

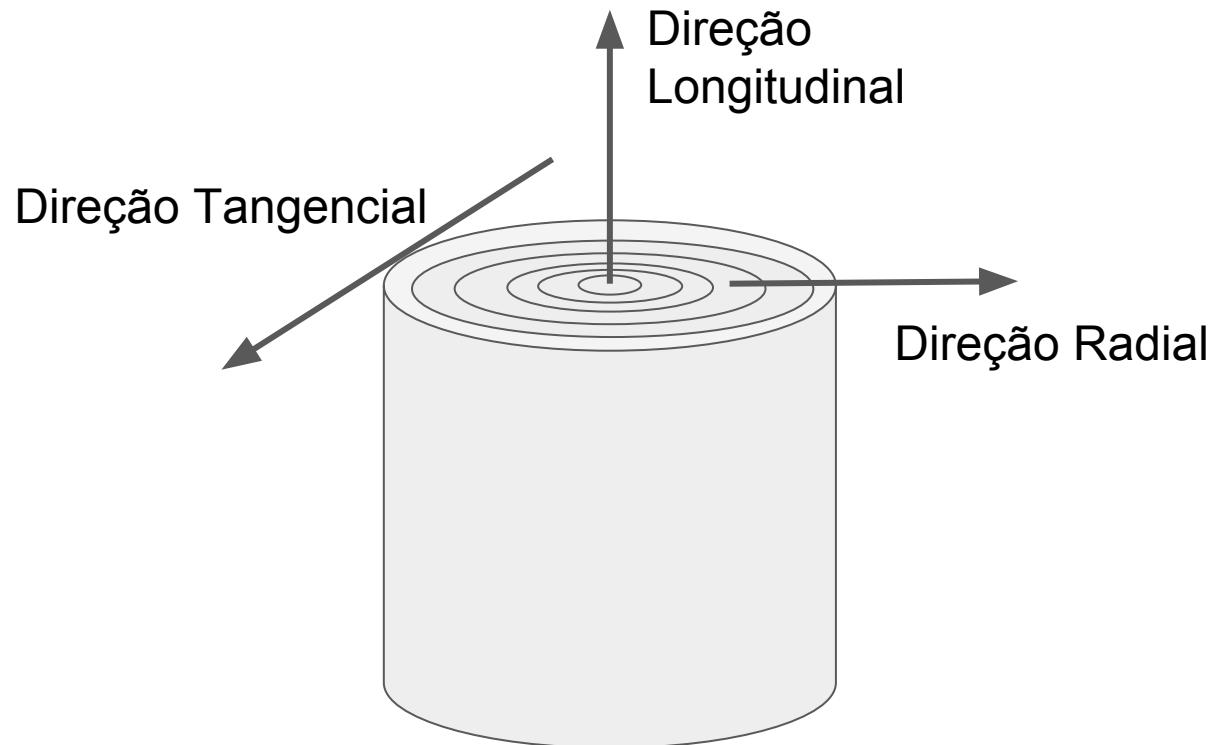
Histogramas espectrais locais na segmentação de raios parenquimáticos em imagens microscópicas da madeira

Rayner Harold Montes Condori
Universidade de São Paulo

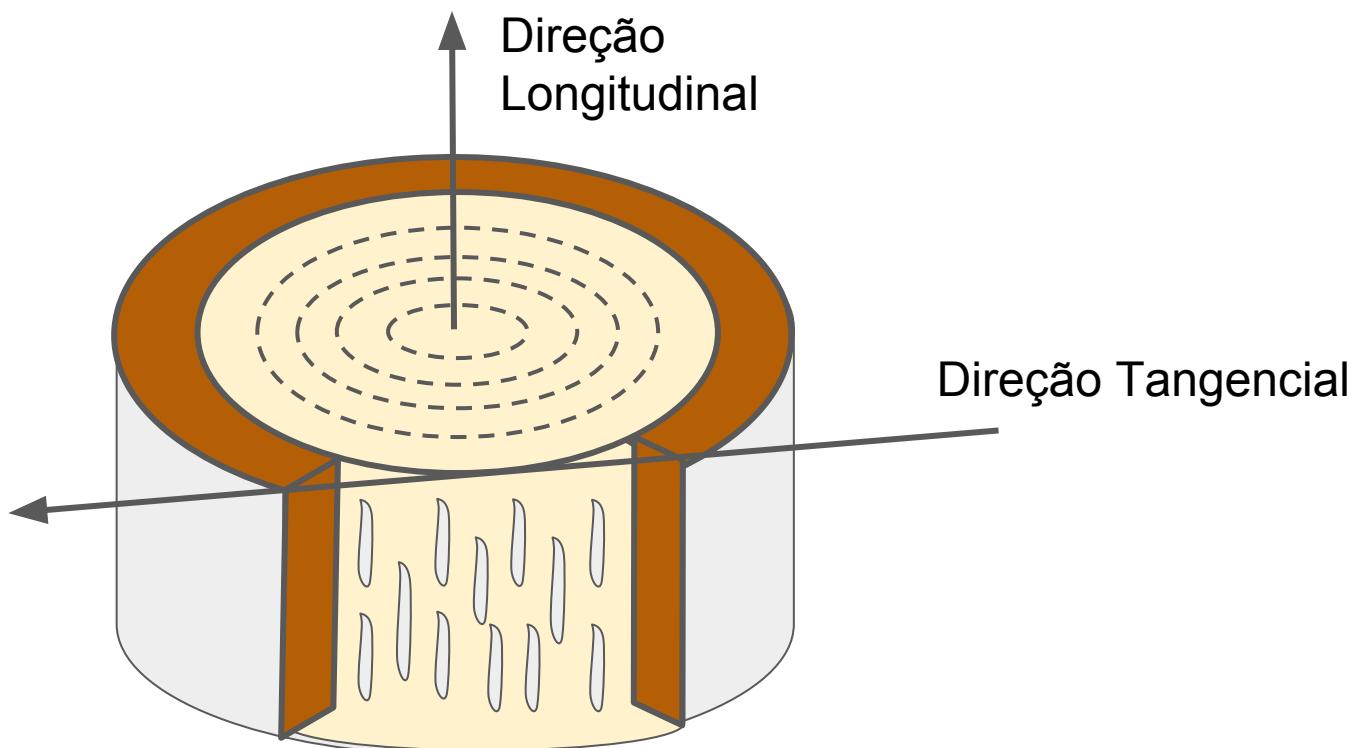
GitHub da aula

<https://goo.gl/Q7yZGb>

Dados: Tronco de árvore



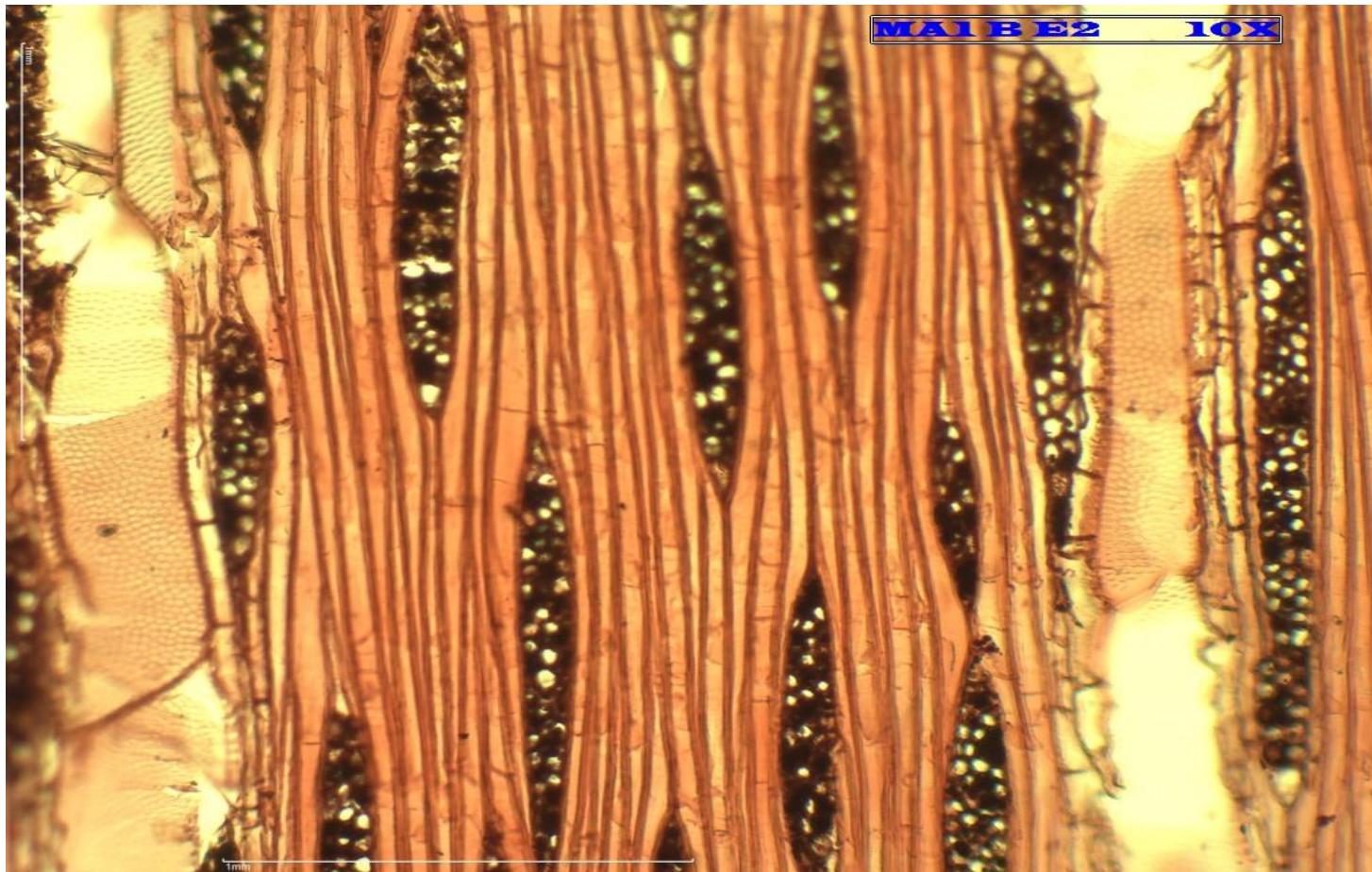
Tronco de árvore: corte longitudinal tangencial



Corte longitudinal tangencial: raios parenquimáticos

Moena Amarela

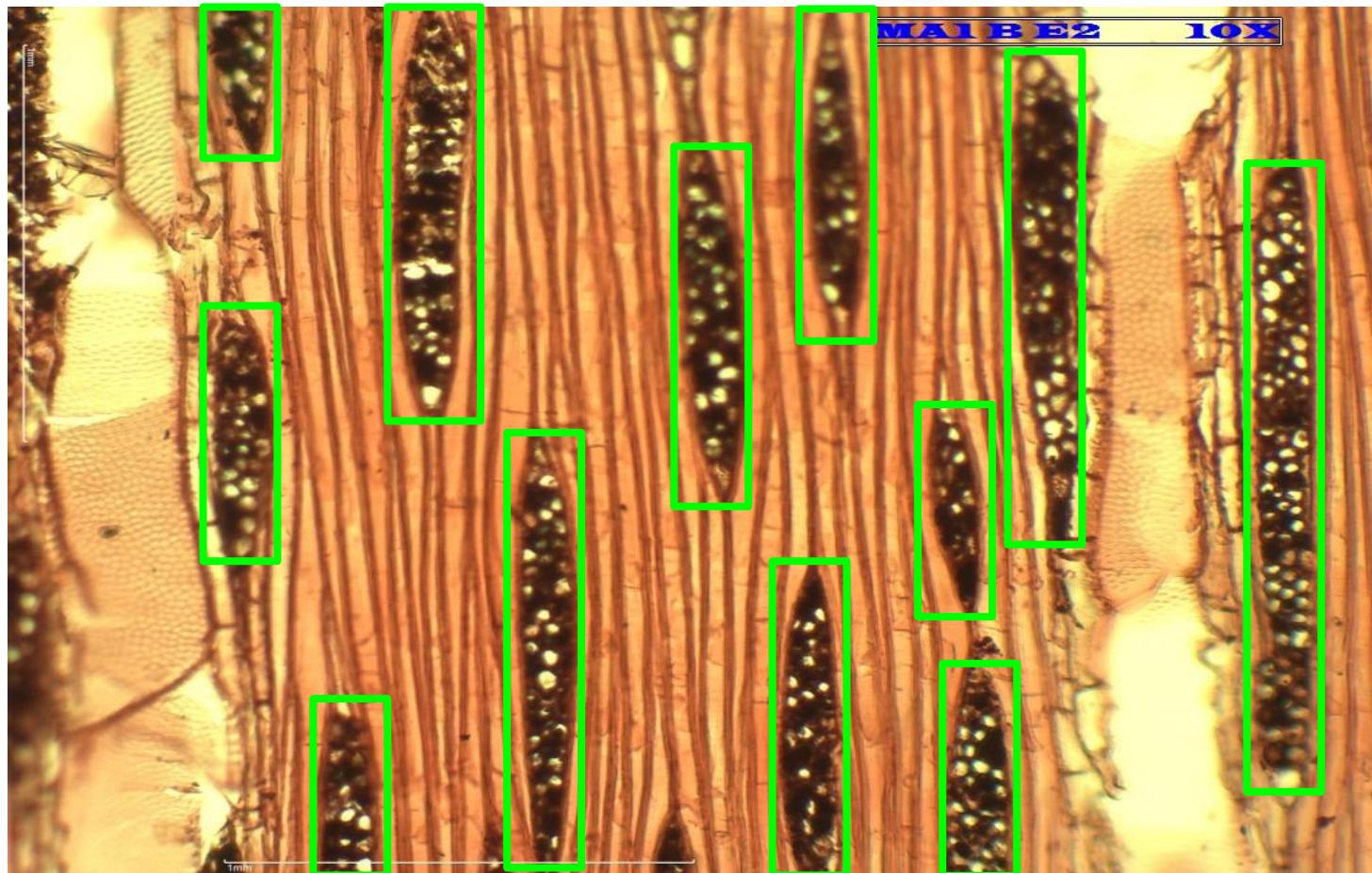
Familia: Lauraceae



Raios parenquimáticos: detecção

Moena Amarela

Família: Lauraceae



Raios parenquimáticos: binarização



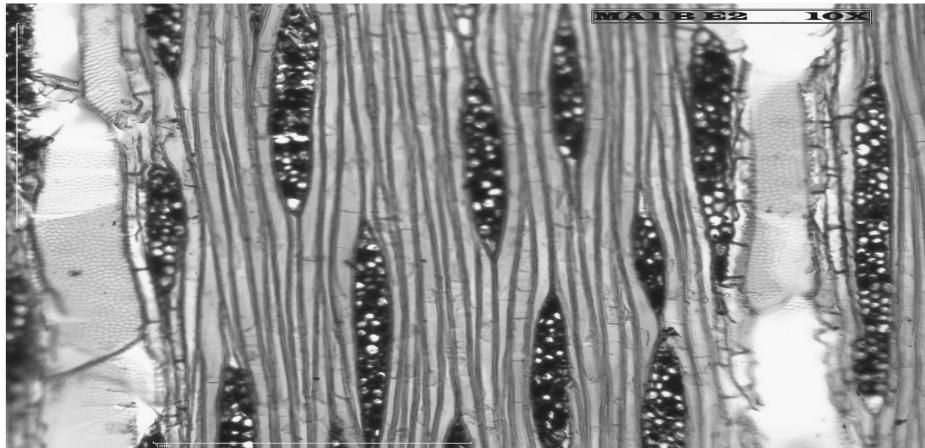
Raios parenquimáticos: métodos

- Ex 1: Limiarização
 - Análise de histograma
 - Método de Otsu
- Ex 2: Convolução
 - Filtro Sobel
 - Filtro de Gaussiano.
 - Filtro Laplaciano do gaussiano.
 - Filtro de Gabor
- Ex 3: Histogramas locais
 - Ideia
 - Histograma padrão
 - Comparação de histogramas
 - Matriz de distâncias
- Ex 4: Histogramas espectrais locais

Ex1.m

Ex1 - Limiarização

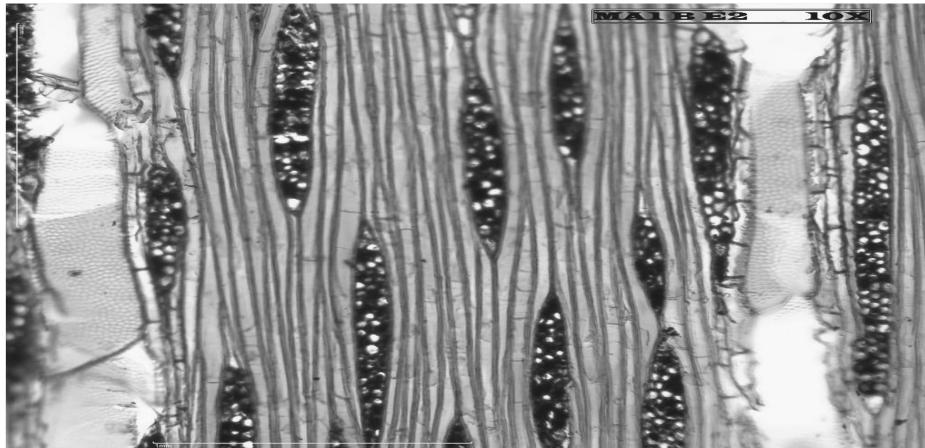
0 - 255



Ex1 - Limiarização

0 - 1

im2doub1
e

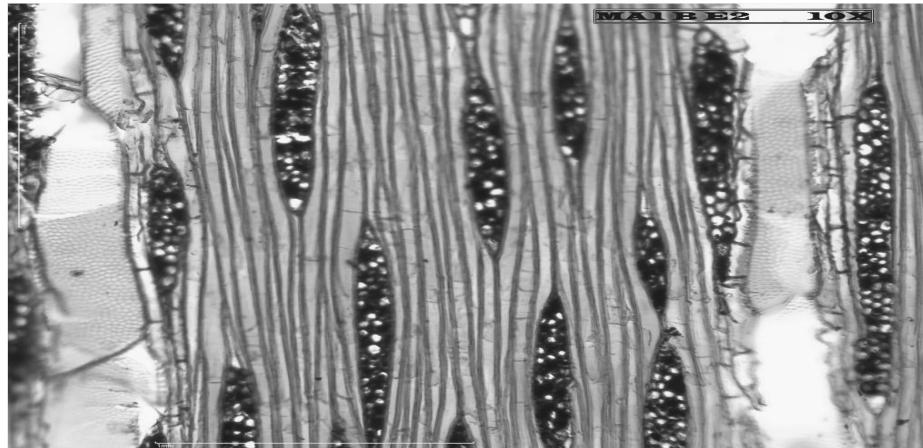


Limiar = ?

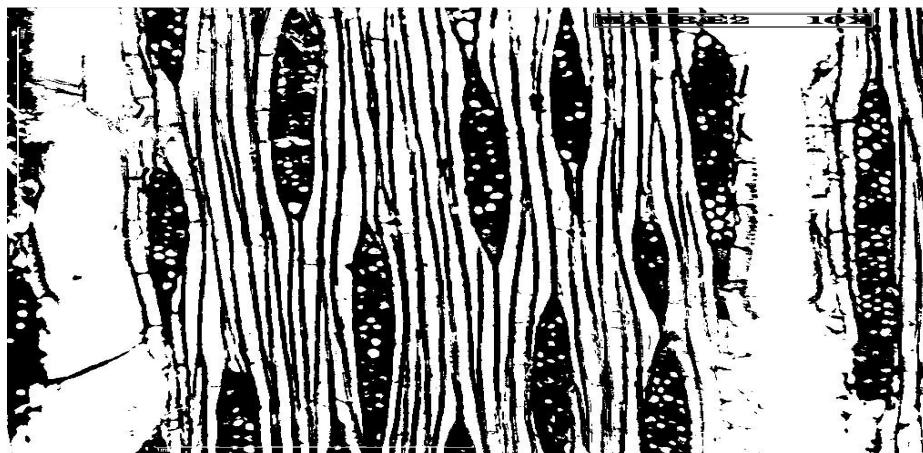
Ex1 - Limiarização

0 - 1

im2doub1
e



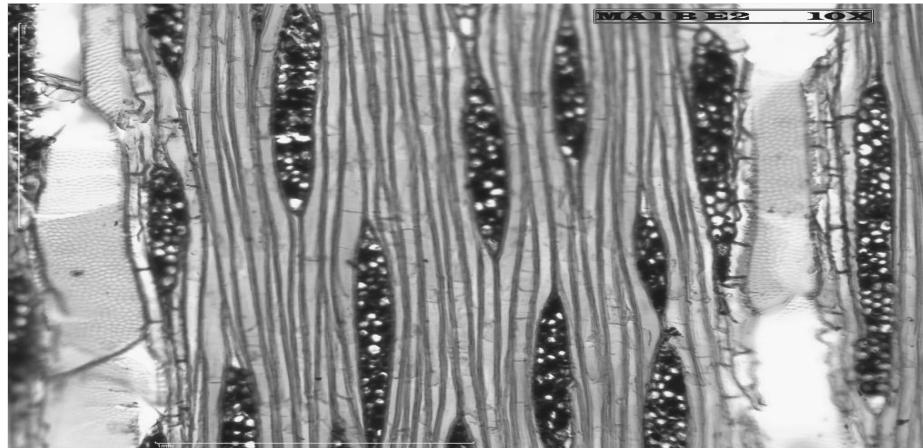
Limiar = 0.5



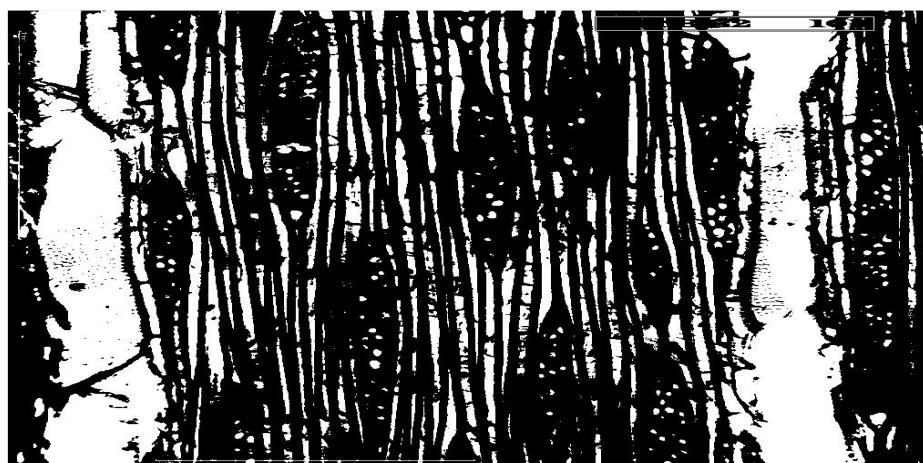
Ex1 - Limiarização

0 - 1

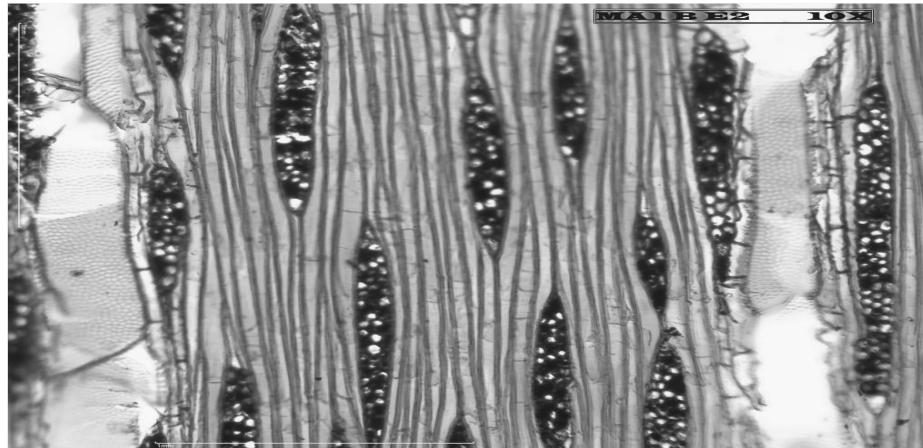
im2doub1
e



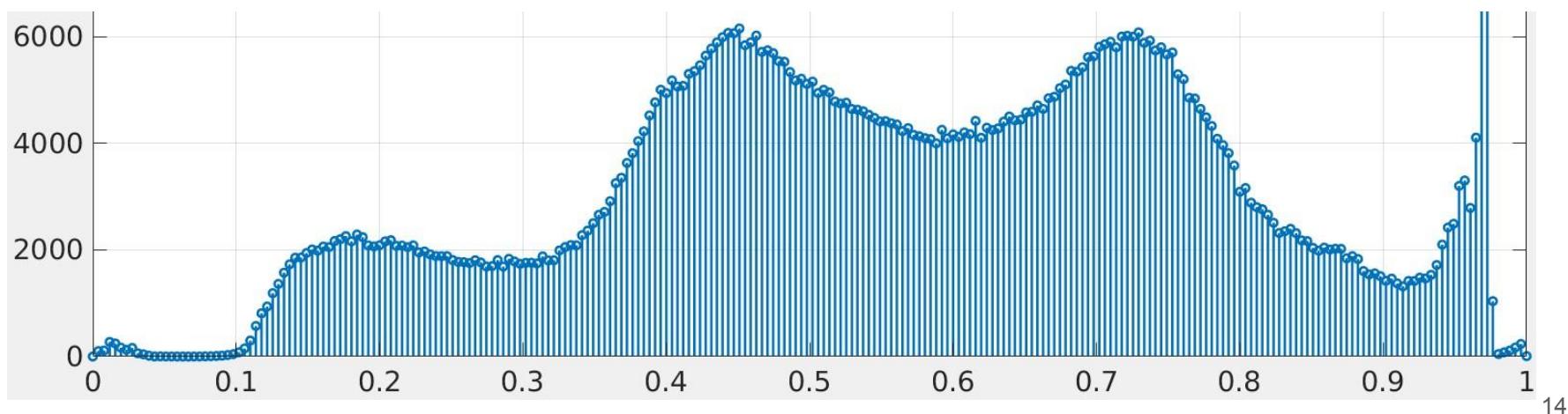
Limiar = 0.7



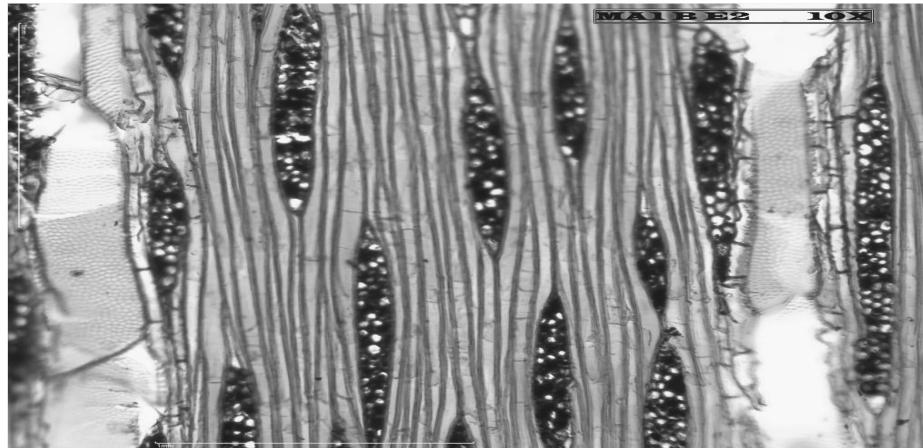
Ex1 - Limiarização: Análise do histograma



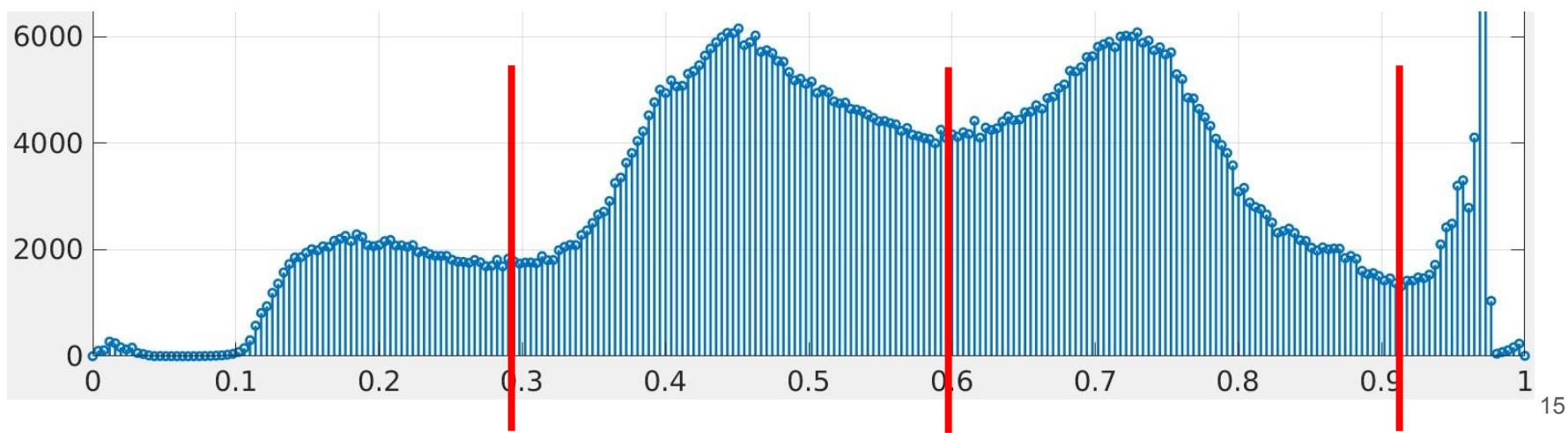
imhist



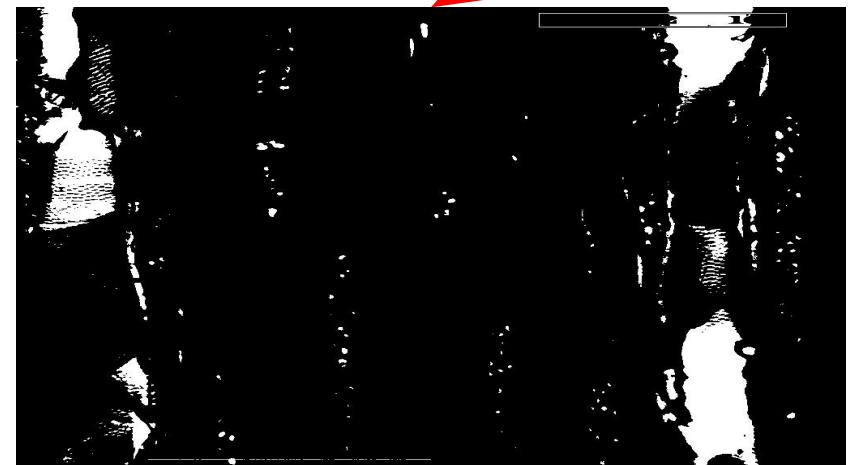
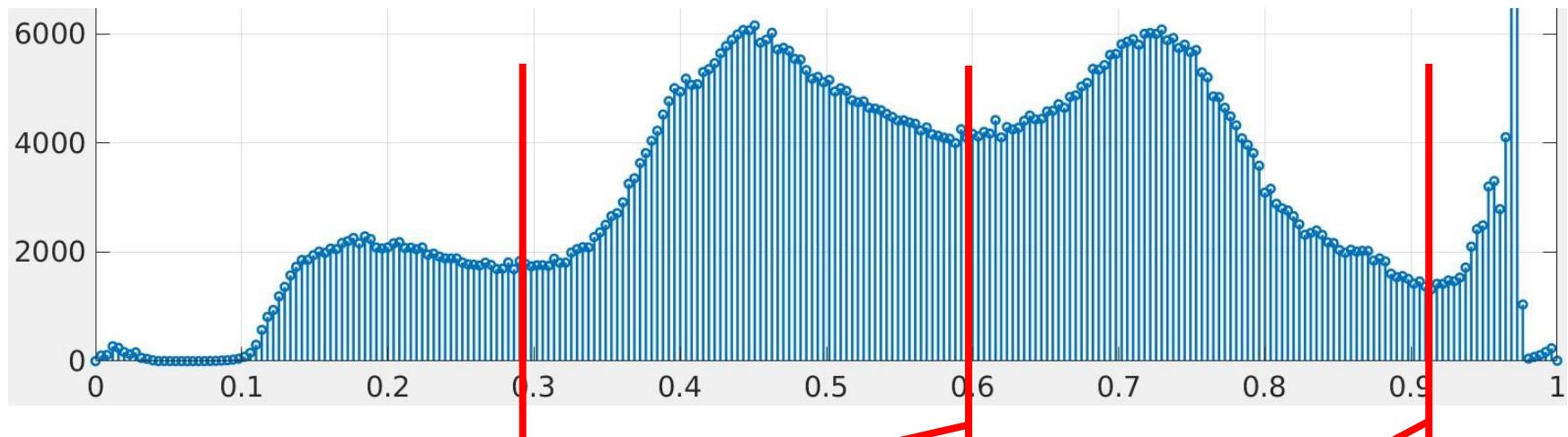
Ex1 - Limiarização: Análise do histograma



