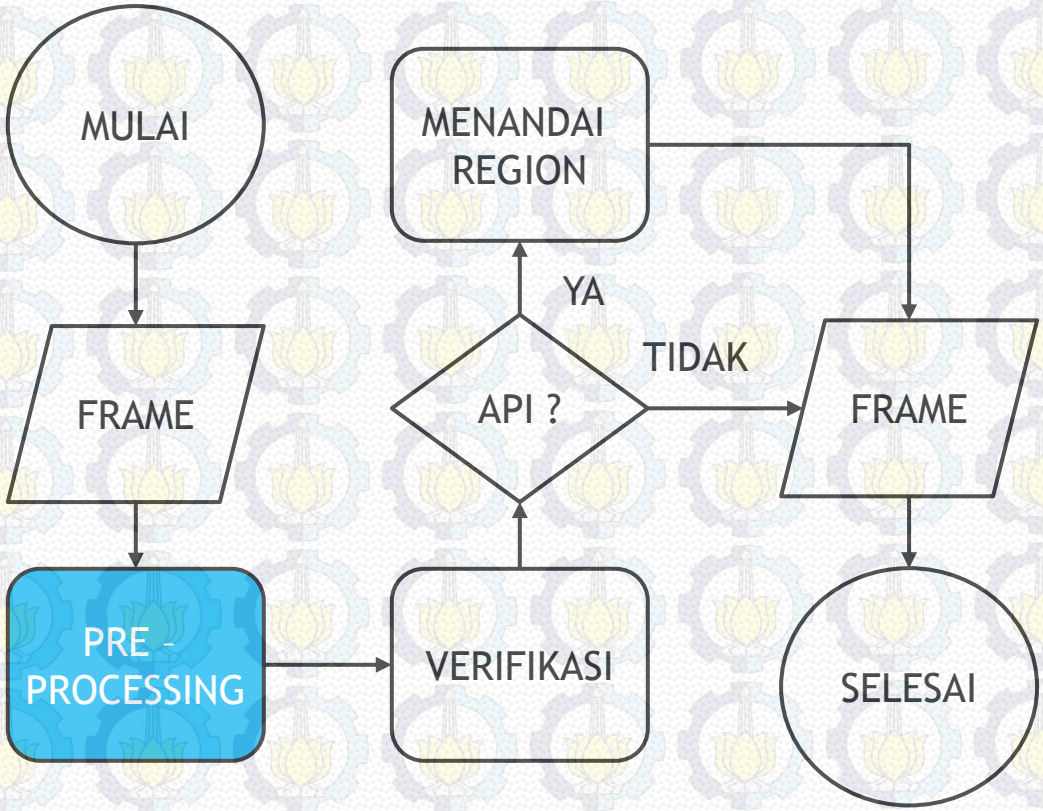
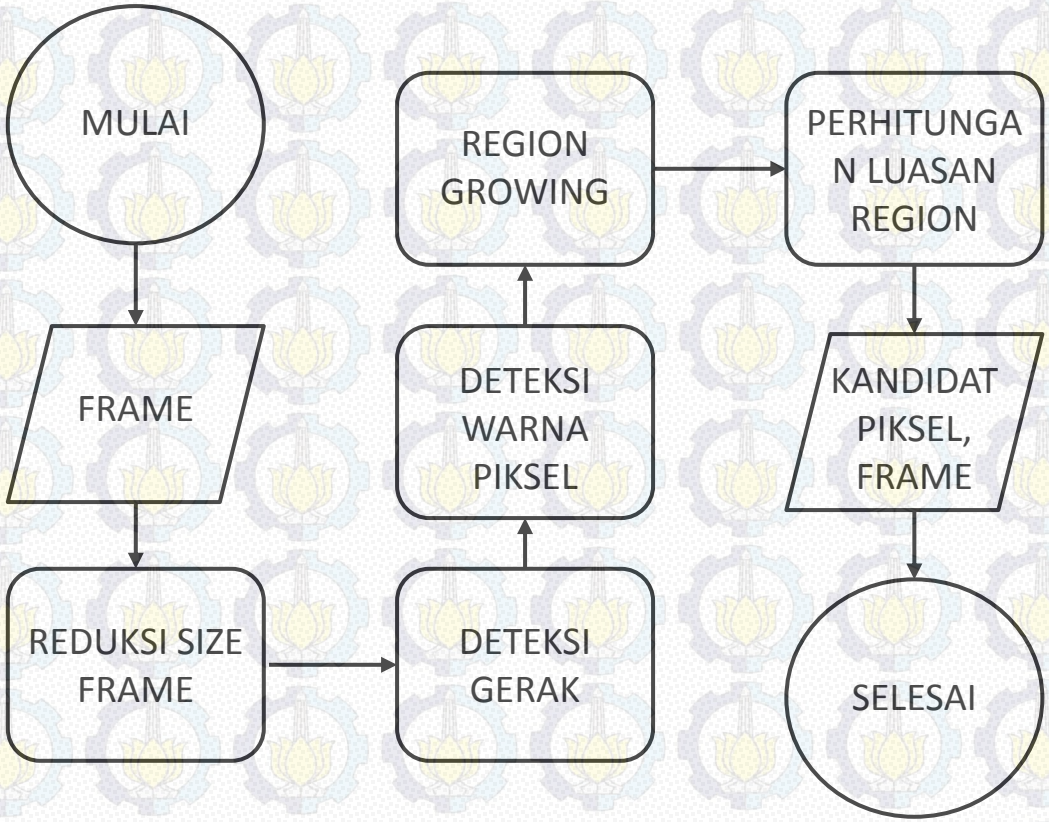


DIAGRAM ALIR PREPROCESSING



REDUKSI SIZE FRAME

- Melakukan reduksi *size frame* yang sedang diproses
- Menggunakan *gaussian pyramind*

$$g_1(i,j) = \sum_{m=-2}^{2} \sum_{n=-2}^{2} w(m,n) \,.\, g_0\,(2i+m, 2j+n)$$

i

REDUKSI SIZE FRAME

DETEKSI GERAK

- Menggunakan *Gaussian Mixture Model*
- Setiap piksel mempunyai K model (jumlah K berkisar antara 3-5)
- Setiap piksel mempunyai K nilai w, μ, σ dimana :
  - w adalah bobot
  - μ adalah rata-rata/*mean*
  - σ adalah standar deviasi

i

DETEKSI GERAK

- Setiap piksel akan dibandingkan dengan *background model*
- *Background model* didapatkan menggunakan persamaan berikut :

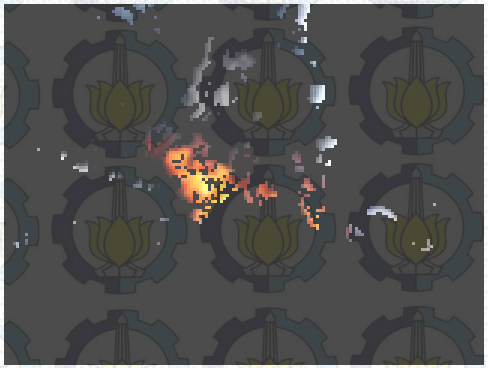
$$B = argmin(\sum_{j=1}^{b} w_j > T)$$

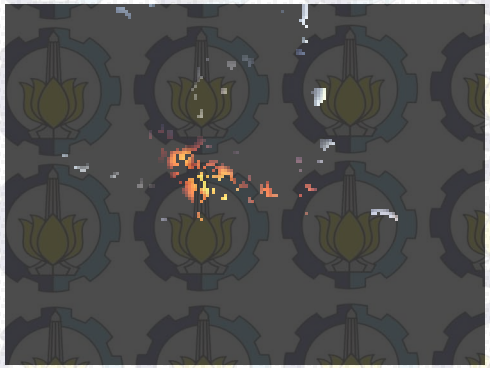
DETEKSI GERAK

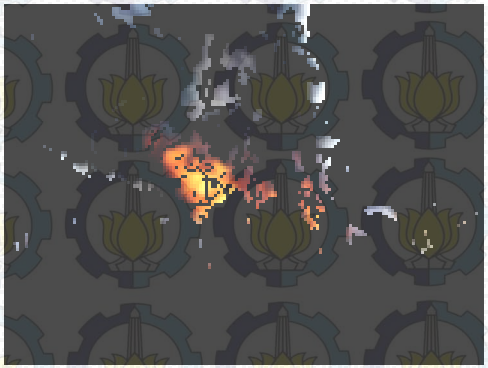
Frame N

Frame N+1

Frame N+2







DETEKSI WARNA PIKSEL

- Menggunakan probabilitas distribusi Gaussian

- Setiap nilai R,G,B piksel akan dihitung nilai probabilitas nya. Nilai probabilitas suatu piksel dihitung menggunakan persamaan

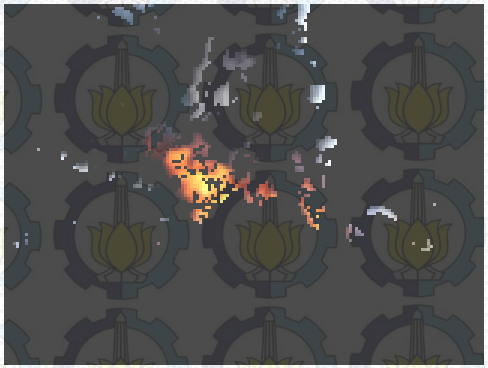
$$p = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$$

DETEKSI WARNA PIKSEL

- Setelah mendapatkan nilai probabilitas R,G,B dilakukan perhitungan probabilitas piksel menggunakan persamaan berikut.

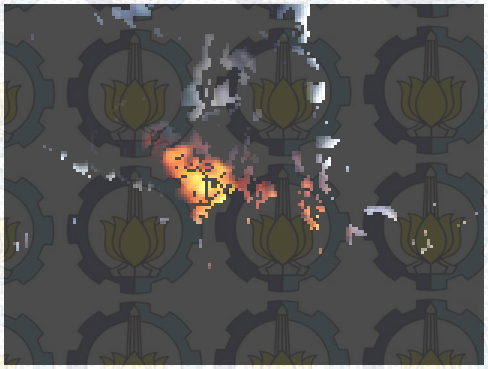
$$p(I(x,y)) = \prod_{i \in \{R,G,B\}} p_i(I_i(x,y))$$

DETEKSI WARNA PIKSEL

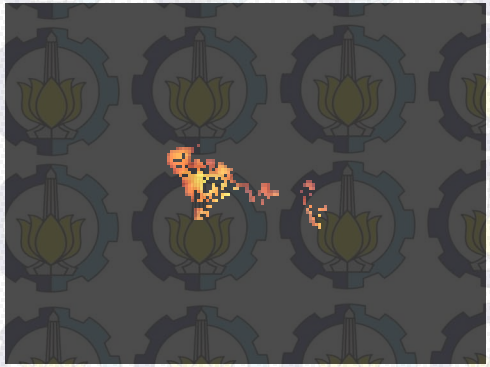


Frame N

Frame N+1



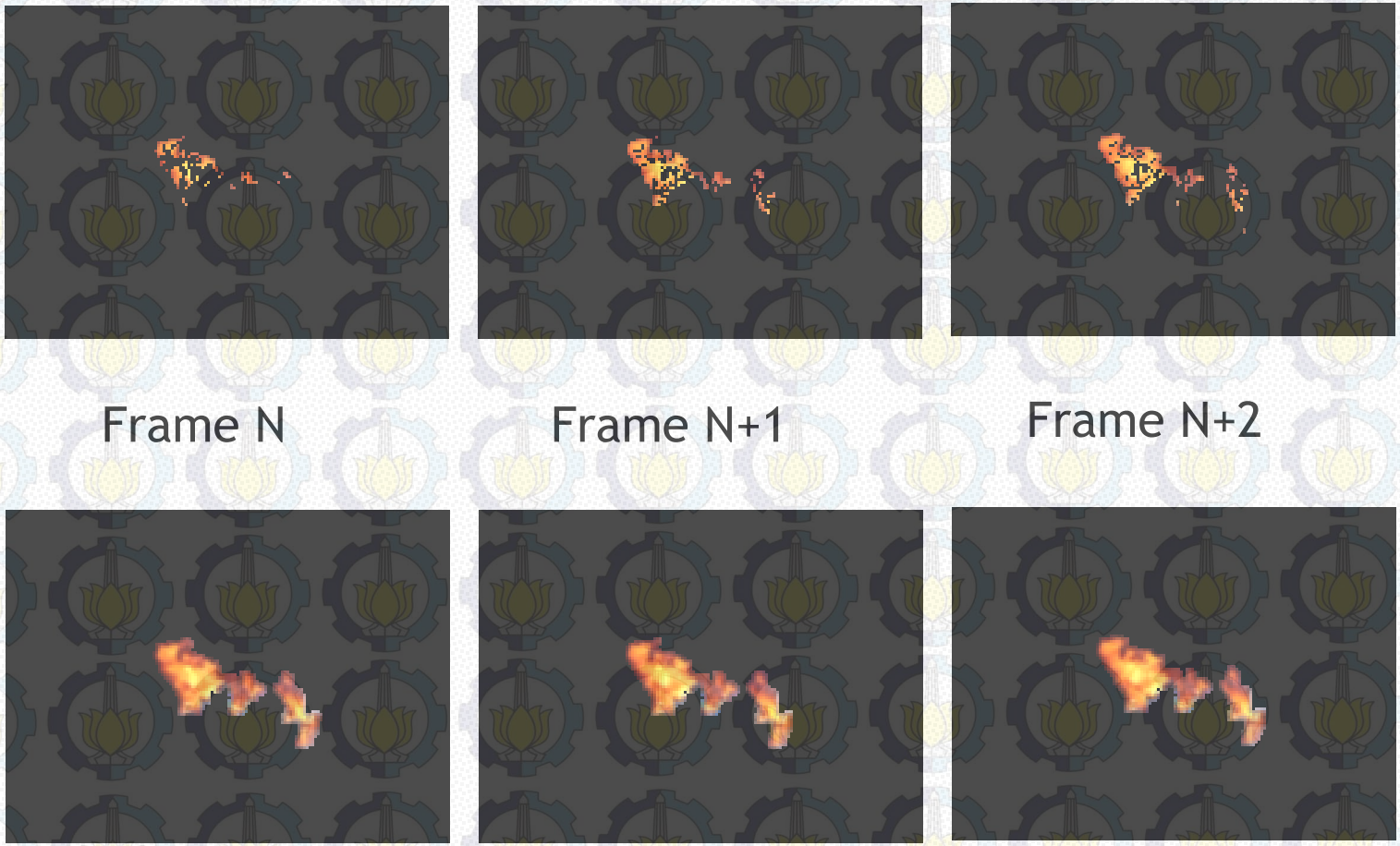
Frame N+2



REGION GROWING

- Digunakan untuk mendapatkan *region api*
- Inisialisasi *seed* didapatkan dari kandidat piksel api yang dihasilkan pada tahap deteksi warna piksel
- Tingkat homogen piksel dilihat dari probabilitas warna piksel tetangga

