Investigation of Wordlength Effect on Discriminative Power of Co-occurrence Matrix – Derived Features for Digital Image Texture Analysis

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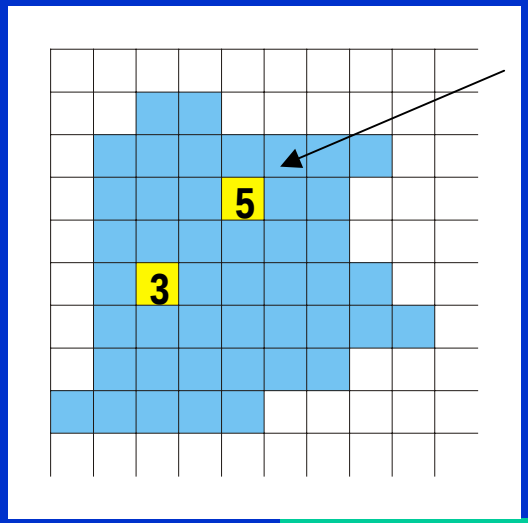
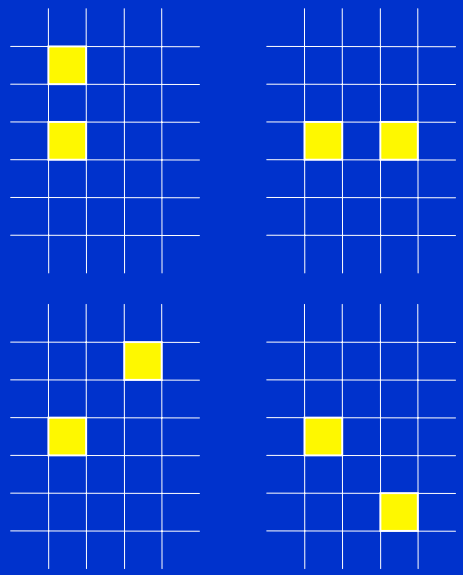
Plan of presentation

- Co-occurrence matrix
- Aim of investigation
- Wordlength effect on digital images
- Materials and methods
- Results
- Conclusions