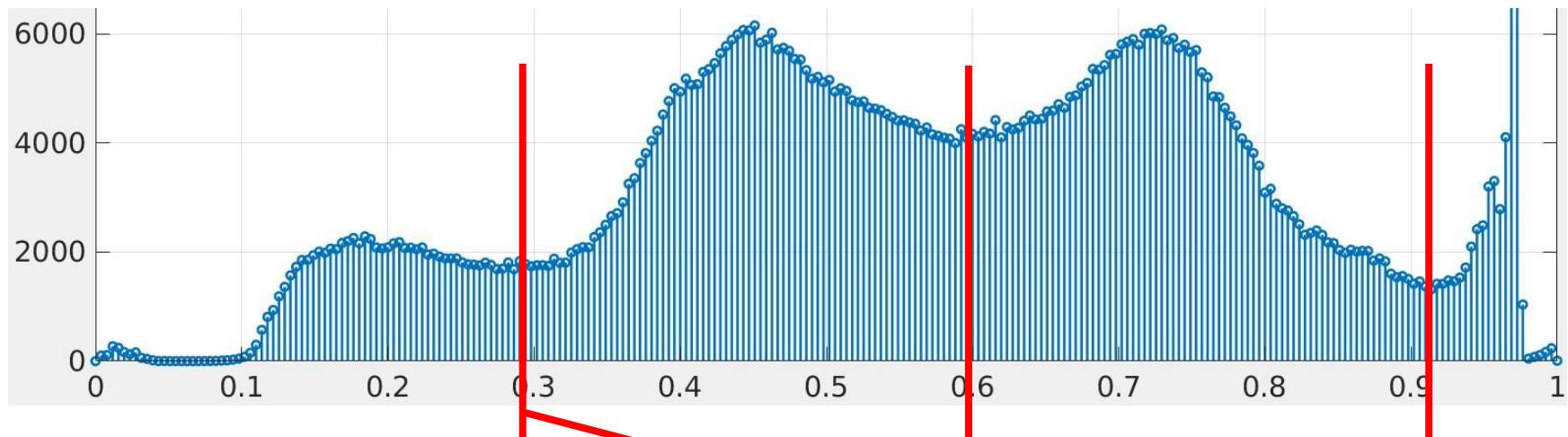
imhist



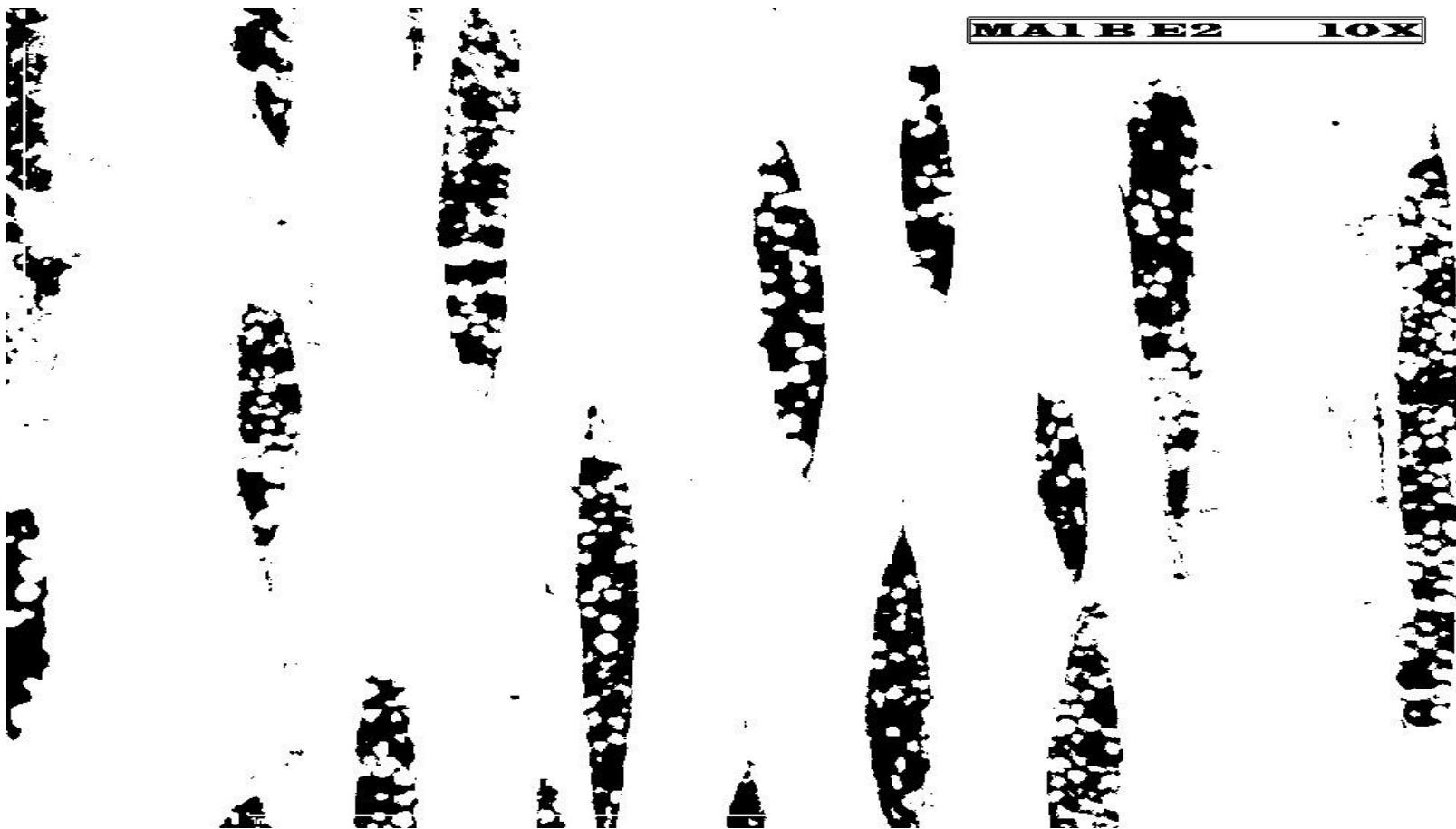
Ex1 - Limiarização: Análise do histograma



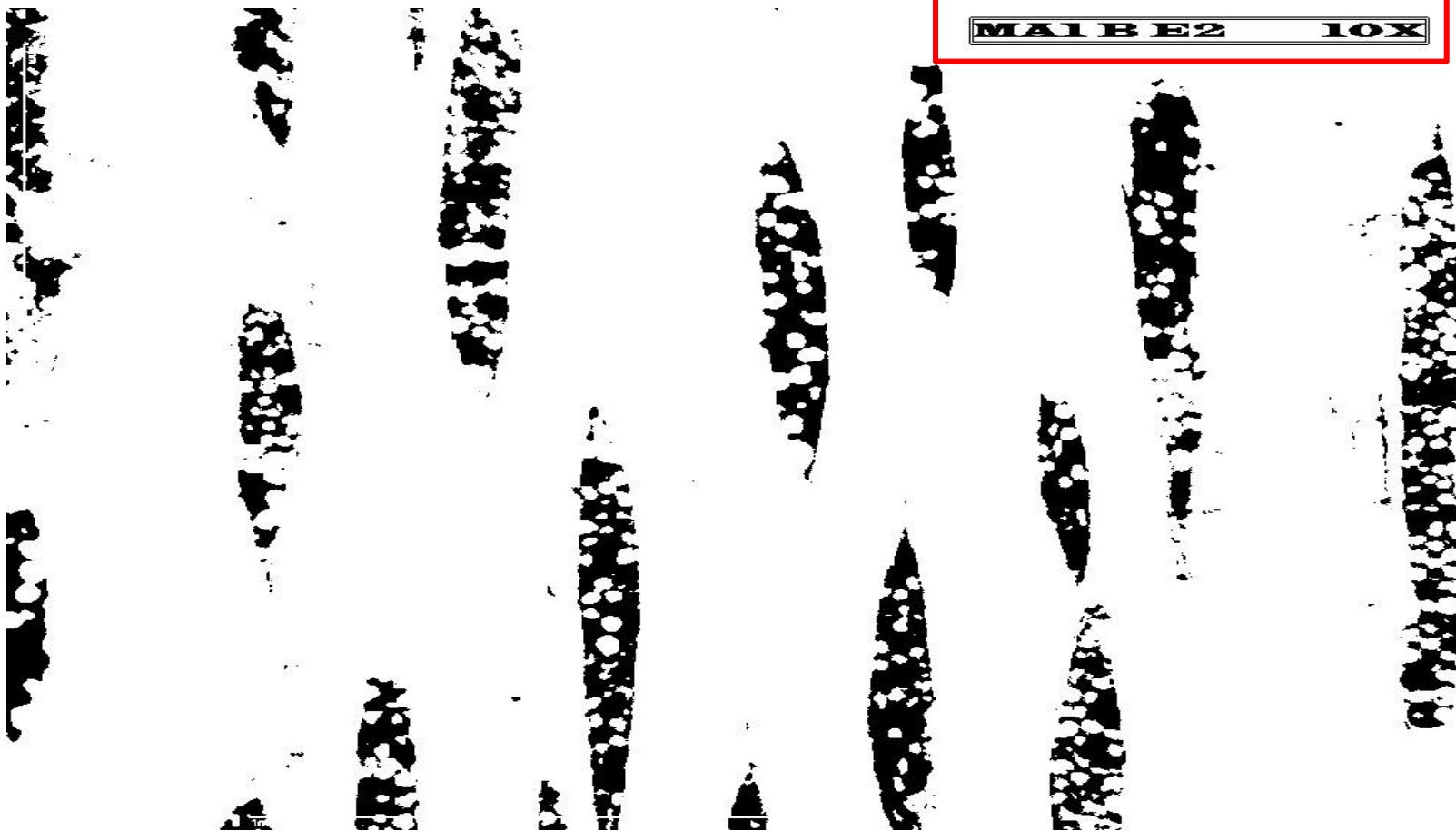
Ex1 - Limiarização: Análise do histograma



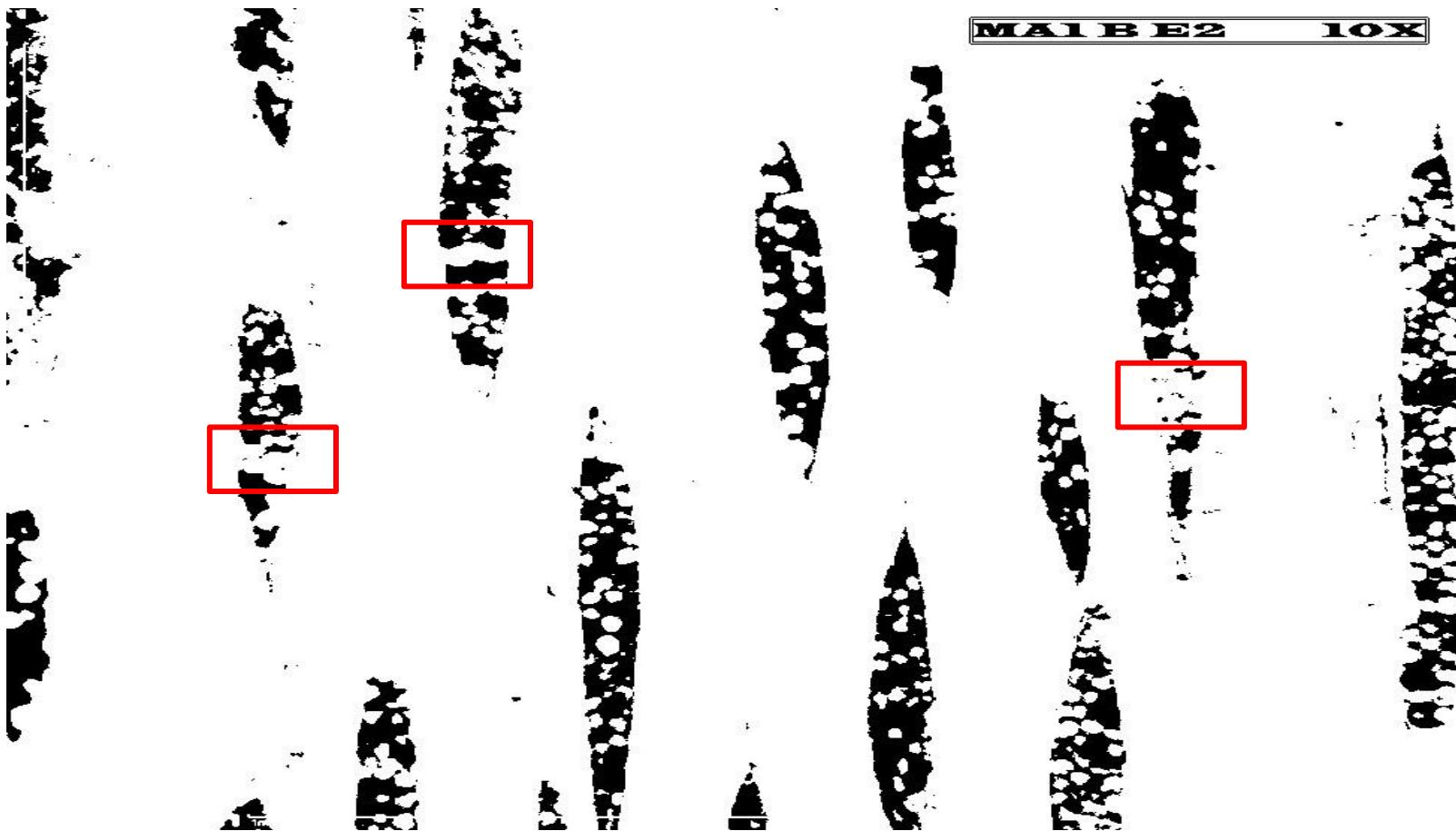
Ex1 - Limiarização: resultado



Ex1 - Limiarização: problemas

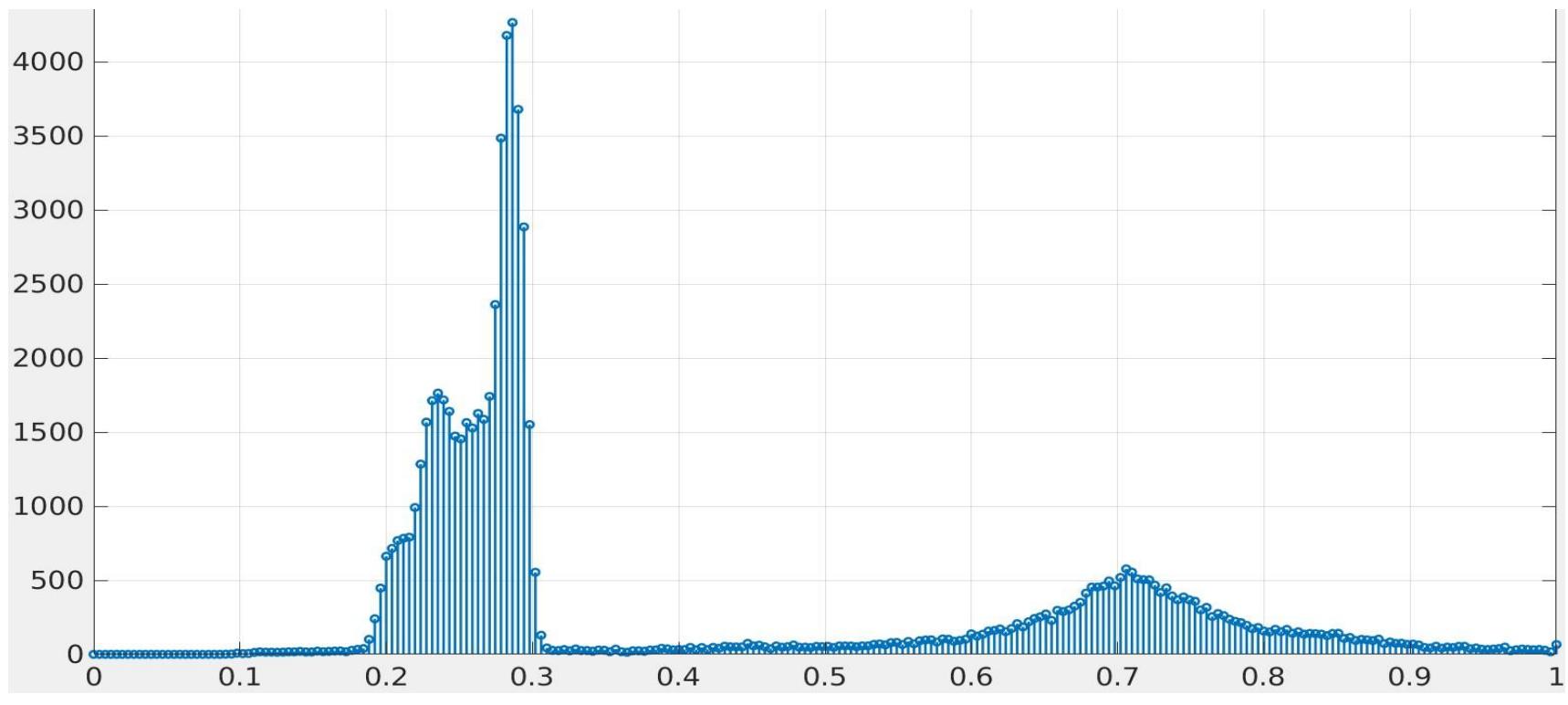


Ex1 - Limiarização: problemas



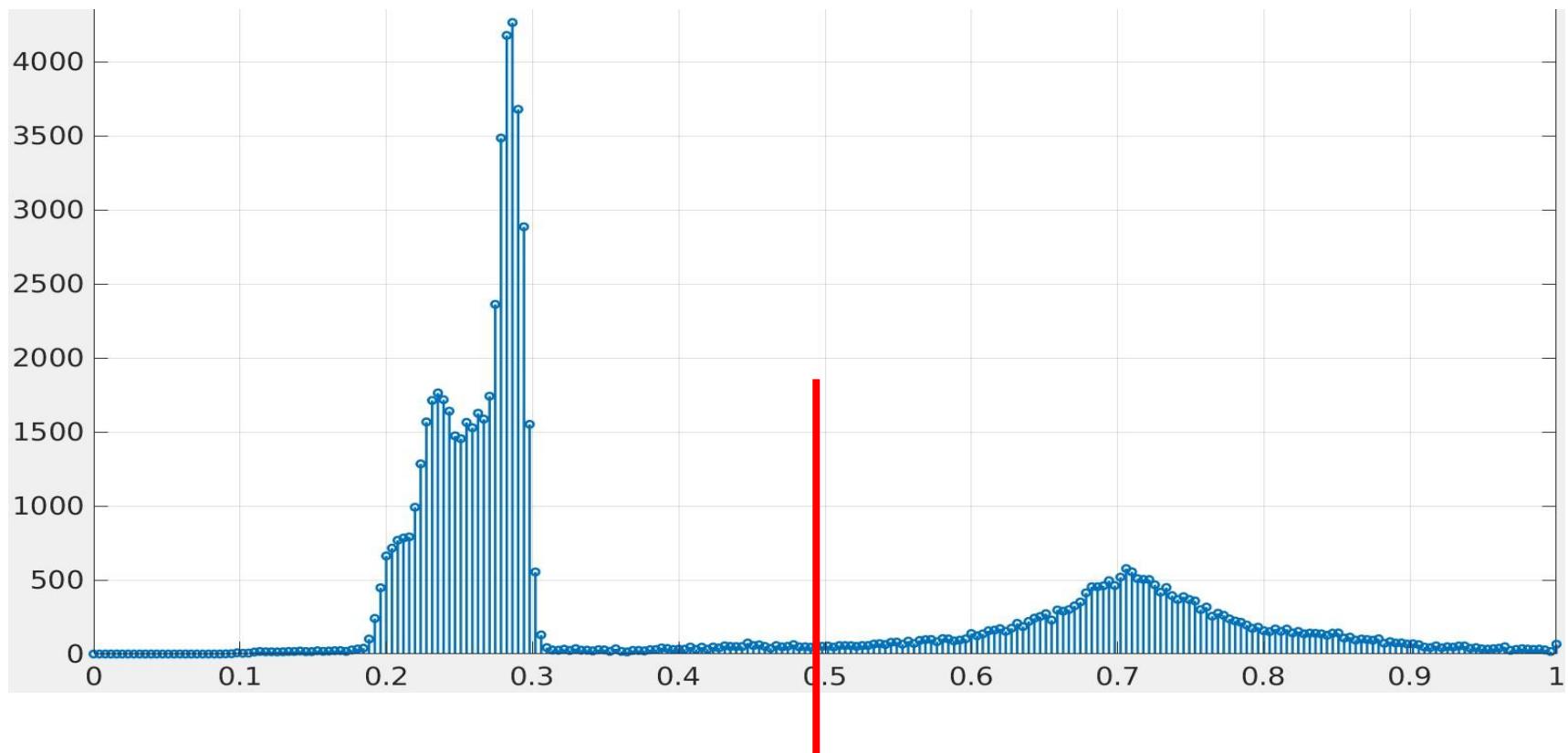
Ex1 - Limiarização: Otsu

- Este método tenta encontrar automaticamente o melhor limiar possível analisando o histograma
- Trabalha muito bem com histogramas bimodais



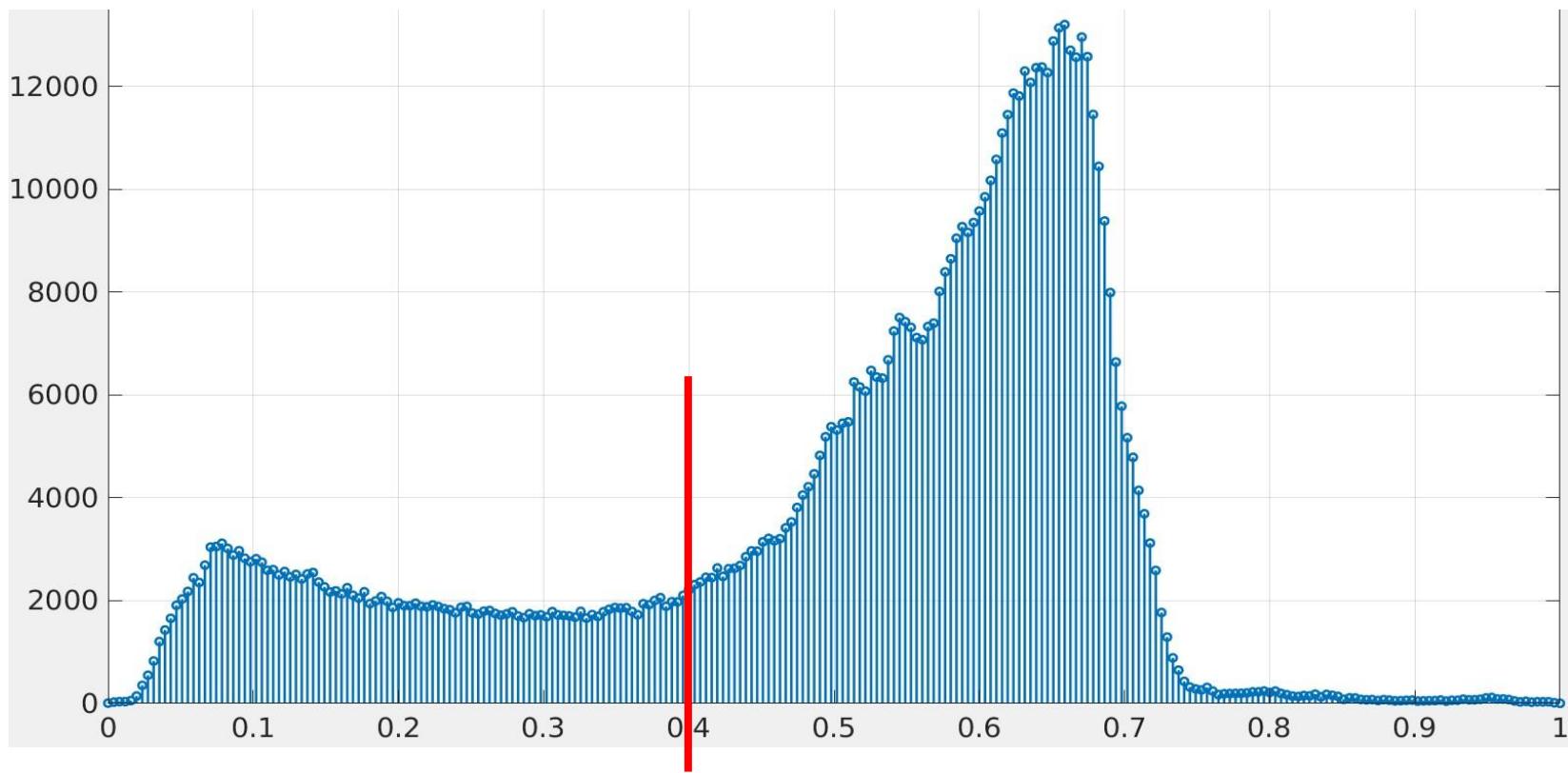
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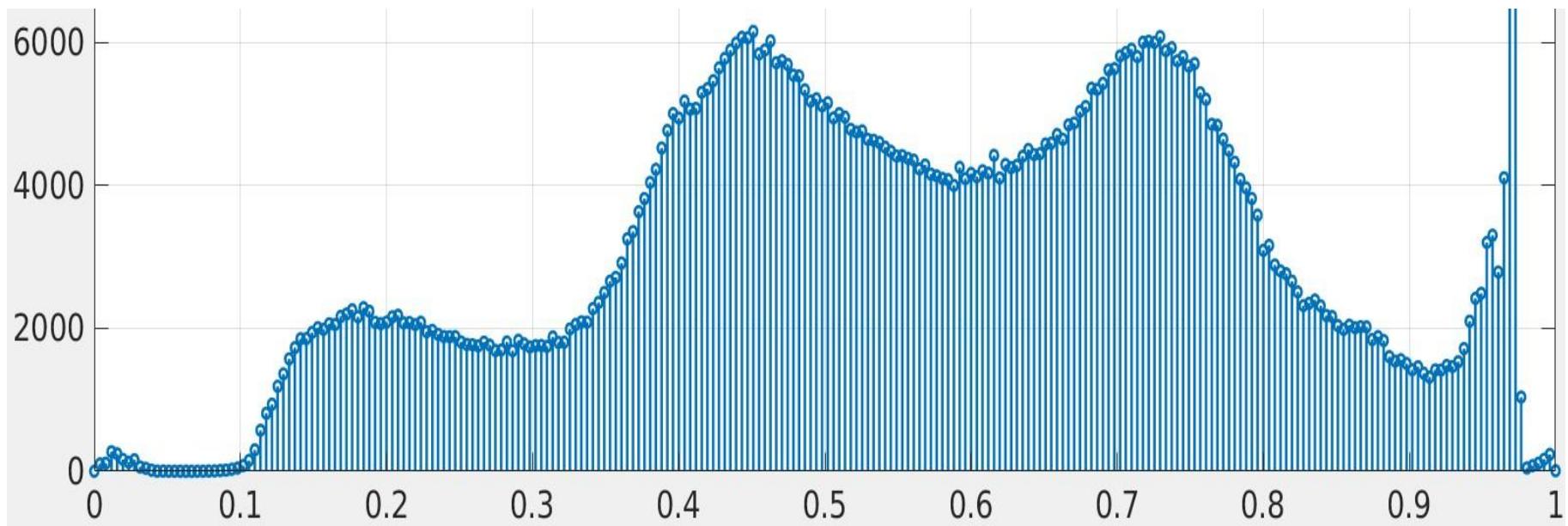
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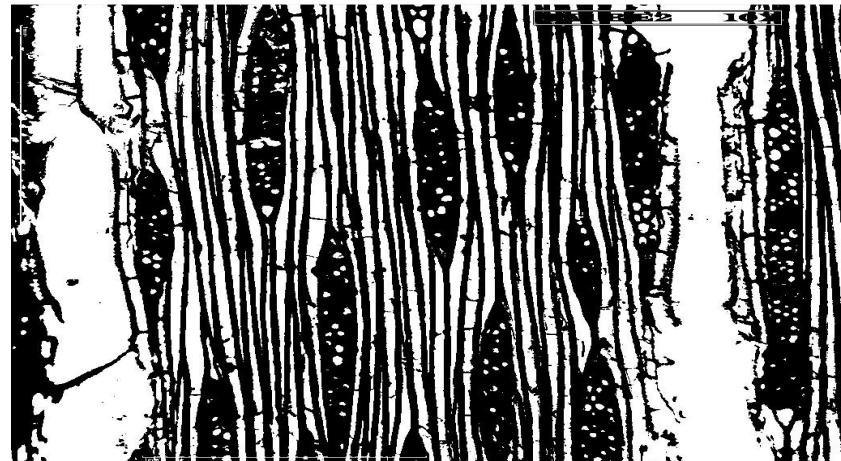
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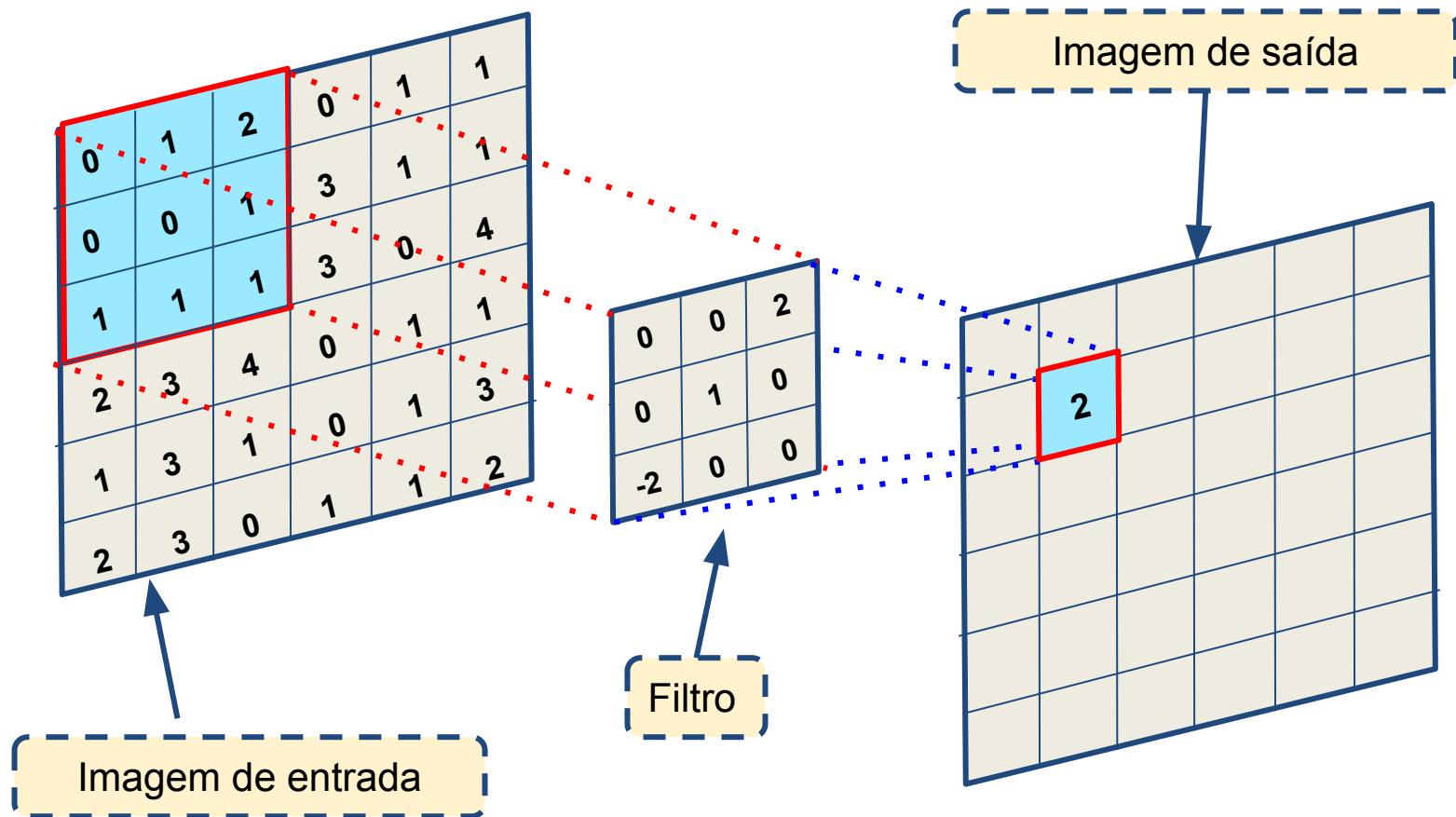
Ex1 - Limiarização: Otsu

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- Trabalha muito bem com histogramas bimodais

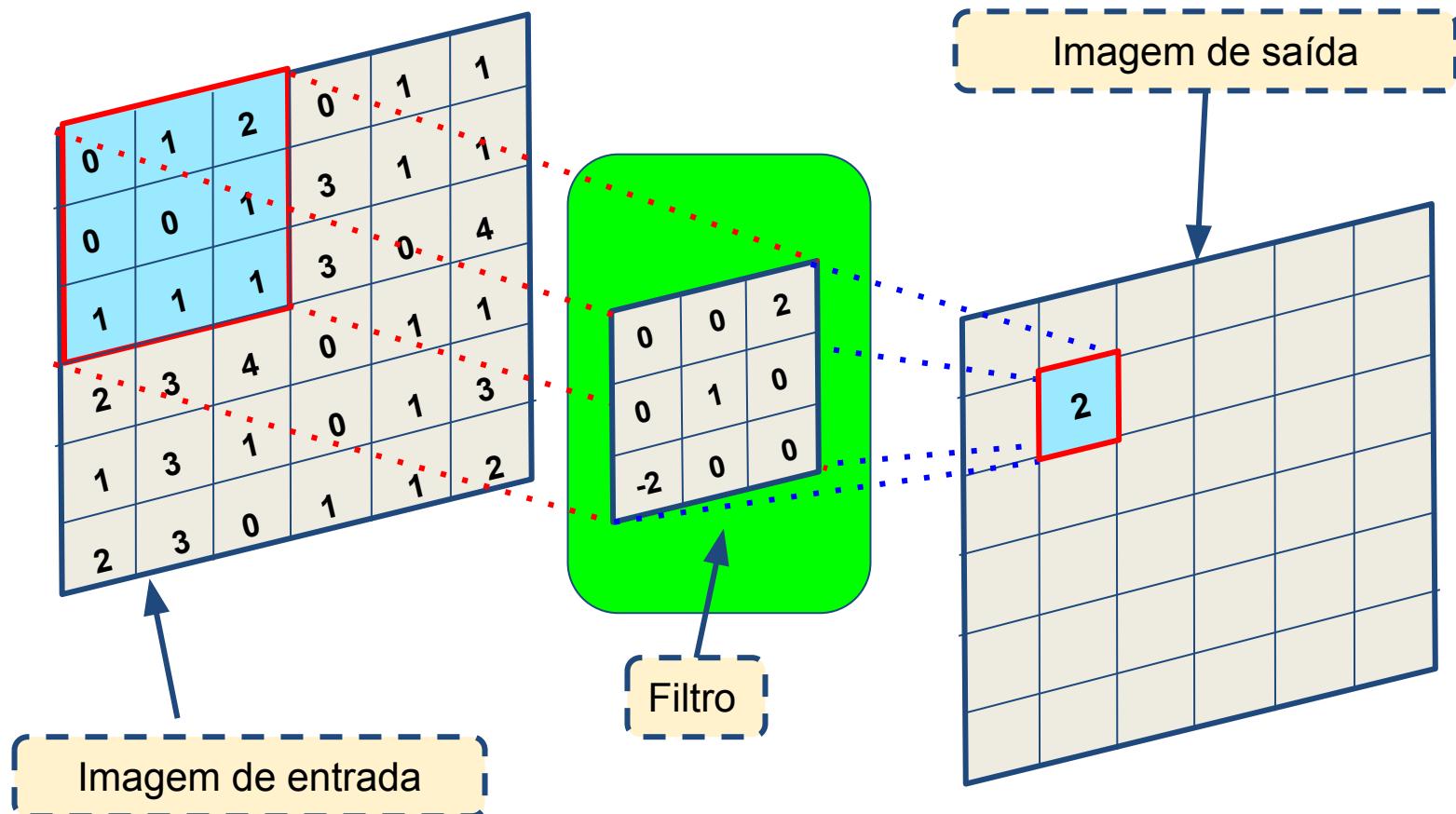


Ex2.m

Ex2 - Convolução



Ex2 - Convolução

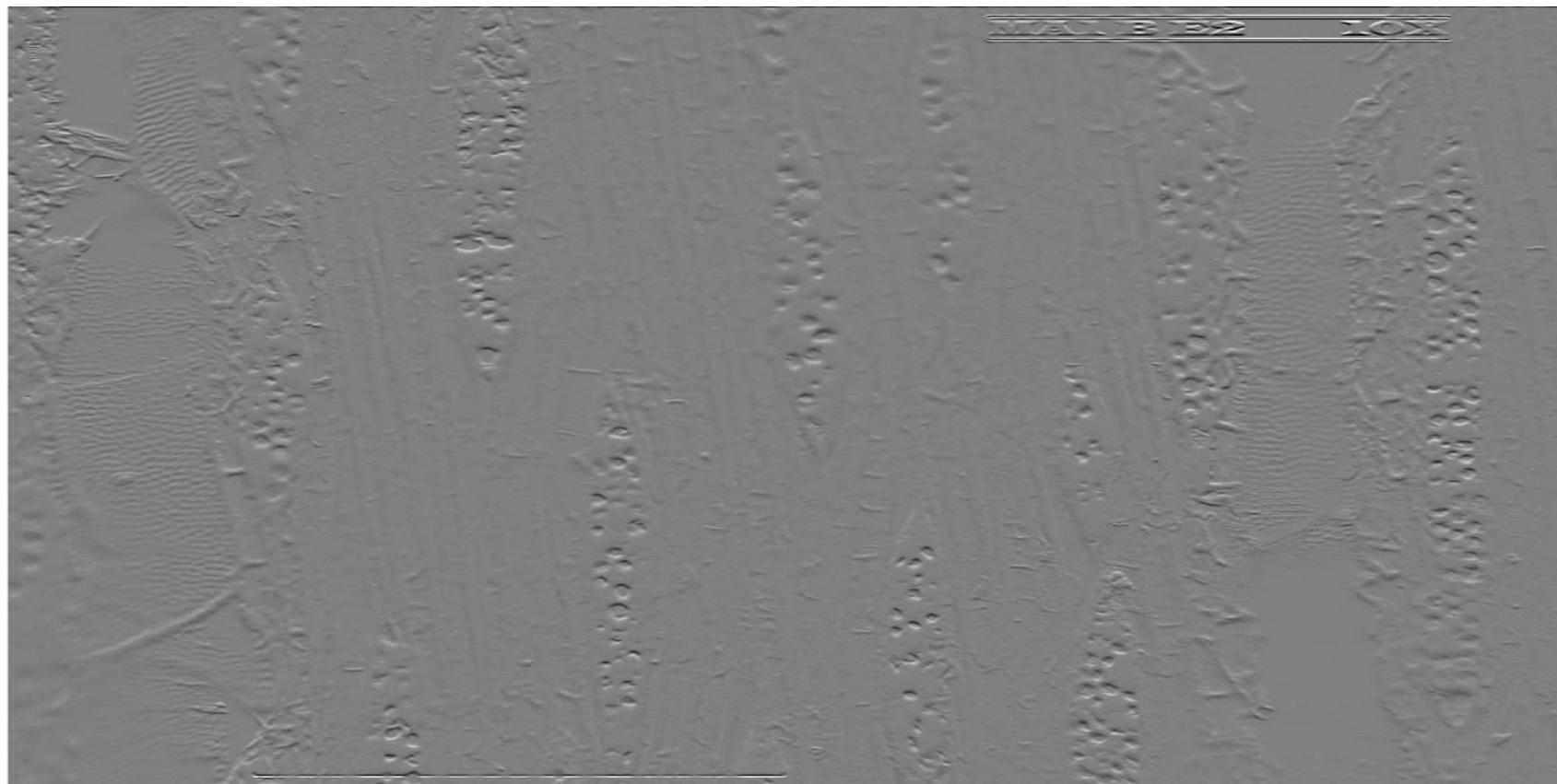


Filtro Sobel

- Usado na detecção de contornos.
- Aproxima a gradiente através de diferenças finitas