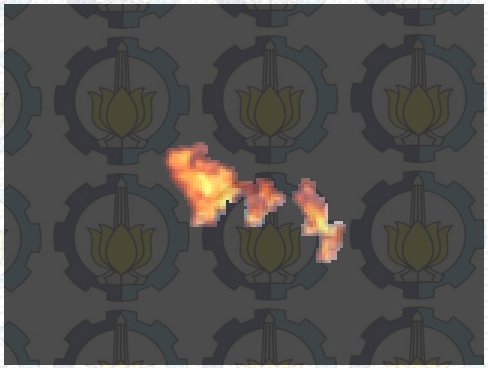
REGION GROWING



PERHITUNGAN LUASAN REGION

- Digunakan untuk menghilangkan noise
- Menggunakan luasan yang didapatkan pada proses region growing
- Jika luasan region > 1% total piksel frame diangga api

PERHITUNGAN LUASAN REGION



Frame N

Frame N+1

Frame N+2

FRAME MASUKAN

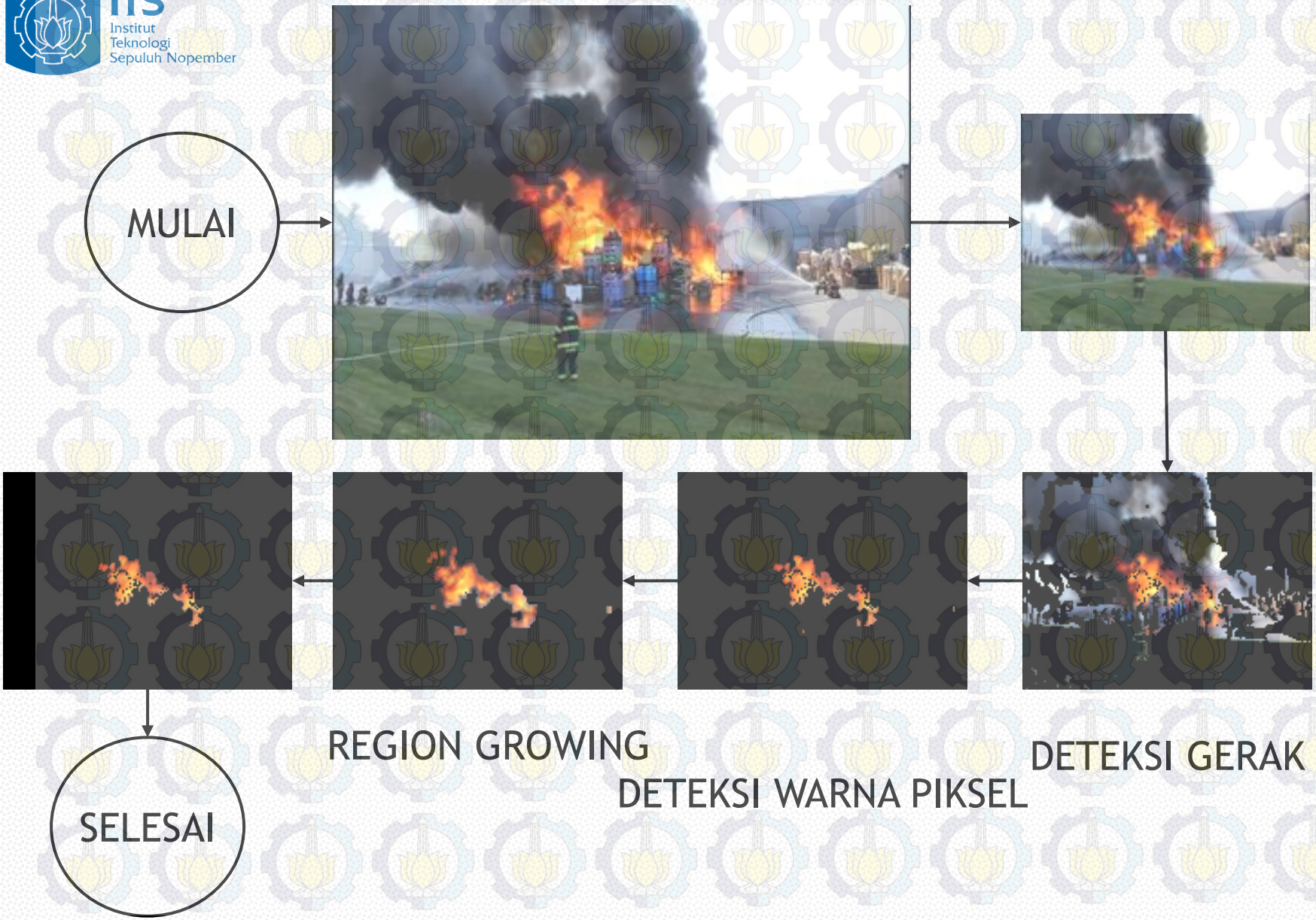


DIAGRAM ALIR PROSES UTAMA

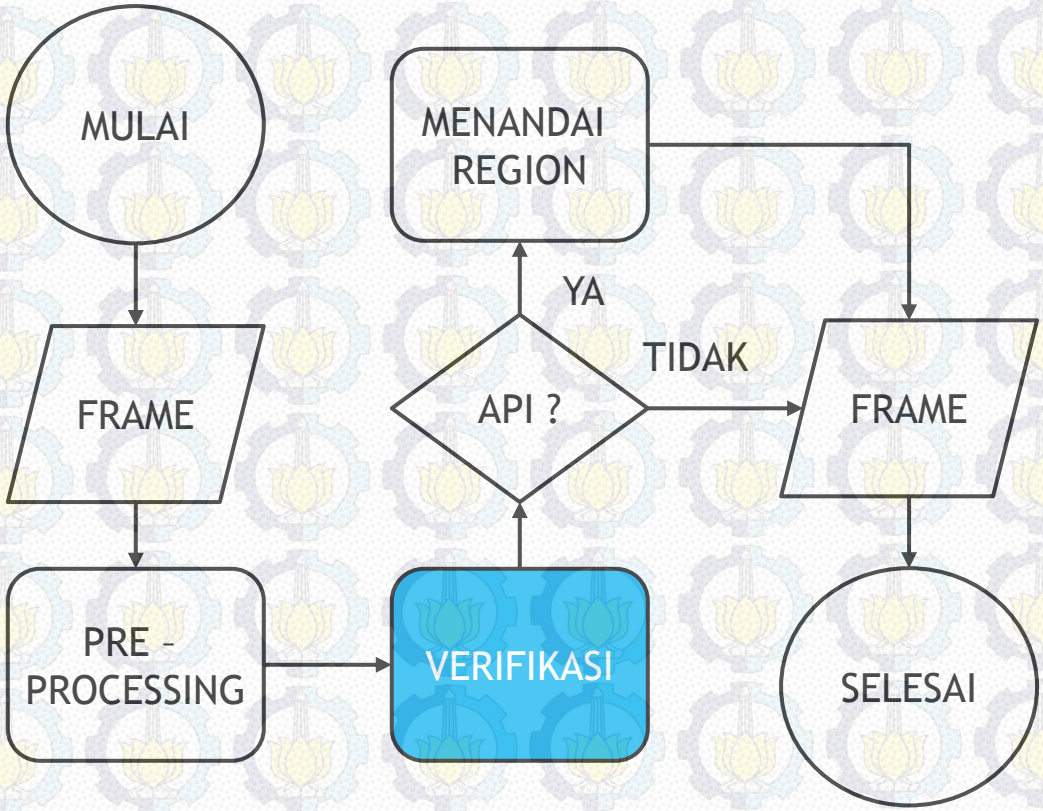
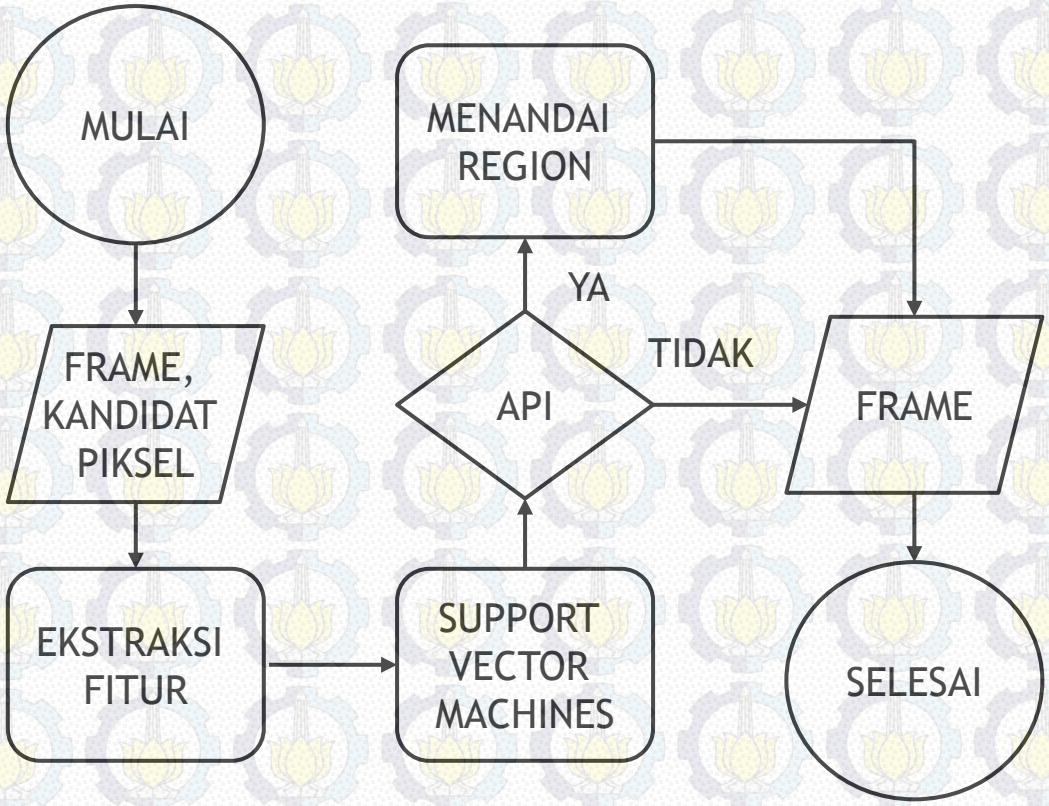
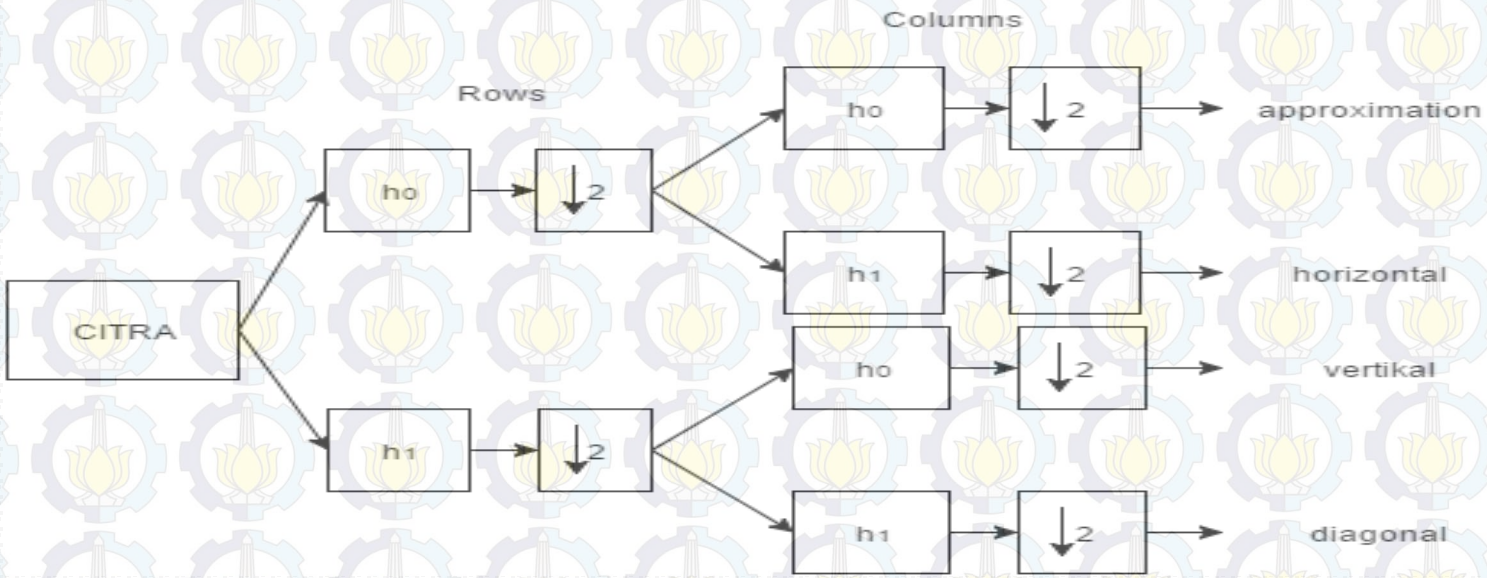


DIAGRAM ALIR VERIFIKASI



EKSTRAKSI FITUR

- Menggunakan wavelet daubachies 4



EKSTRAKSI FITUR

- Citra yang dilakukan wavelet sebanyak 10 buah, yaitu frame yang sedang diproses dan 9 citra sebelumnya secara berututan

- List piksel yang lolos tahap preprocessing akan dihitung nilai wavelet koordinat piksel tersebut menggunakan persamaan.

$$M_n(x,y) = |LH_n(x,y)|^2 + |HL_n(x,y)|^2 + |HH_n(x,y)|^2$$

- Nilai M_n didapat dari ekstraksi fitur sebanyak sepuluh buah

EKSTRAKSI FITUR

- Nilai fitur dilakukan normalisasi menggunakan normalisasi min max.