Construction of CO matrix



Example of ROI



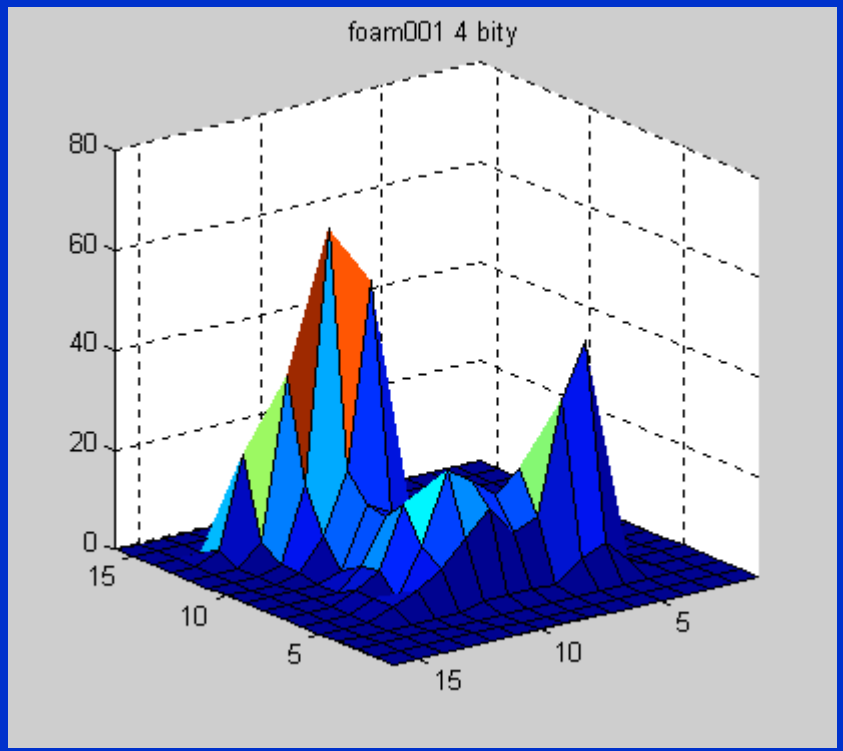
Masks for different directions

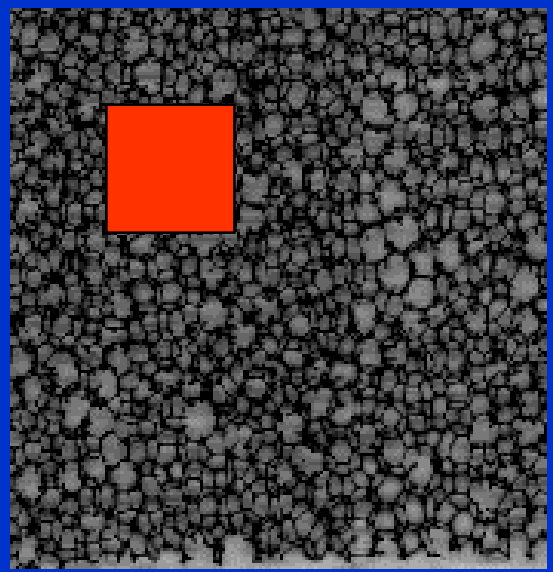
CO matrix

grey level	1	2	3	4	5	6	7	8
1								
2								
3					+1			
4								
5			+1					
6								
7								
8								

Direction 45°, d=2

Example of CO matrix for 16 grey levels





direction 45°, distance 1

The aim of this investigation was to analyse the effect of reduced word length on discriminative power of CO-derived features

- **Estimation of CO matrix elements is computationally demanding.**

- **The number of pixels in a typical ROI is small which causes the probabilities in CO matrix inaccurate at a large number of bits per pixel.**

CO matrix derived features

- angular second moment
- contrast
- correlation
- sum of squares
- inverse difference moment
- sum average
- sum variance
- sum entropy
- entropy
- difference variance
- difference entropy