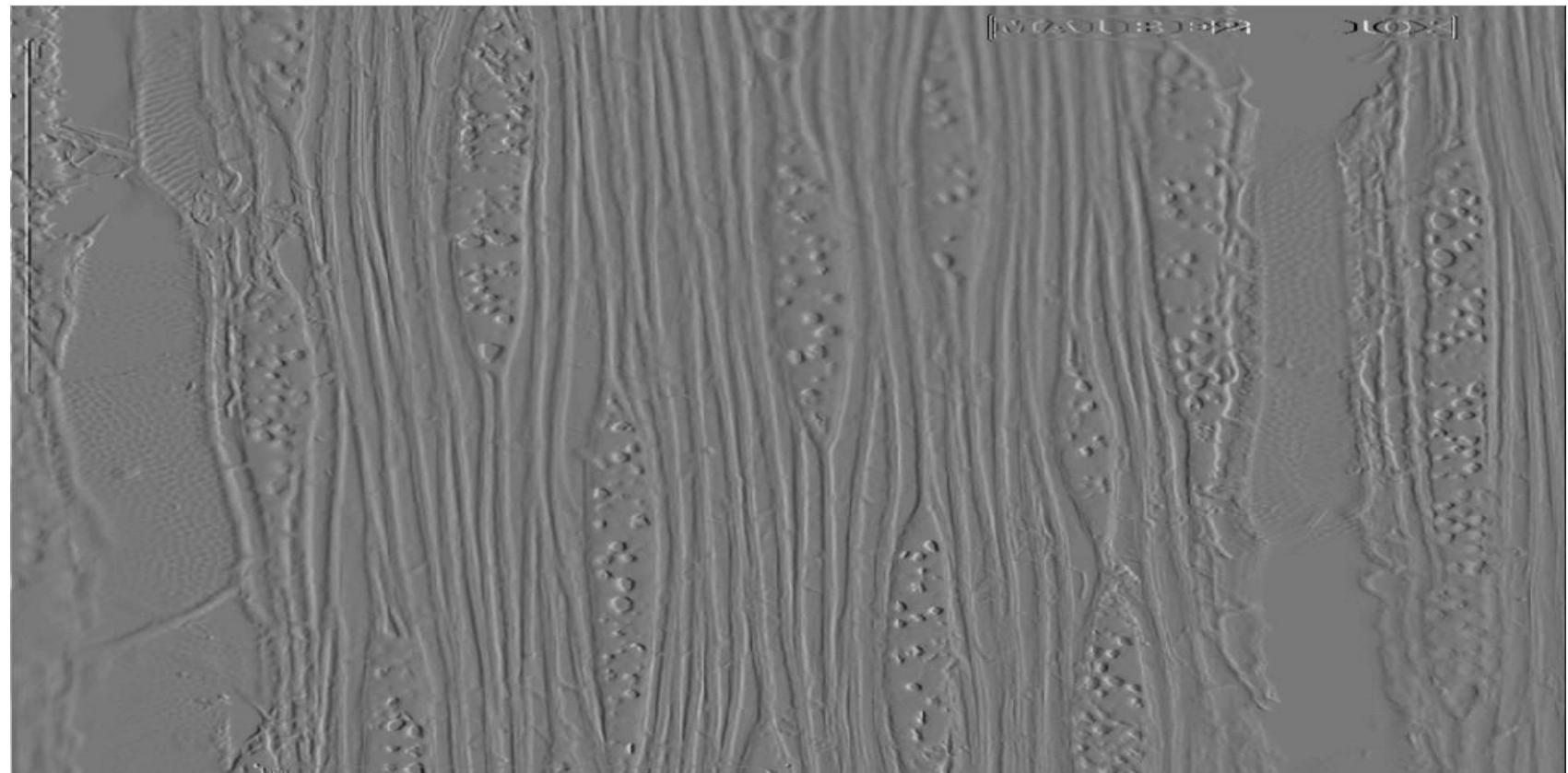
Ex2 - Filtro Sobel

- Usado na detecção de contornos
- Gradiente vertical (filtro de 3 x 3)



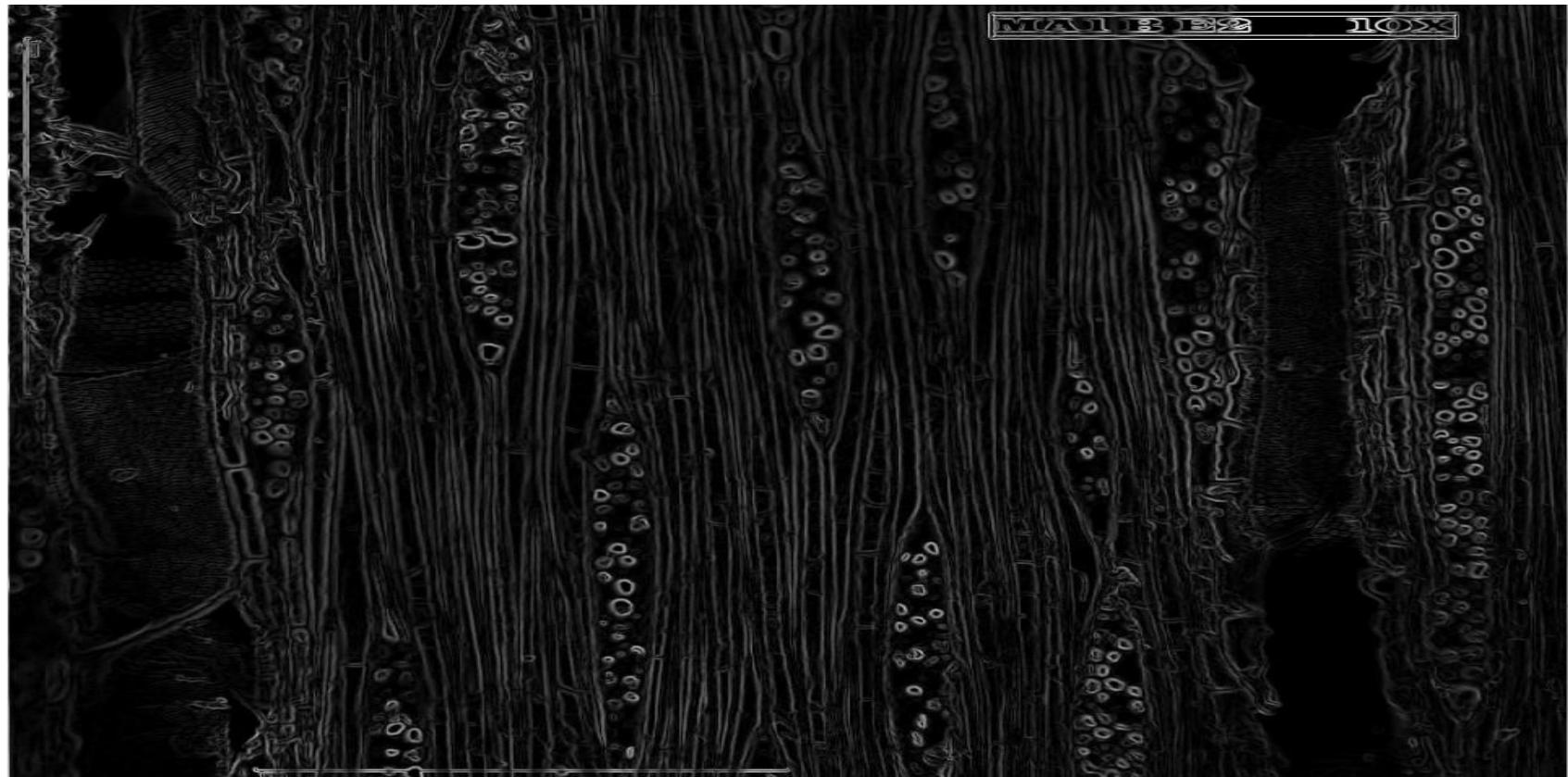
Ex2 - Filtro Sobel

- Usado na detecção de contornos
- Gradiente horizontal (filtro de 3 x 3)



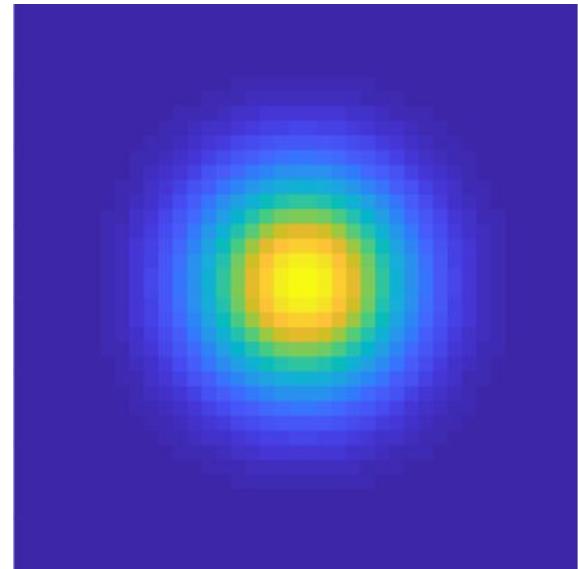
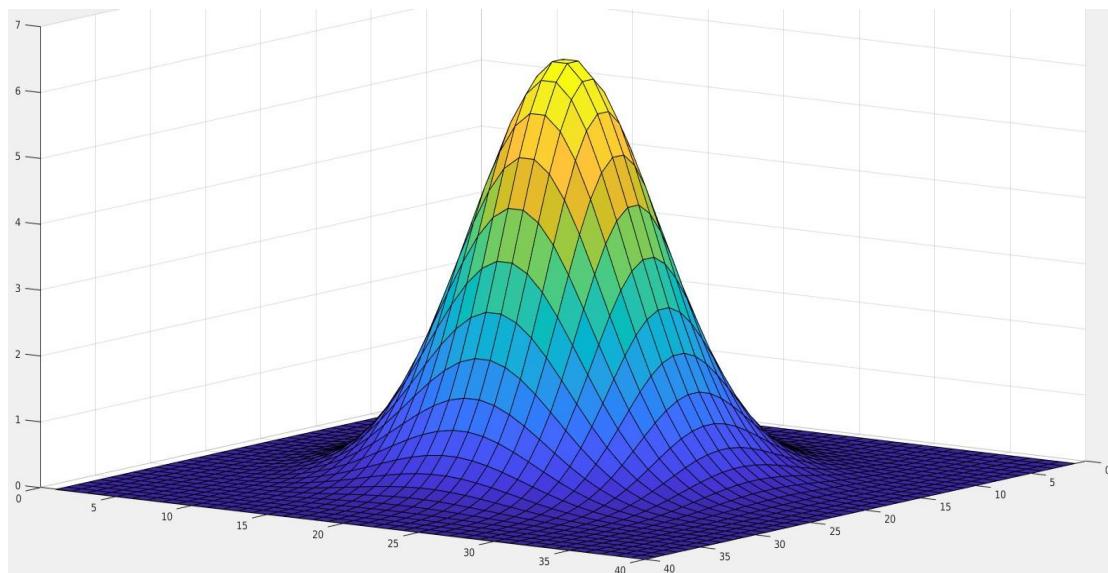
Ex2 - Filtro Sobel

- Usado na detecção de contornos
- Magnitude da gradiente



Ex2 - Filtro gaussiano

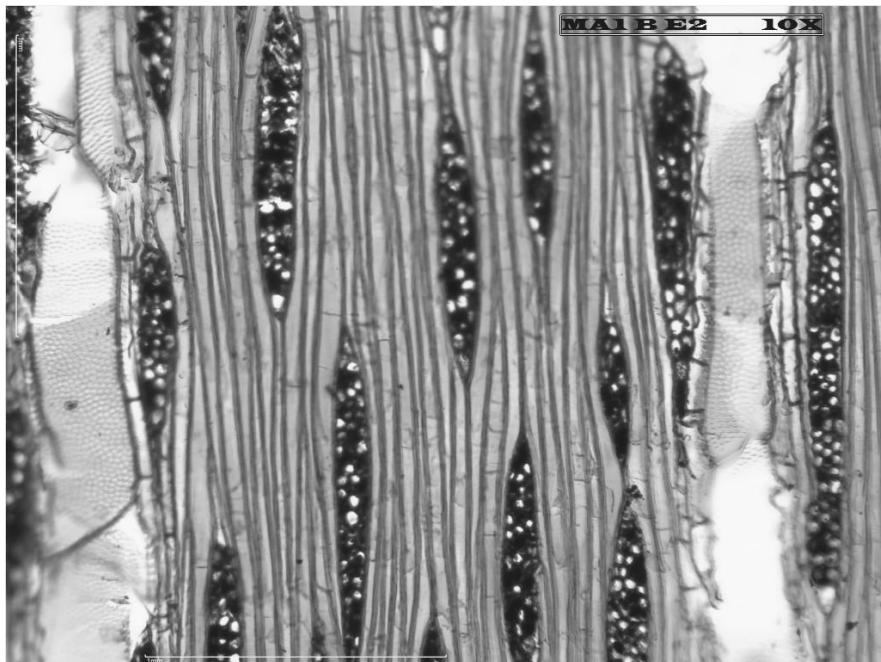
- Usado para suavizar uma imagem com o objetivo de reduzir o nível de ruído



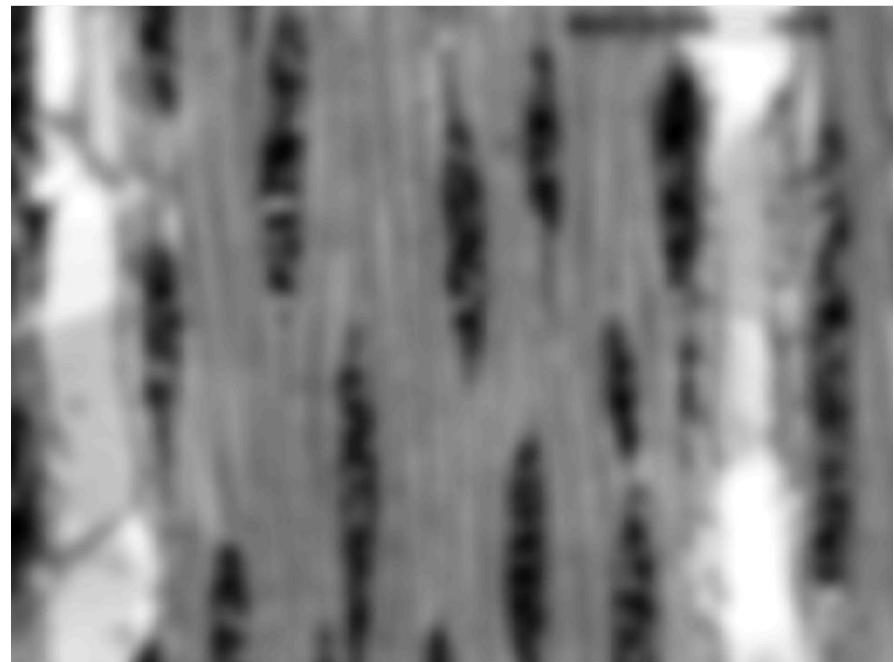
Ex2 - Filtro gaussiano

- Usado para suavizar uma imagem com o objetivo de reduzir o nível de ruído

Original



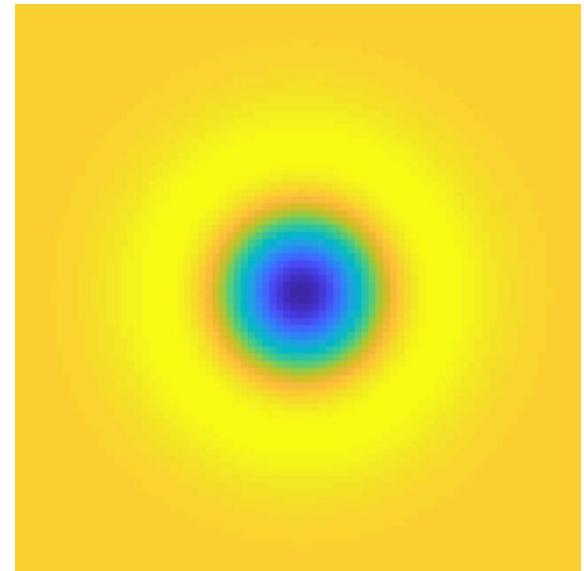
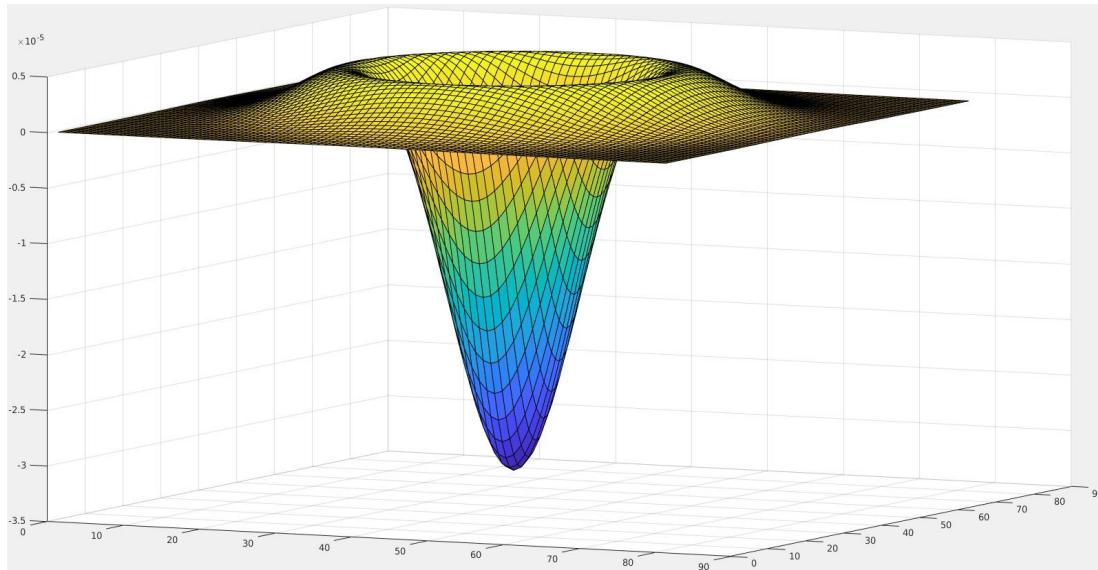
Sigma = 10



Matlab : `imgaussfilt`

Ex2 - Filtro laplaciano do gaussiano

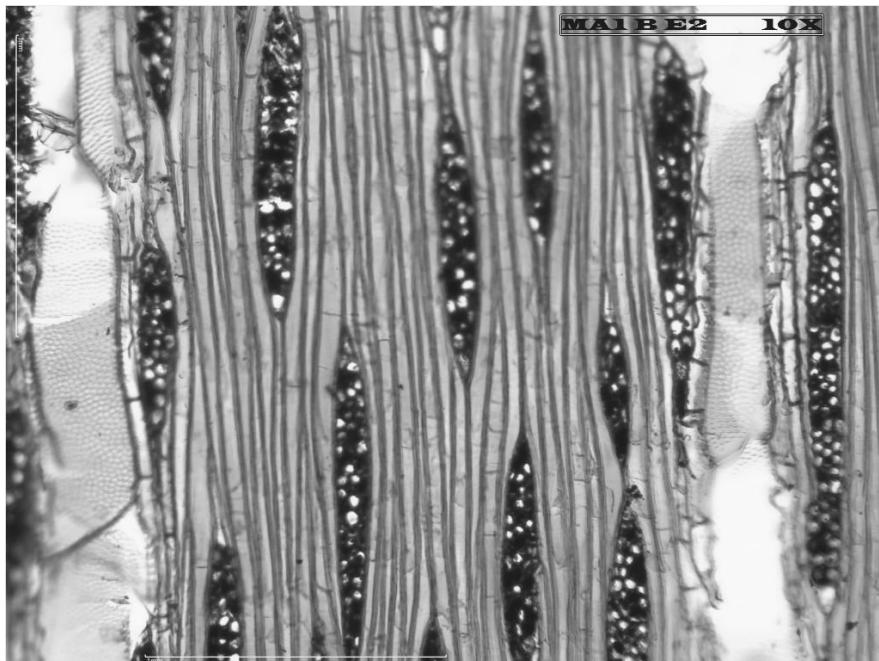
- É a mistura do filtro laplaciano com o filtro gaussiano.
- O filtro laplaciano é usado para aproximar a segunda derivada de uma imagem
- O objetivo é fazer com que o filtro laplaciano seja menos suscetível ao ruído.



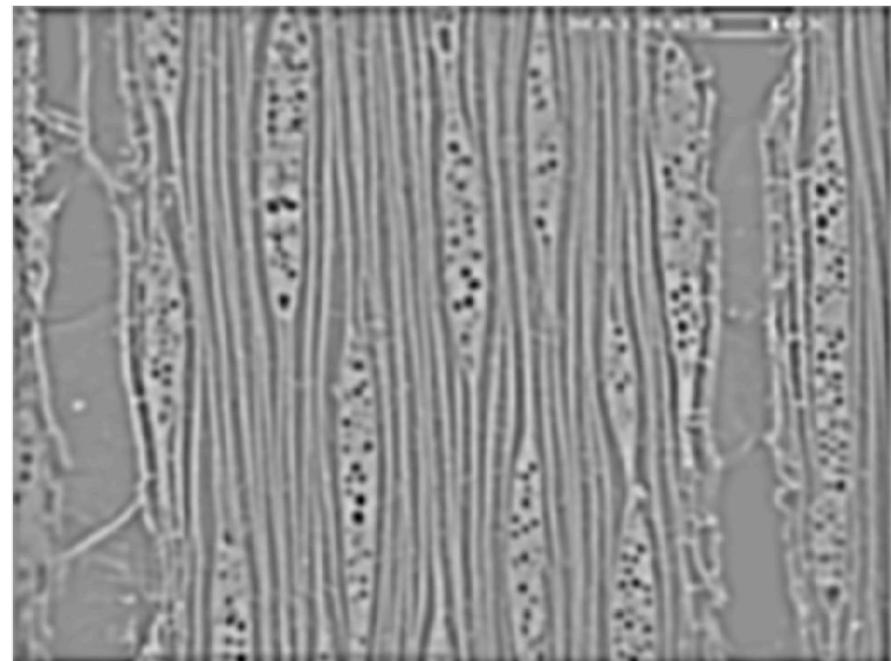
Ex2 - Filtro laplaciano do gaussiano

- É a mistura do filtro laplaciano usado para aproximar a segunda derivada de uma imagem com o filtro gaussiano.

Original



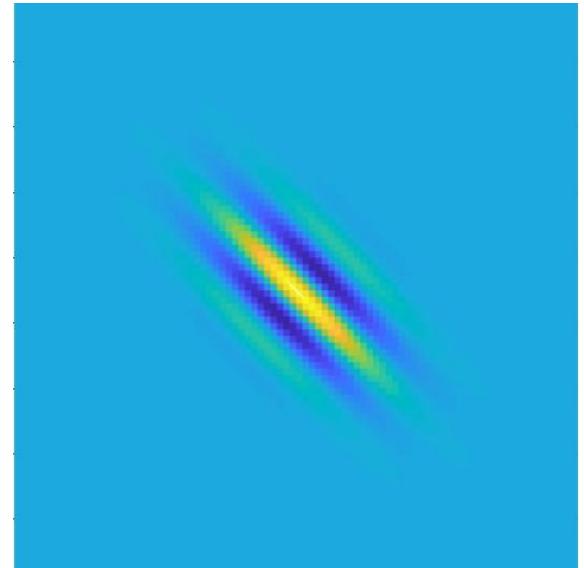
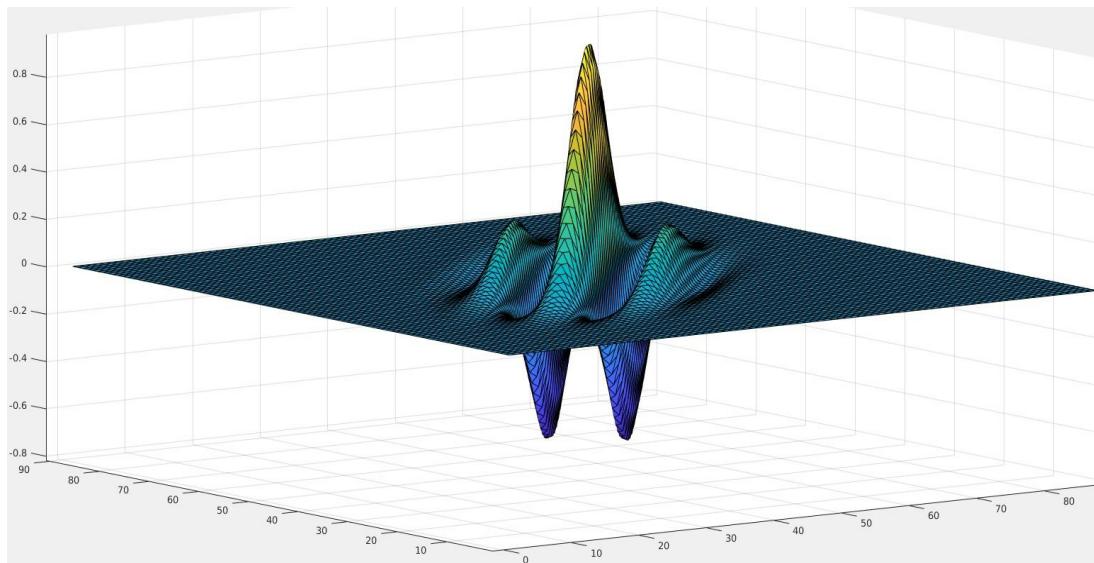
Sigma = 5



Matlab: fspecial, imfilter

Ex2 - Filtros de Gabor

- É um filtro composto que tem parte: (i) gaussiana, (ii) senoidal
- Também tem uma parte real e uma complexa
- Tem vários parâmetros, dois deles são os mais importantes: (i) comprimento de onda, (ii) orientação (ângulo)



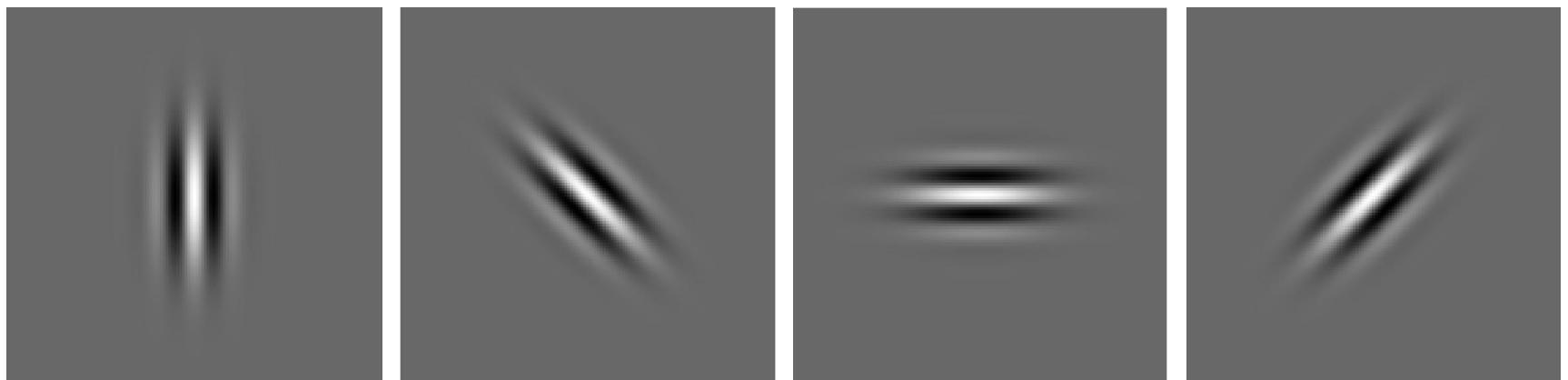
Ex2 - Filtros de Gabor: Comprimento de onda