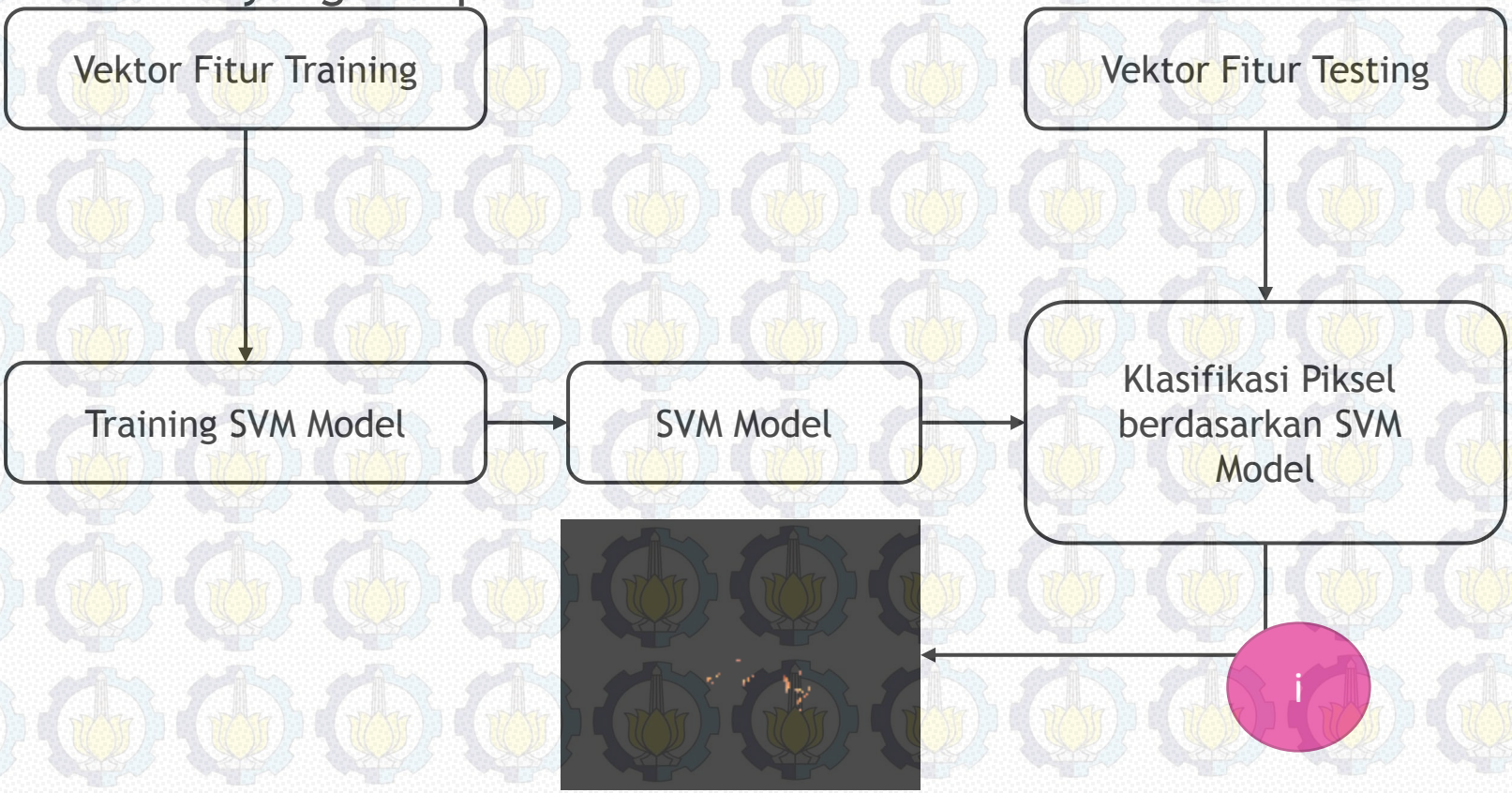
- Nilai min & max didapatkan dari nilai M_n min dan M_n max setiap frame

$$Y_{new} = \frac{(Y - Y_{min})}{Y_{max} - Y_{min}}$$

- Nilai fitur disorting secara ascending

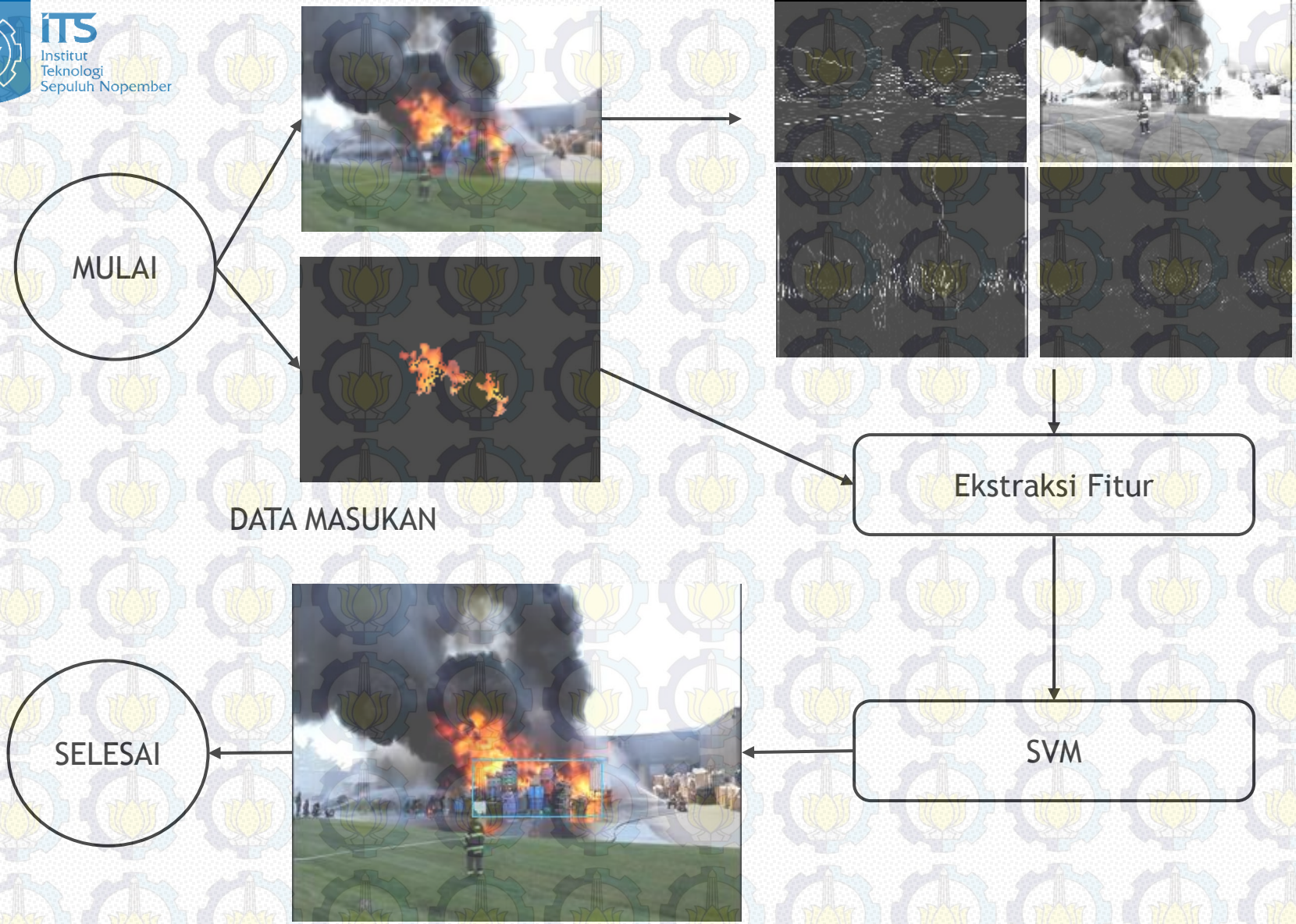
SUPPORT VECTOR MACHINES

- Klasifikasi untuk melakukan verifikasi terhadap piksel api dari data fitur yang didapatkan



MENANDAI REGION

- Piksel-piksel yang lolos verifikasi akan ditandari sebagai piksel api.
- Digunakan titik ekstrim piksel api, yaitu :
  - X_{min}
  - Y_{min}
  - X_{max}
  - Y_{max}


MULAI
DATA MASUKAN
Ekstraksi Fitur
SVM
SELESAI

PENDAHULUAN

RANCANGAN & IMPLEMENTASI

SKENARIO UJI COBA

KESIMPULAN & SARAN

DATA UJI

38 Video Kejadian
34 Video Api
33 Video Bukan Api

DATA TRAINING

- 520 Data Fitur Api, 6 Video Api
- 932 Data Fitur Bukan Api, 4 Video Bukan Api

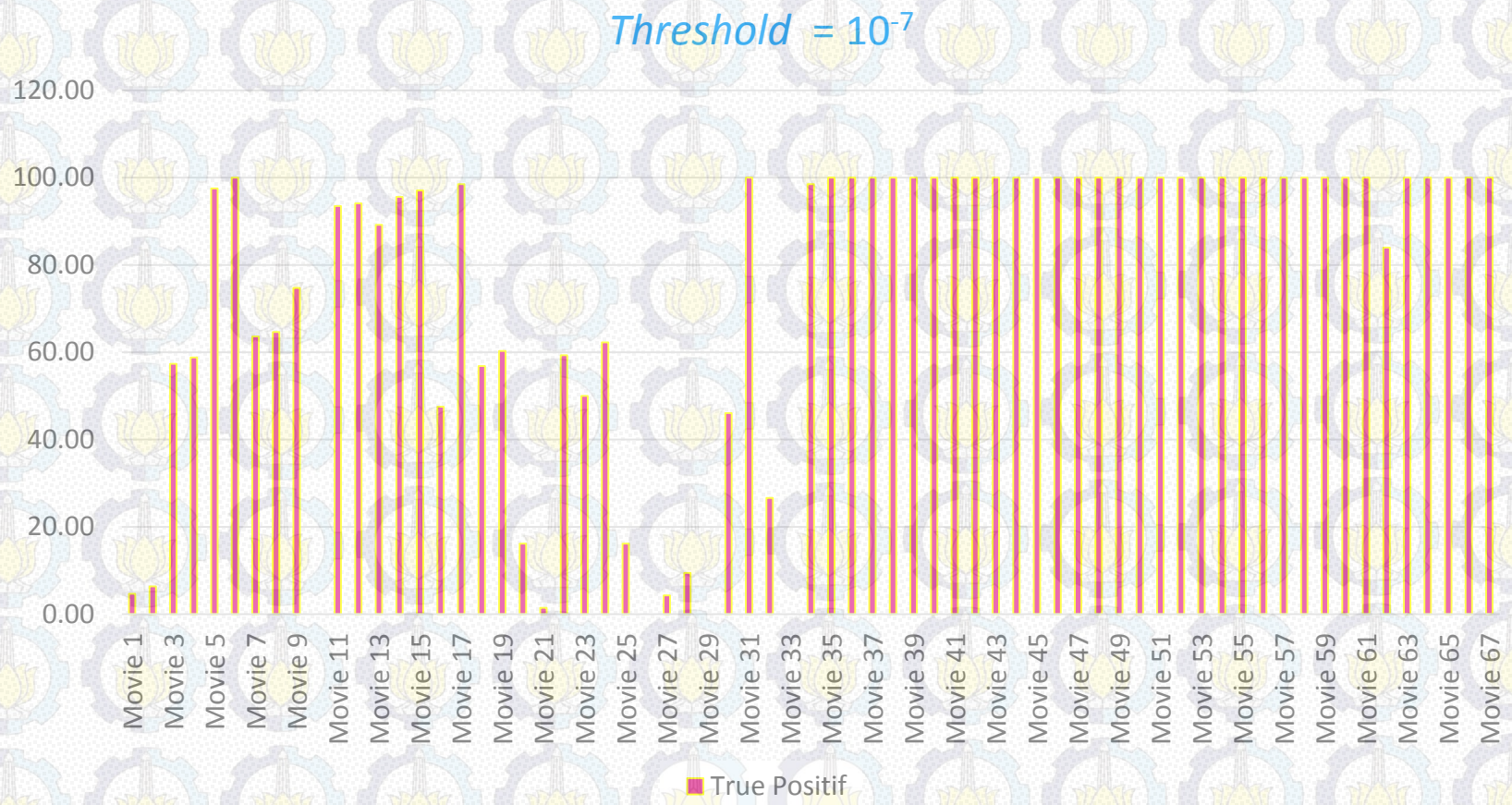
PARAMETER KEBENARAN

- True Positif
- False Positif
- Missing Rate

SKENARIO 1

- Variasi *Threshold* warna piksel api
  - 10^{-7}
  - 10^{-8}
  - 5×10^{-9}
  - 10^{-9}
- $C = 5$
- Kernel = RBF