Wordlength effect on digital image

8 bits

5 bits

4 bits

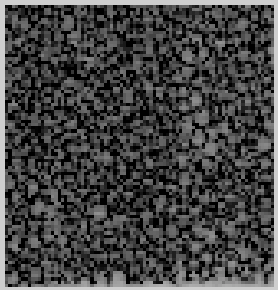
3 bits

2 bits

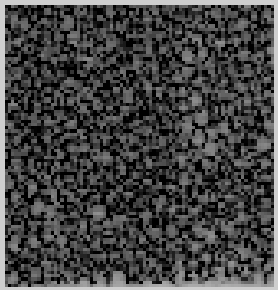
1 bit

Wordlength effect on digital texture

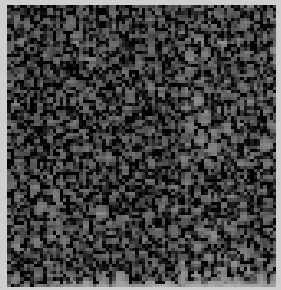
8 bits



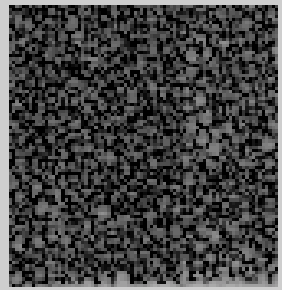
7 bits



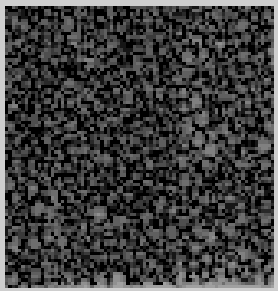
6 bits



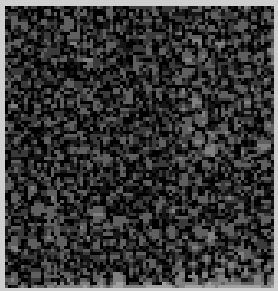
5 bits



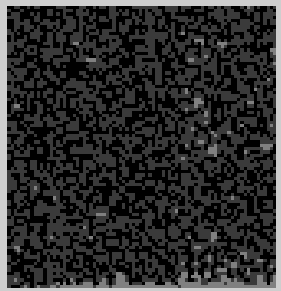
4 bits



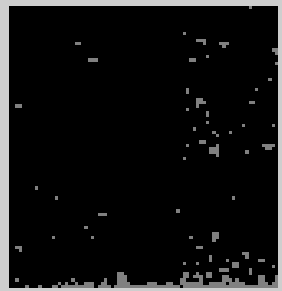
3 bits



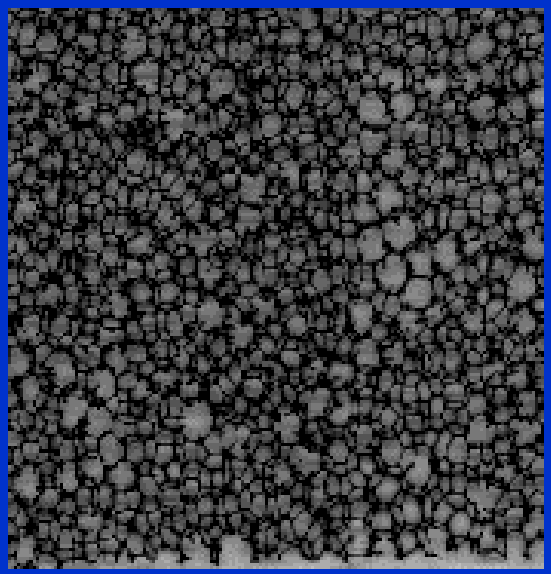
2 bits



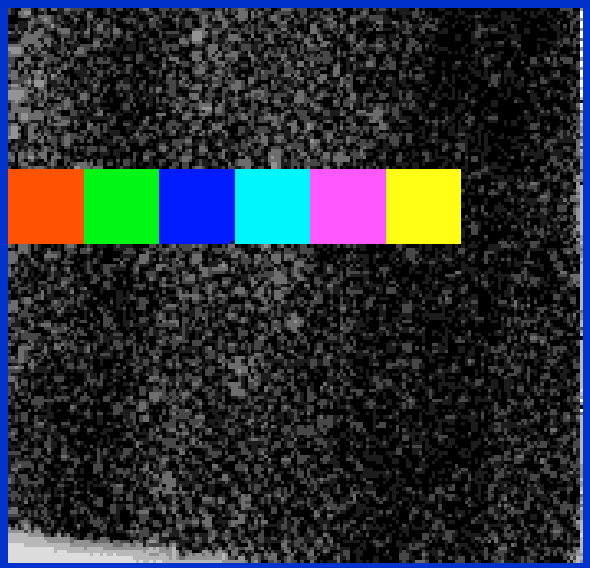
1 bit



Synthetic foam textures



Foam001.bmp



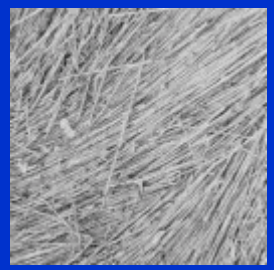
Foam002.bmp

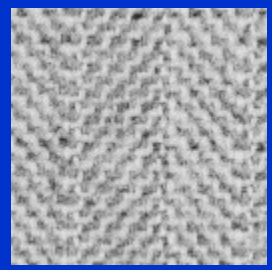
48 ROIs with dimensions 23x23 pixels, placed uniformly on the image