- $\text{Lambda} = 5, 8, 12, 15$ $\text{Theta} = 0$



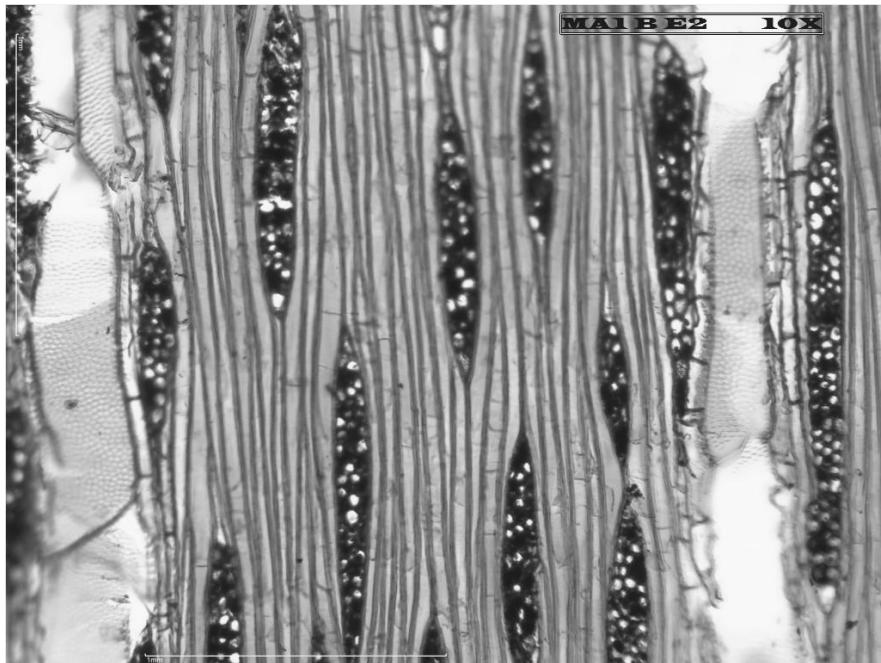
Ex2 - Filtros de Gabor: Orientação

- $\text{Lambda} = 15$ $\text{Theta} = 0, 45(\pi/4), 90 (\pi/2), 135 (3\pi/4)$

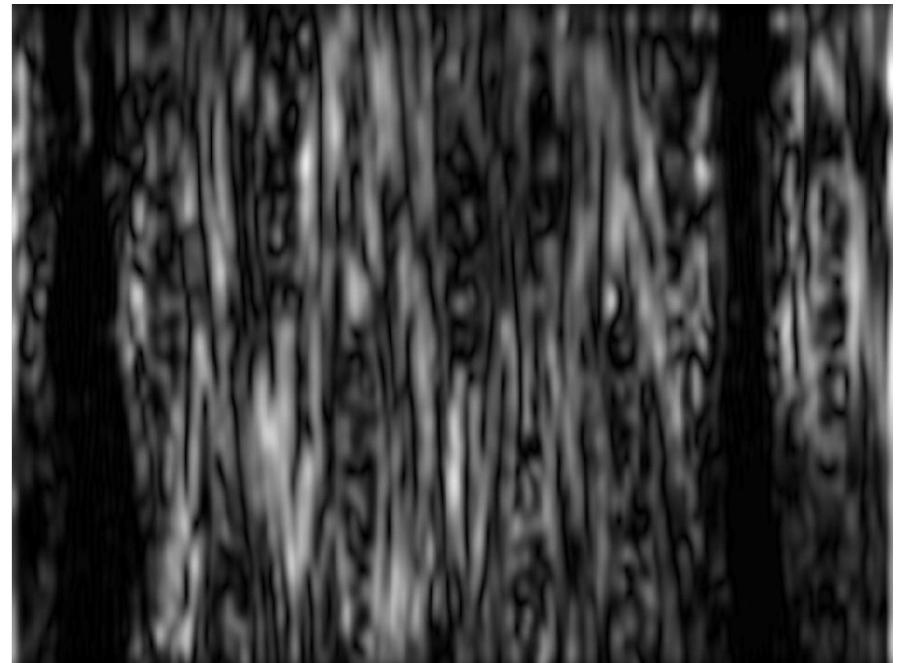


Ex2 - Filtros de Gabor

Original



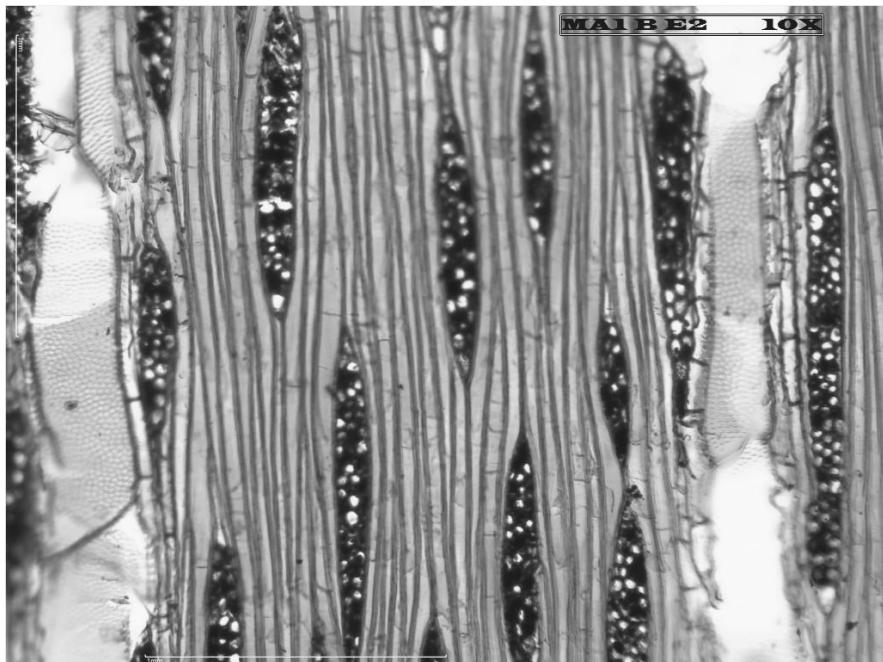
Lambda = 10, theta = 0



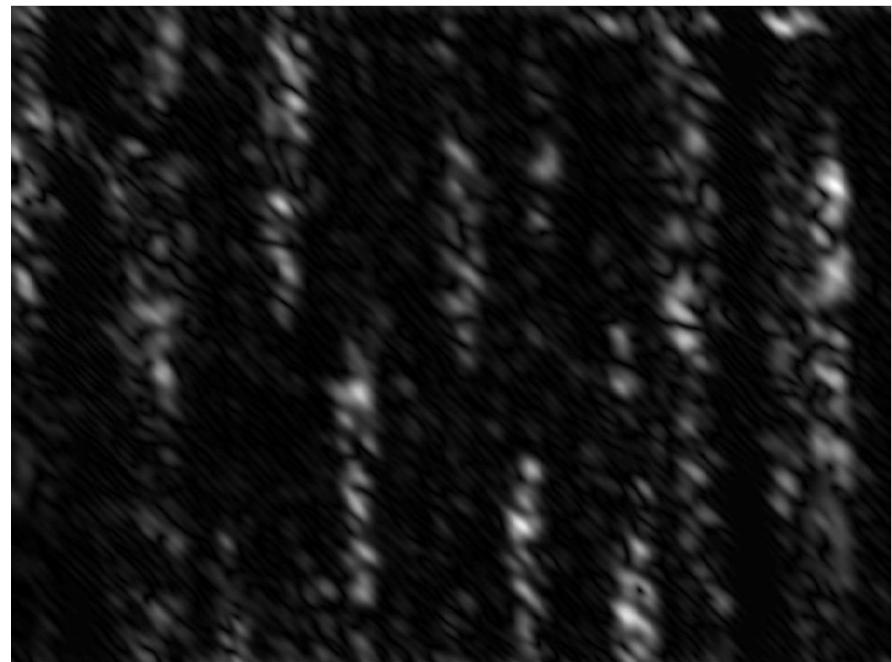
Matlab : imgaborfilt

Ex2 - Filtros de Gabor

Original



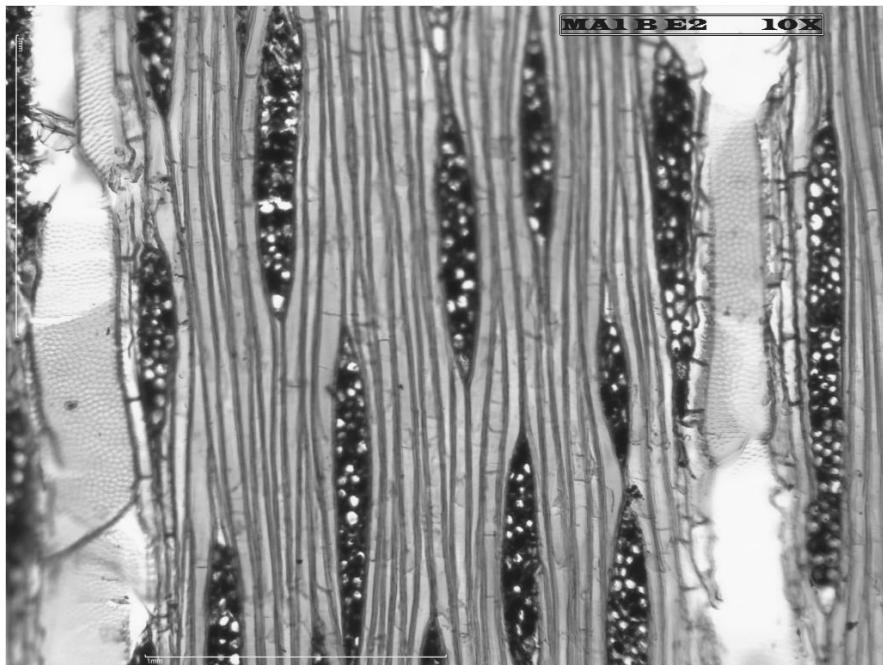
Lambda = 10, theta = pi/4



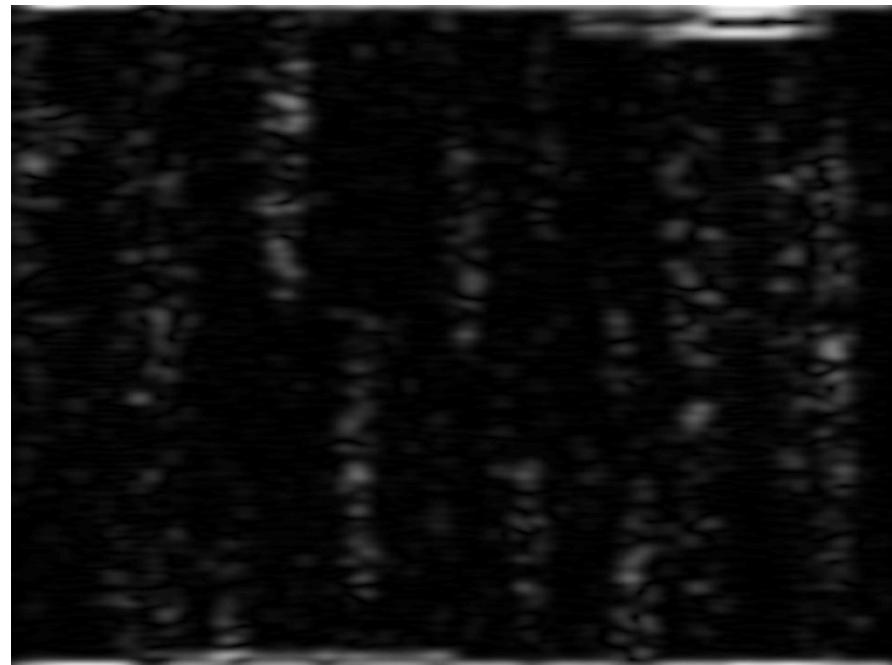
Matlab : imgaborfilt

Ex2 - Filtros de Gabor

Original

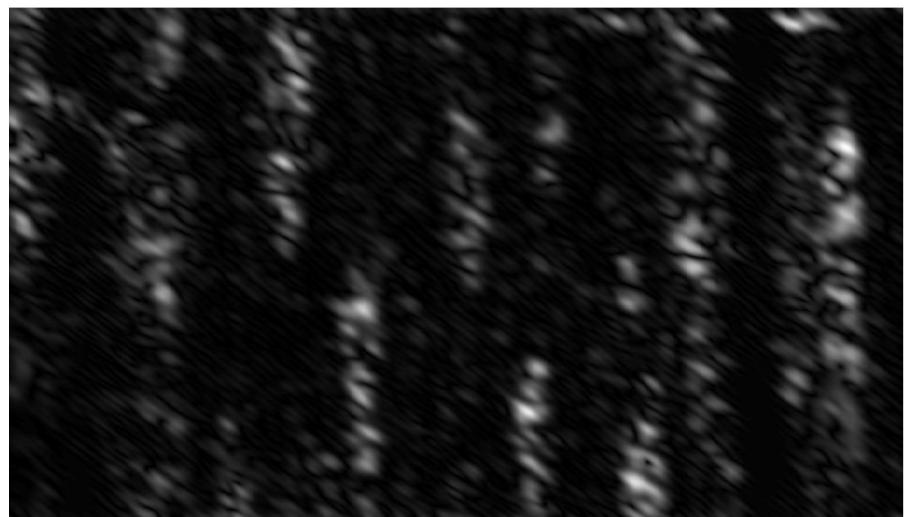
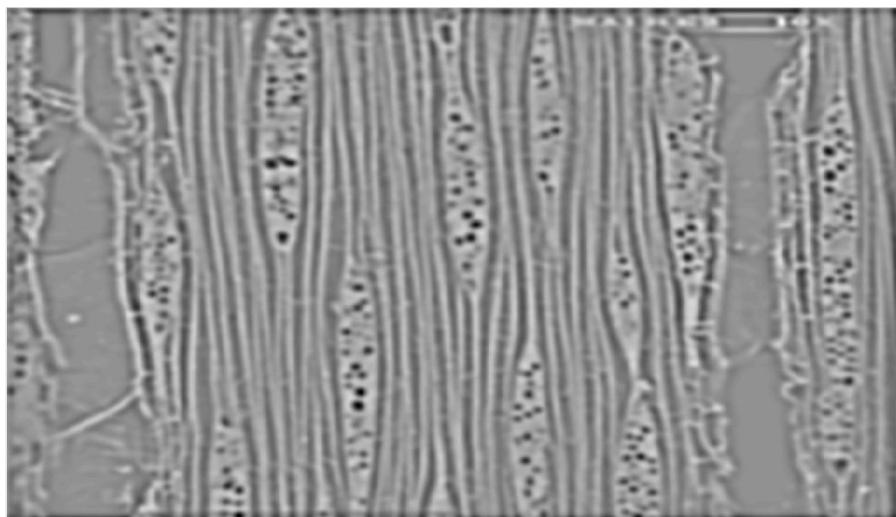
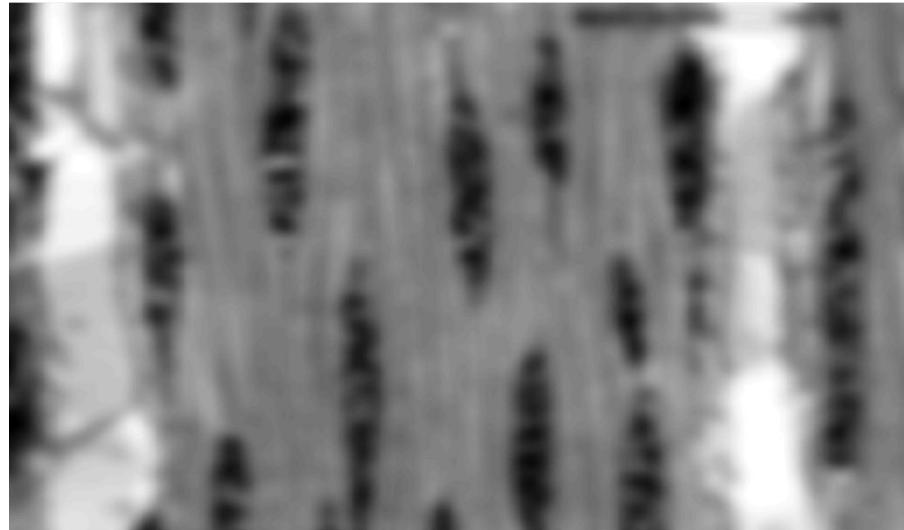
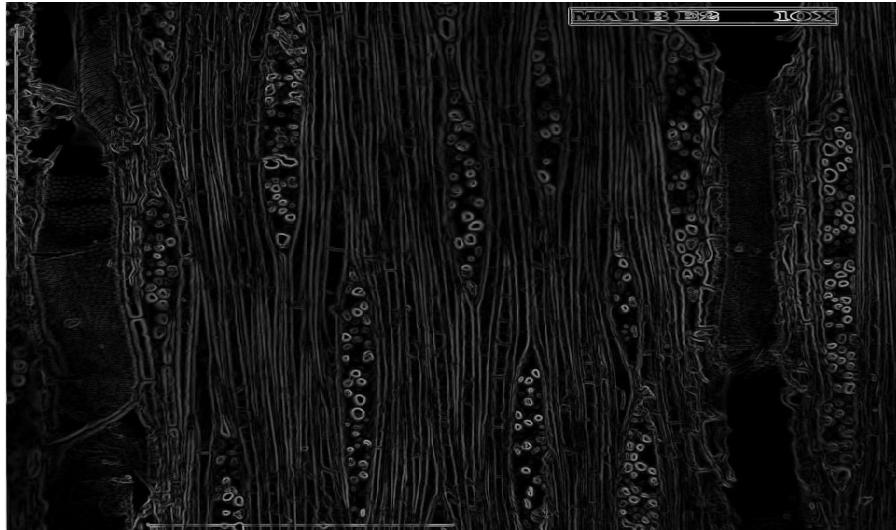


Lambda = 10, theta = pi/2



Matlab : imgaborfilt

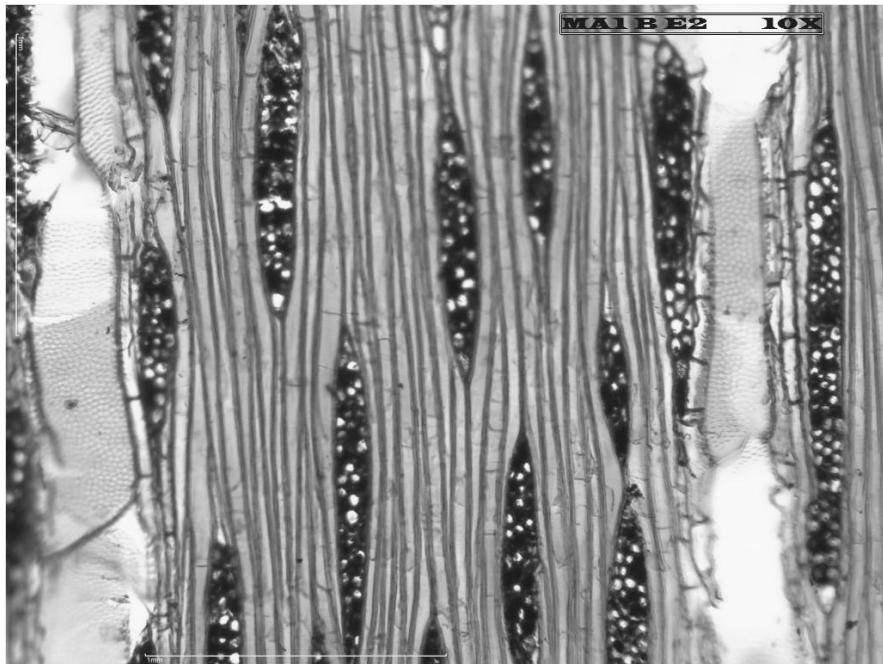
Ex2 - Qual ficou melhor?



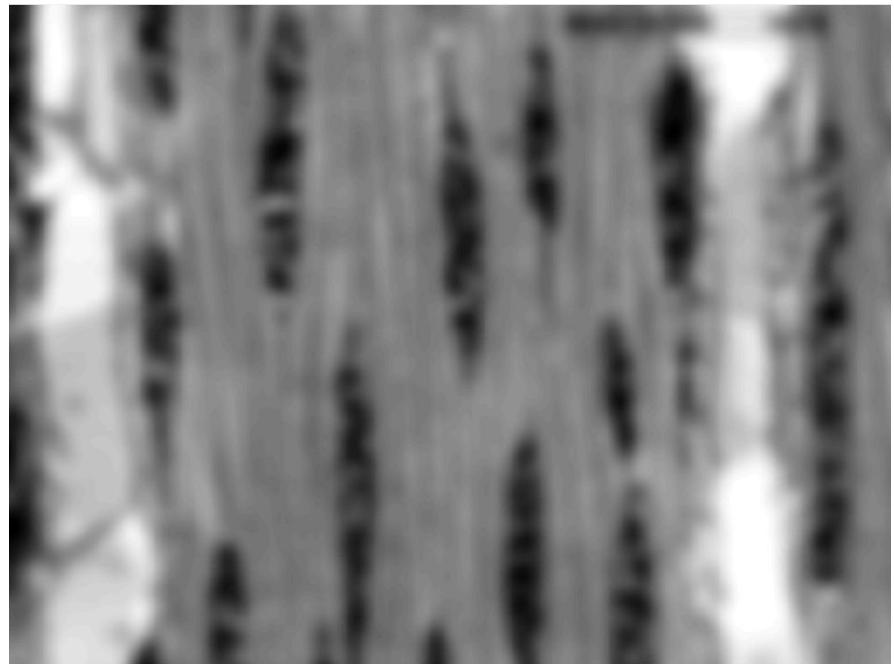
Ex2 - Limiarização em imagem suavizada

Usando filtro de Gauss

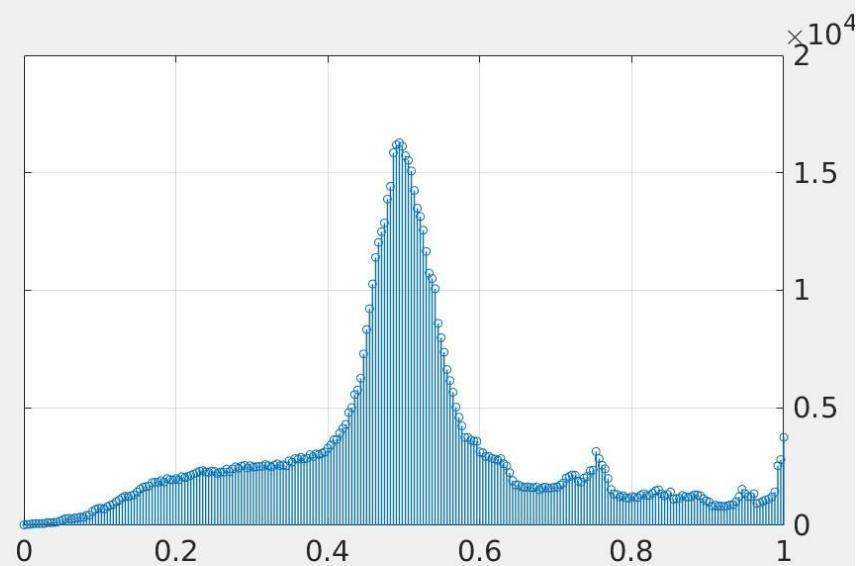
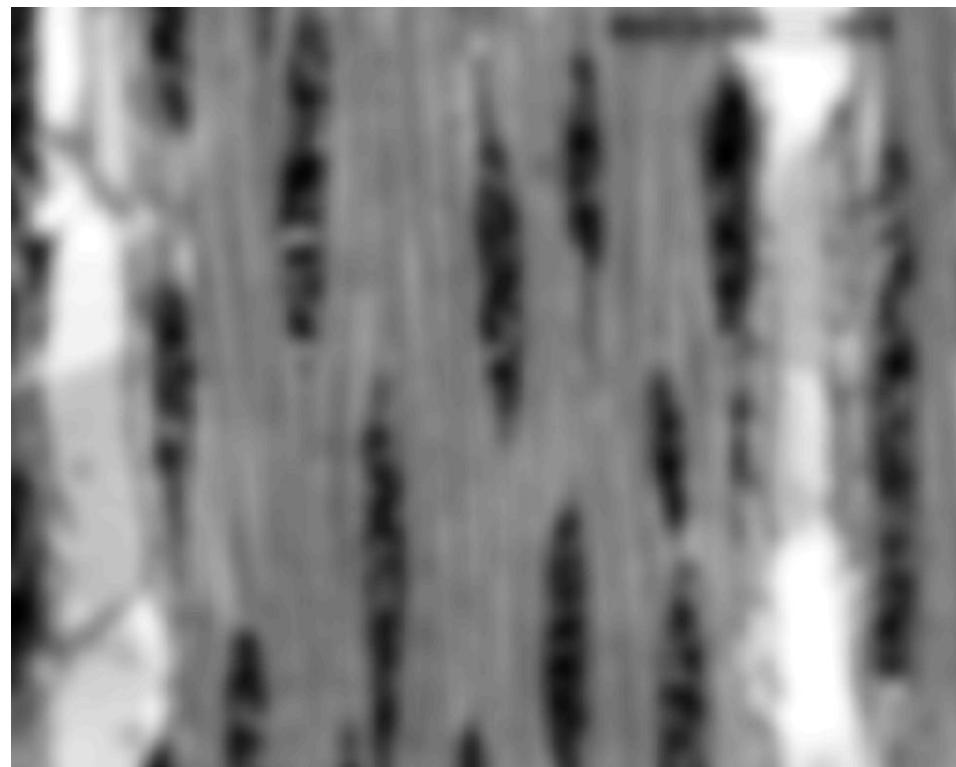
Original



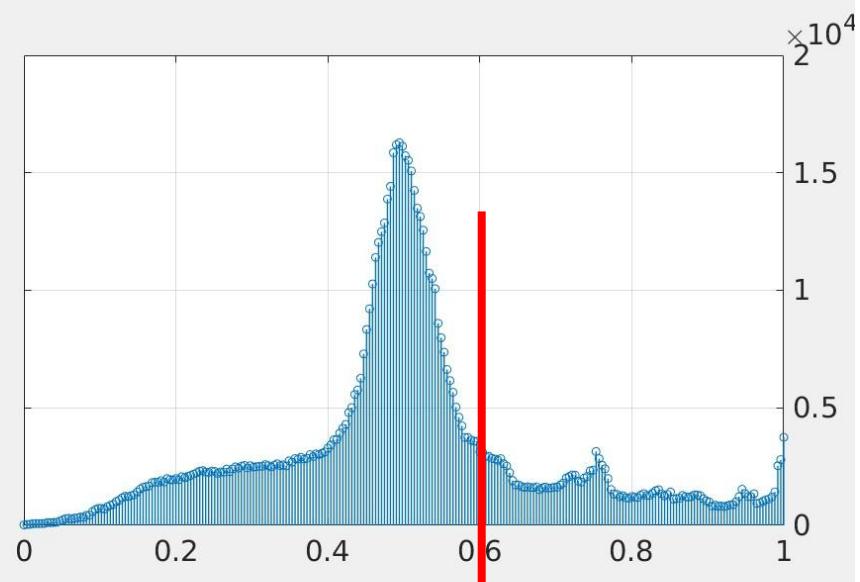
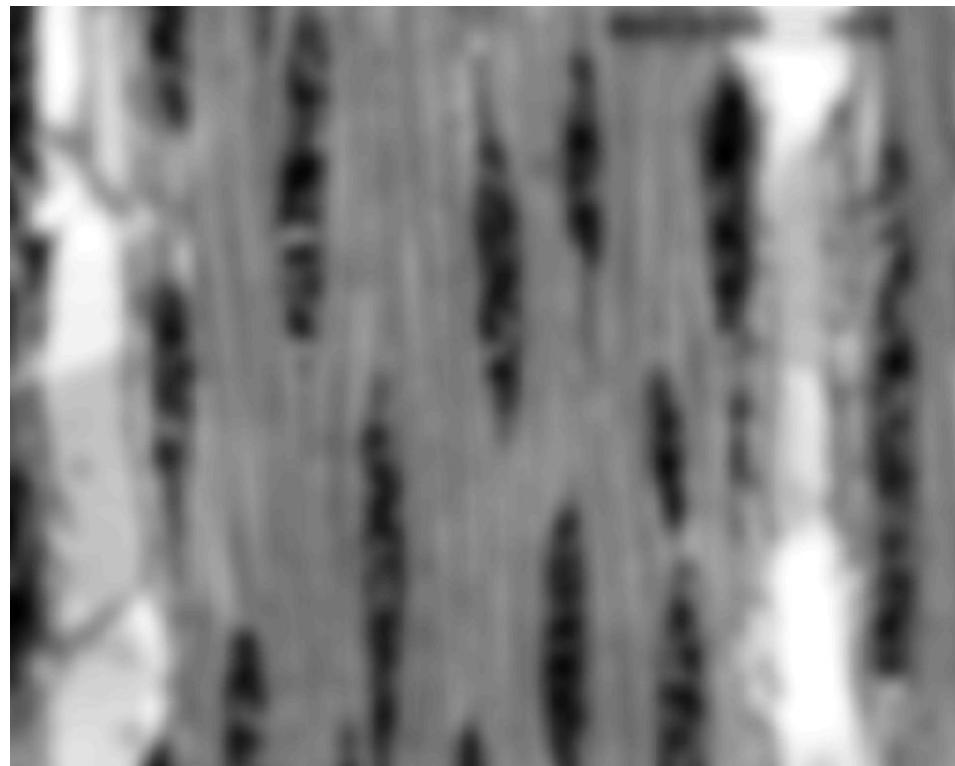
Sigma = 10



Ex2 - Limiarização em imagem suavizada

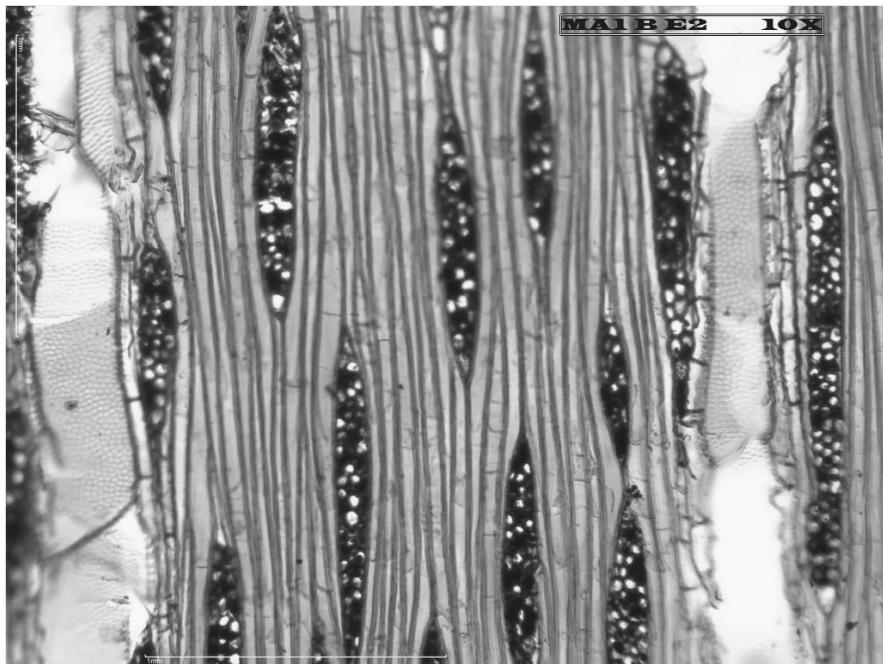


Ex2 - Limiarização em imagem suavizada



Ex2 - Limiarização em imagem suavizada

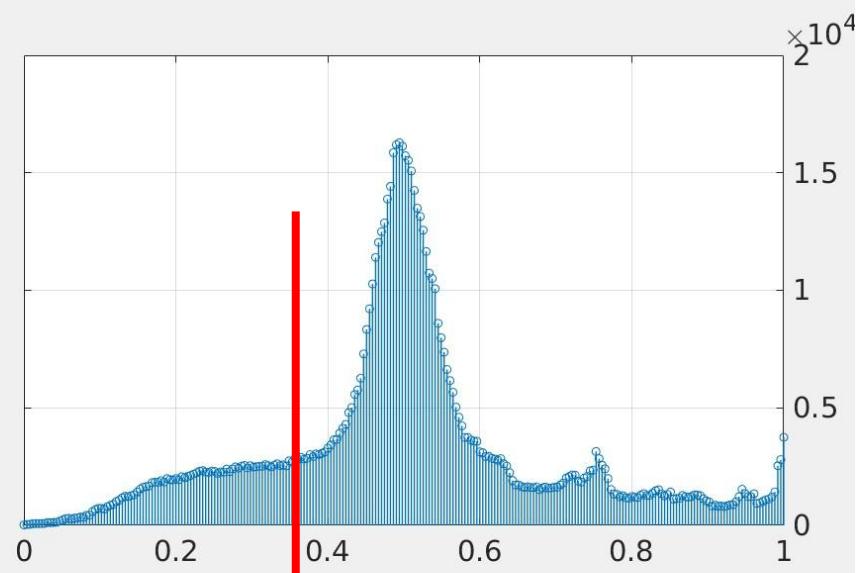
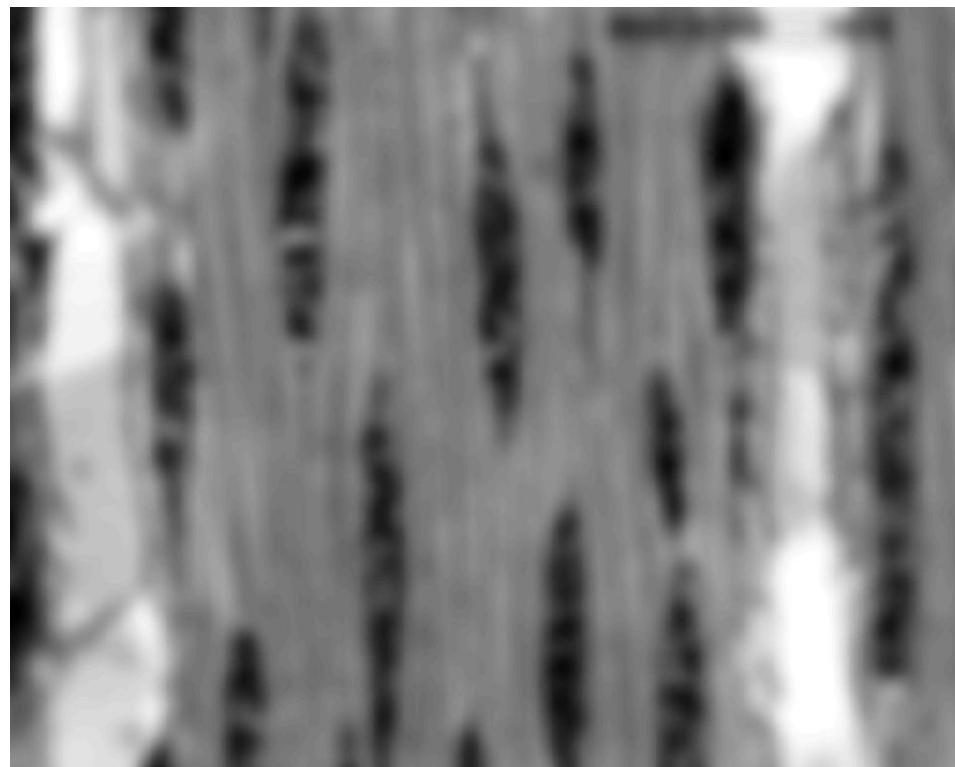
Original