SKENARIO 1


Threshold = 10-7
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
Movie 21
Movie 23
Movie 25
Movie 27
Movie 29
Movie 31
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Movie 55
Movie 57
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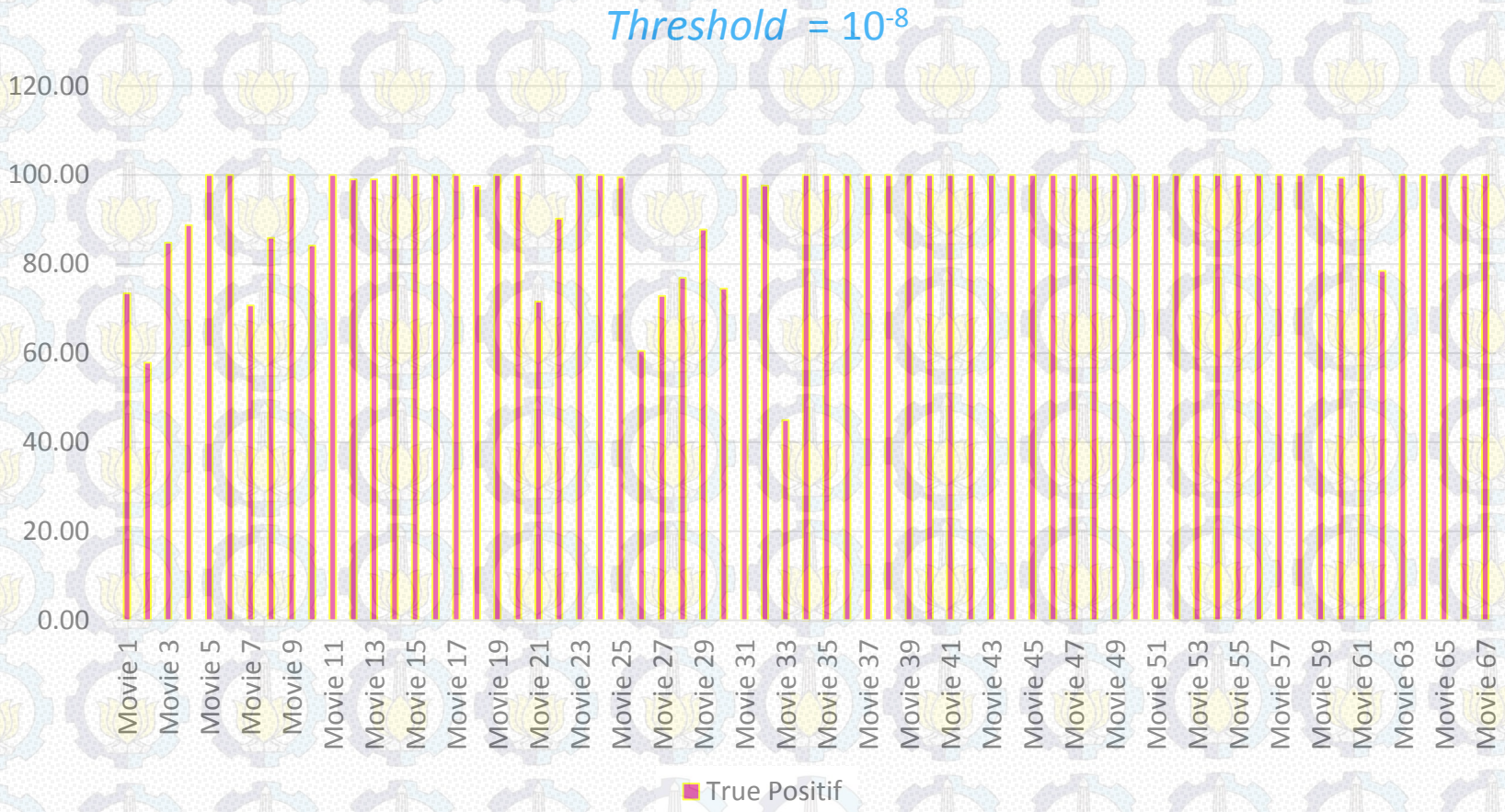
Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 1


Threshold = 10-8
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
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Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
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Movie 31
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Movie 57
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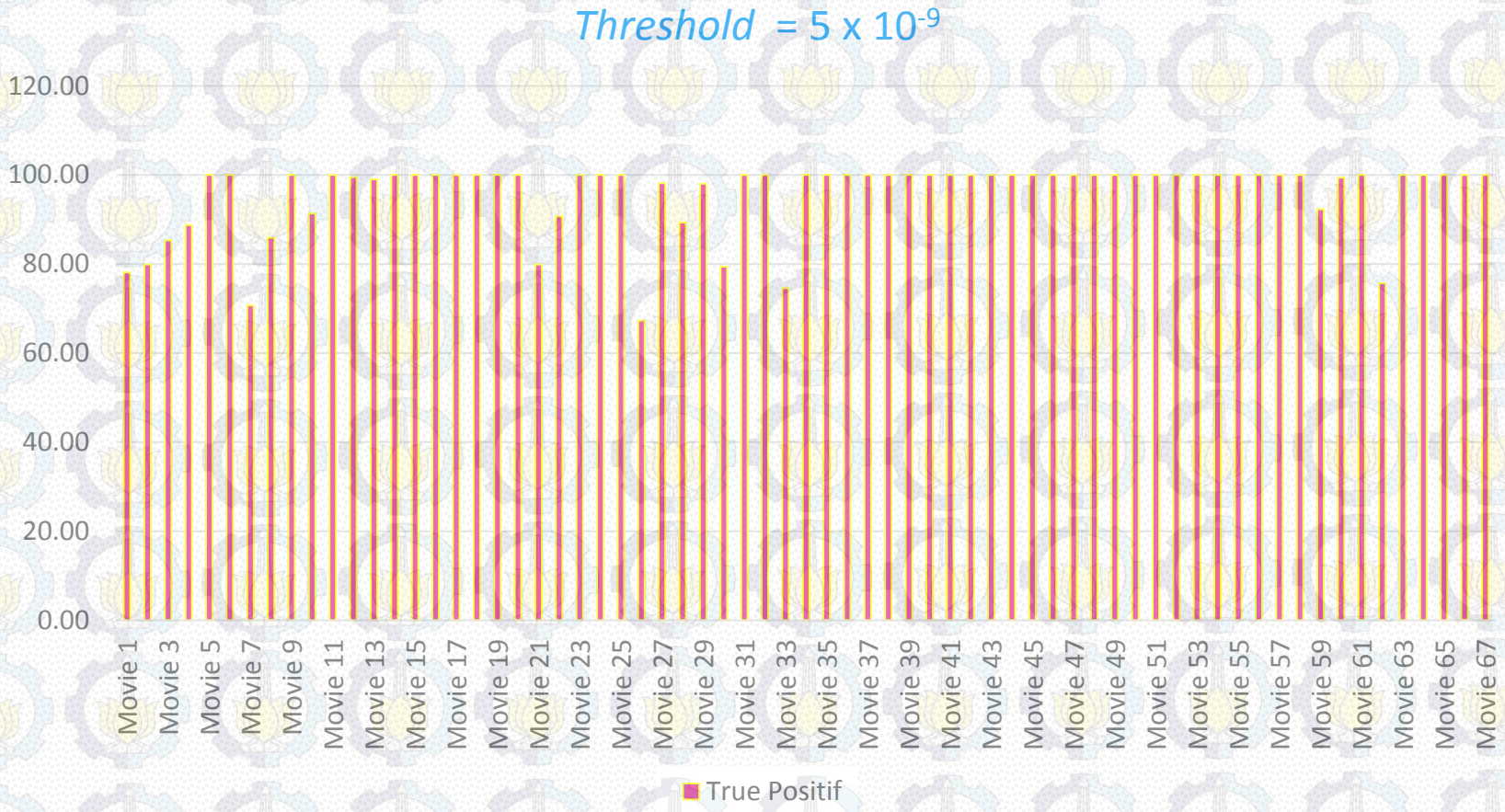
Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 1


Threshold = 5 x 10^{-9}
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
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Movie 23
Movie 25
Movie 27
Movie 29
Movie 31
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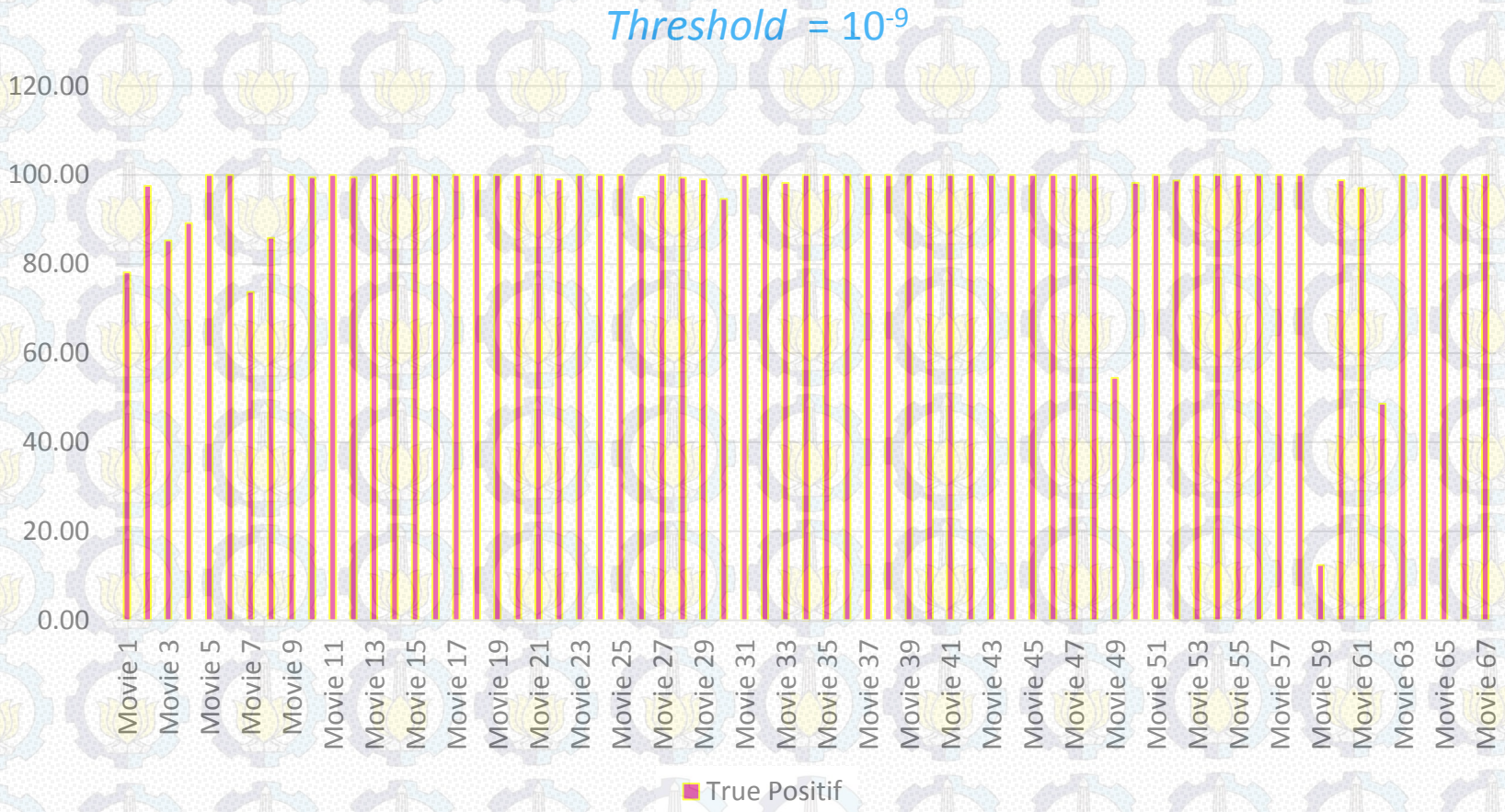
Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 1


Threshold = 10-9
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
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Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
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Movie 23
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Movie 31
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Movie 47
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Movie 57
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Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 1