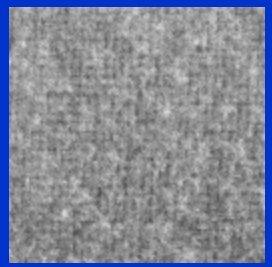
Textures from Brodatz catalogue

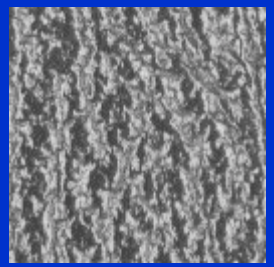

Grass

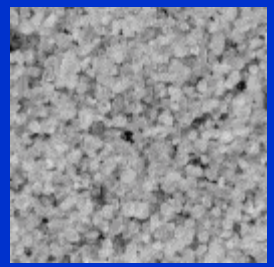

Bark

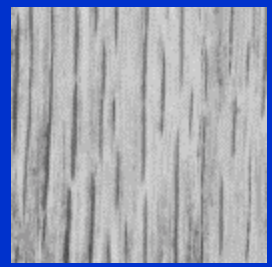

Straw

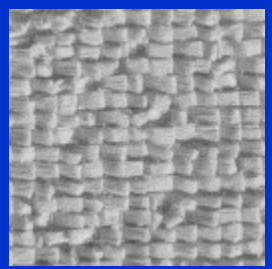

Herringbone weave

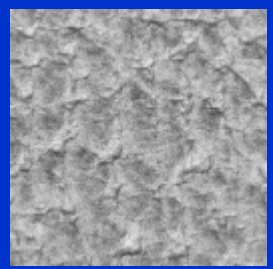

Woolen cloth

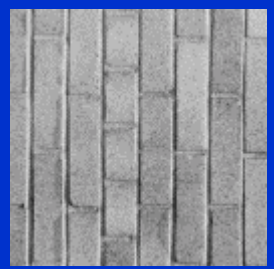

Pressed calf leather

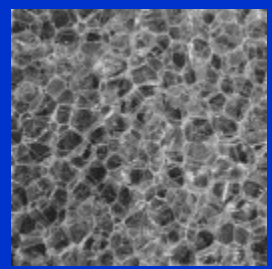

Beach sand


Wood grain


Raffia