Binarizada - limiar = 0.6

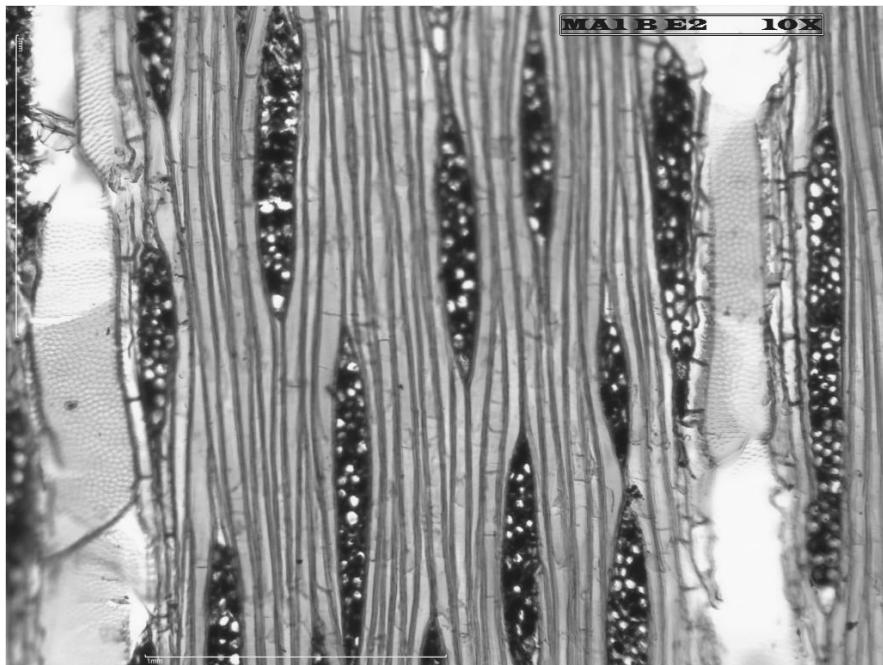


Ex2 - Limiarização em imagem suavizada



Ex2 - Limiarização em imagem suavizada

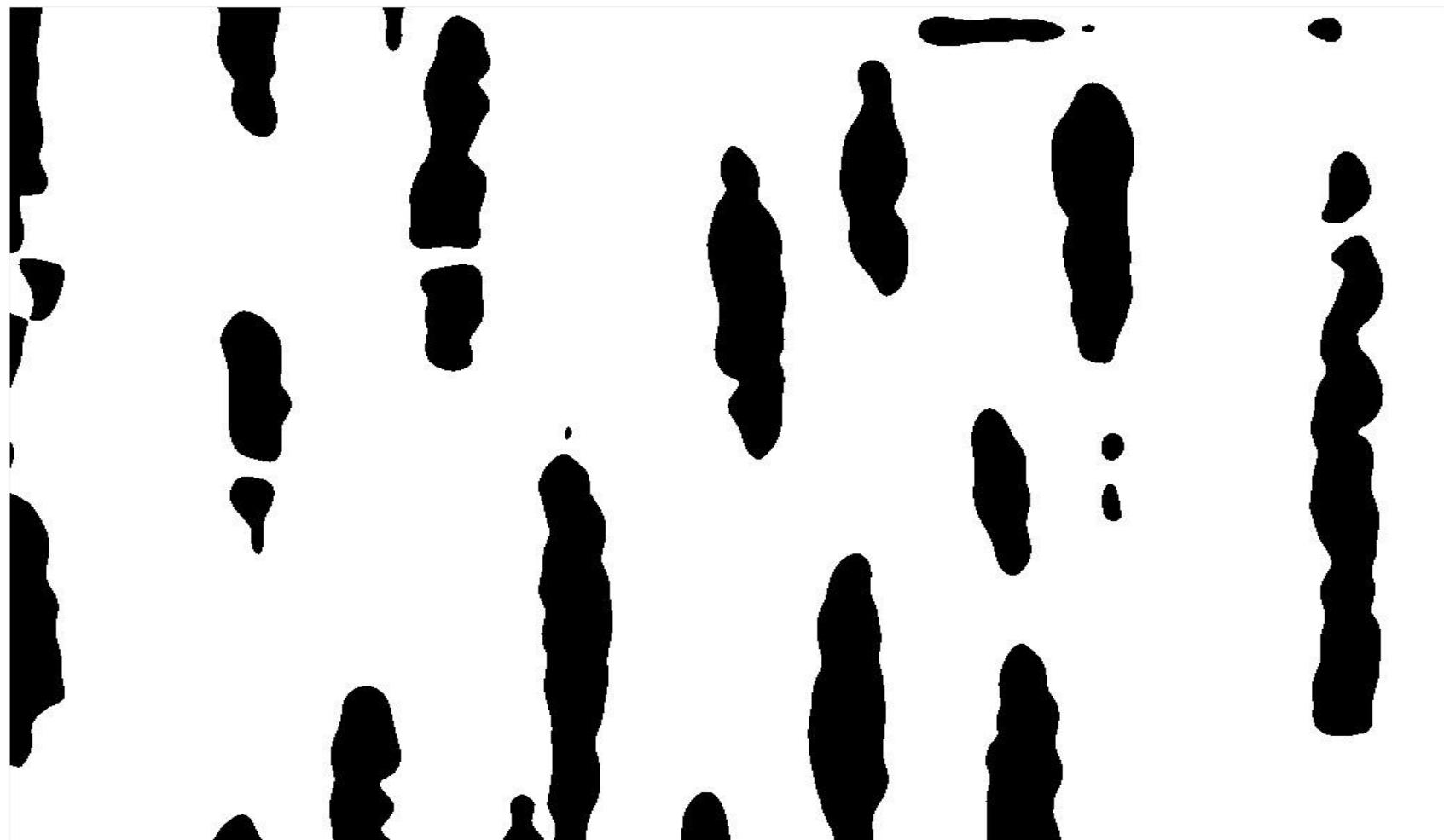
Original



Binarizada - limiar = 0.3



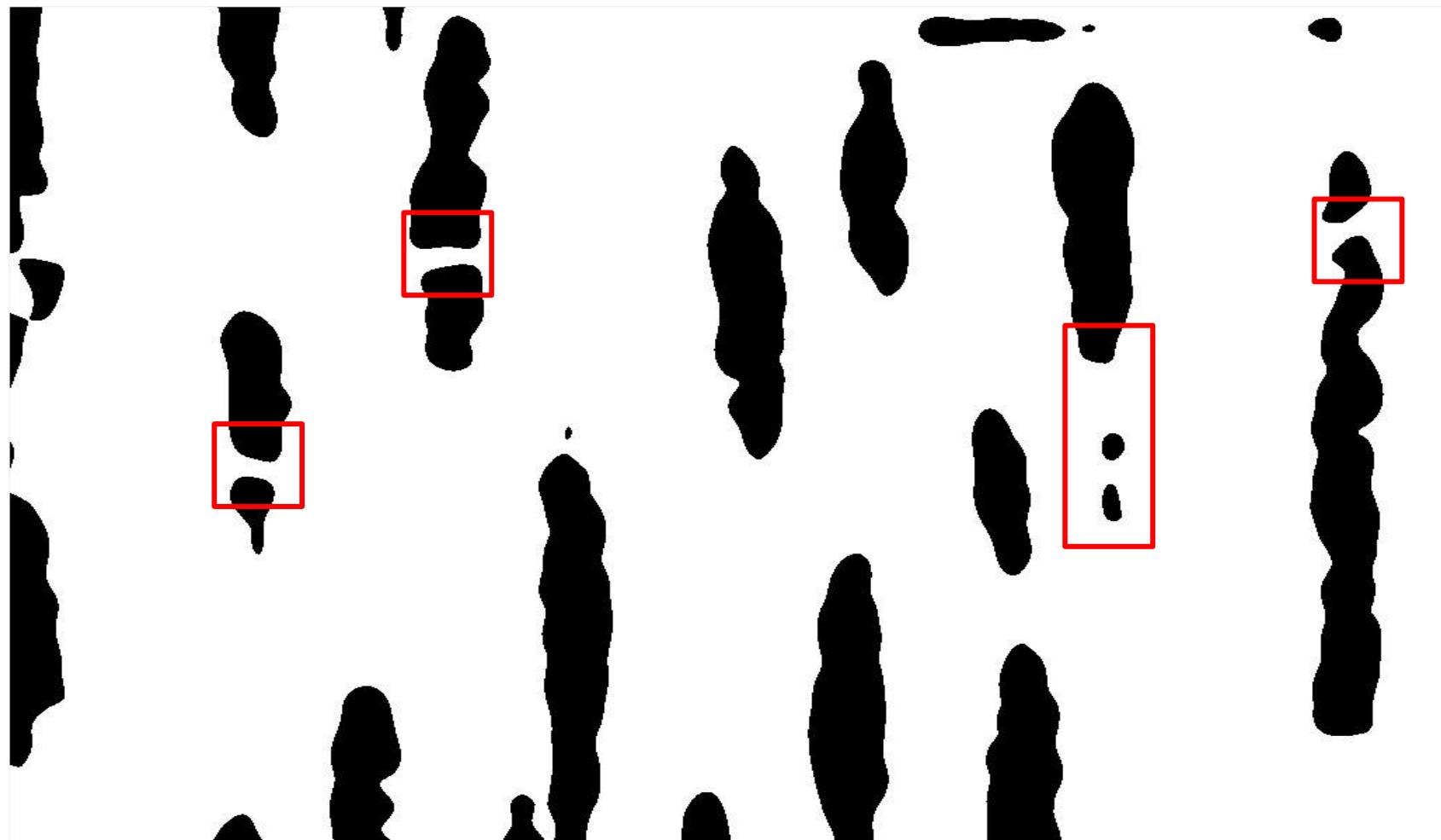
Ex2 - Limiarização em imagem suavizada: resultado



Ex2 - Limiarização em imagem suavizada: problemas



Ex2 - Limiarização em imagem suavizada: problemas



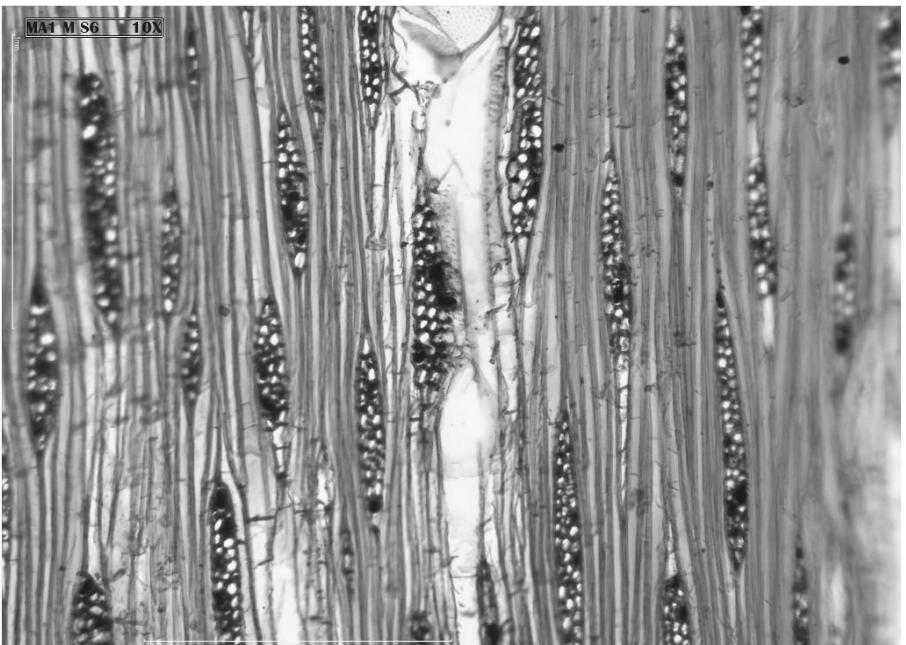
Ex2 - Limiarização em imagem suavizada: problemas

É muito provável que este método não funcione com todas as imagens

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Original



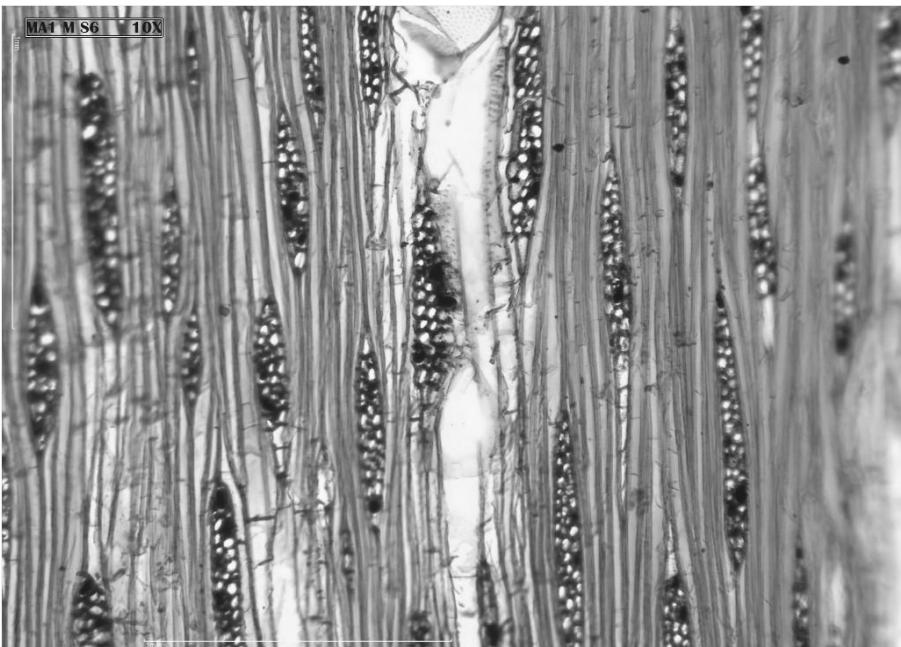
Sigma = 10



Ex2 - Limiarização em imagem suavizada: problemas

É muito provável que este método não funcione com todas as imagens

Original

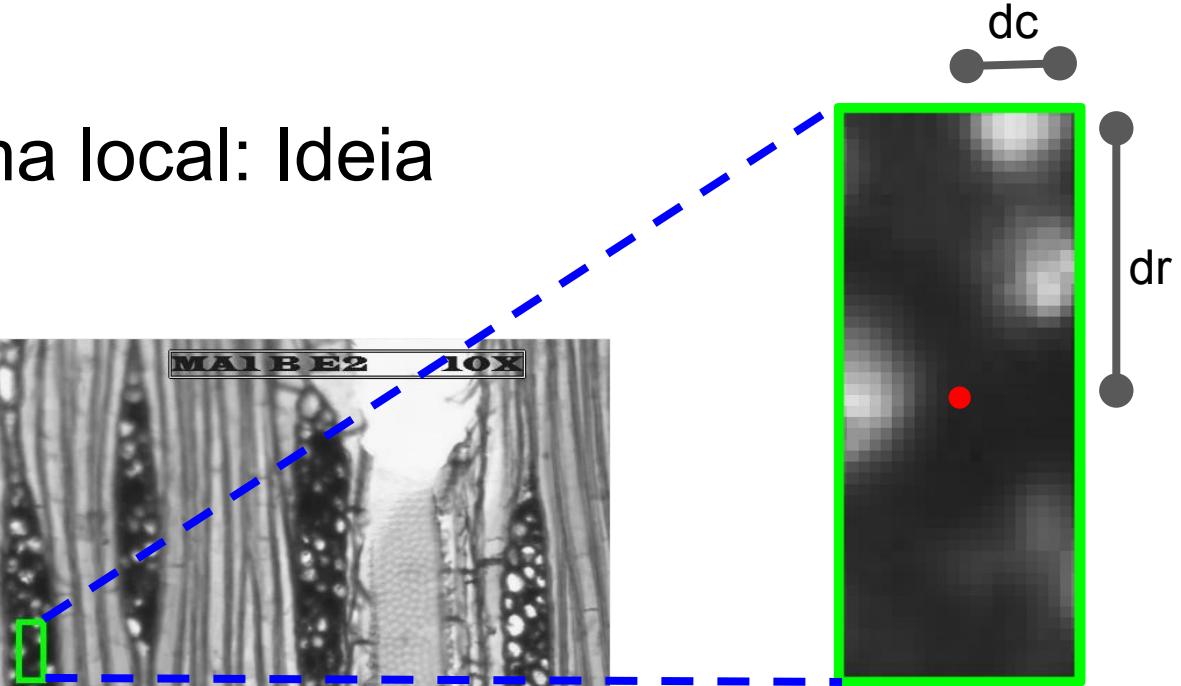
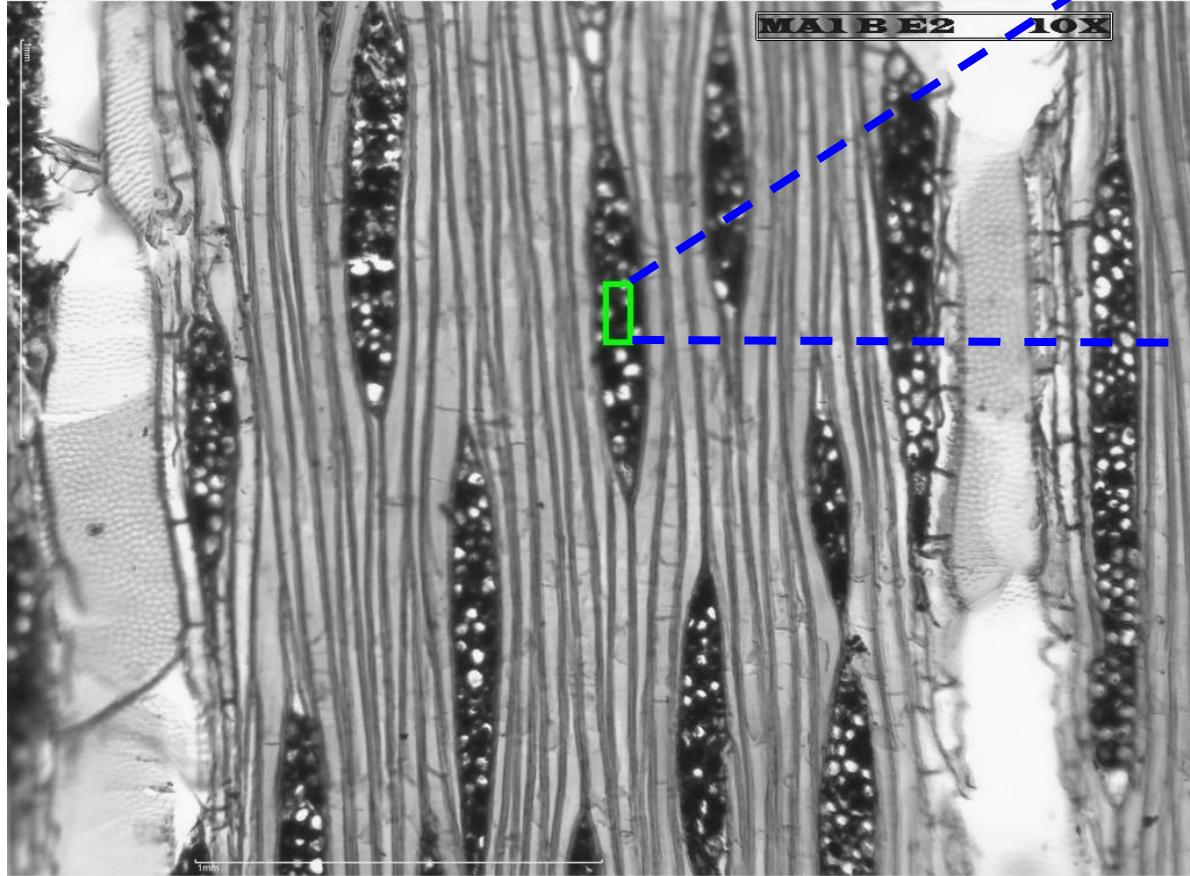


Sigma = 10

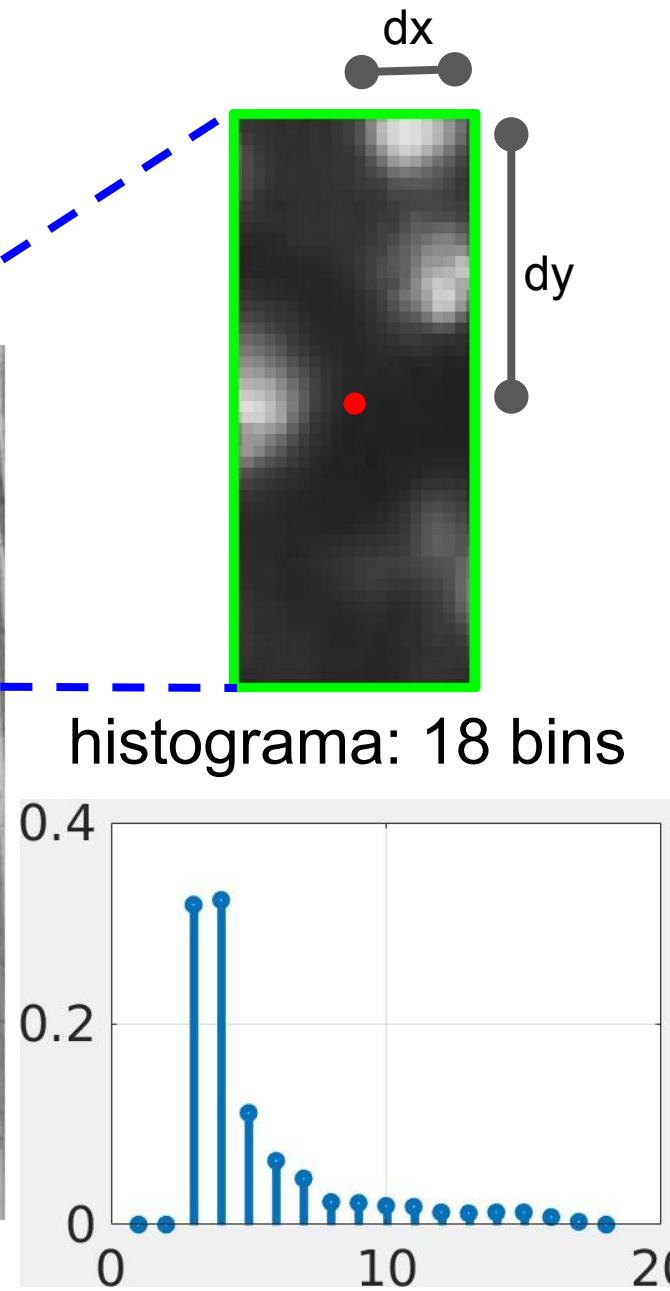
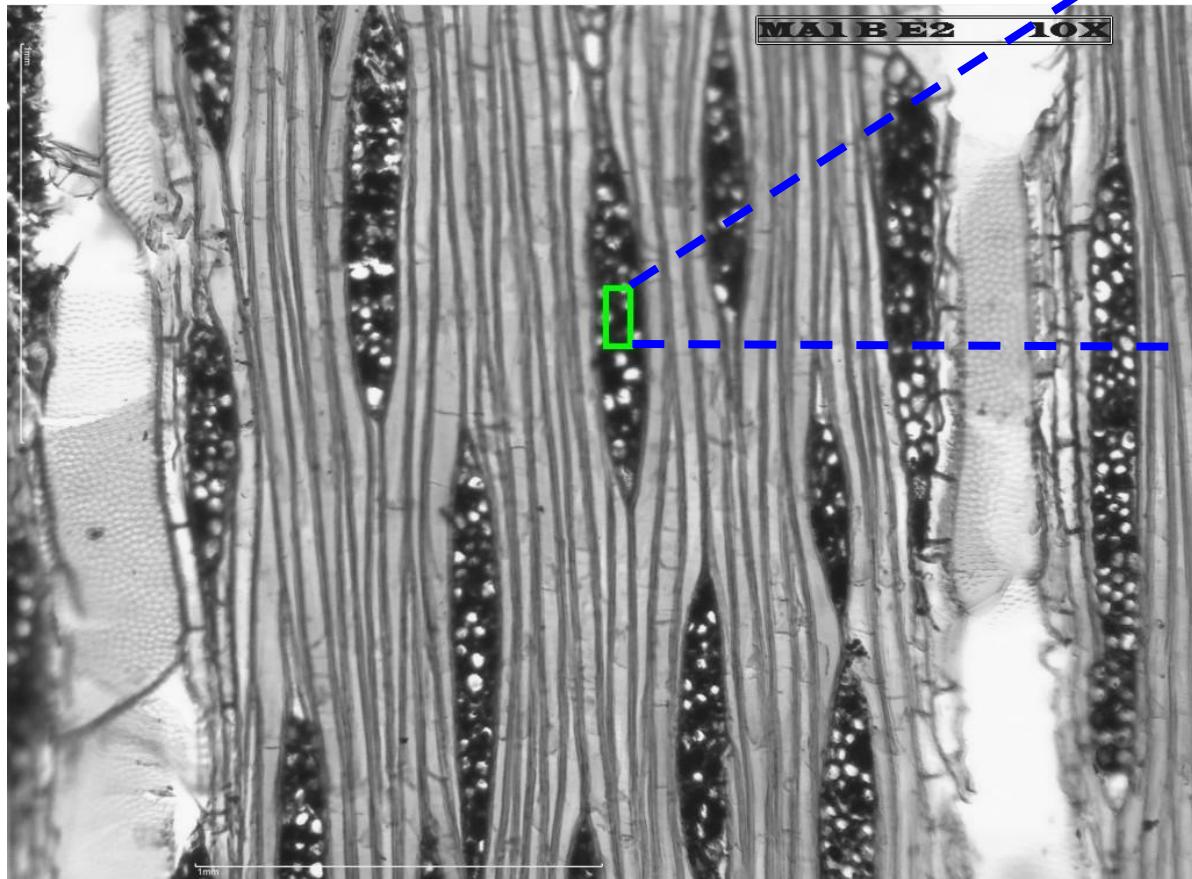


Ex3.m

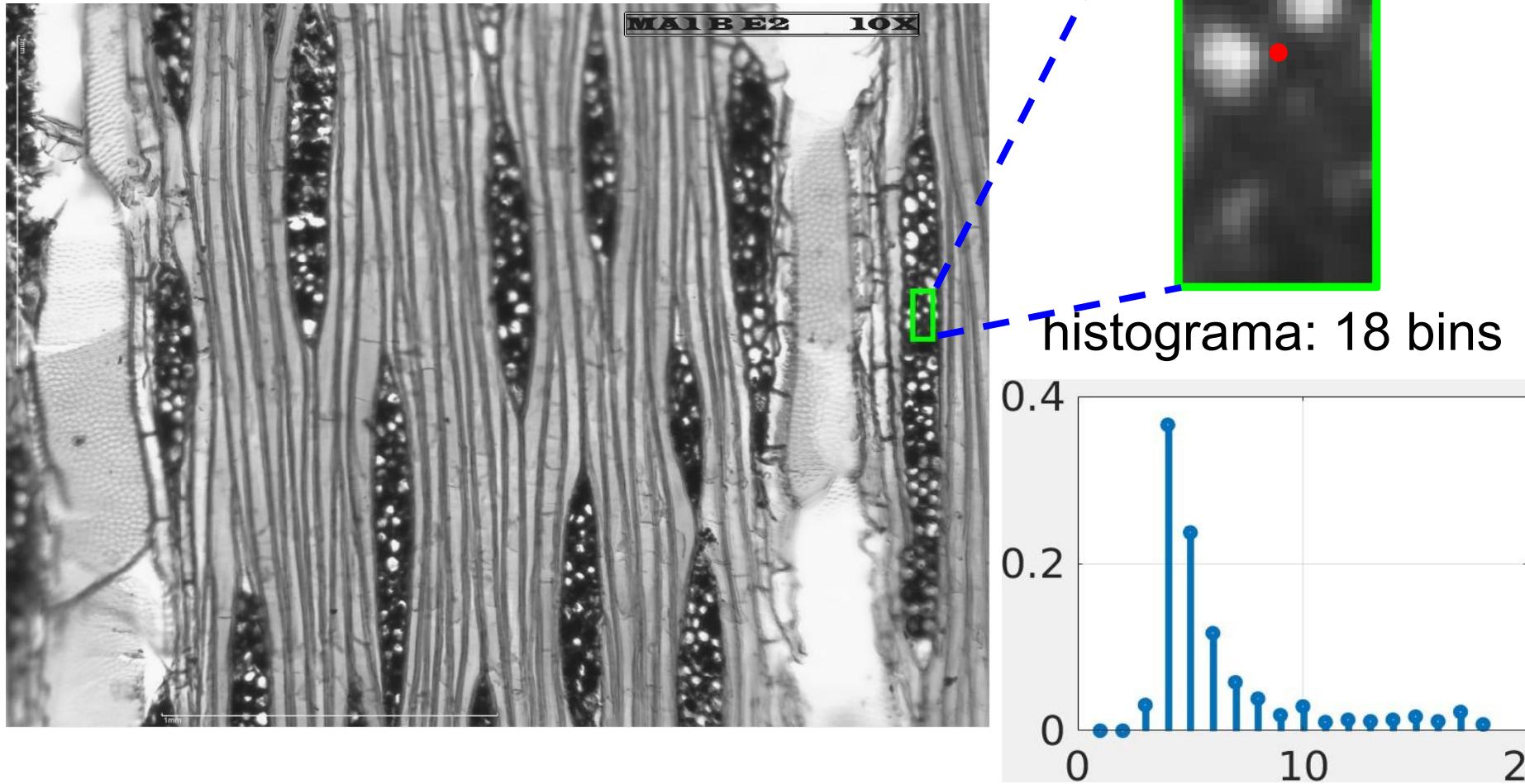
Ex3 - Histograma local: Ideia



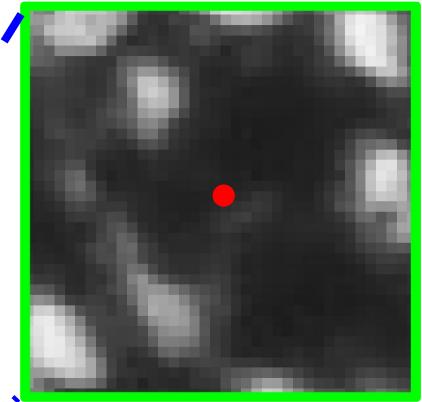
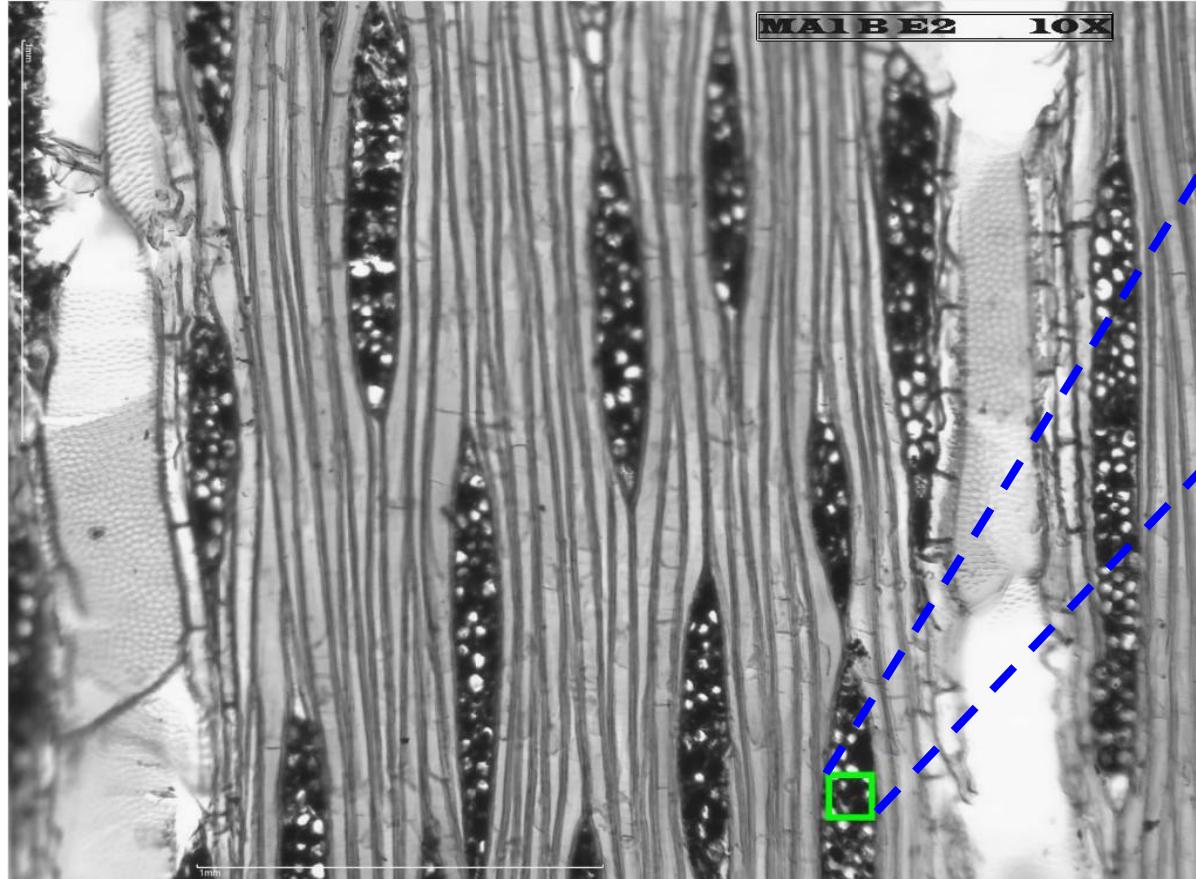
Ex3 - Histograma local: Ideia



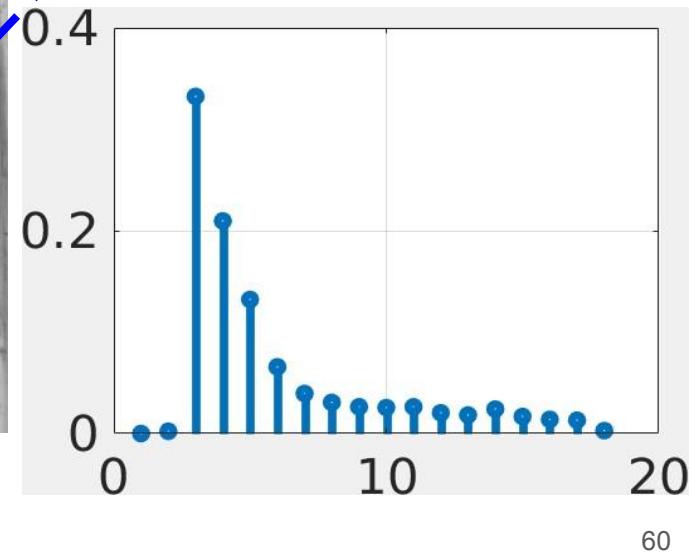
Ex3 - Histograma local: Ideia



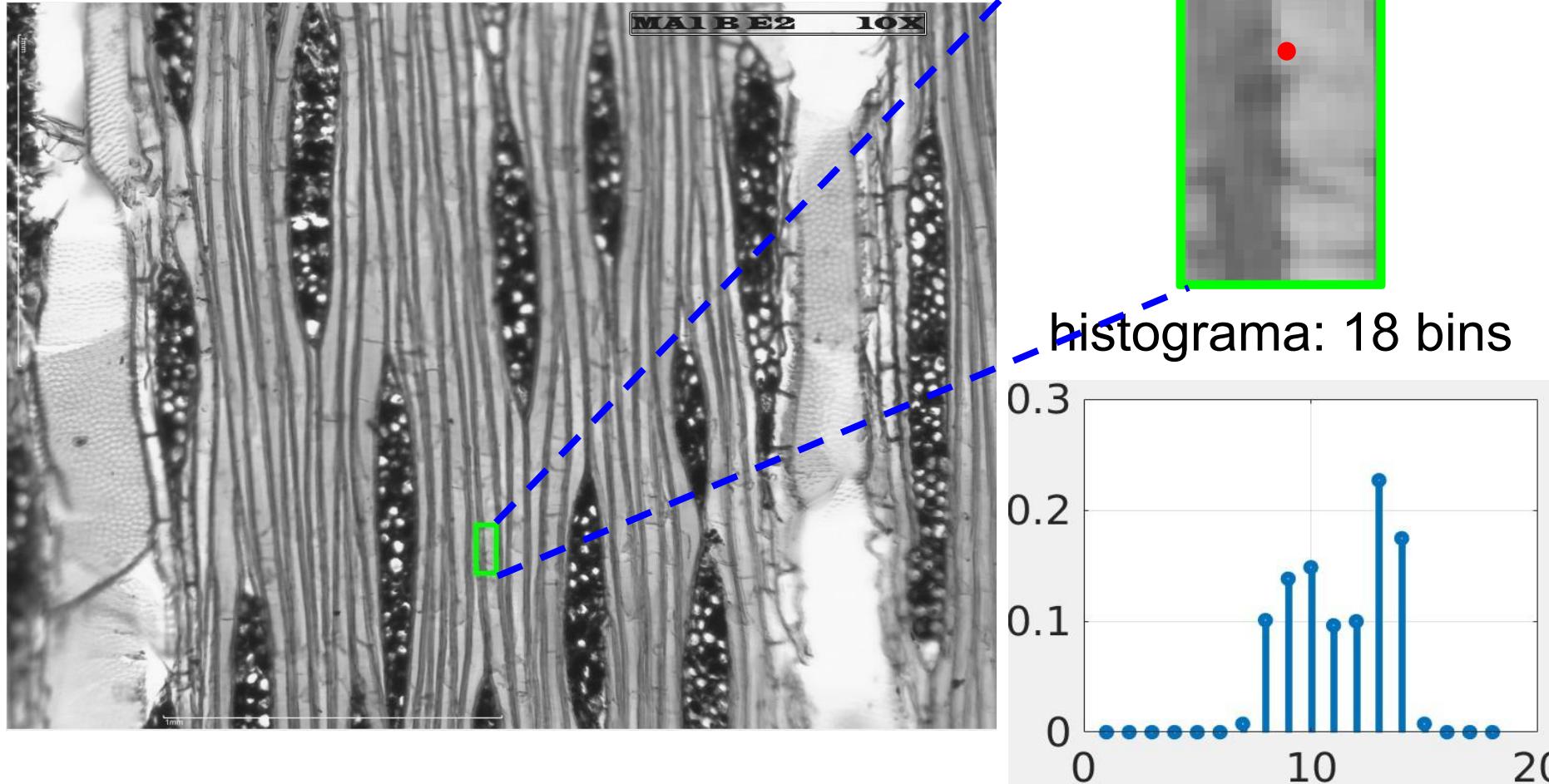
Ex3 - Histograma local: Ideia



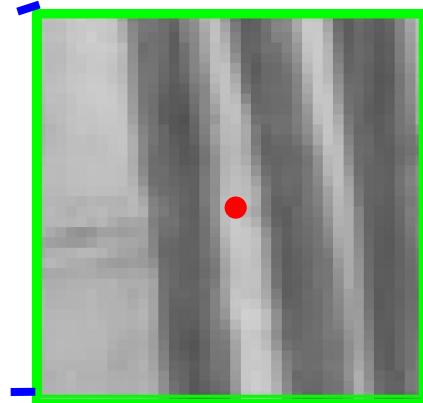
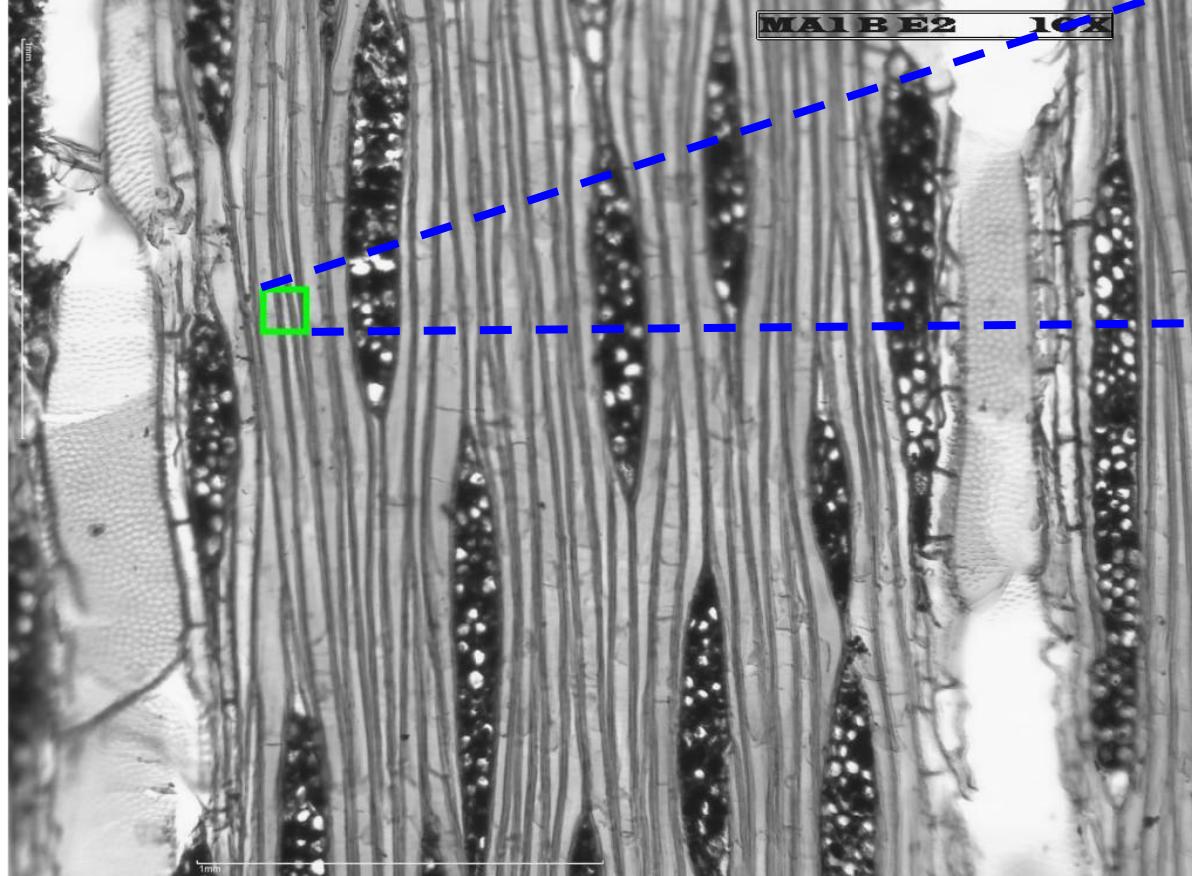
histograma: 18 bins