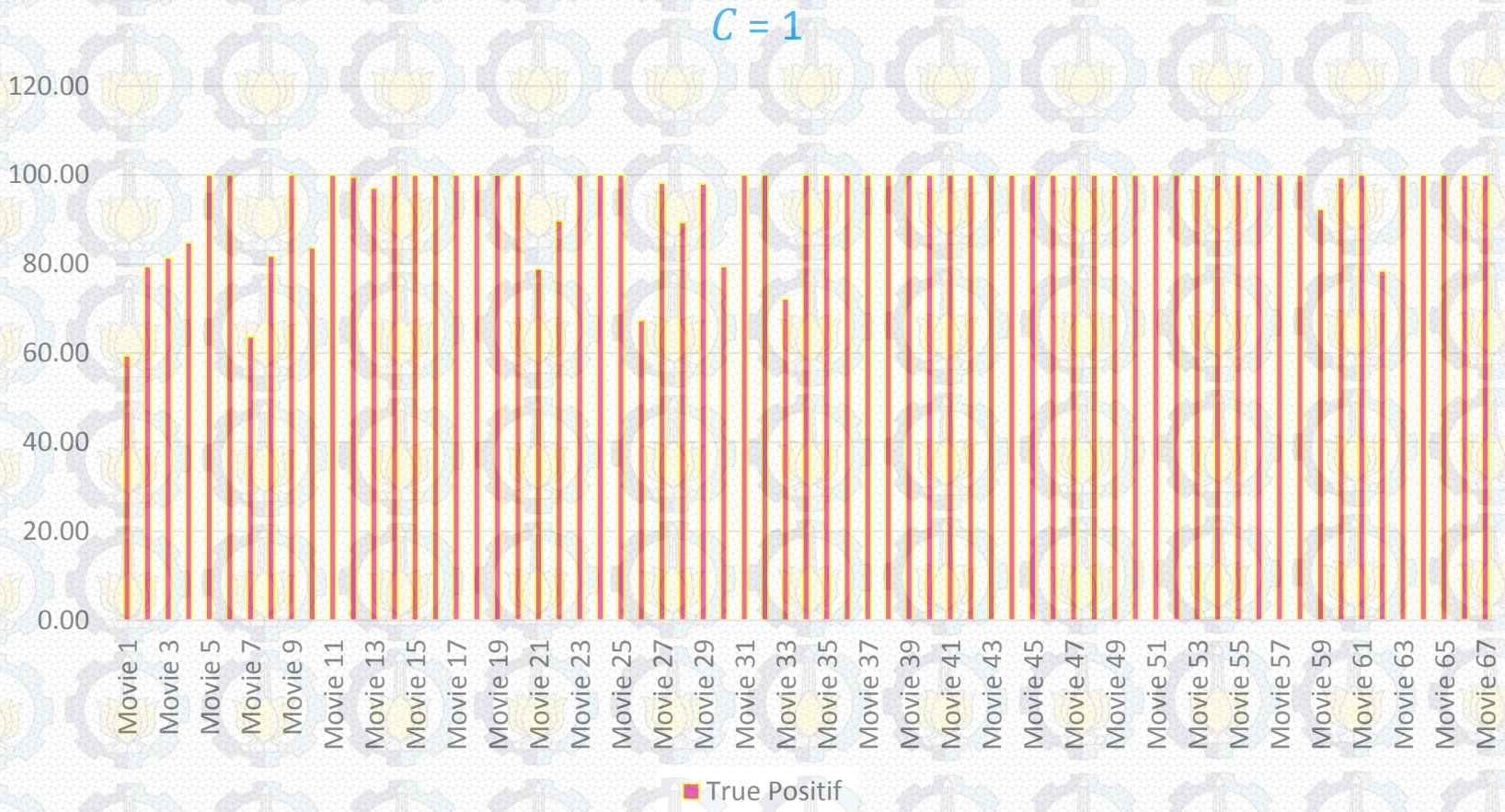
- Akurasi terbaik yang didapatkan ketika *threshold* = 5×10^{-9}

Threshold	True Positif (%)	False Positif (%)	Missing Rate (%)
10^{-7}	75.15	0.24	24.61
10^{-8}	93.96	0.33	5.71
5×10^{-9}	95.87	0.49	3.64
10^{-9}	95.56	2.86	1.58

SKENARIO 2

- Variasi C pada klasifikasi
  - 1
  - 3.5
  - 5
  - 7
- *Threshold* = 5×10^{-9}
- Kernel = RBF

SKENARIO 2


$C = 1$
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
Movie 21
Movie 23
Movie 25
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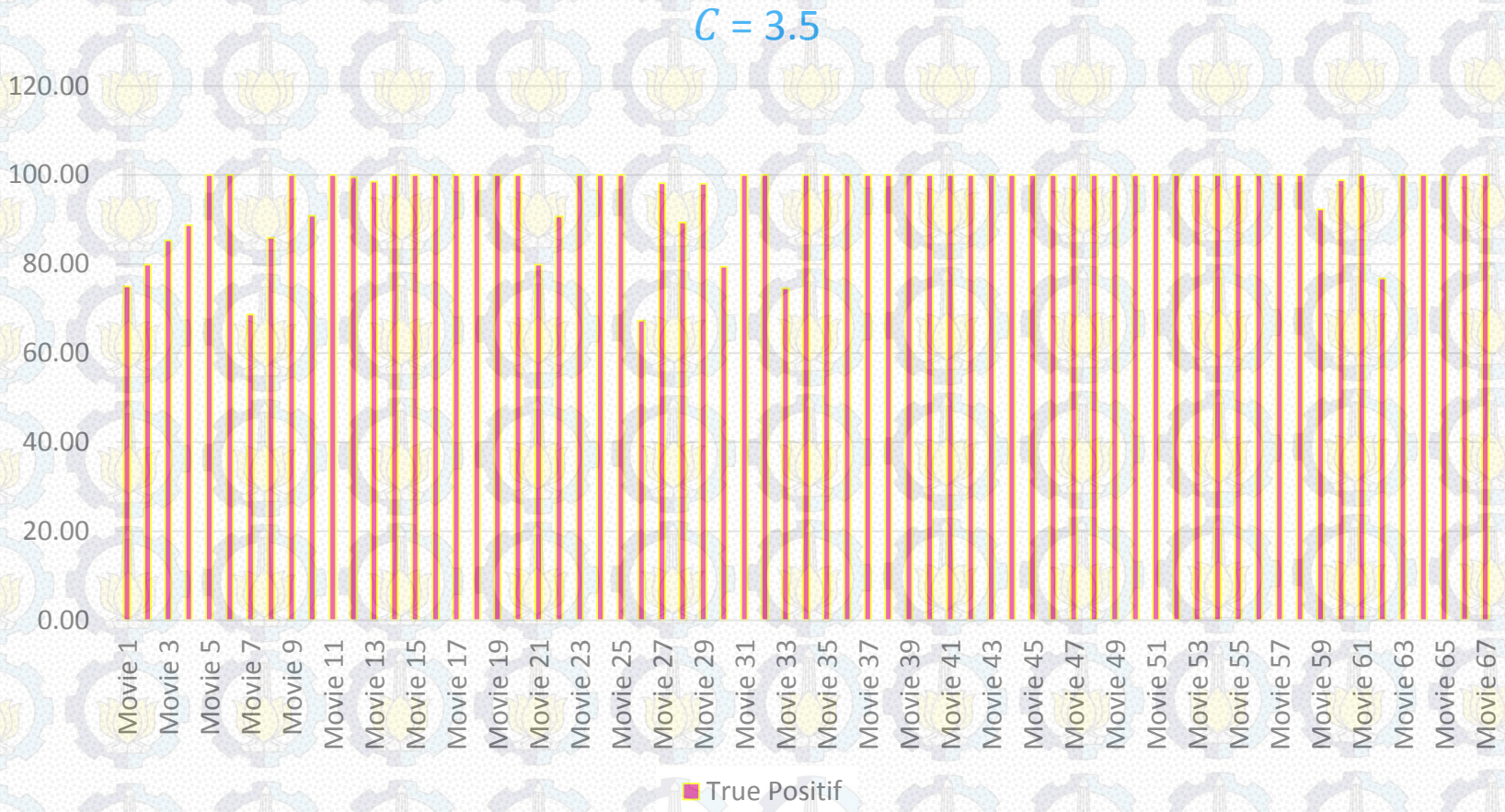
Movie 67
True Positif

SKENARIO 2


C = 3.5
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
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Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
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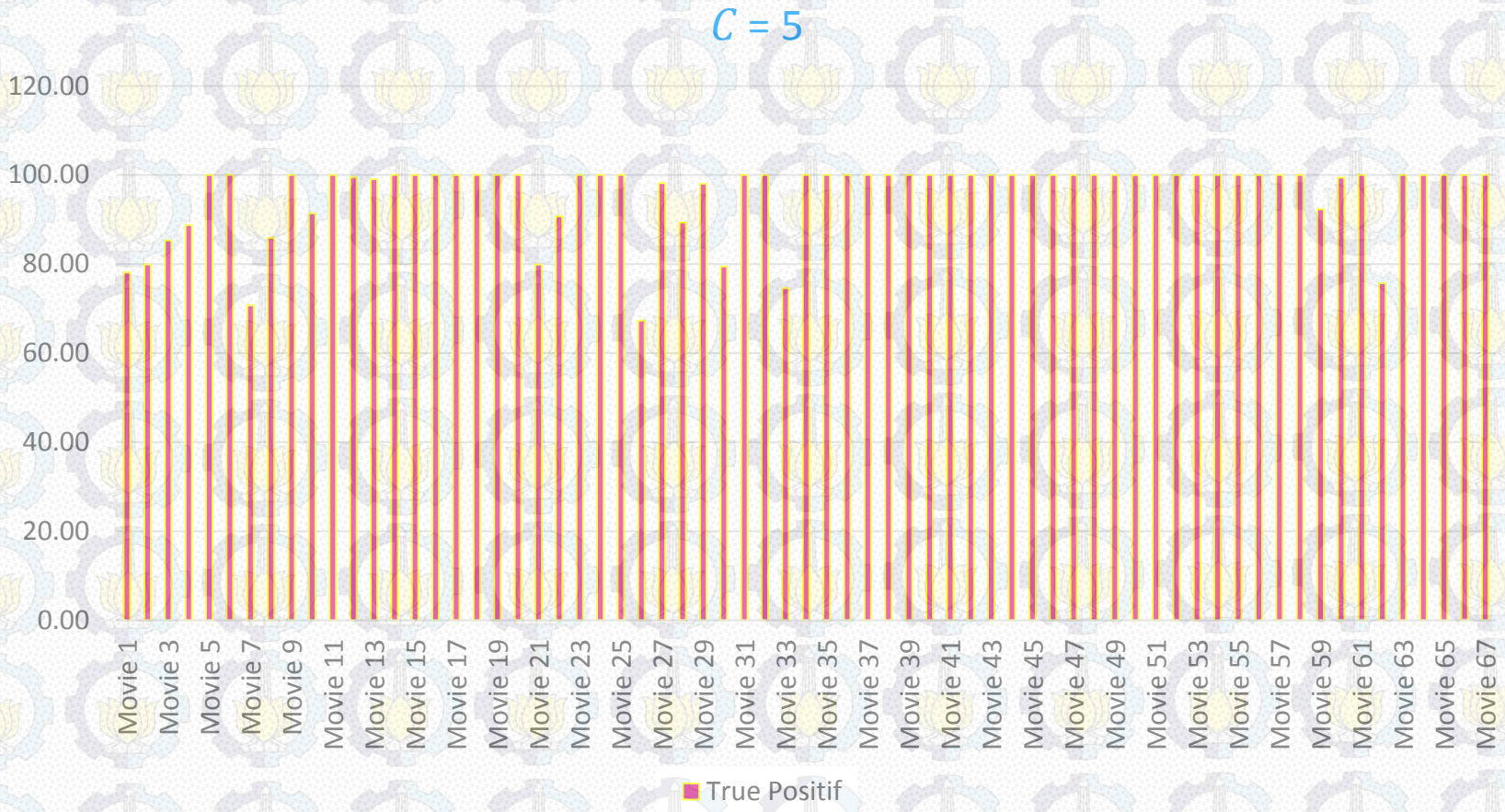
Movie 65
Movie 67
True Positif

SKENARIO 2


$C = 5$
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
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Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
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Movie 25
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Movie 31
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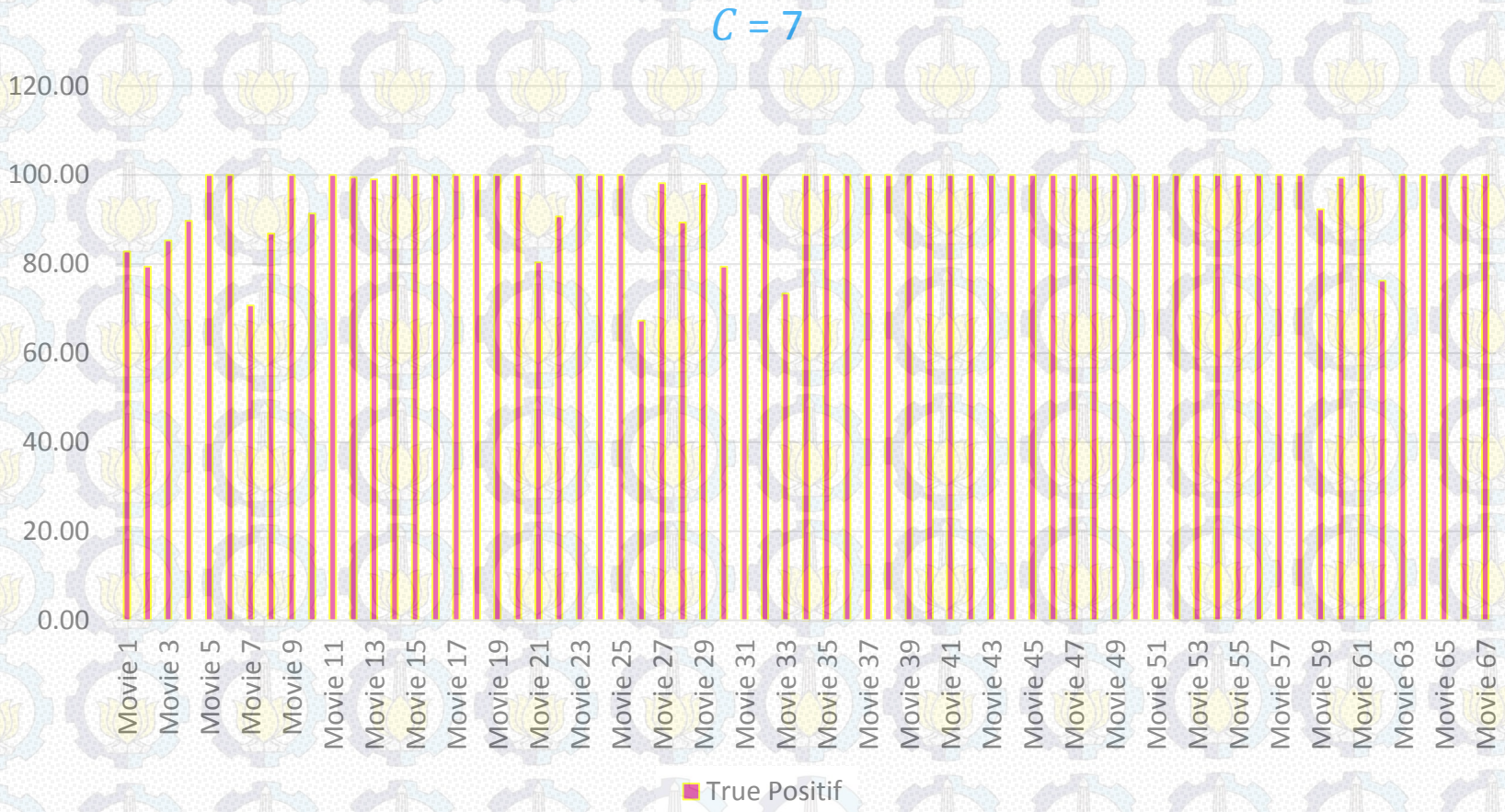
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 2