Pigskin

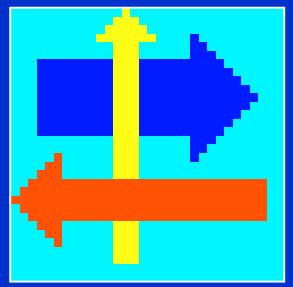

Brick wall


Plastic Bubbles

http://www.eletel.p.lodz.pl/cost/download_eng.html

Methods

MaZda



Convert

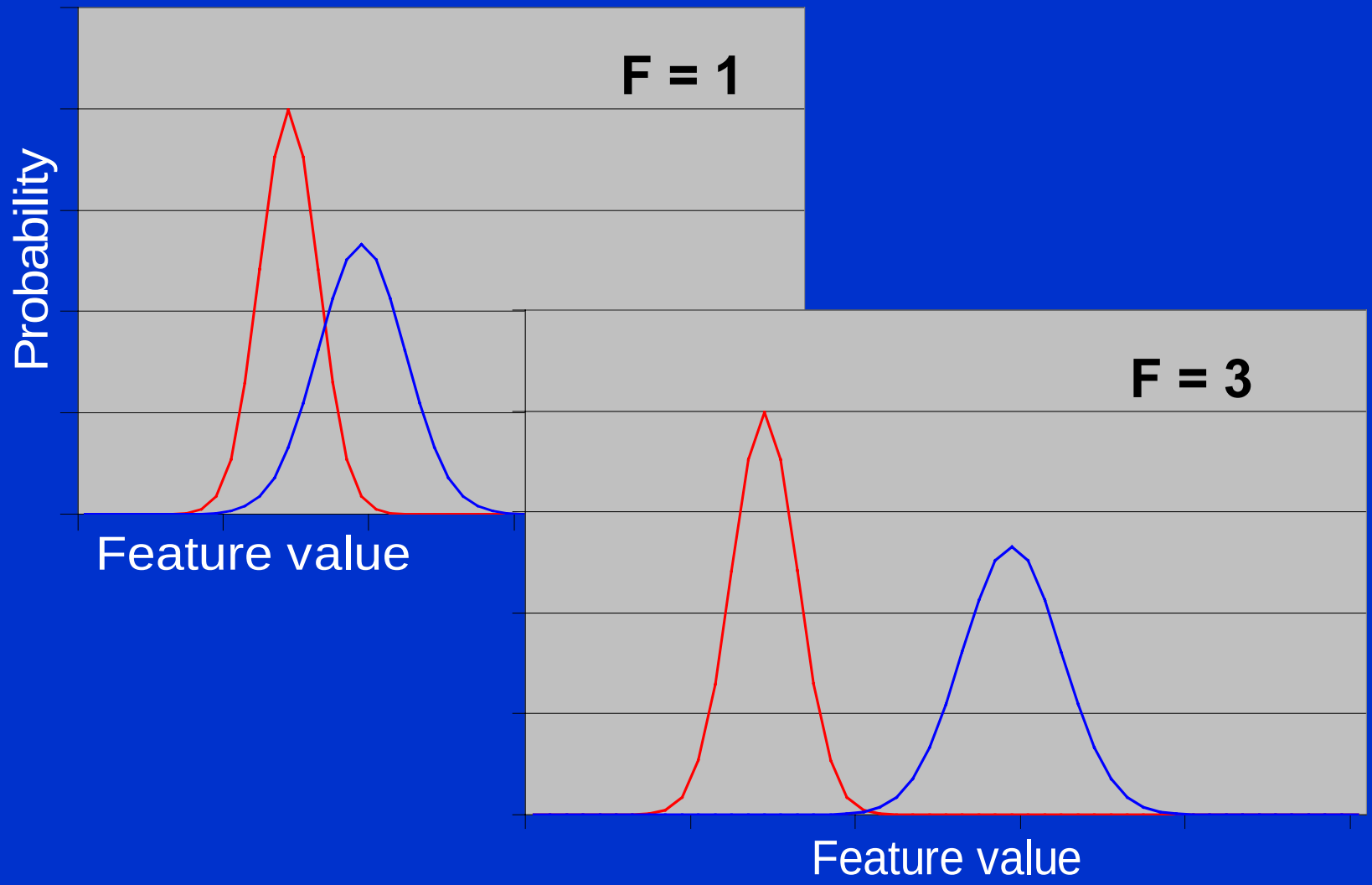
CALCULATION OF F COEFFICIENT FOR EACH TEXTURE PAIR

11 CO matrix features,
distance = 1,
directions: 0°, 45°, 90°, 135°

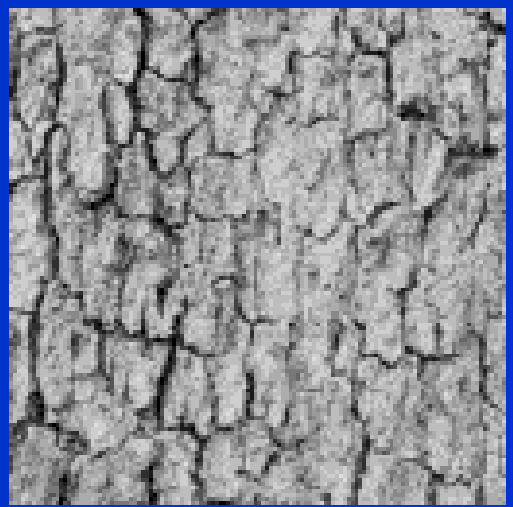
$$F = \frac{|\mu_{T1} - \mu_{T2}|}{\sigma_{T1} + \sigma_{T2}}$$

F is calculated for each number of bits (4 ÷ 8)