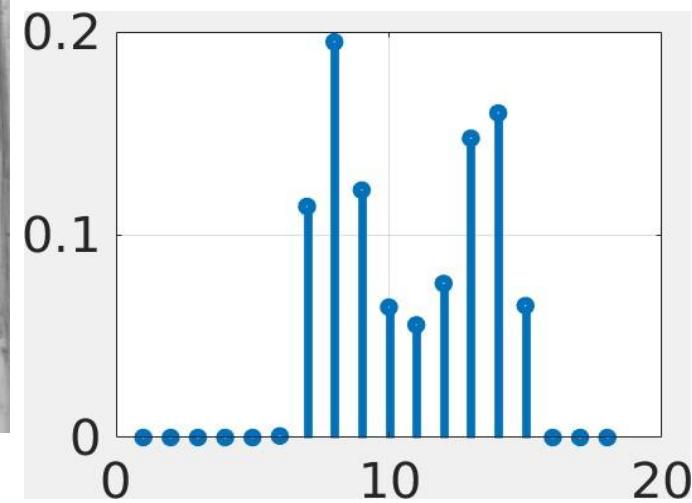
Ex3 - Histograma local: Ideia



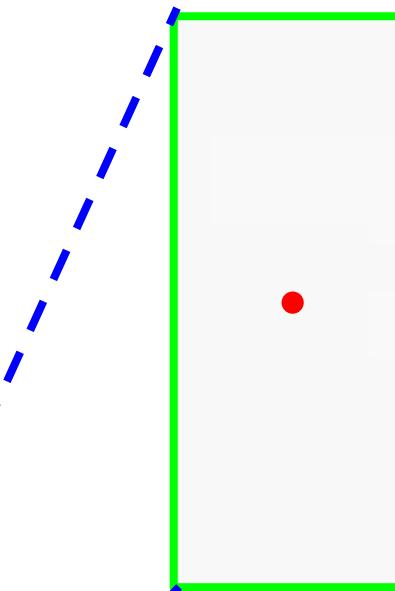
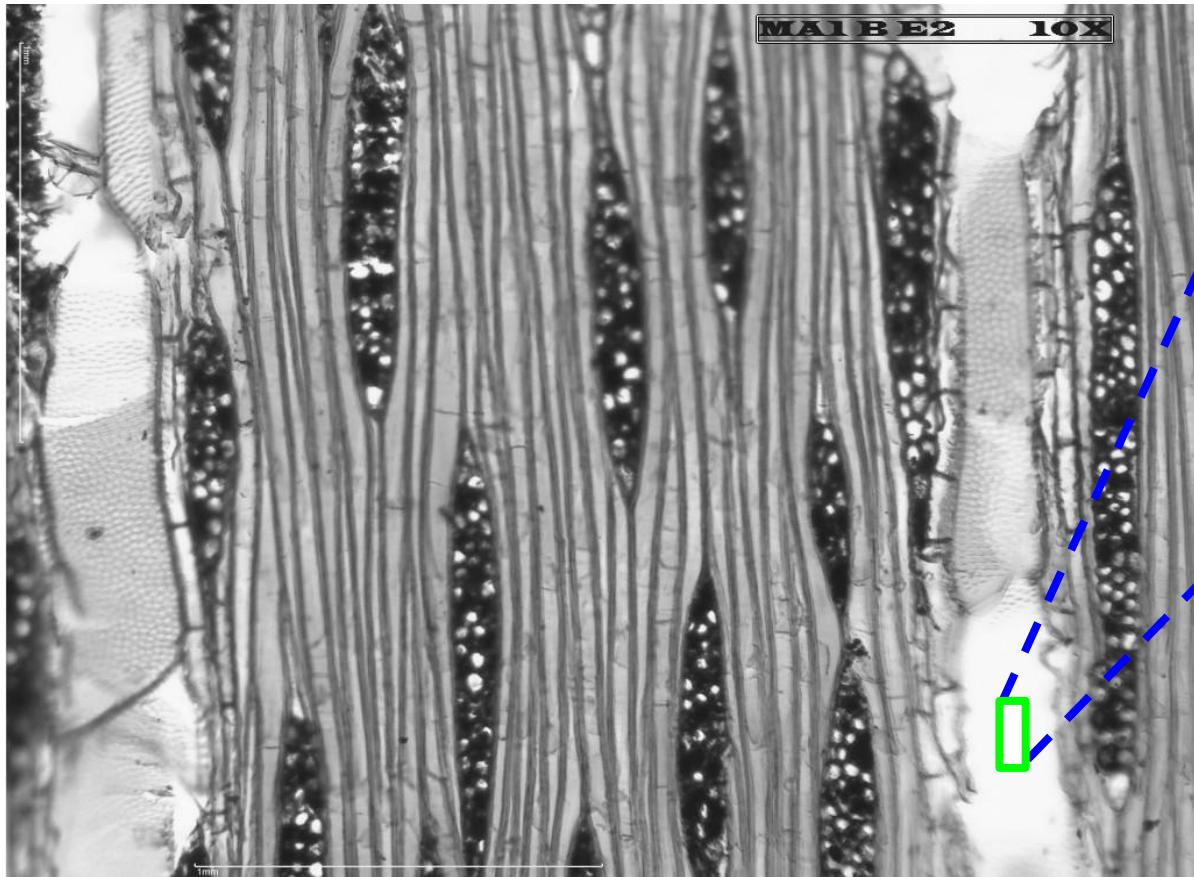
Ex3 - Histograma local: Ideia



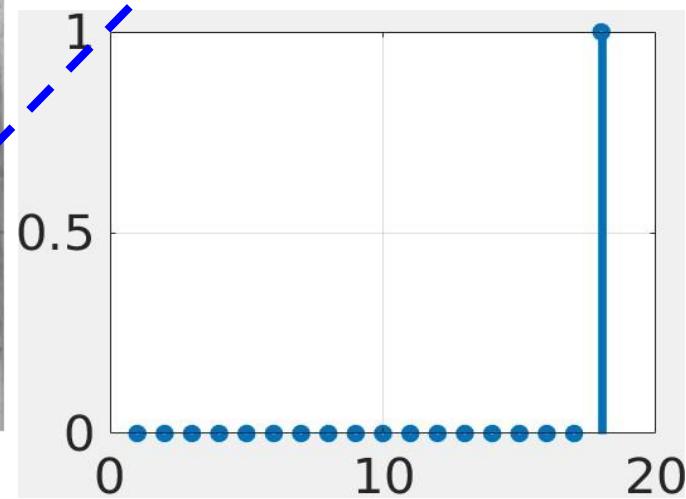
histograma: 18 bins



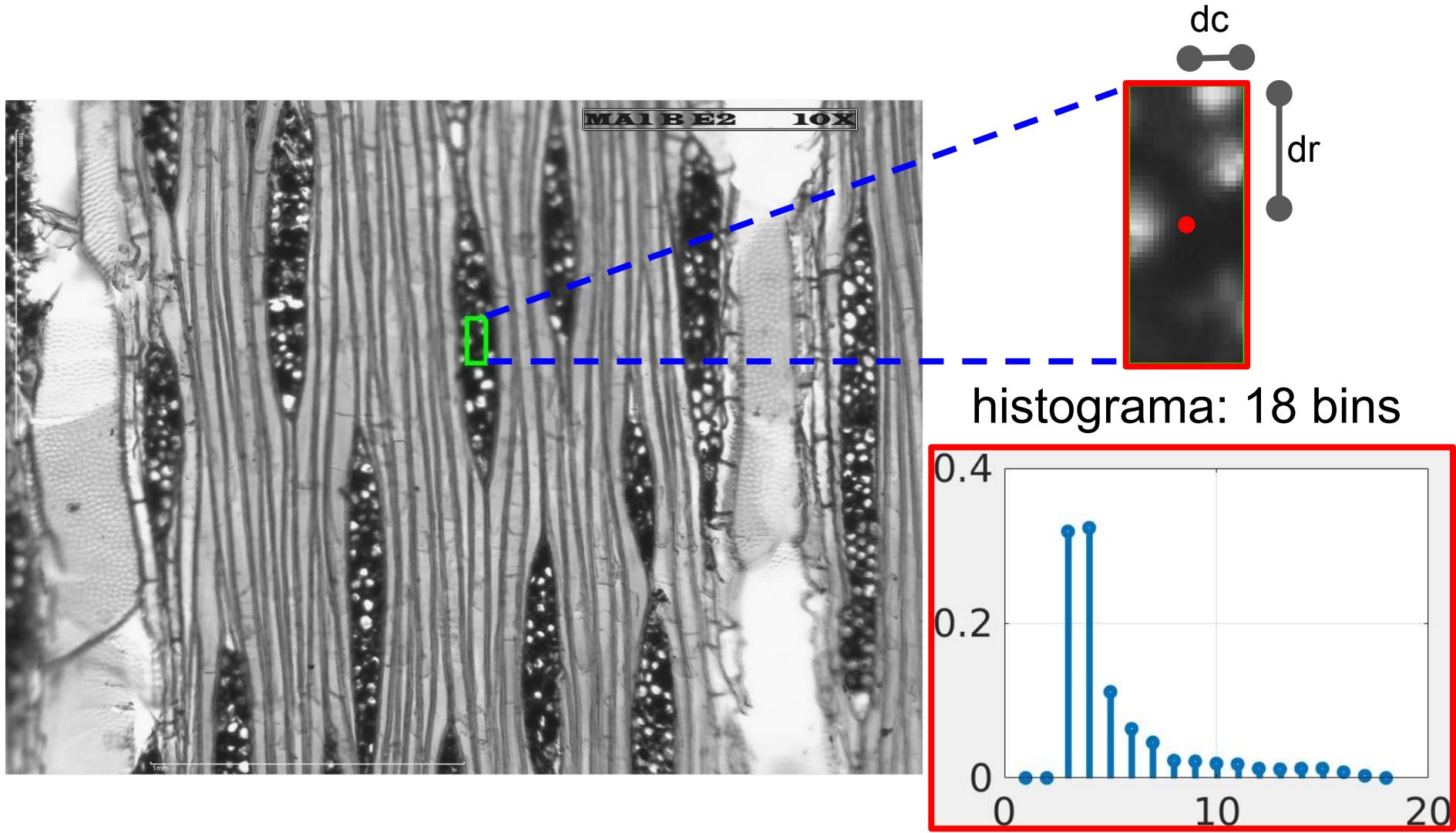
Ex3 - Histograma local: Ideia



histograma: 18 bins

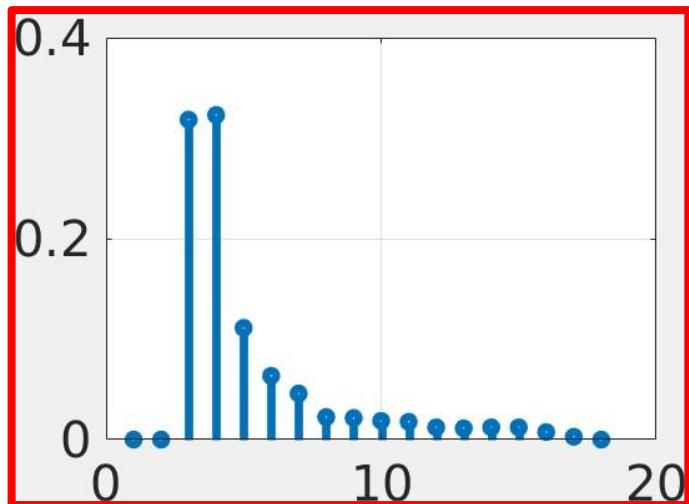


Ex3 - Histograma padrão

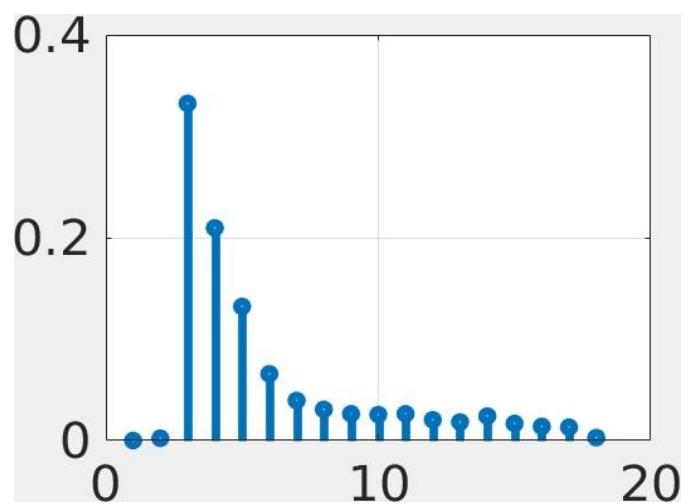


Ex3 - Histograma local: Comparação

Histograma padrão (H)

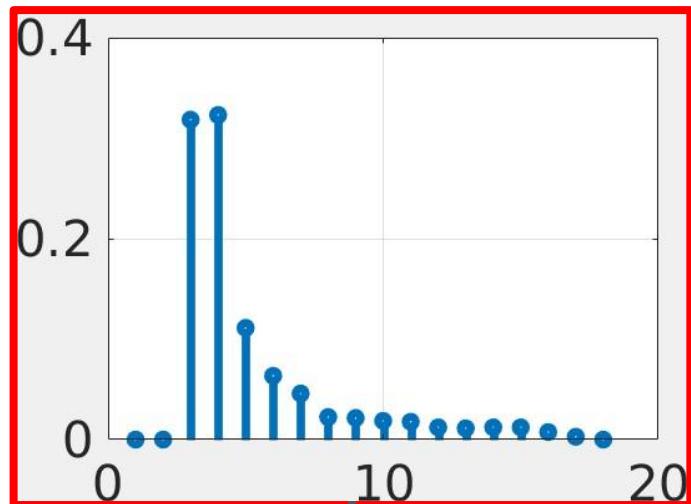


Outro histograma (G)

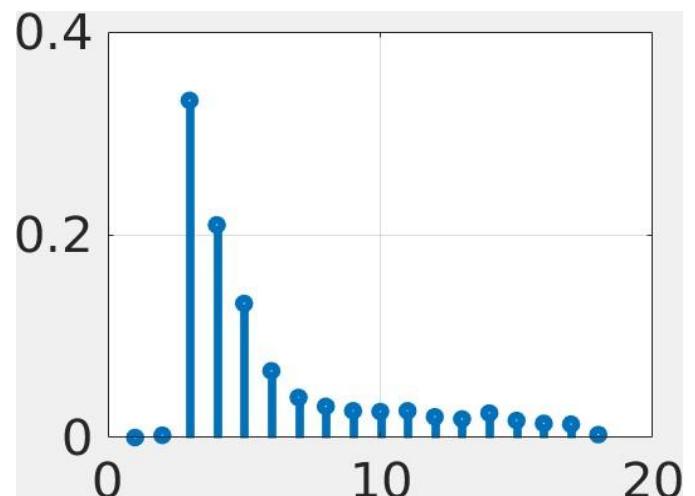


Ex3 - Histograma local: Comparação

Histograma padrão (H)



Outro histograma (G)



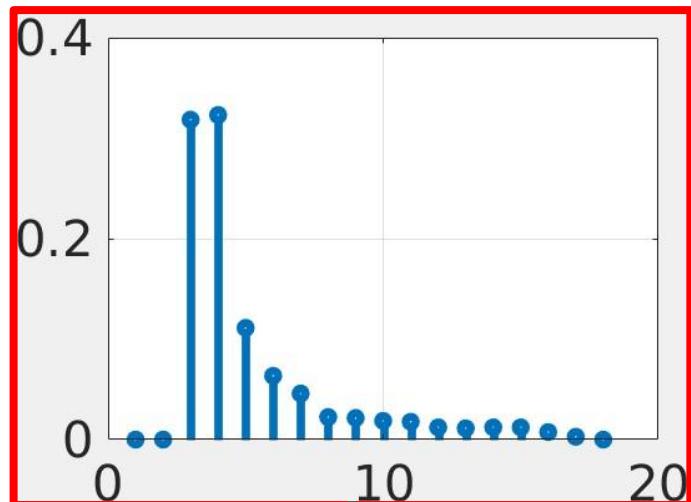
Distância Chi-square

$$\sum_{i=1}^{n_{\text{bins}}} \frac{(H_i - G_i)^2}{(H_i + G_i)}$$

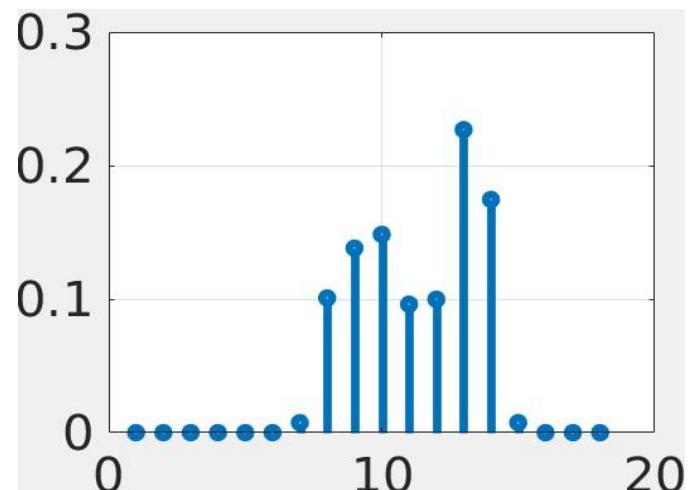
Valor baixo

Ex3 - Histograma local: Comparação

Histograma padrão (H)



Outro histograma (G)

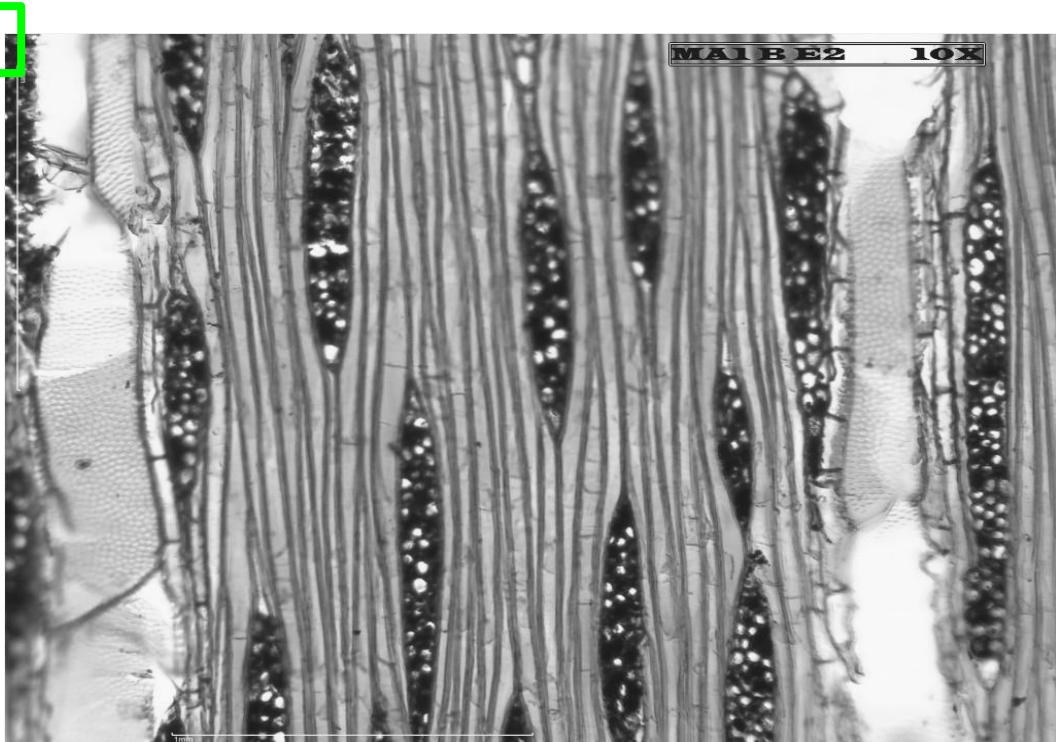


Distância Chi-square

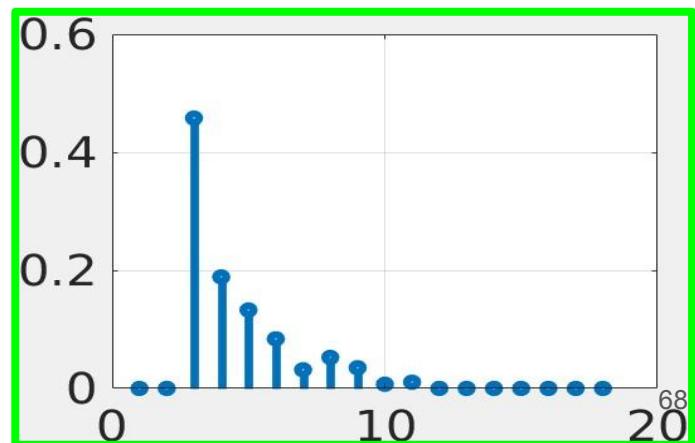
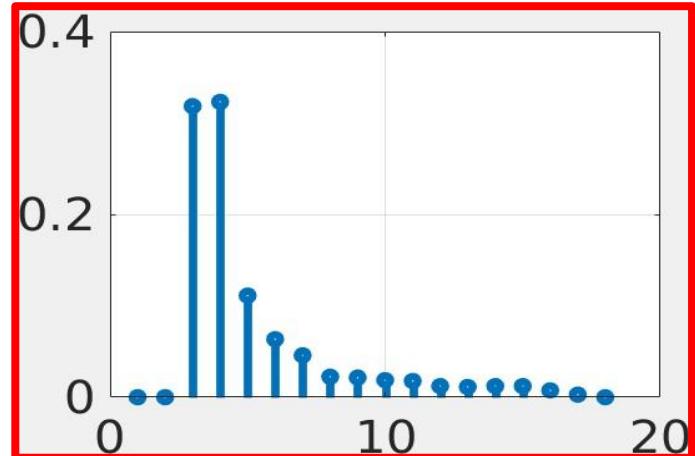
$$\sum_{i=1}^{n_{\text{bins}}} \frac{(H_i - G_i)^2}{(H_i + G_i)}$$

Valor grande

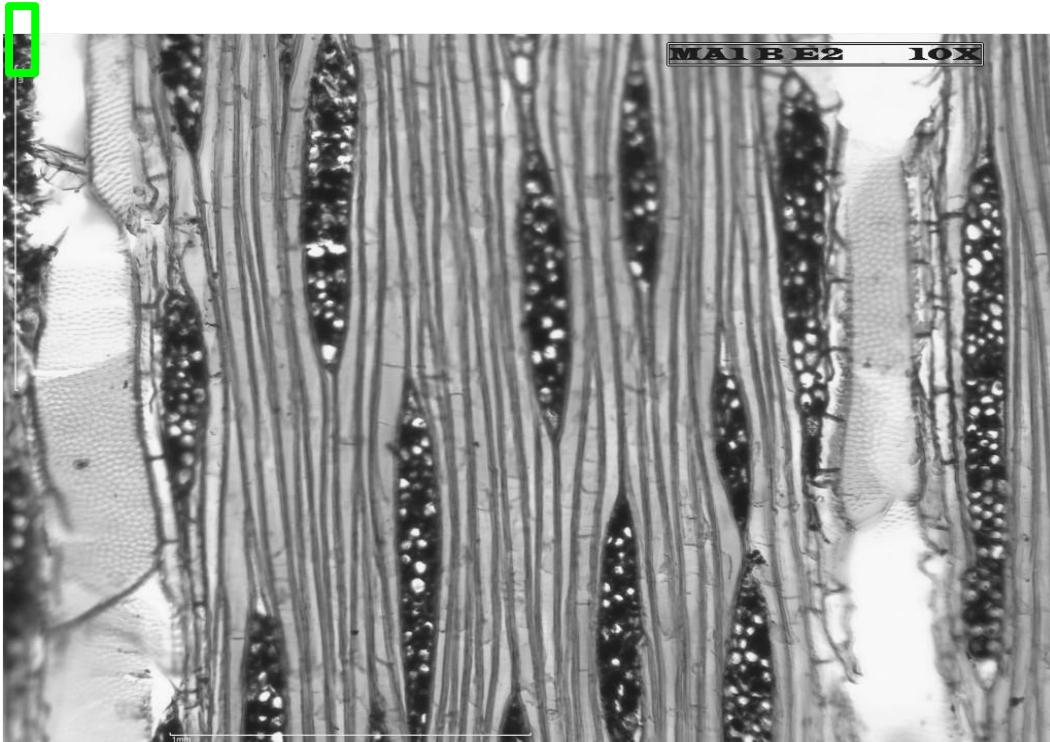
Ex3 - Histograma local: Imagem de distâncias



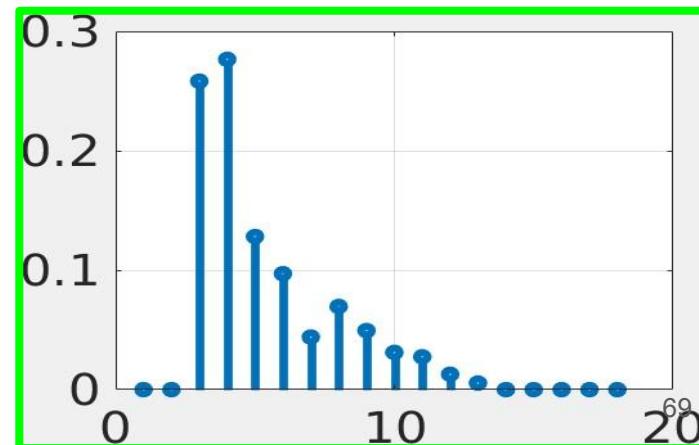
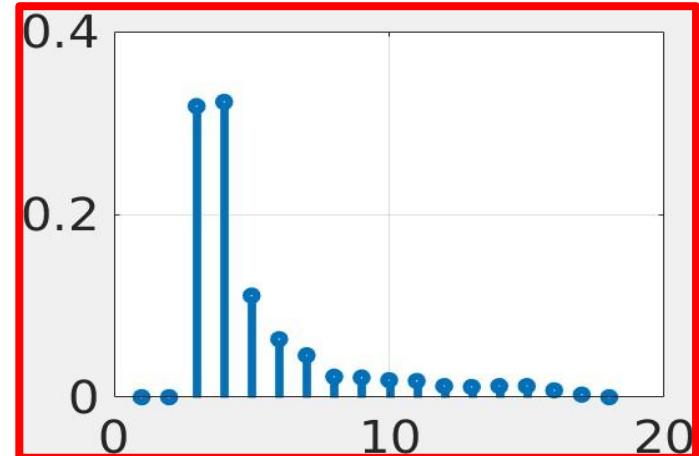
Histograma padrão (H)



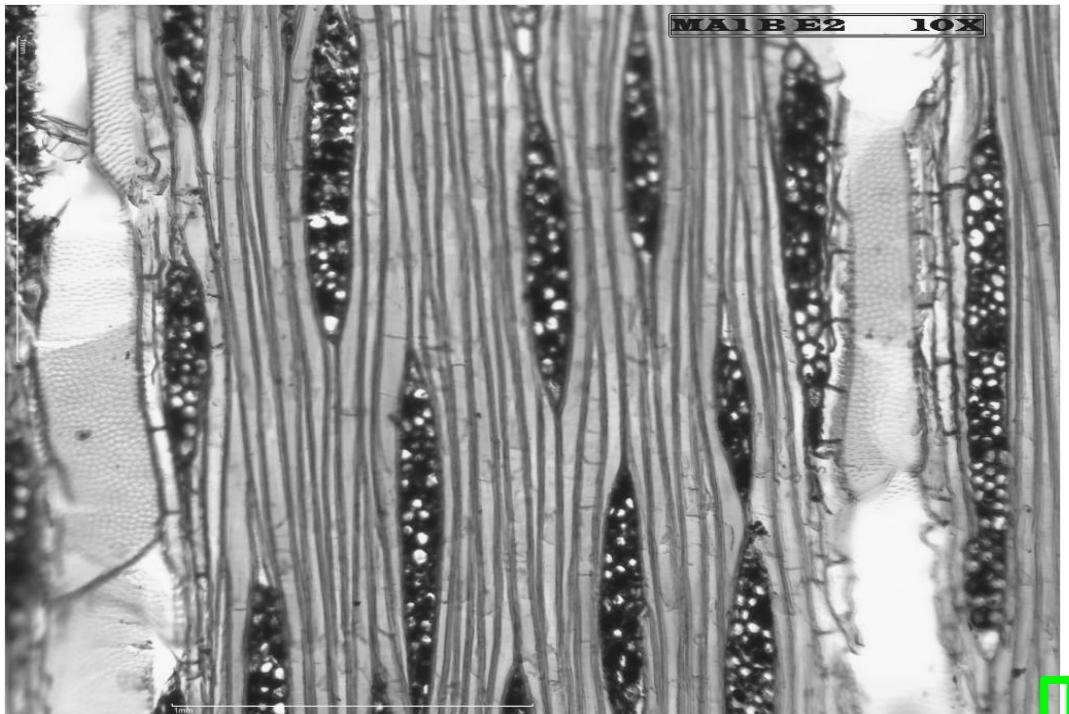
Ex3 - Histograma local: Imagem de distâncias



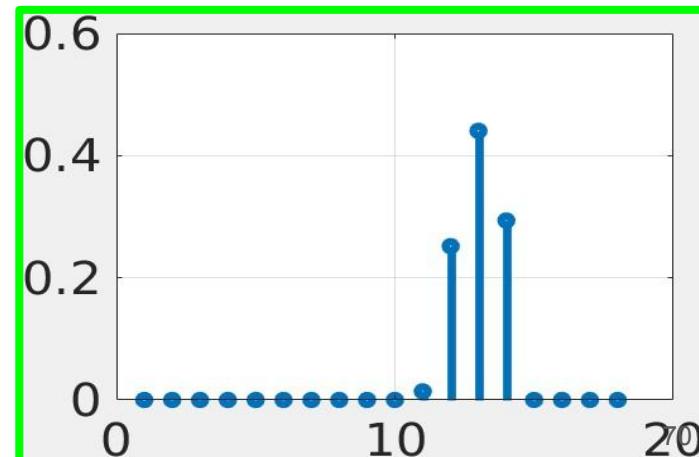
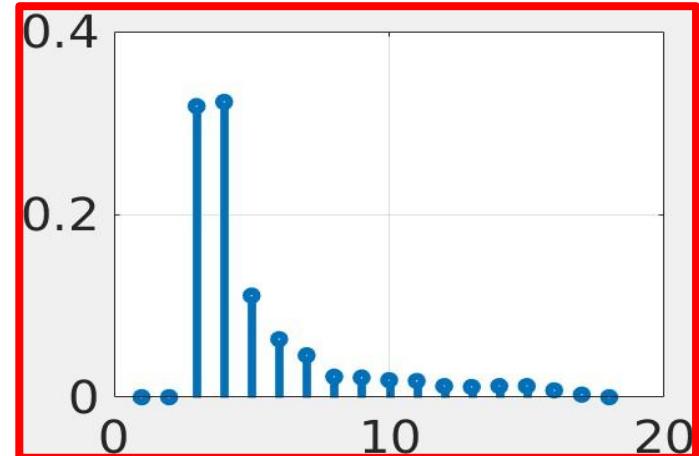
Histograma padrão (H)



Ex3 - Histograma local: Imagem de distâncias



Histograma padrão (H)