$C = 7$
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
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Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
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Movie 23
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Movie 57
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Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 2

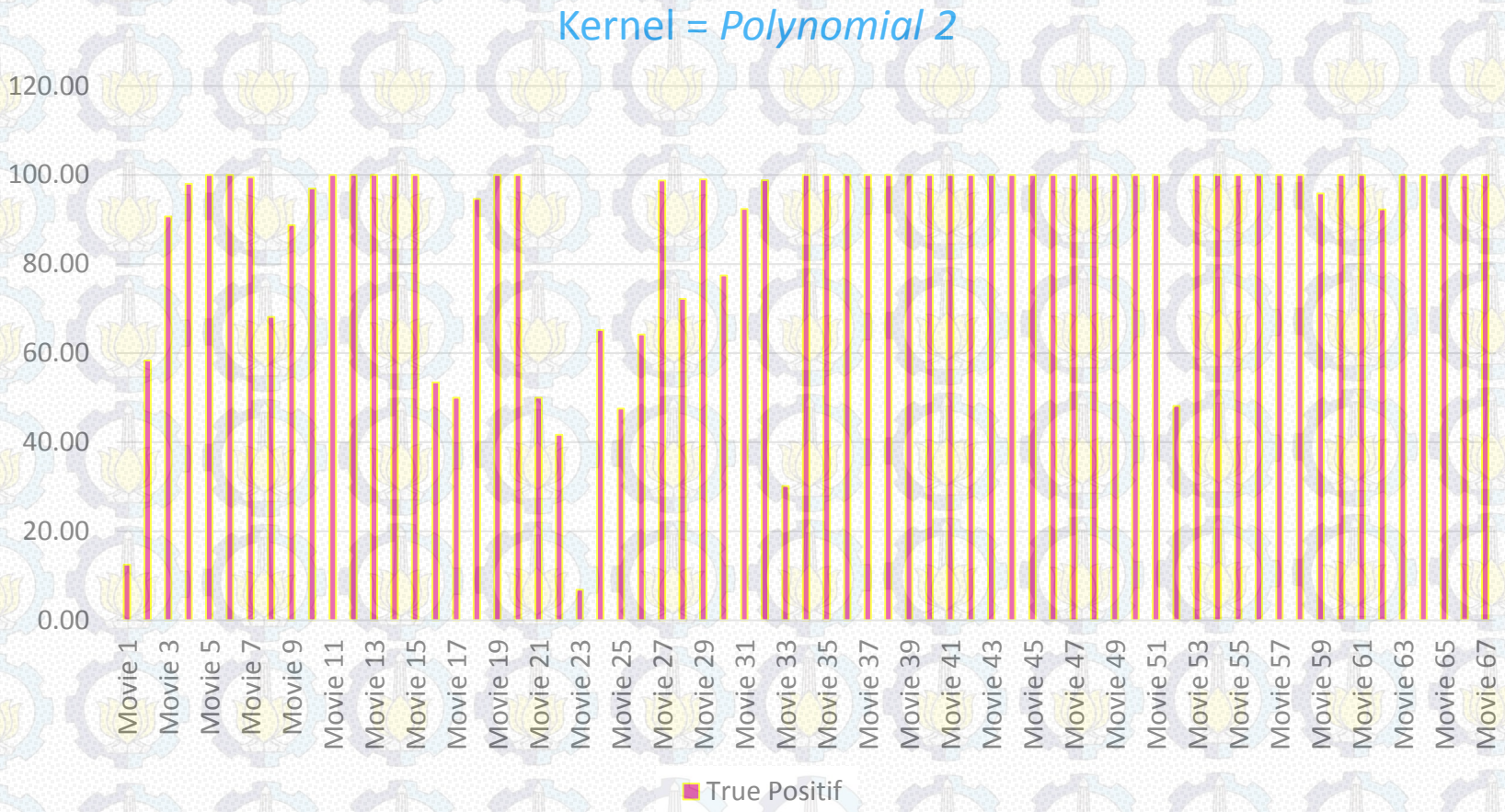
- Akurasi terbaik yang didapatkan ketika C = 7

C	True Positif (%)	False Positif (%)	Missing Rate (%)
1	95.13	0.45	4.42
3.5	95.79	0.48	3.74
5	95.87	0.49	3.64
7	95.96	0.48	3.56

SKENARIO 3

- Variasi Kernel pada klasifikasi
  - *Polynomial 2*
  - *Polynomial 3*
  - RBF
- *Threshold* = 5×10^{-9}
- $C = 5$

SKENARIO 3


Kernel = *Polynomial 2*
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
Movie 21
Movie 23
Movie 25
Movie 27
Movie 29
Movie 31
Movie 33
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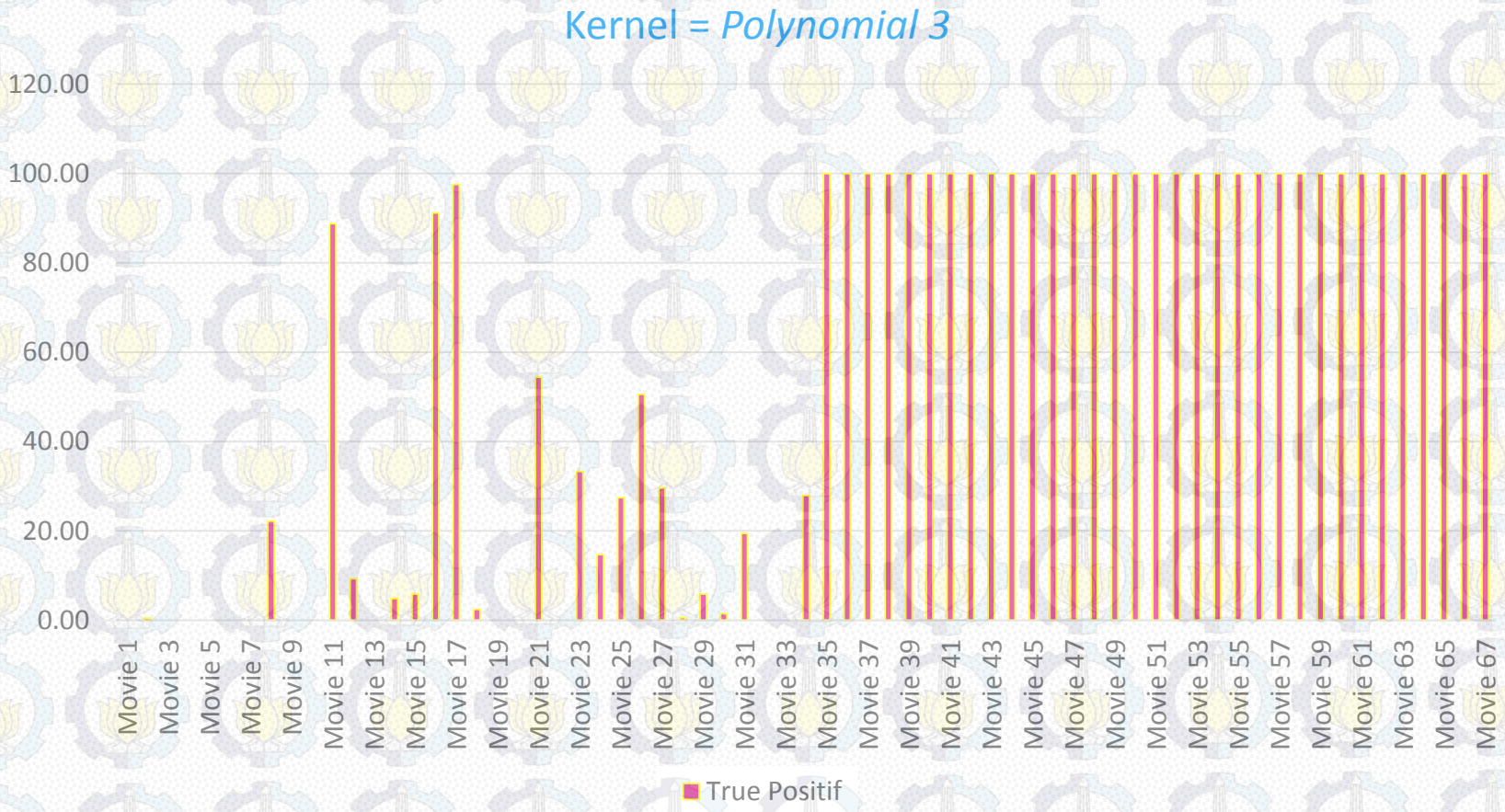
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 3


Kernel = *Polynomial 3*
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
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Movie 7
Movie 9
Movie 11
Movie 13
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Movie 53
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Movie 57
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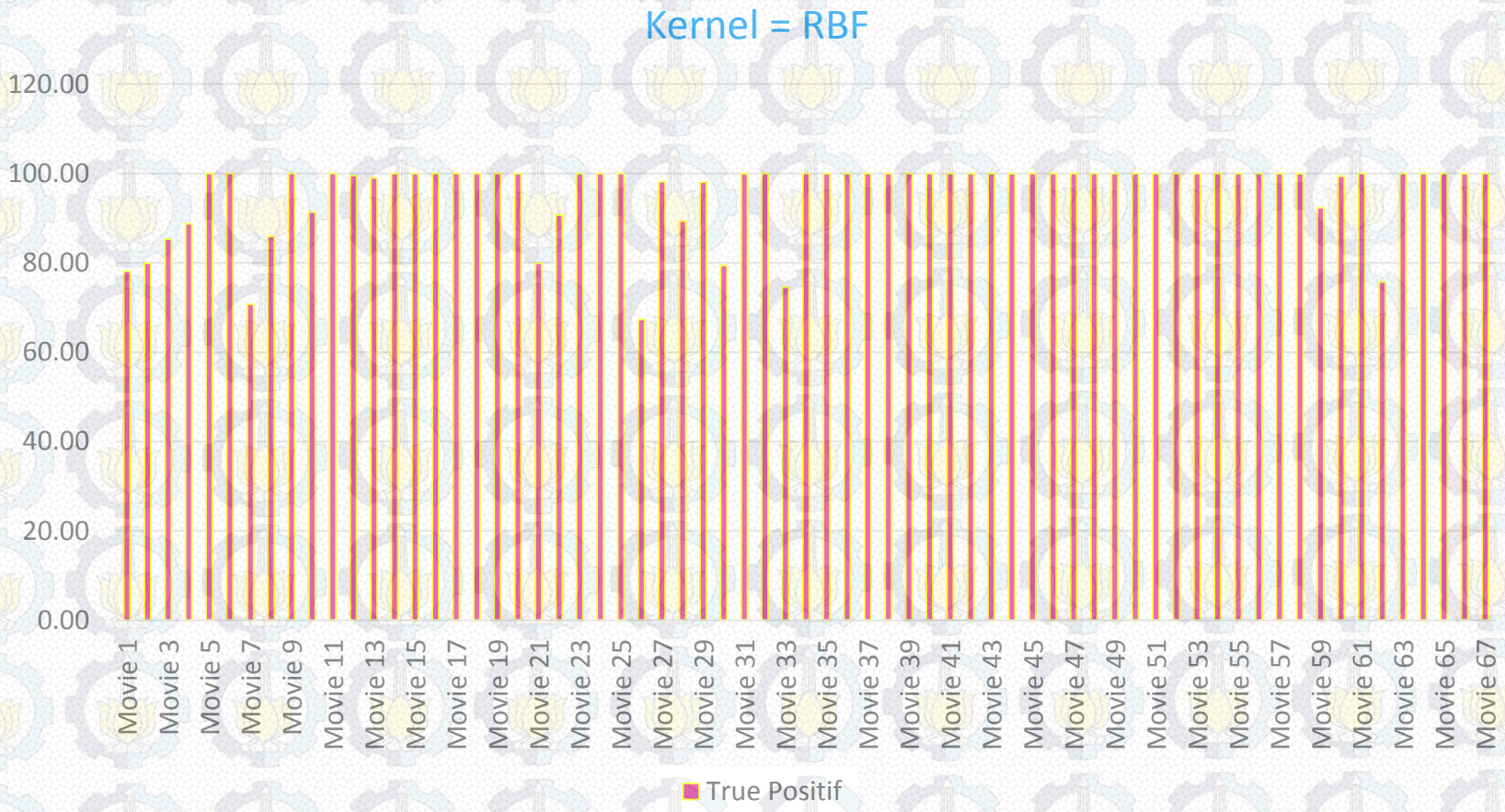
Movie 67
True Positif

SKENARIO 3


Kernel = RBF
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
Movie 21
Movie 23
Movie 25
Movie 27
Movie 29
Movie 31
Movie 33
Movie 35
Movie 37
Movie 39
Movie 41
Movie 43
Movie 45
Movie 47
Movie 49
Movie 51
Movie 53
Movie 55
Movie 57
Movie 59
Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 3