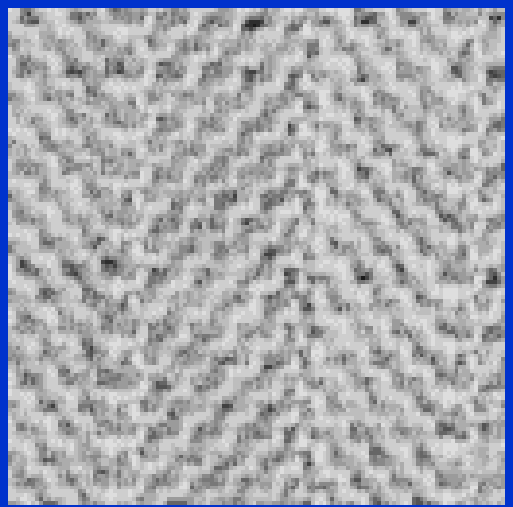
Example of feature distributions



Example of texture pair with F<1

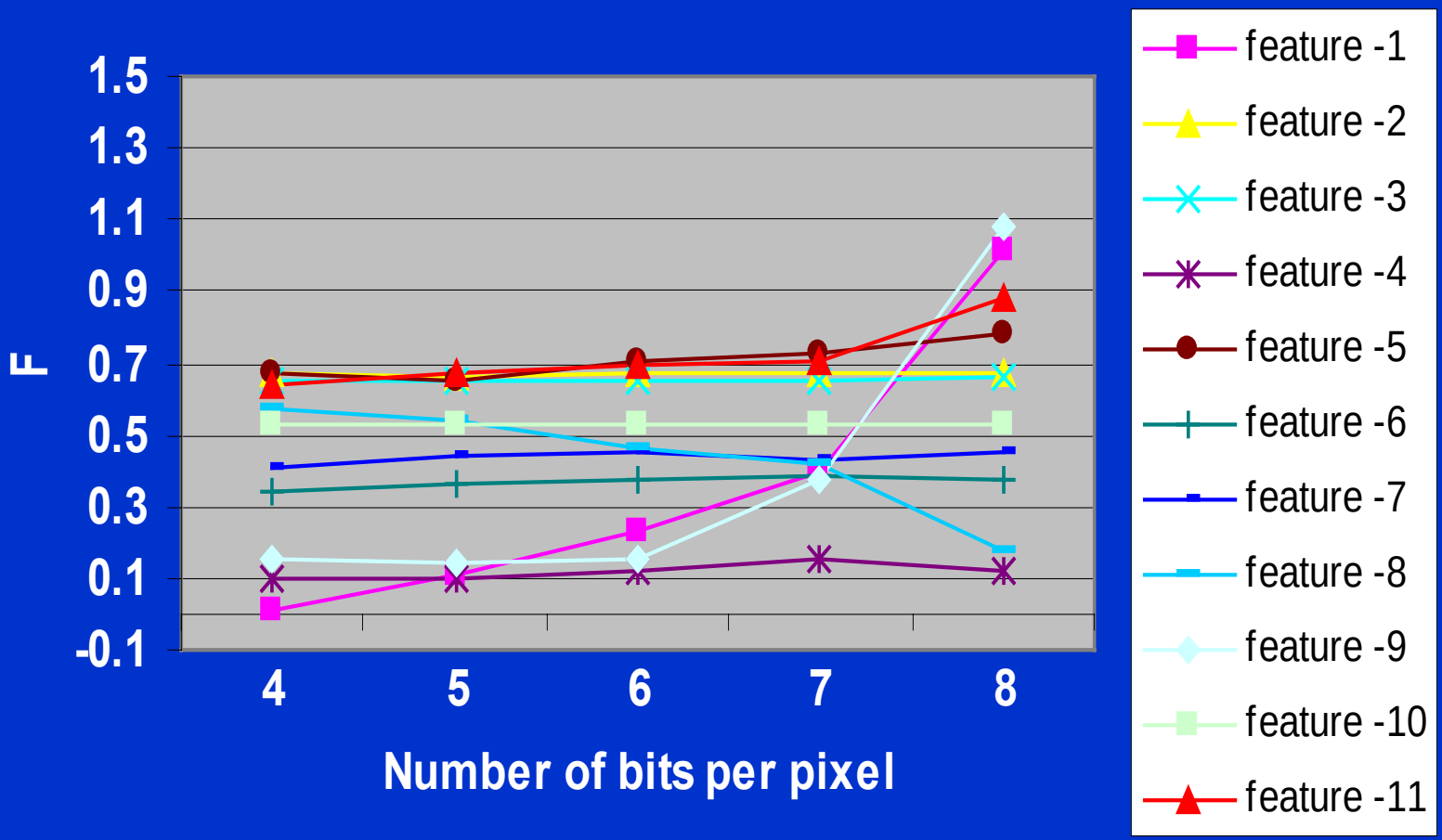


Bark

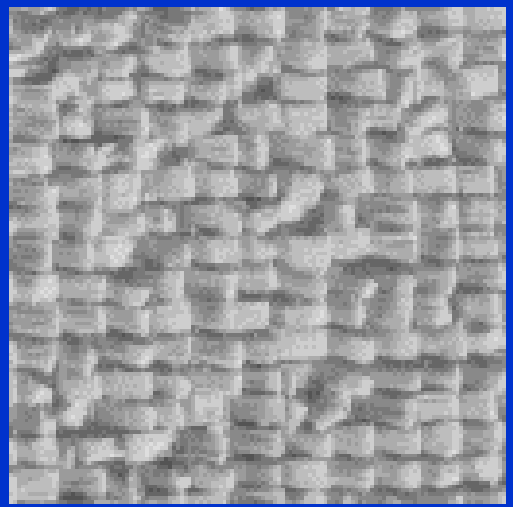