Ex3 - Histograma local: Imagem de distâncias

Original

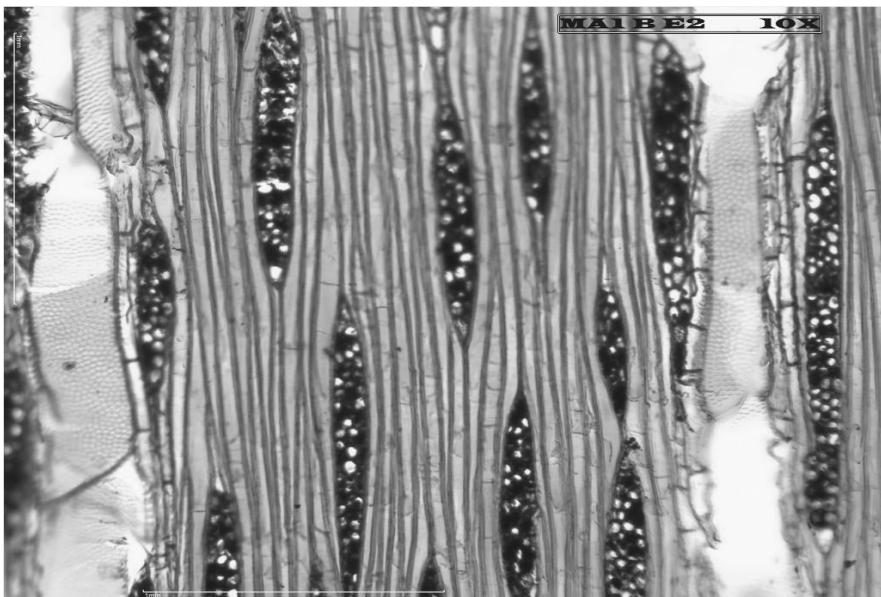
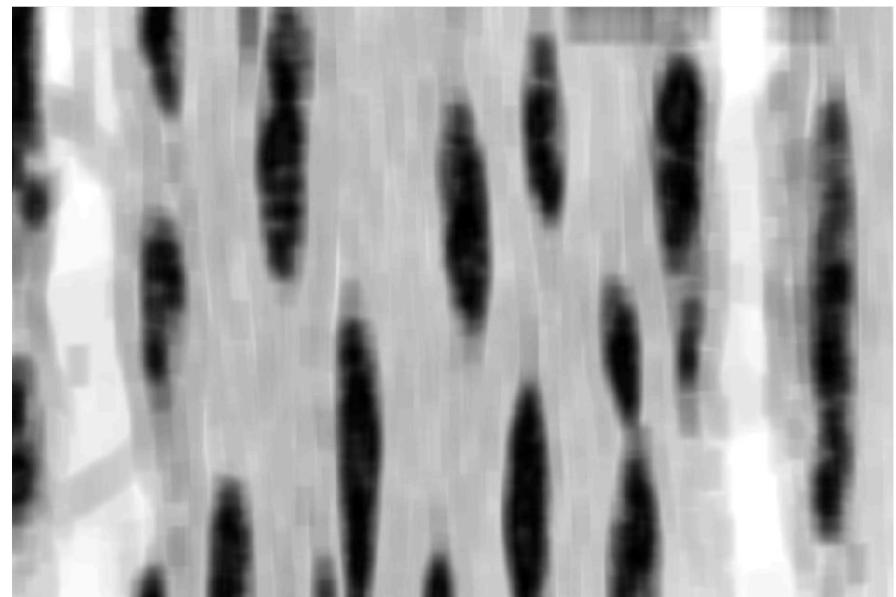
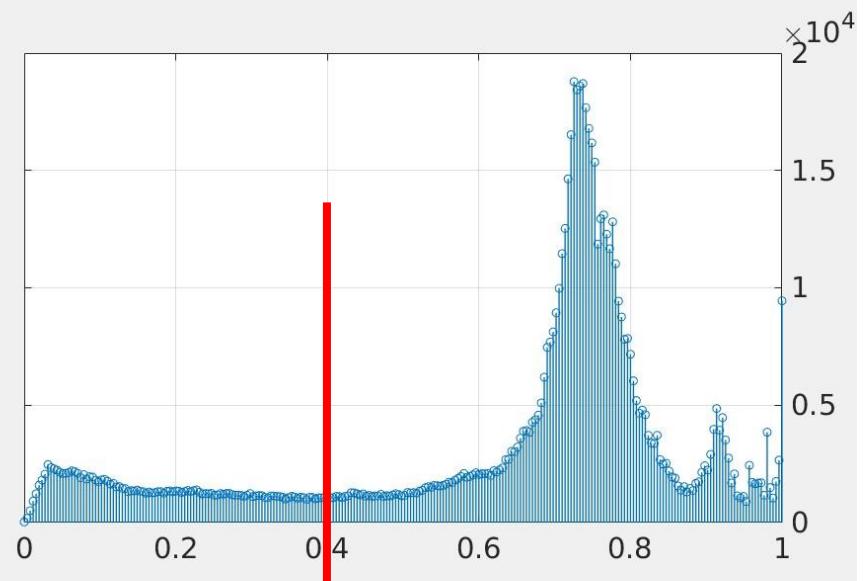
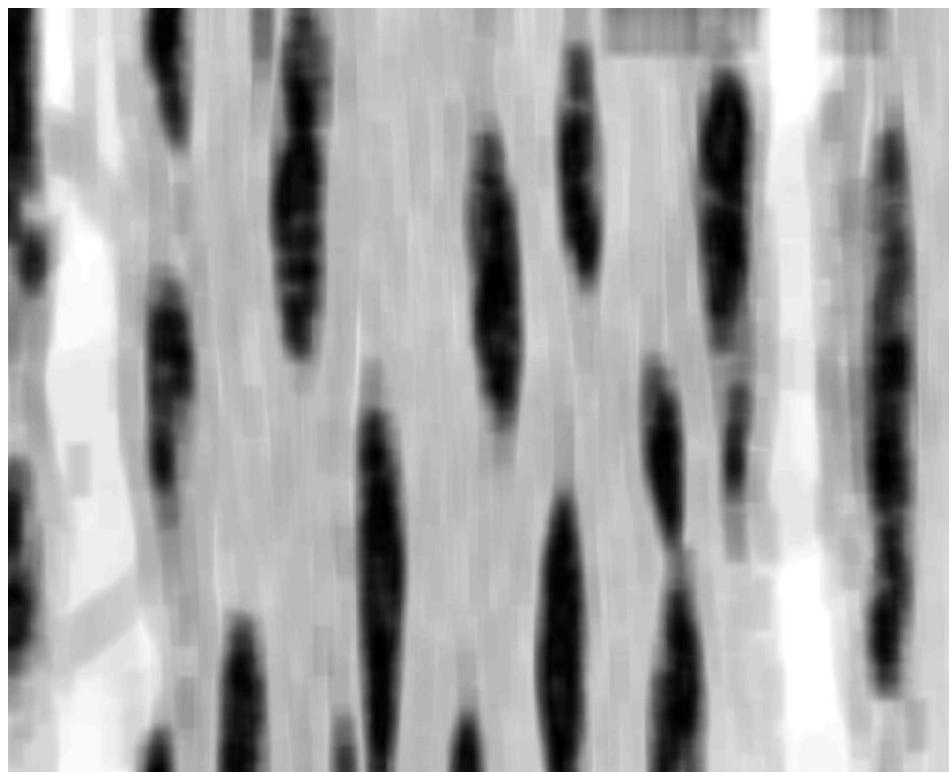


Imagen de distâncias

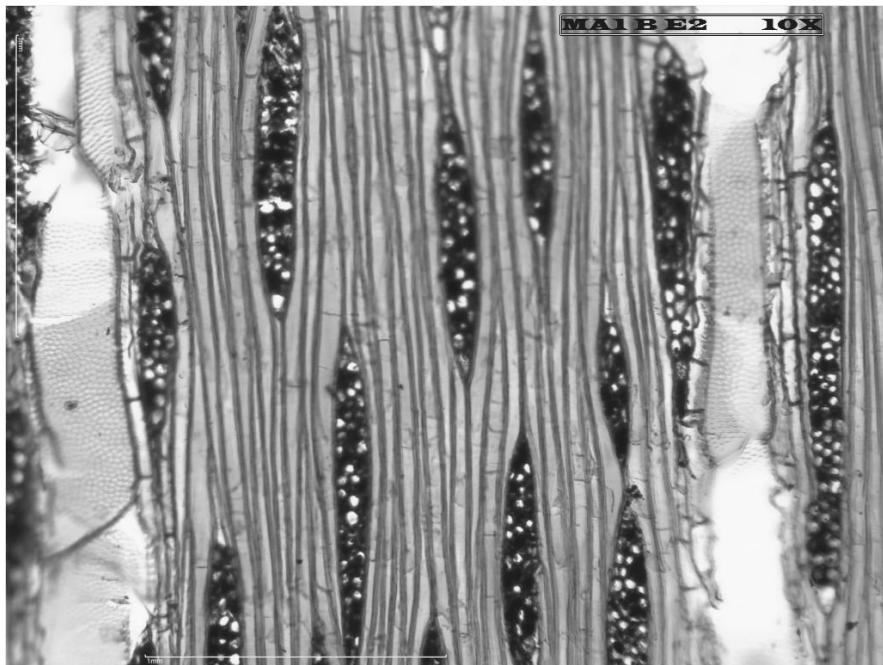


Ex3 - Limiarização em imagem de distâncias



Ex3 - Limiarização em imagem de distâncias

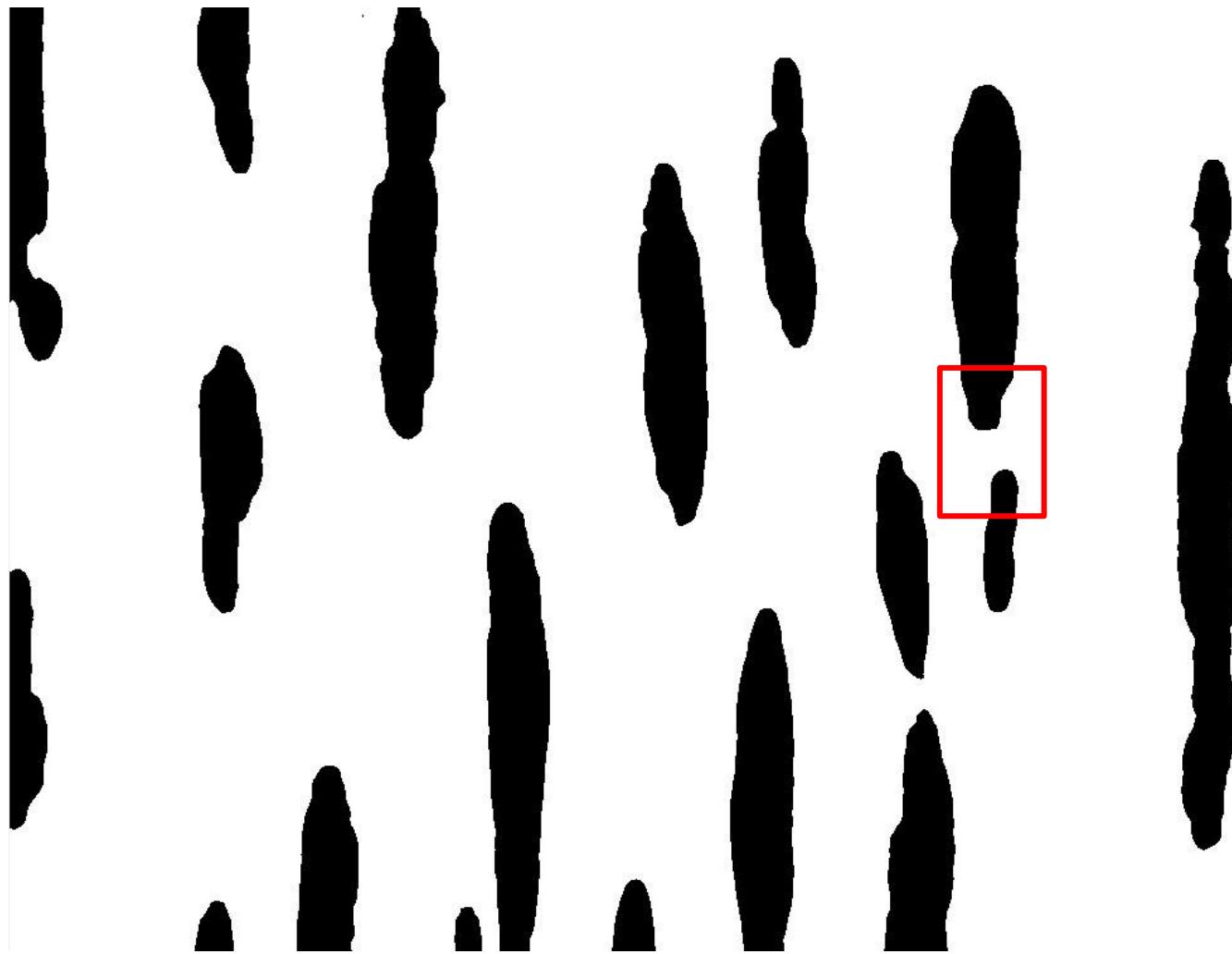
Original



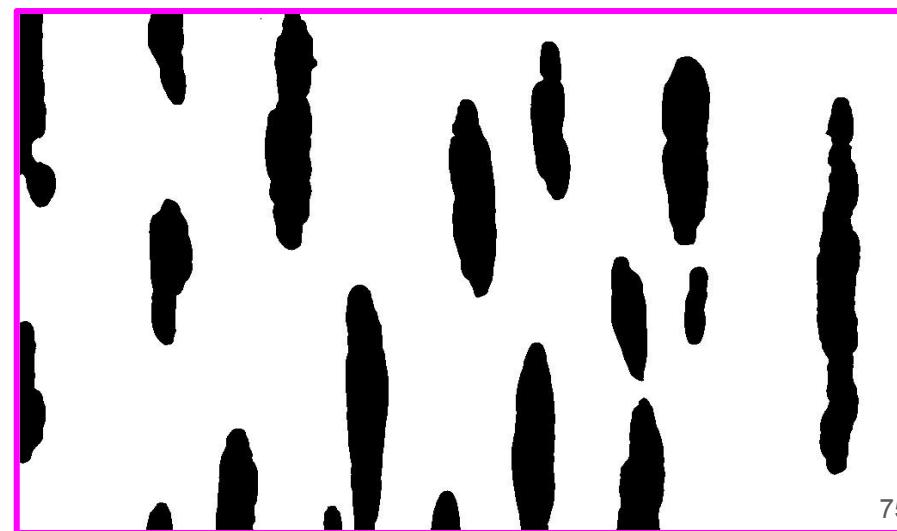
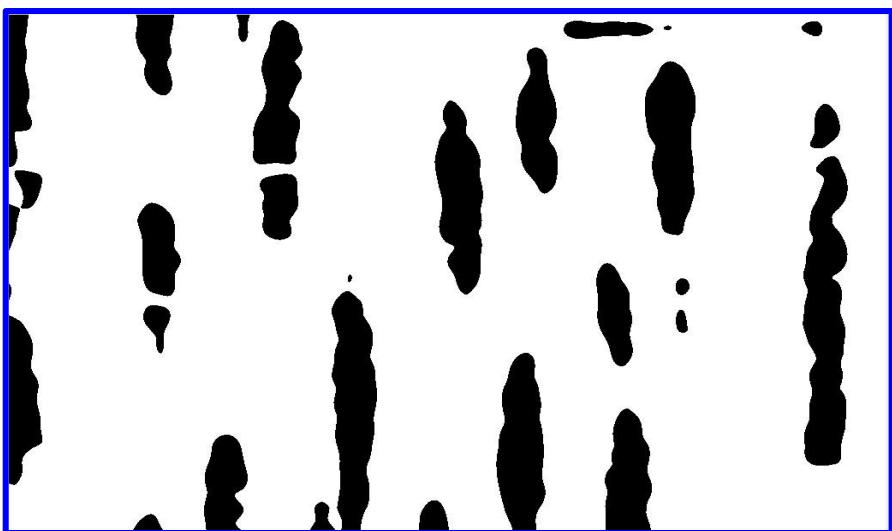
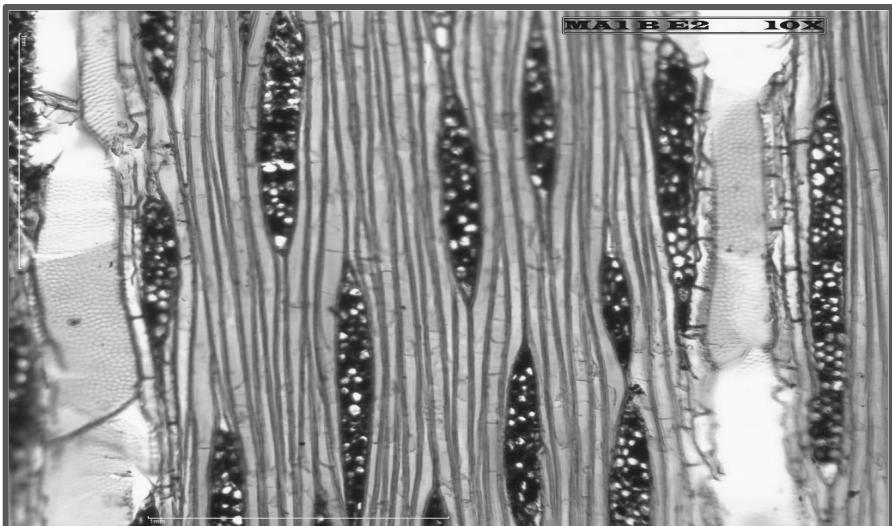
Binarizada - limiar = 0.4



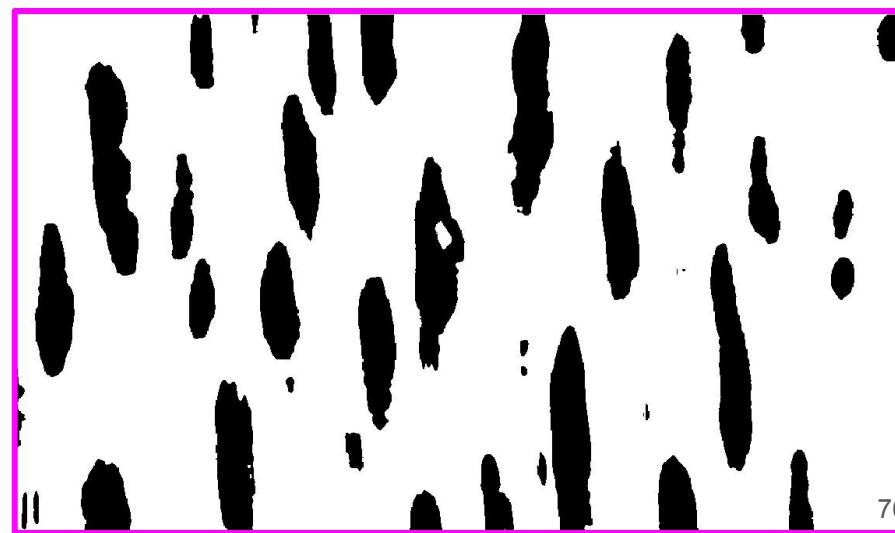
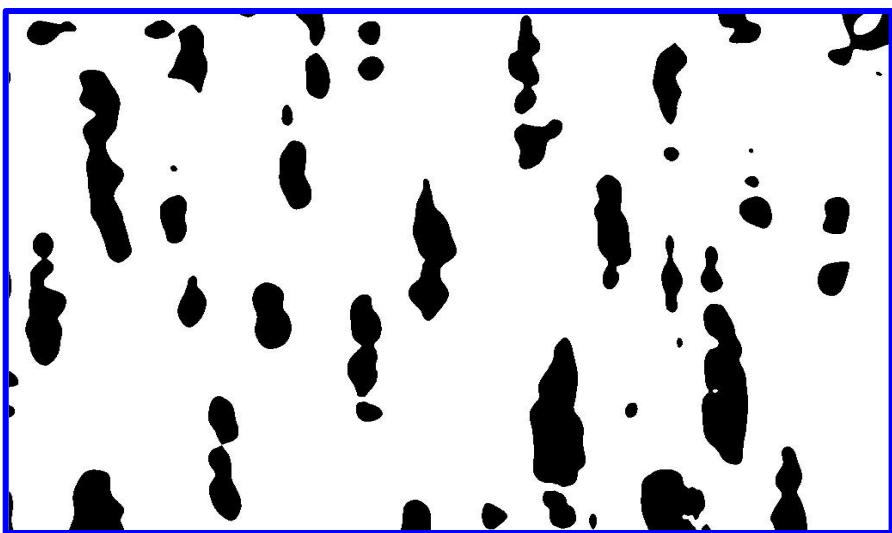
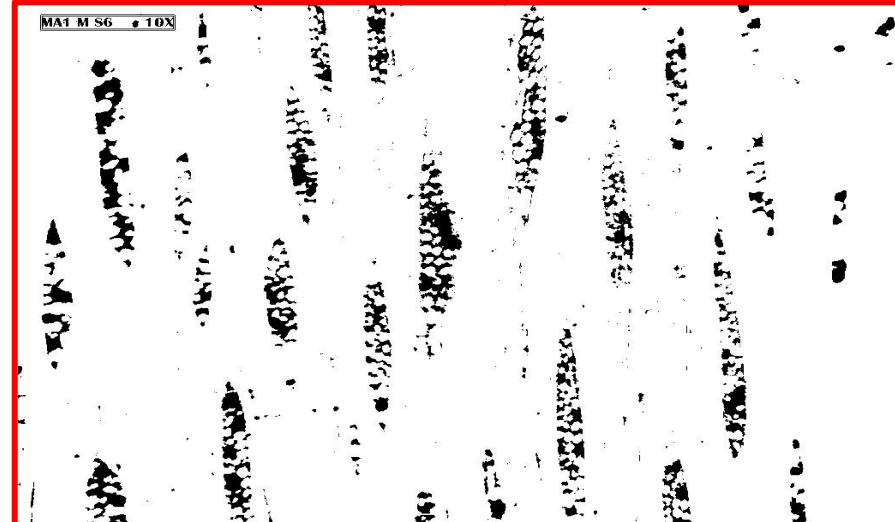
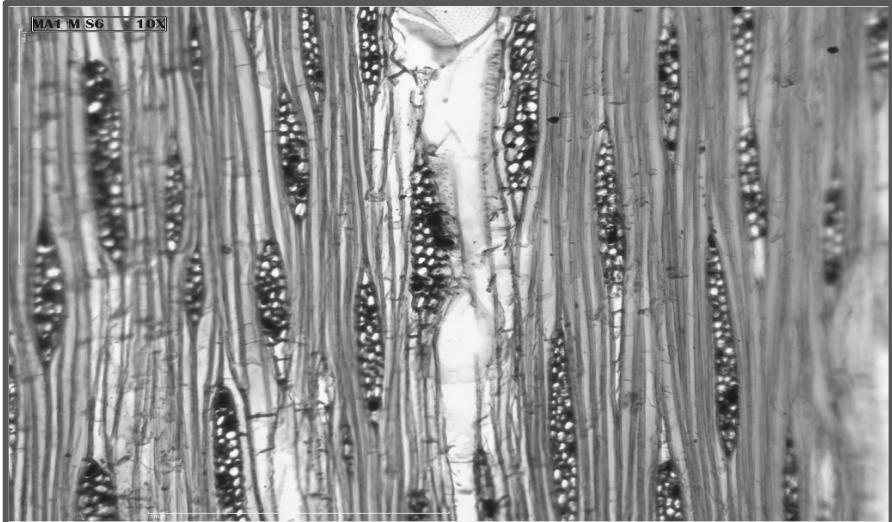
Ex3 - Limiarização: Problemas



Comparação de resultados: Ex1, Ex2 e Ex3



Comparação de resultados: Ex1, Ex2 e Ex3



Ex3 - Histogramas locais: Possíveis melhorias

- Usar dois ou mais histogramas padrões
- Usar K-Means (ou outro método semelhante)
- Usar histogramas espectrais locais

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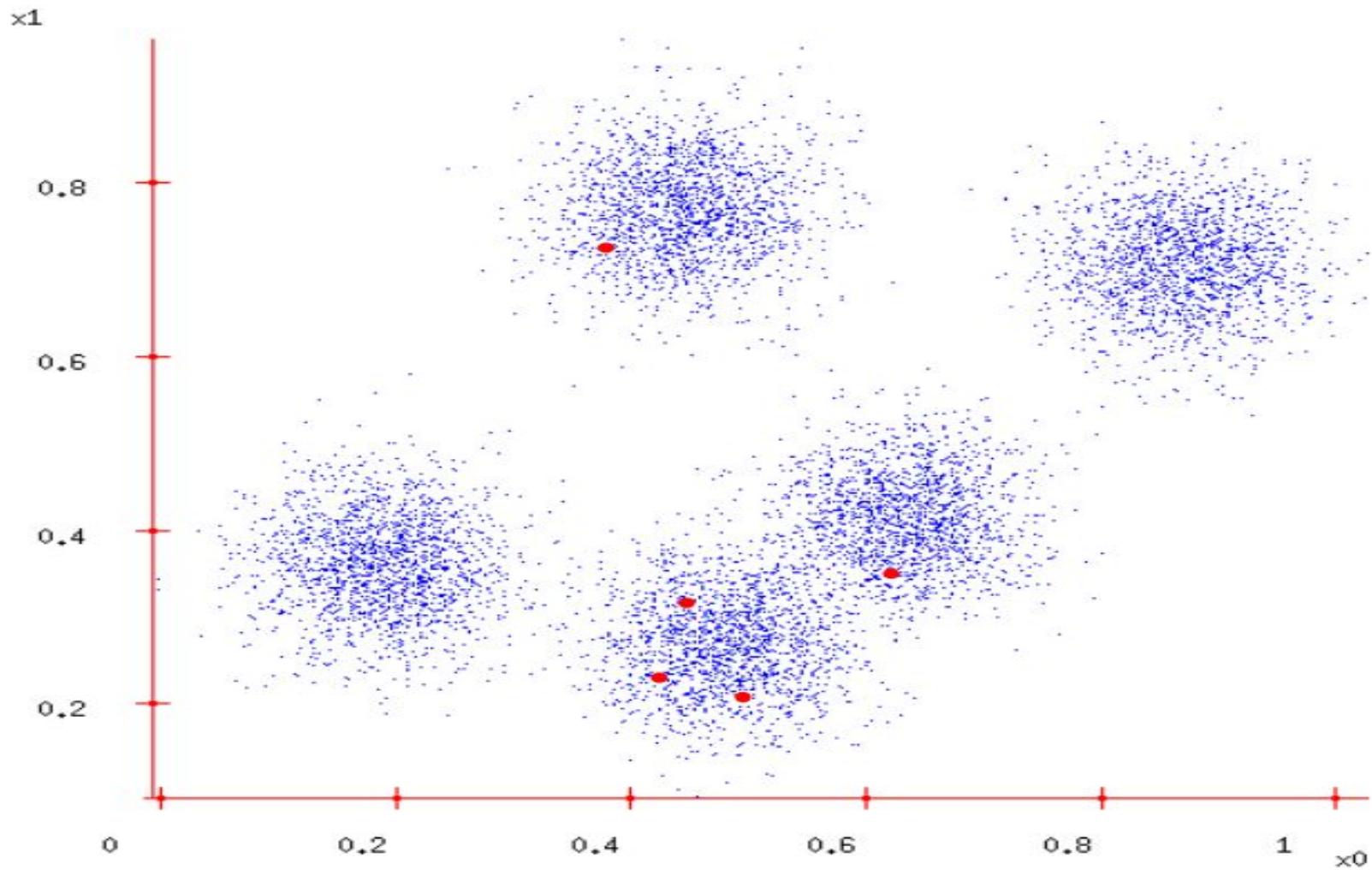
K-Means

- K-means é o método mais conhecido de *clustering*
- Trabalha com pontos (vetores) de M-dimensões
- Precisa de um número fixo K de clusters

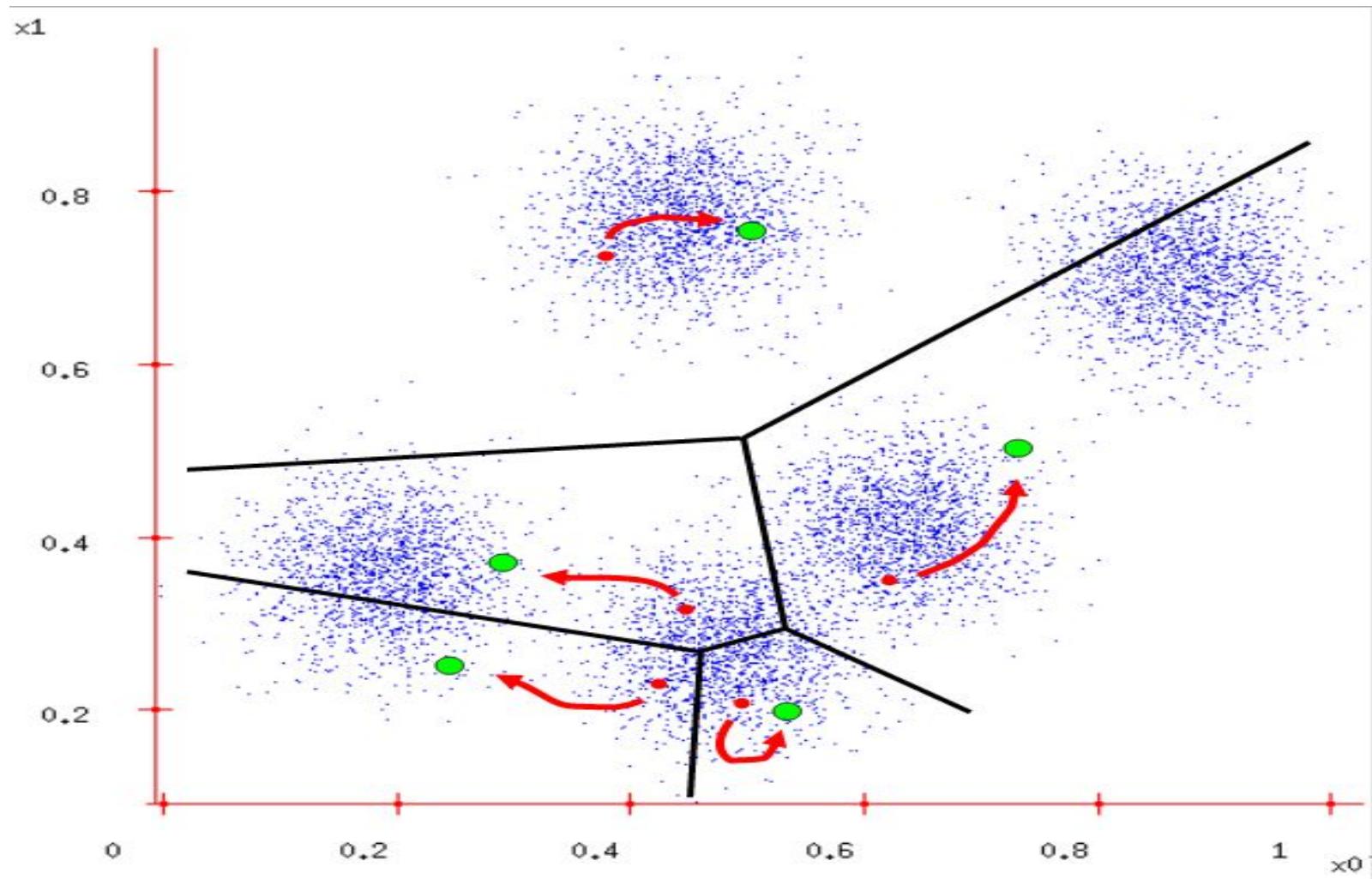
K-Means - Demo

- Dado um problema com N pontos bidimensionais

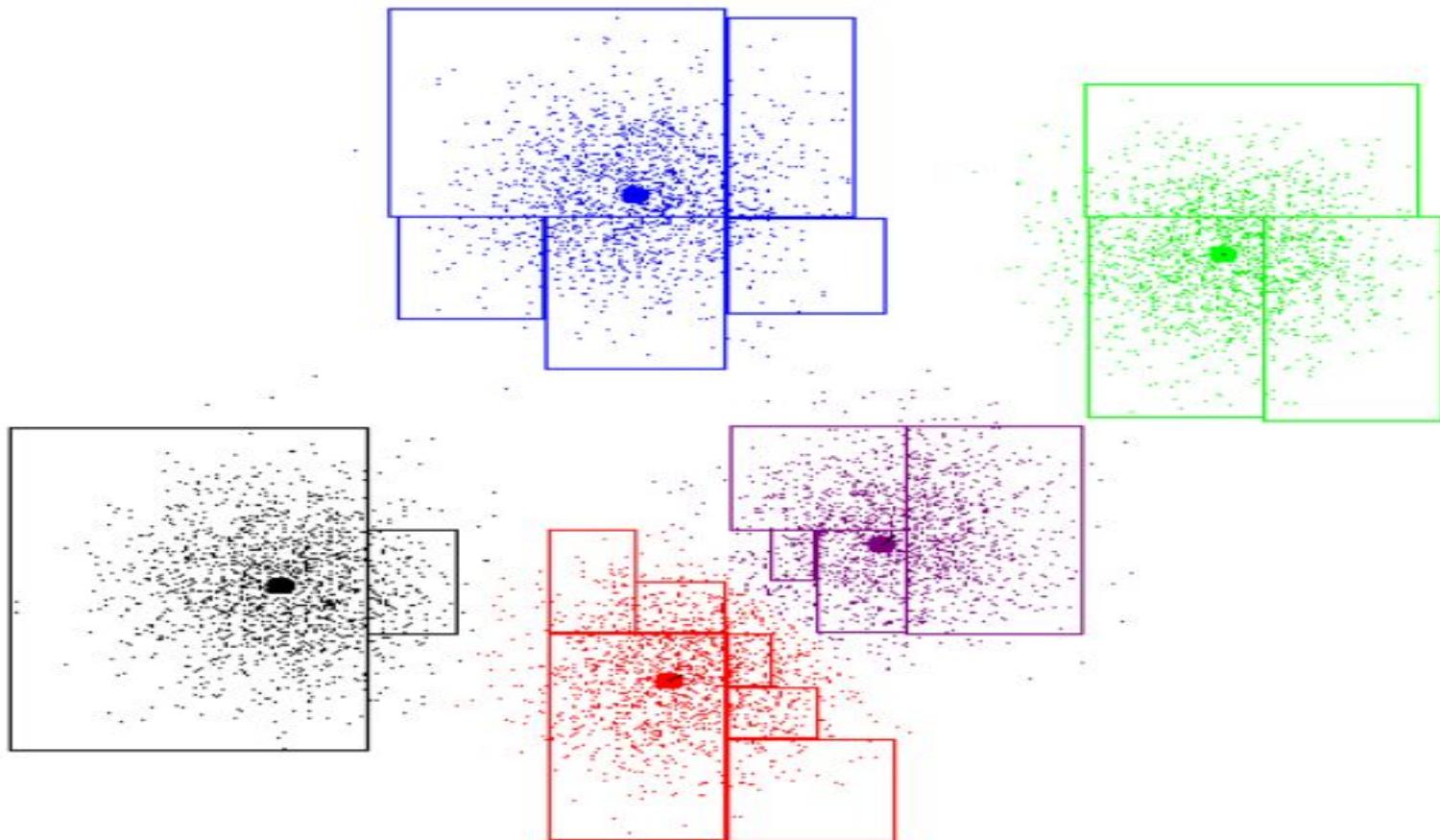
K-Means - Demo (K = 5)



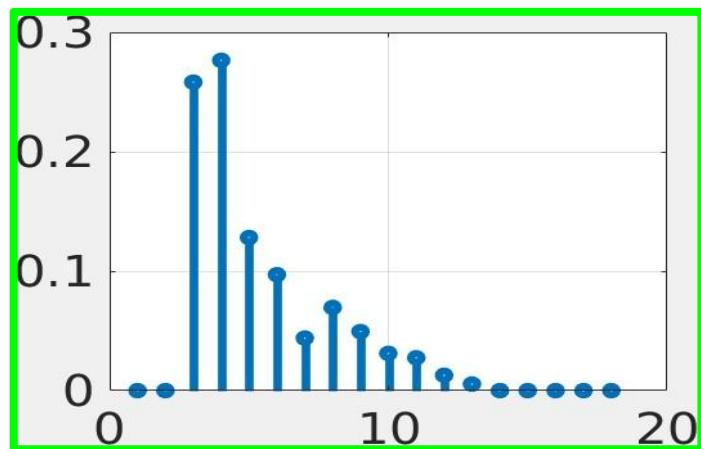
K-Means - Demo (K = 5)



K-Means - Demo (K = 5)