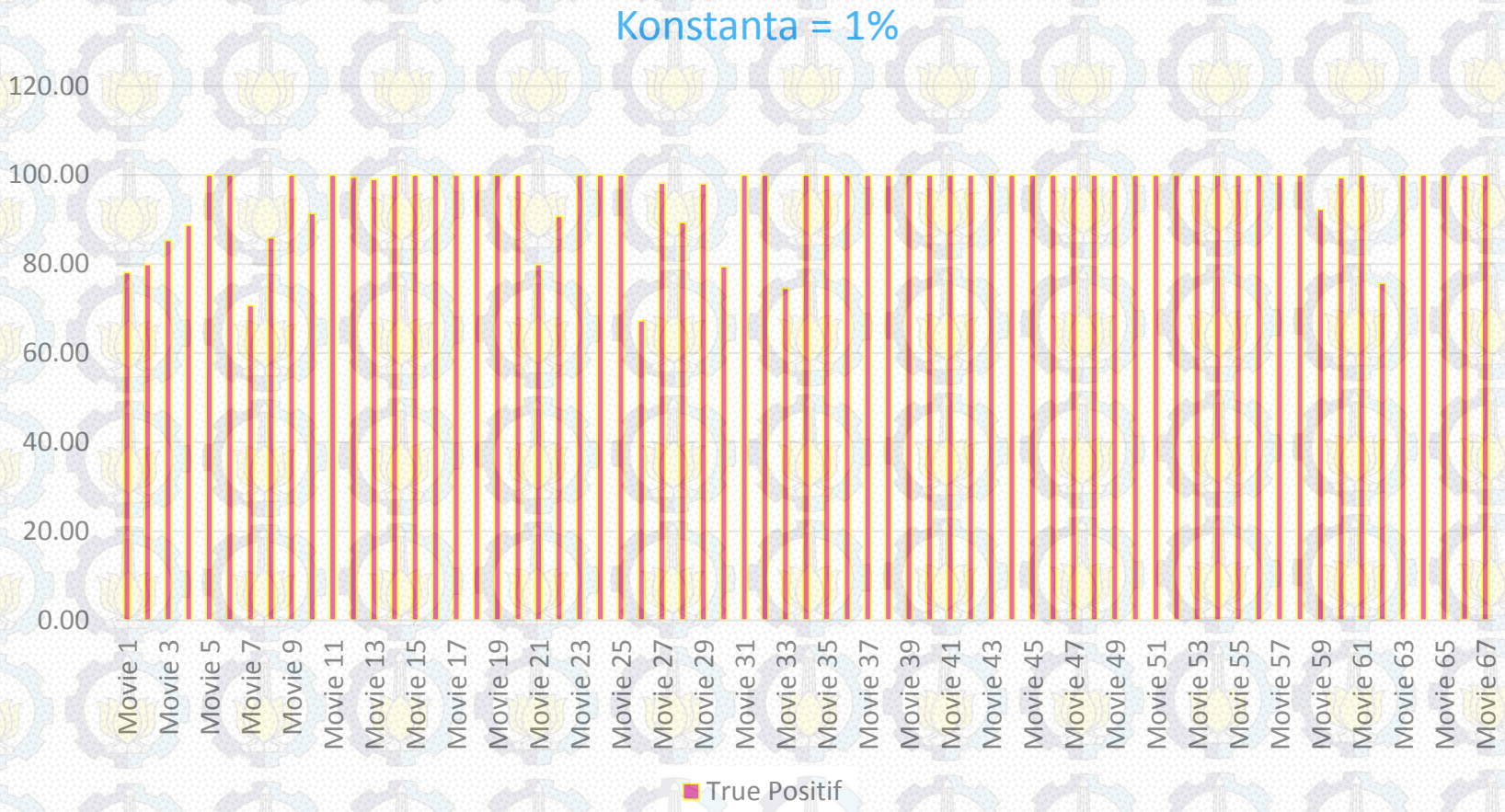
- Akurasi terbaik yang didapatkan ketika Kernel yang digunakan adalah RBF

Kernel	True Positif (%)	False Positif (%)	Missing Rate (%)
Polynomial 2	87.93	0.95	11.12
Polynomial 3	58.03	0.00	41.97
RBF	95.87	0.49	3.64

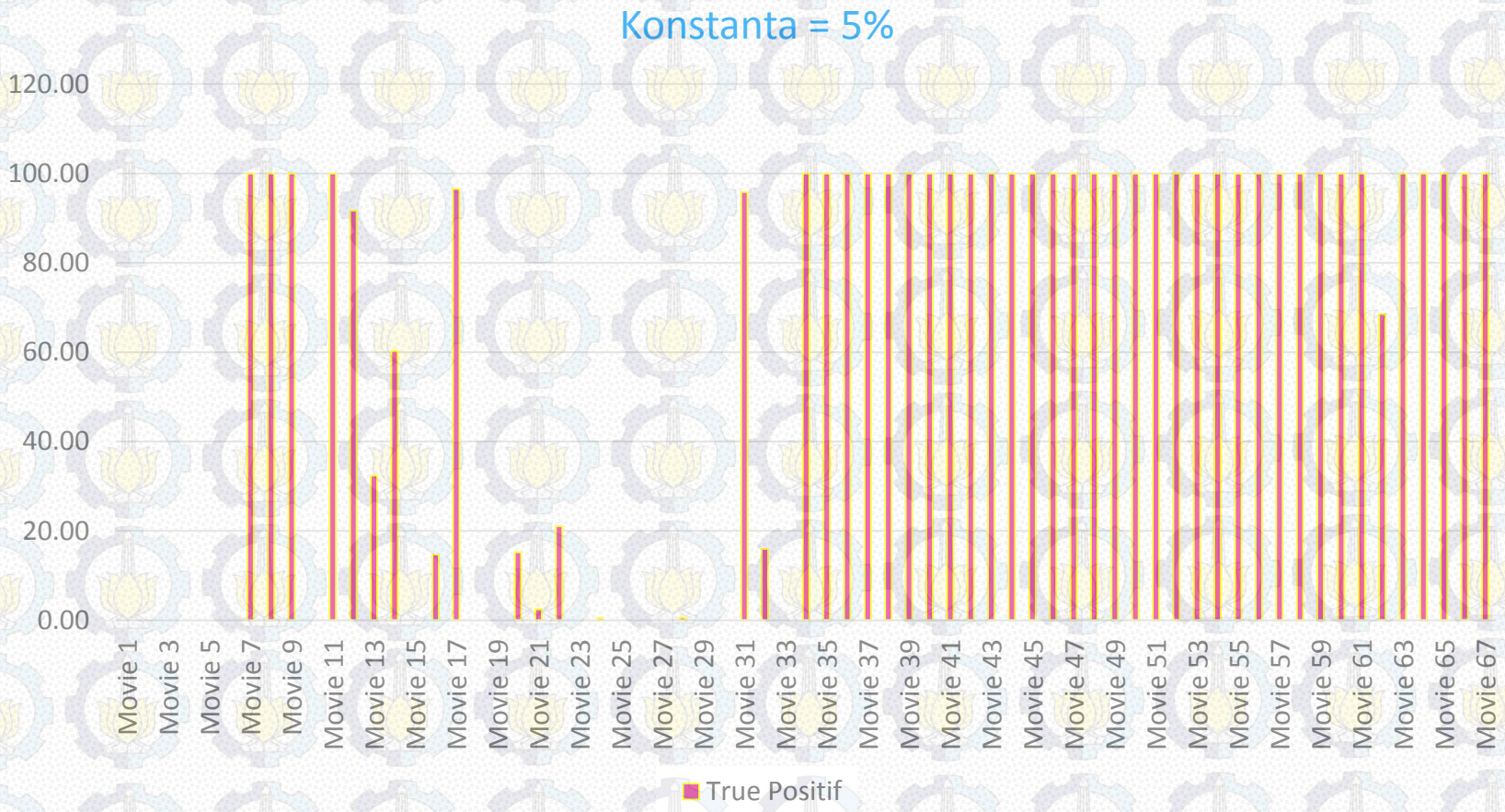
SKENARIO 4

- Variasi Konstanta *Region*
  - 1%
  - 5%
  - 10%
- Kernel = RBF
- *Threshold* = 5×10^{-9}
- $C = 5$

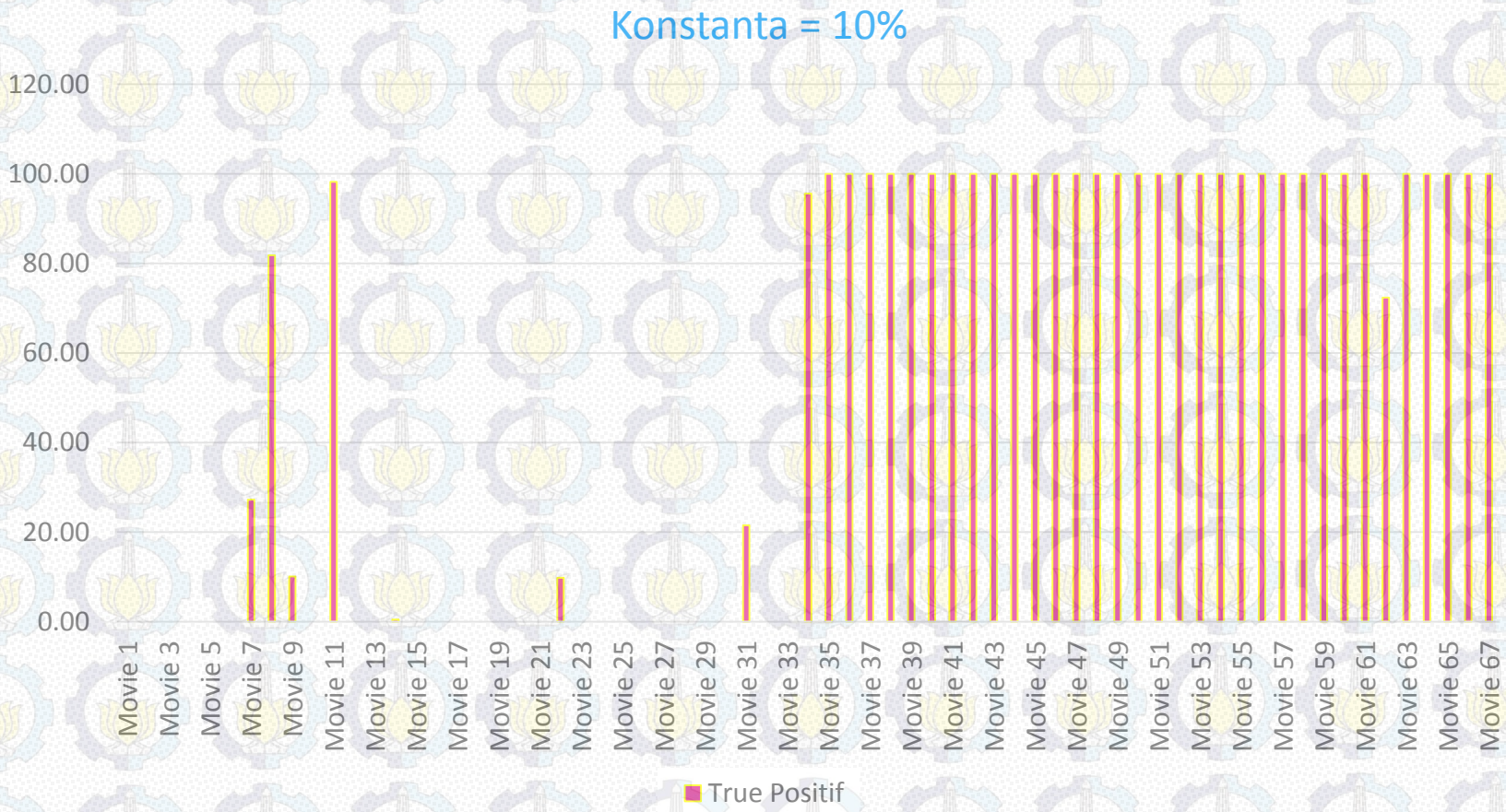
SKENARIO 4


Konstanta = 1%
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
Movie 21
Movie 23
Movie 25
Movie 27
Movie 29
Movie 31
Movie 33
Movie 35
Movie 37
Movie 39
Movie 41
Movie 43
Movie 45
Movie 47
Movie 49
Movie 51
Movie 53
Movie 55
Movie 57
Movie 59
Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 4


Konstanta = 5%
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
Movie 21
Movie 23
Movie 25
Movie 27
Movie 29
Movie 31
Movie 33
Movie 35
Movie 37
Movie 39
Movie 41
Movie 43
Movie 45
Movie 47
Movie 49
Movie 51
Movie 53
Movie 55
Movie 57
Movie 59
Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 4


Konstanta = 10%
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
Movie 21
Movie 23
Movie 25
Movie 27
Movie 29
Movie 31
Movie 33
Movie 35
Movie 37
Movie 39
Movie 41
Movie 43
Movie 45
Movie 47
Movie 49
Movie 51
Movie 53
Movie 55
Movie 57
Movie 59
Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 4

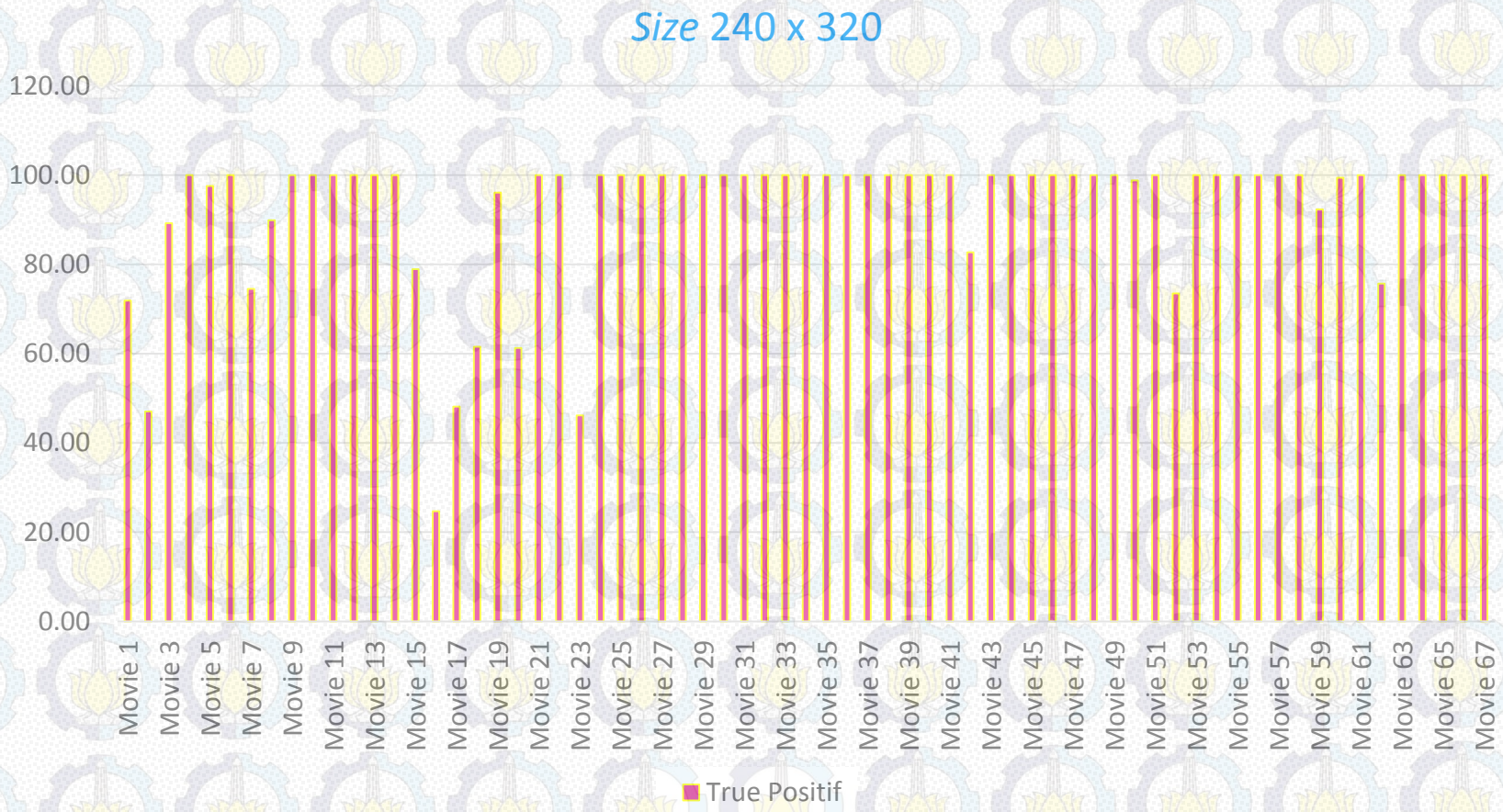
- Akurasi terbaik yang didapatkan ketika Konstanta yang digunakan sebesar 1%

Konstanta	True Positif (%)	False Positif (%)	Missing Rate (%)
1%	95.87	0.49	3.64
5%	62.92	0.47	36.61
10%	53.99	0.41	45.60

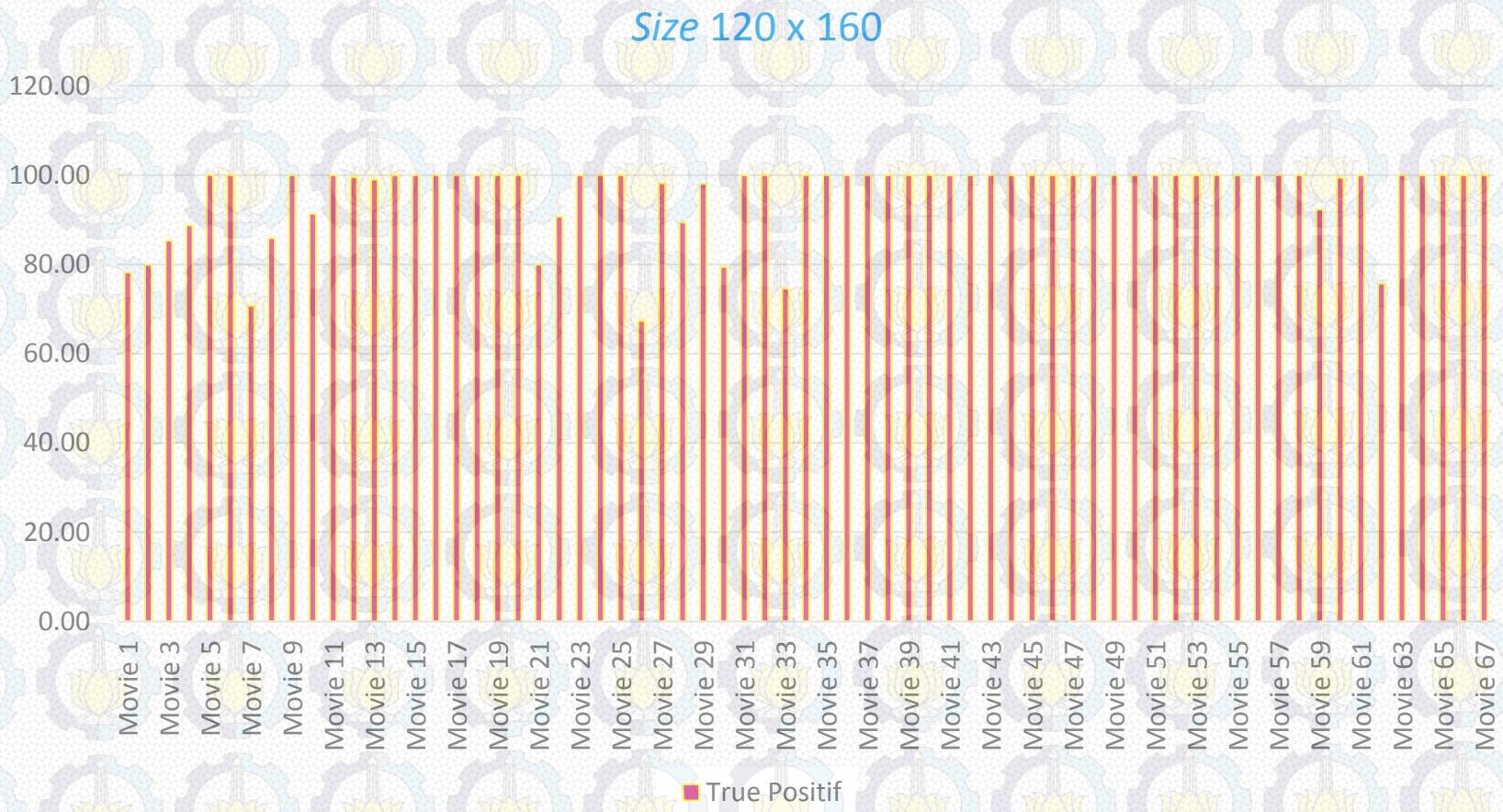
SKENARIO 5

- Variasi Konstanta *size frame*
  - 240 x 320
  - 120 x 160
  - 60 x 80
- Kernel = RBF
- *Threshold* = 5×10^{-9}
- C = 5

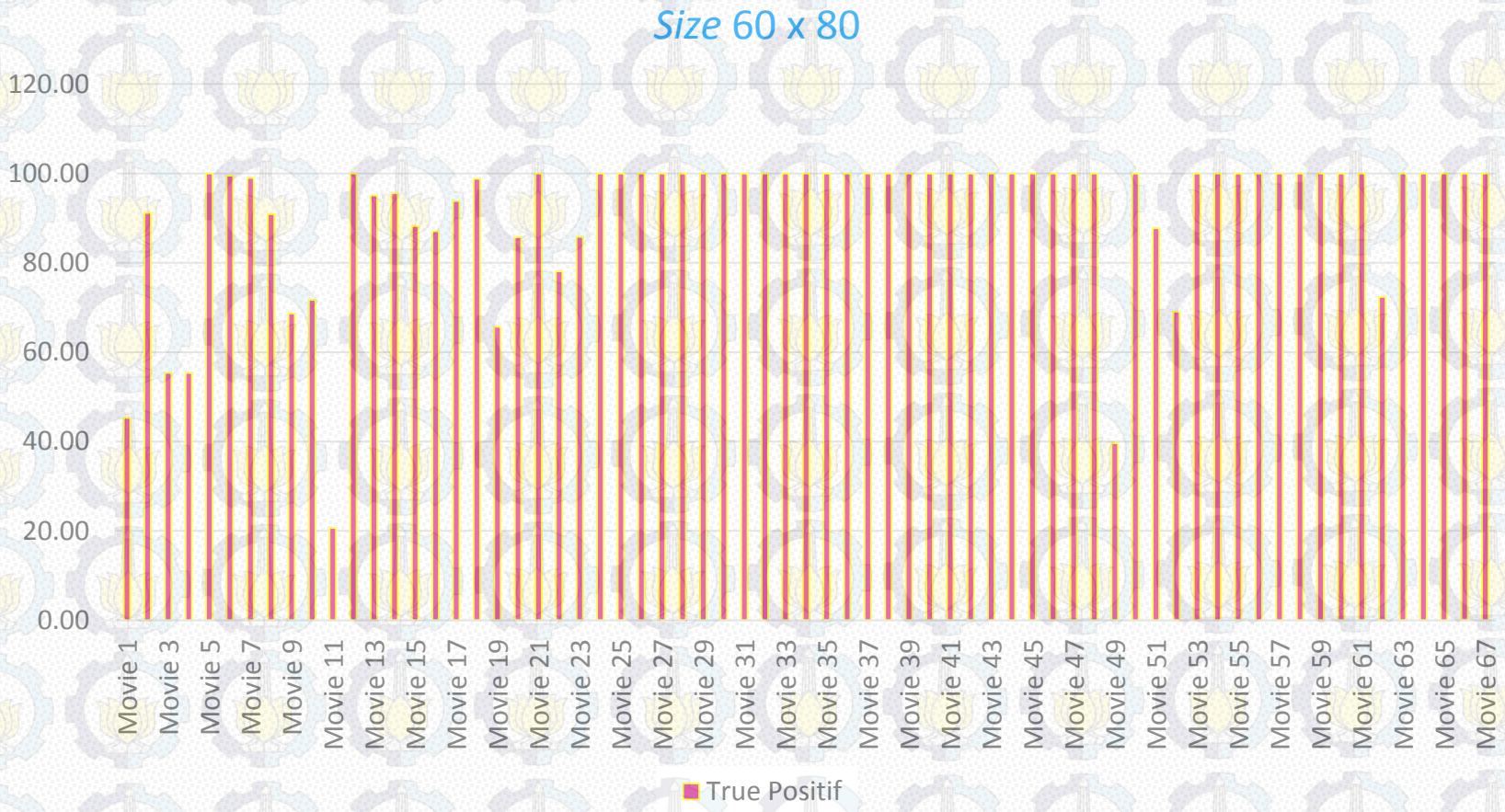
SKENARIO 5


Size 240 x 320
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
Movie 21
Movie 23
Movie 25
Movie 27
Movie 29
Movie 31
Movie 33
Movie 35
Movie 37
Movie 39
Movie 41
Movie 43
Movie 45
Movie 47
Movie 49
Movie 51
Movie 53
Movie 55
Movie 57
Movie 59
Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 5


Size 120 x 160
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
Movie 21
Movie 23
Movie 25
Movie 27
Movie 29
Movie 31
Movie 33
Movie 35
Movie 37
Movie 39
Movie 41
Movie 43
Movie 45
Movie 47
Movie 49
Movie 51
Movie 53
Movie 55
Movie 57
Movie 59
Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 5


Size 60 x 80
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Movie 1
Movie 3
Movie 5
Movie 7
Movie 9
Movie 11
Movie 13
Movie 15
Movie 17
Movie 19
Movie 21
Movie 23
Movie 25
Movie 27
Movie 29
Movie 31
Movie 33
Movie 35
Movie 37
Movie 39
Movie 41
Movie 43
Movie 45
Movie 47
Movie 49
Movie 51
Movie 53
Movie 55
Movie 57
Movie 59
Movie 61
Movie 63
Movie 65
Movie 67
True Positif

SKENARIO 5

- Akurasi terbaik yang didapatkan ketika Size Frame yang digunakan adalah 120 x 160

Size Frame	True Positif (%)	False Positif (%)	Missing Rate (%)	Execution Time (s)
240 x 320	91.96	0.79	7.25	67.38
120 x 160	95.87	0.49	3.64	26.57
60 x 80	90.67	1.82	7.51	7.30

PENDAHULUAN

RANCANGAN & IMPLEMENTASI

SKENARIO UJI COBA

KESIMPULAN & SARAN

KESIMPULAN

- Reduksi *size frame* mempercepat proses deteksi.
- Metode deteksi api menggunakan gaussian mixture model mendeteksi piksel-piksel yang bergerak dengan baik.
- Deteksi warna menyaring piksel-piksel yang tidak masuk kedalam range warna api dapat menyaring piksel-piksel yang tidak termasuk piksel api dengan baik.
- Metode perhitungan luasan region dapat menghilangkan noise dengan baik.

KESIMPULAN

- Penggunaan kernel pada klasifikasi mempengaruhi hasil dari verifikasi piksel.

- Hasil terbaik pada uji coba adalah menggunakan nilai threshold = 5 x 10-9 dan nilai C = 7. Menghasilkan nilai true positif sebesar 95.96, false positif sebesar 0.48 dan missing rate sebesar 3.56.

SARAN

- Analisa fitur pada pross verifikasi perlu dilakukan analisa lebih lanjut.

TERIMA KASIH