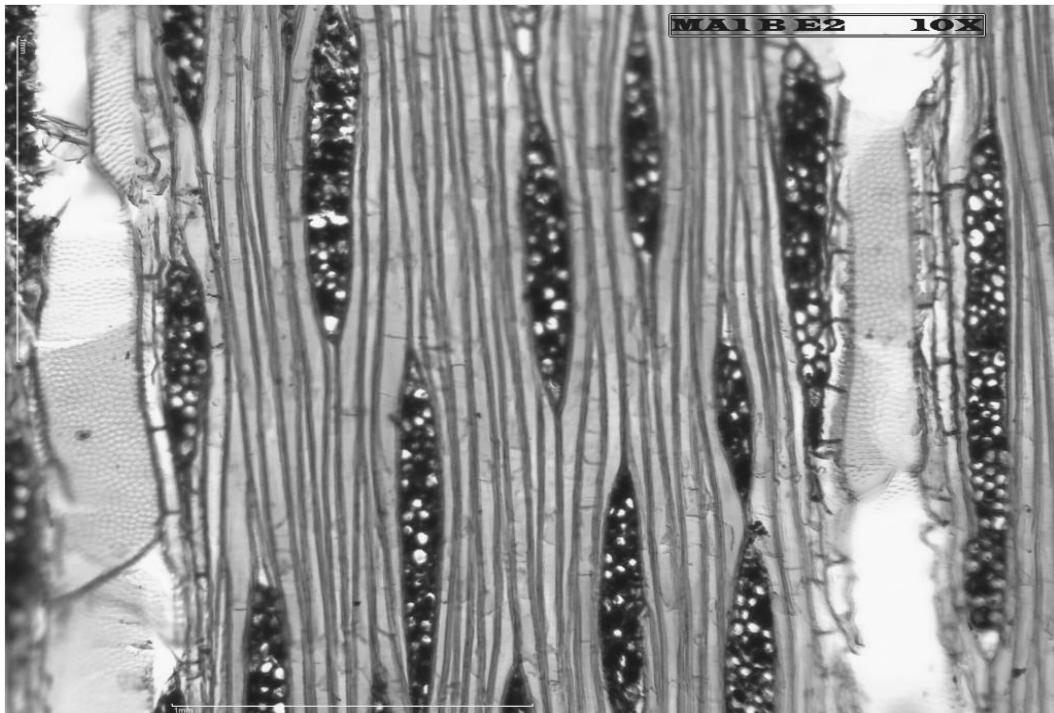


K-means -- Histogramas locais



$$\begin{bmatrix} 0 \\ 0 \\ 0.27 \\ 0.28 \\ 0.13 \\ 0.1 \\ 0.05 \\ 0.07 \\ 0.06 \\ 0.04 \\ 0.04 \\ 0.02 \\ 0.01 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

K-means -- Histogramas locais



$K = 3$

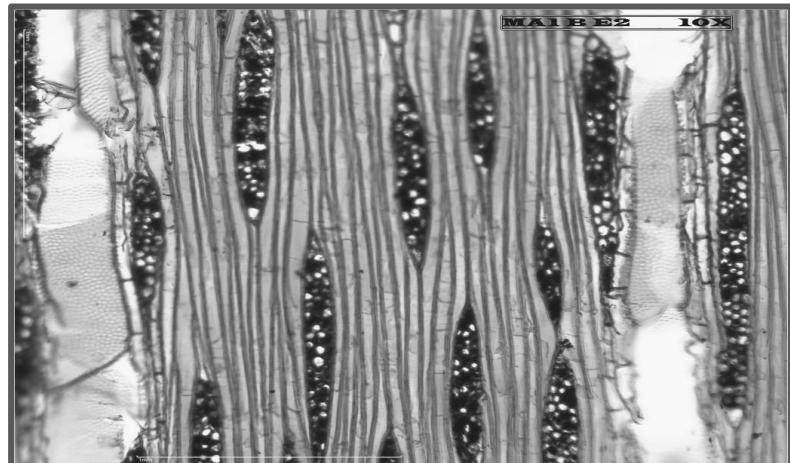
Ex3 - Histogramas locais: Possíveis melhorias

- Usar dois ou mais histogramas padrões
- Usar K-Means (ou outro método semelhante)
- Usar histogramas espectrais locais

Ex4.m

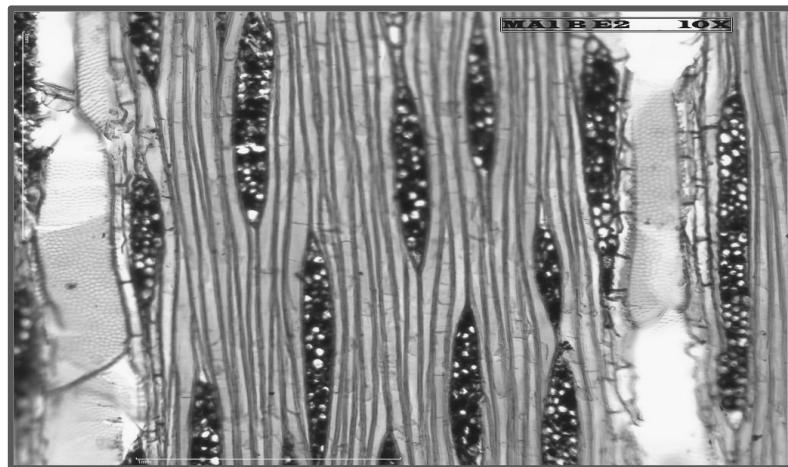
Ex4 - Histogramas espectrais locais

- Usar um banco de filtros

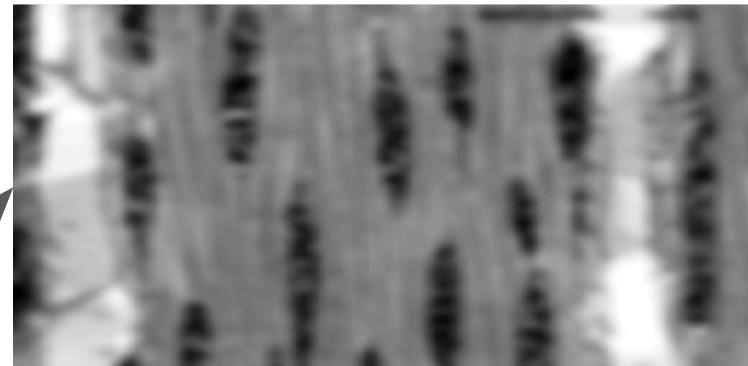


Ex4 - Histogramas espectrais locais

- Usar um banco de filtros

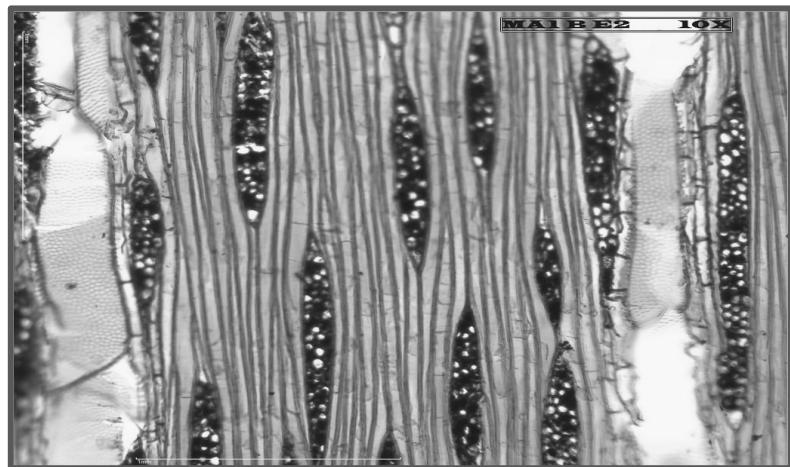


Gauss
sigma = 10



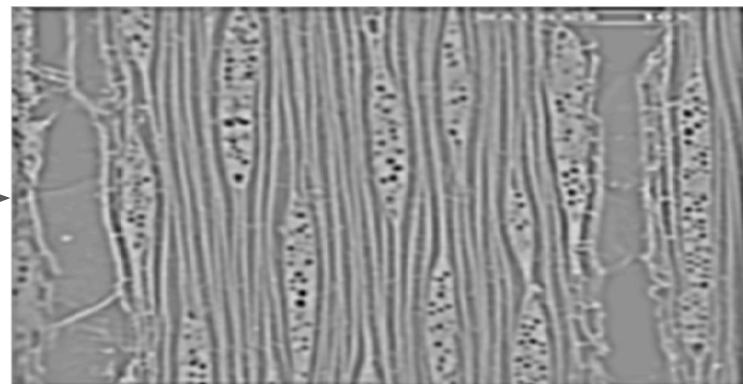
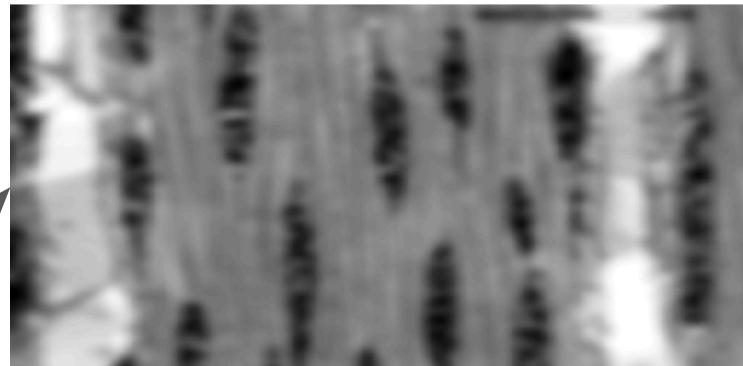
Ex4 - Histogramas espectrais locais

- Usar um banco de filtros



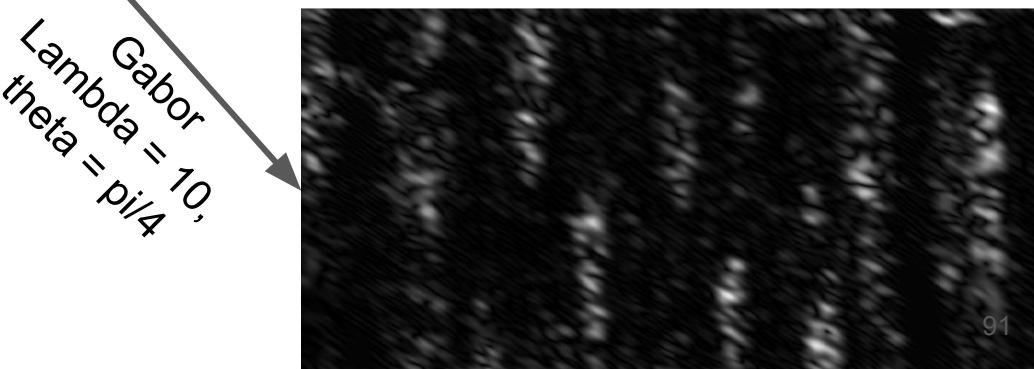
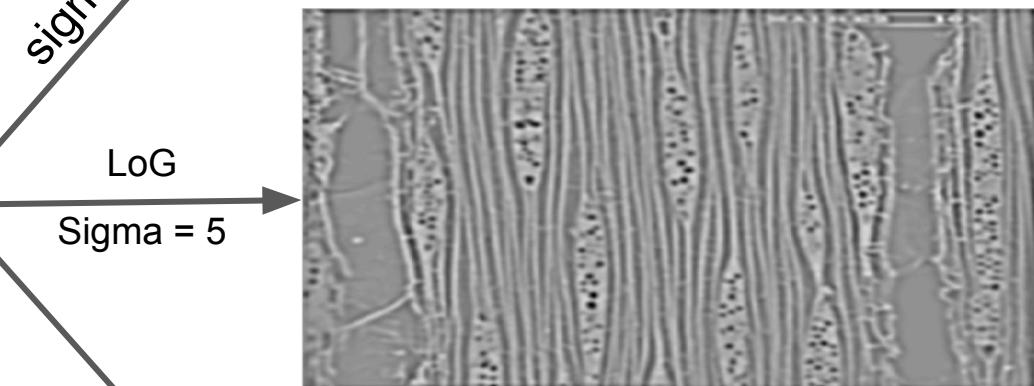
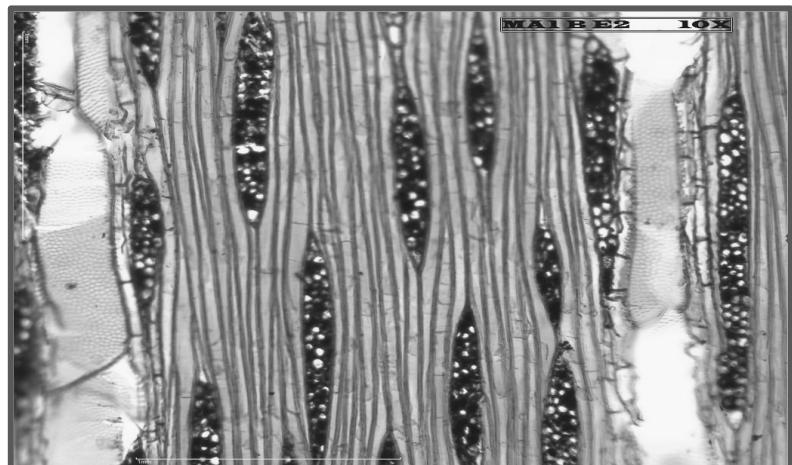
Gauss
sigma = 10

LoG
Sigma = 5



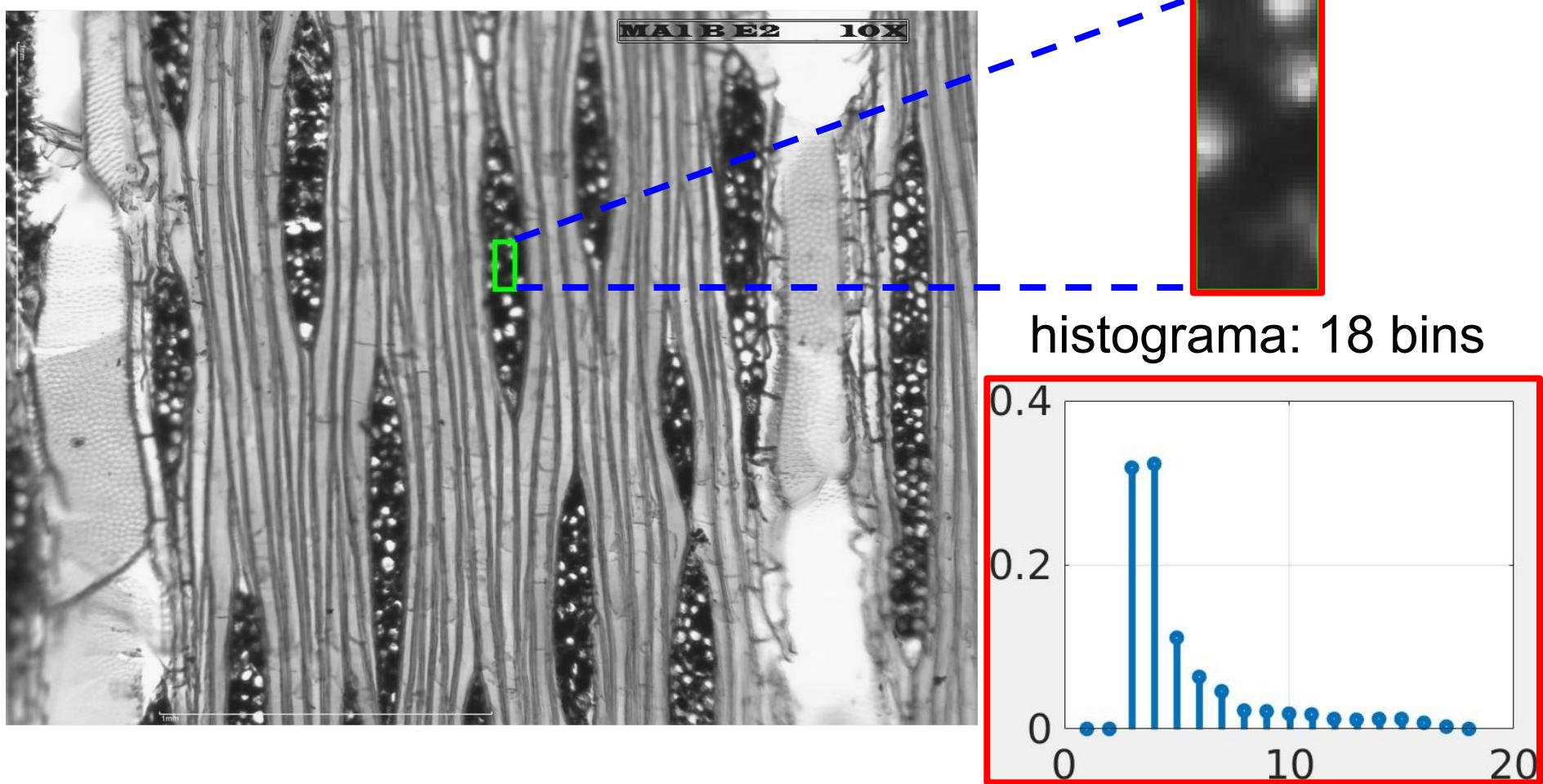
Ex4 - Histogramas espectrais locais

- Usar um banco de filtros

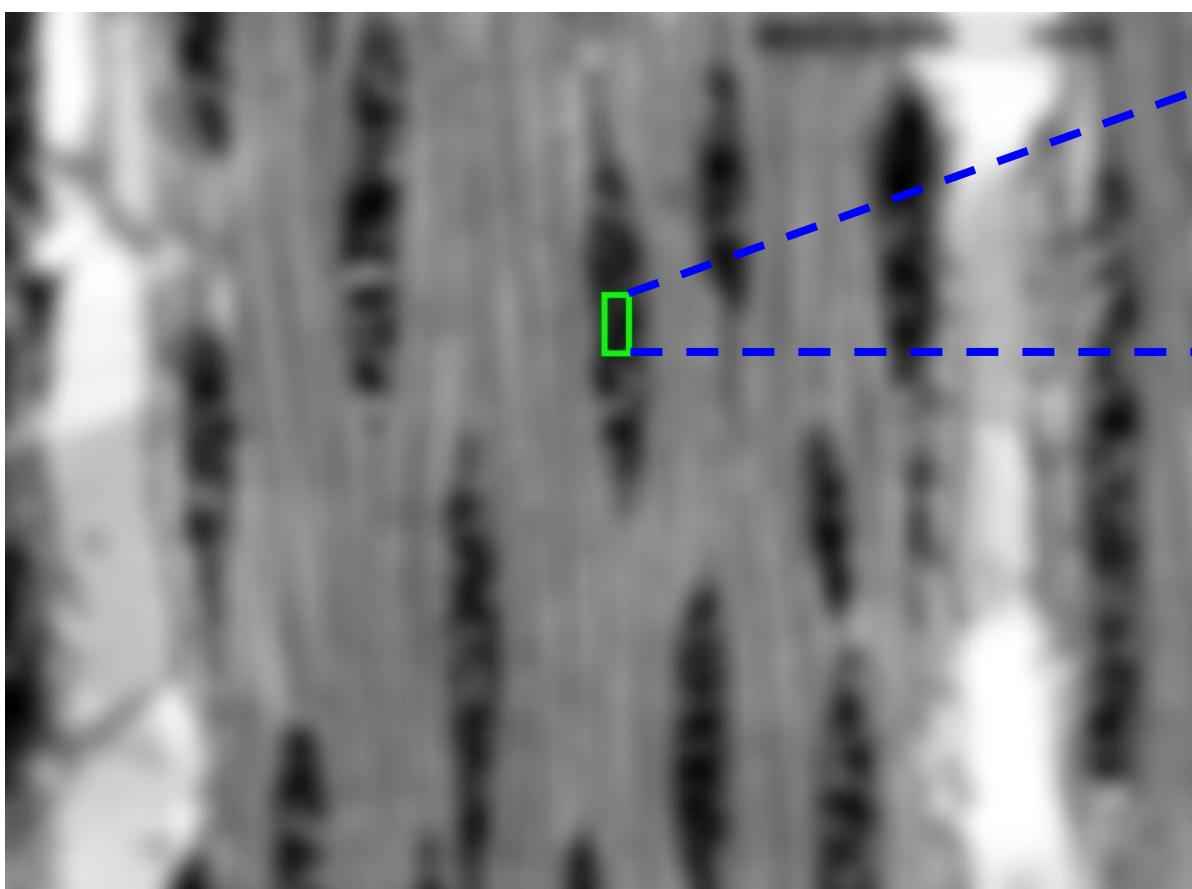


Resultado: Imagem com 4 canais

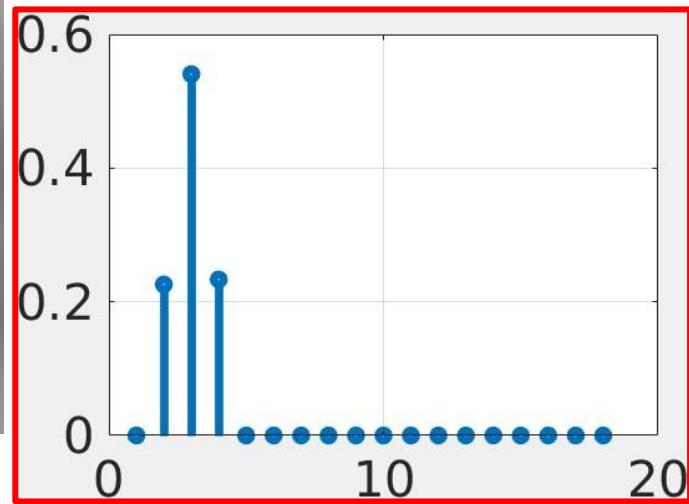
Ex4 - Histograma padrão: Canal 1



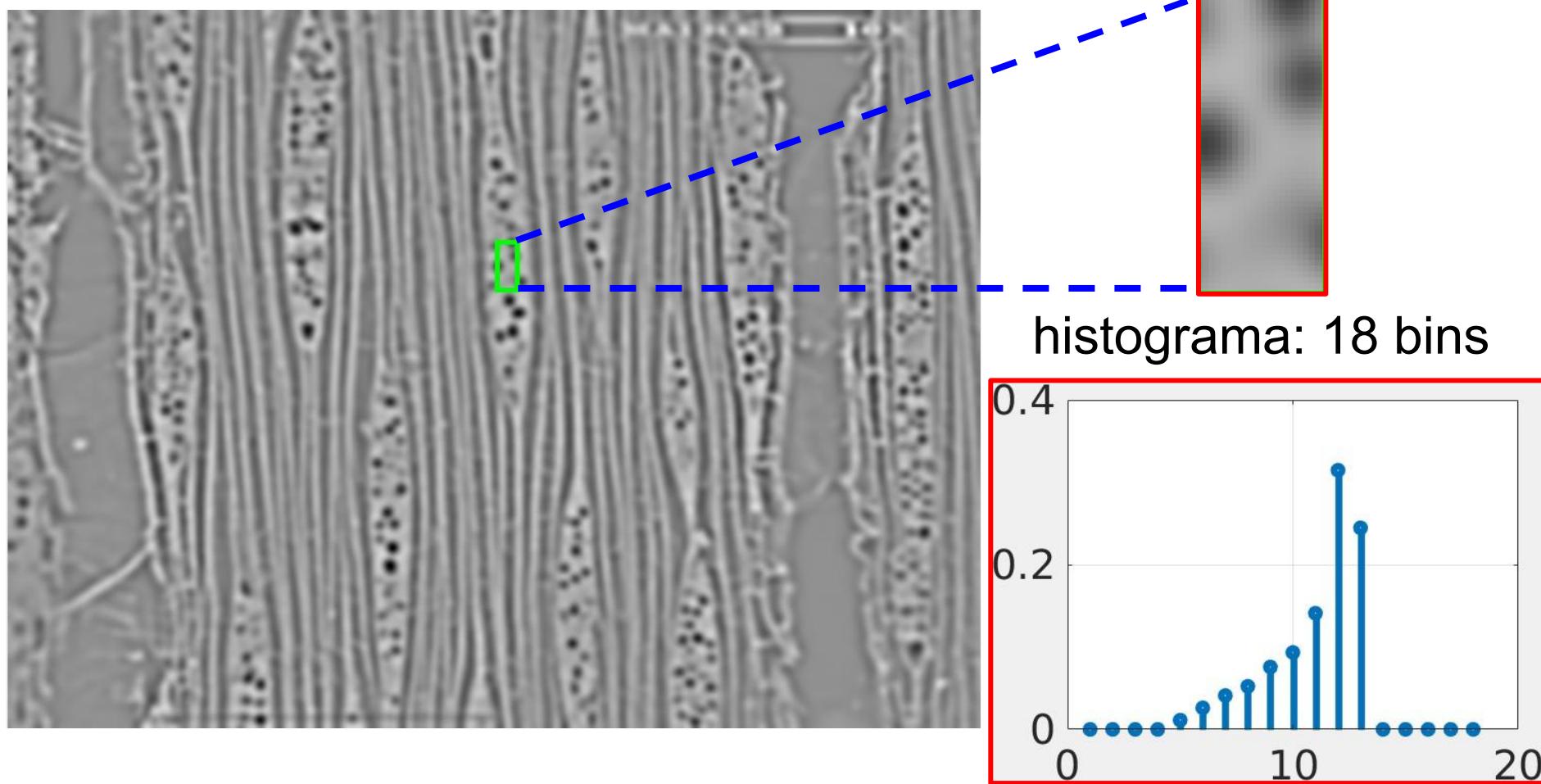
Ex4 - Histograma padrão: Canal 2



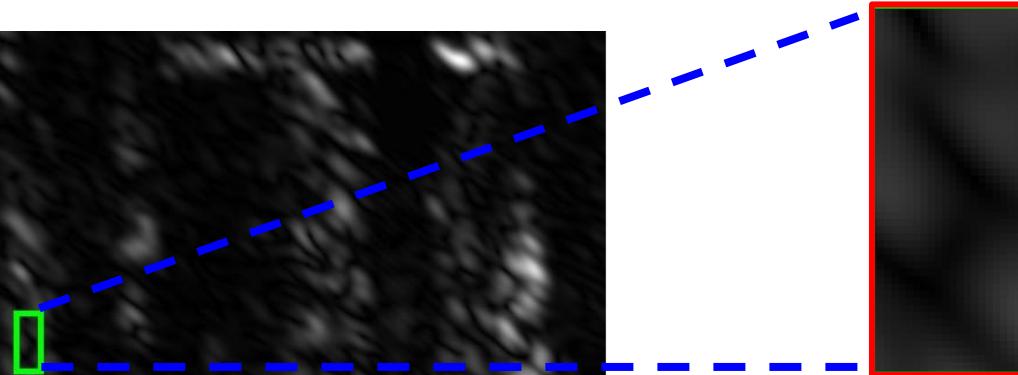
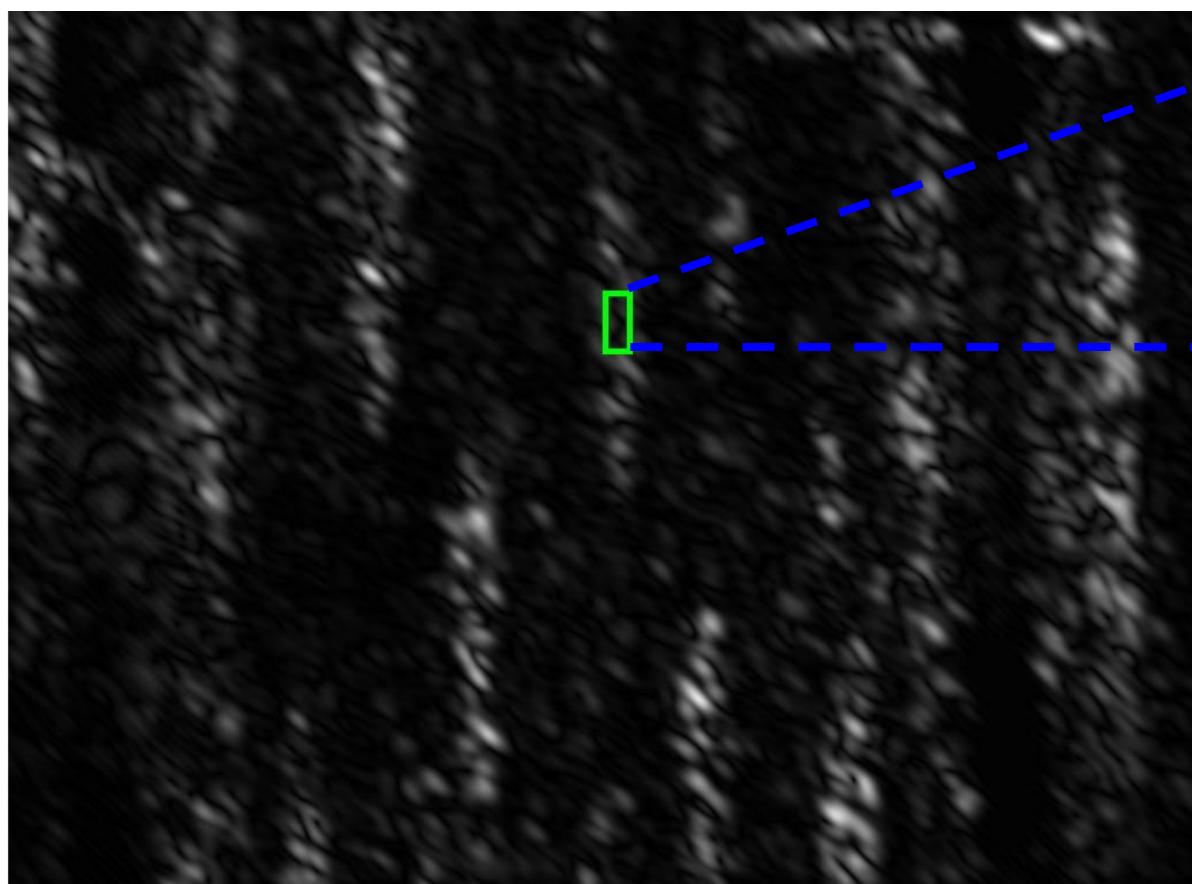
histograma: 18 bins



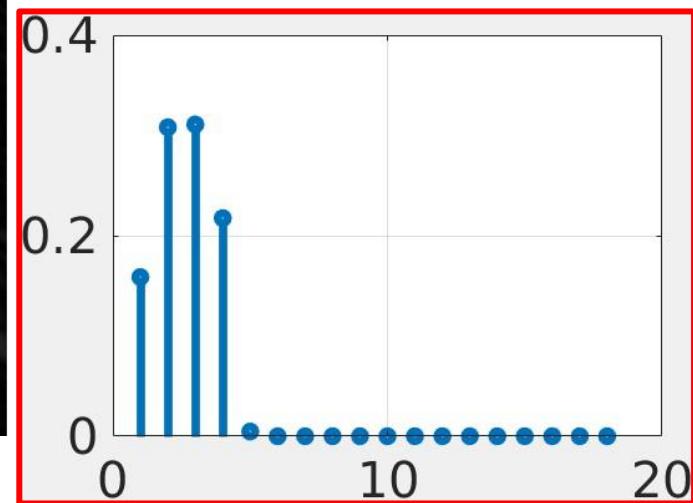
Ex4 - Histograma padrão: Canal 3



Ex4 - Histograma padrão: Canal 4

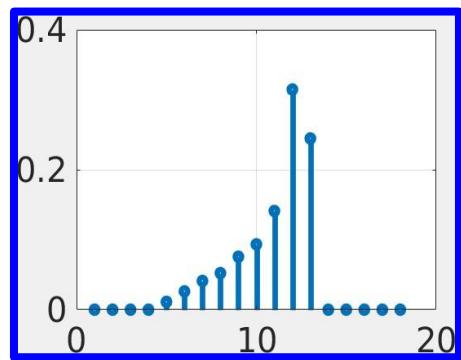


histograma: 18 bins

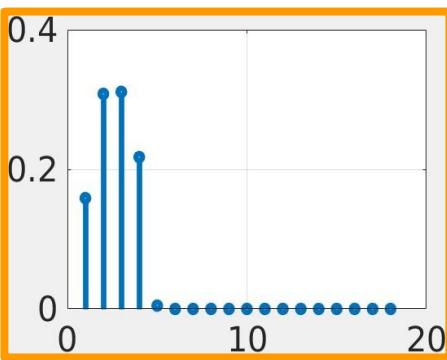


Ex4 - Histograma padrão: Canal 1,2,3,4

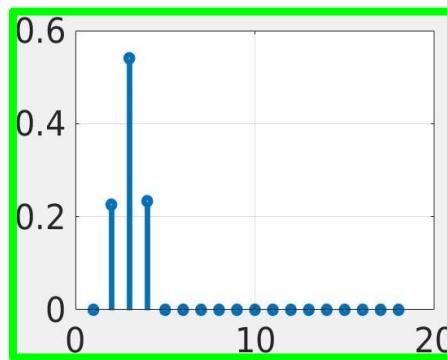
canal 3



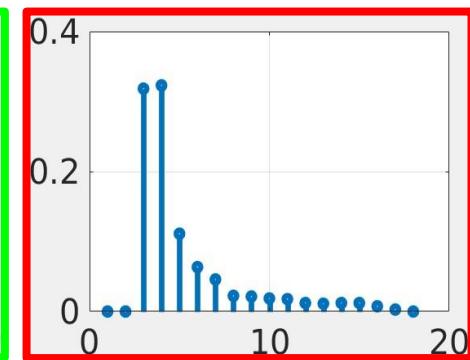
canal 4



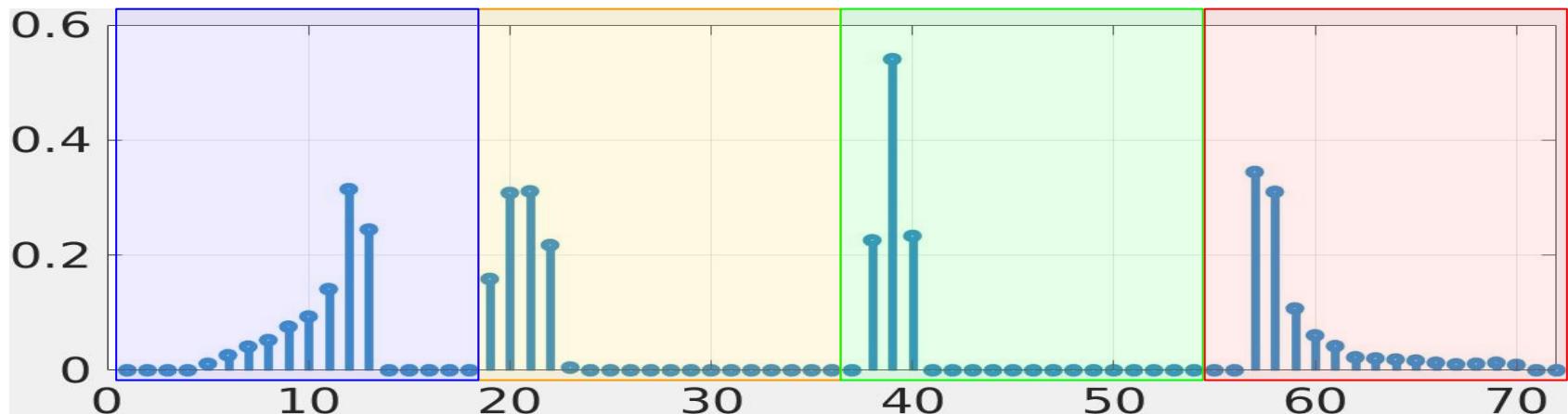
canal 2



canal 1



histograma composto: 72 bins



Obrigado