Herringbone weave

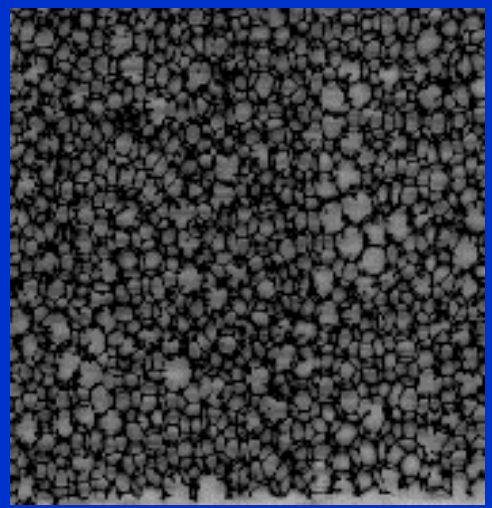
F(#bits) for Bark and Herringbone weave



Example of texture pair with F>3

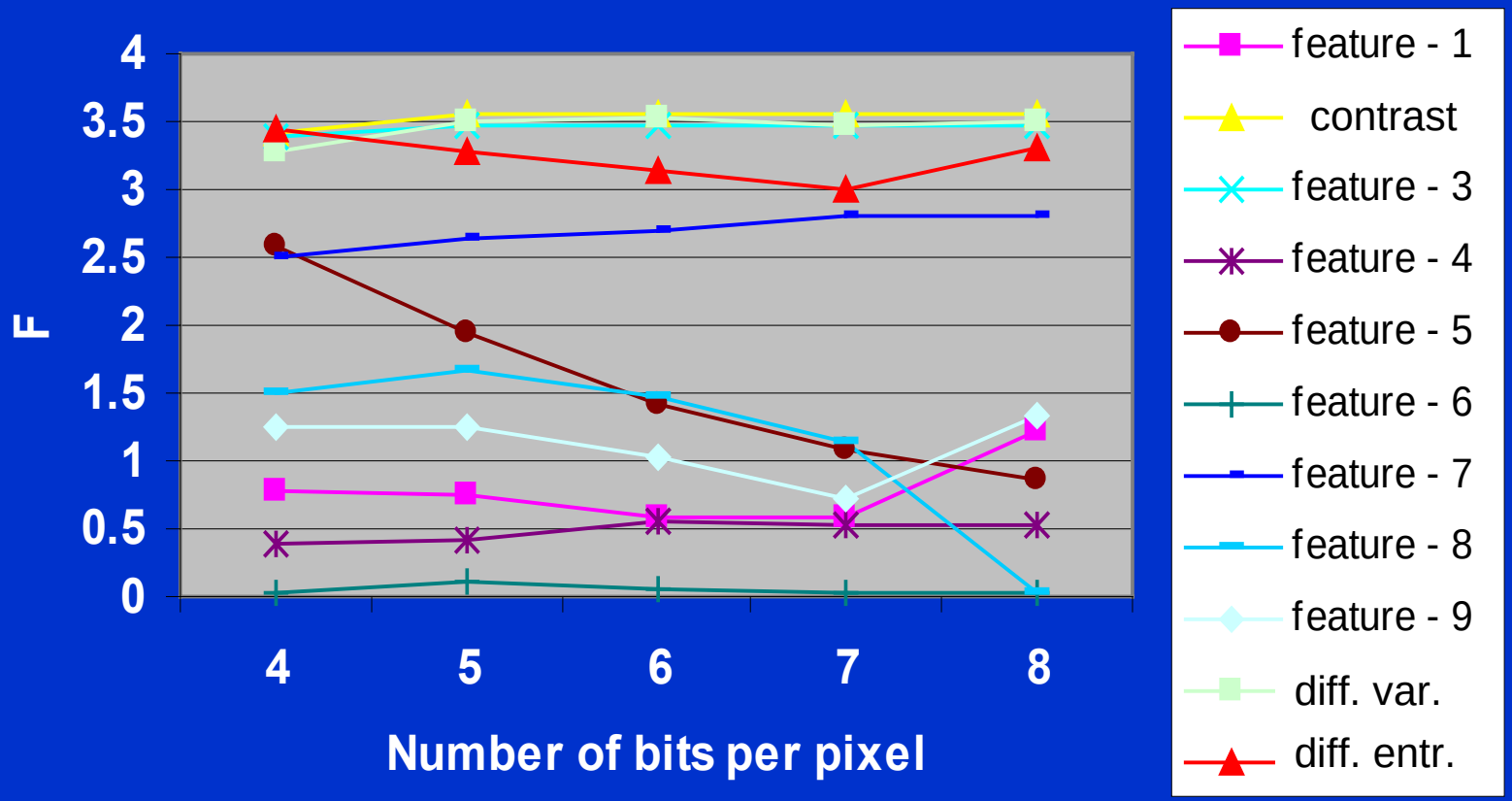


Raffia

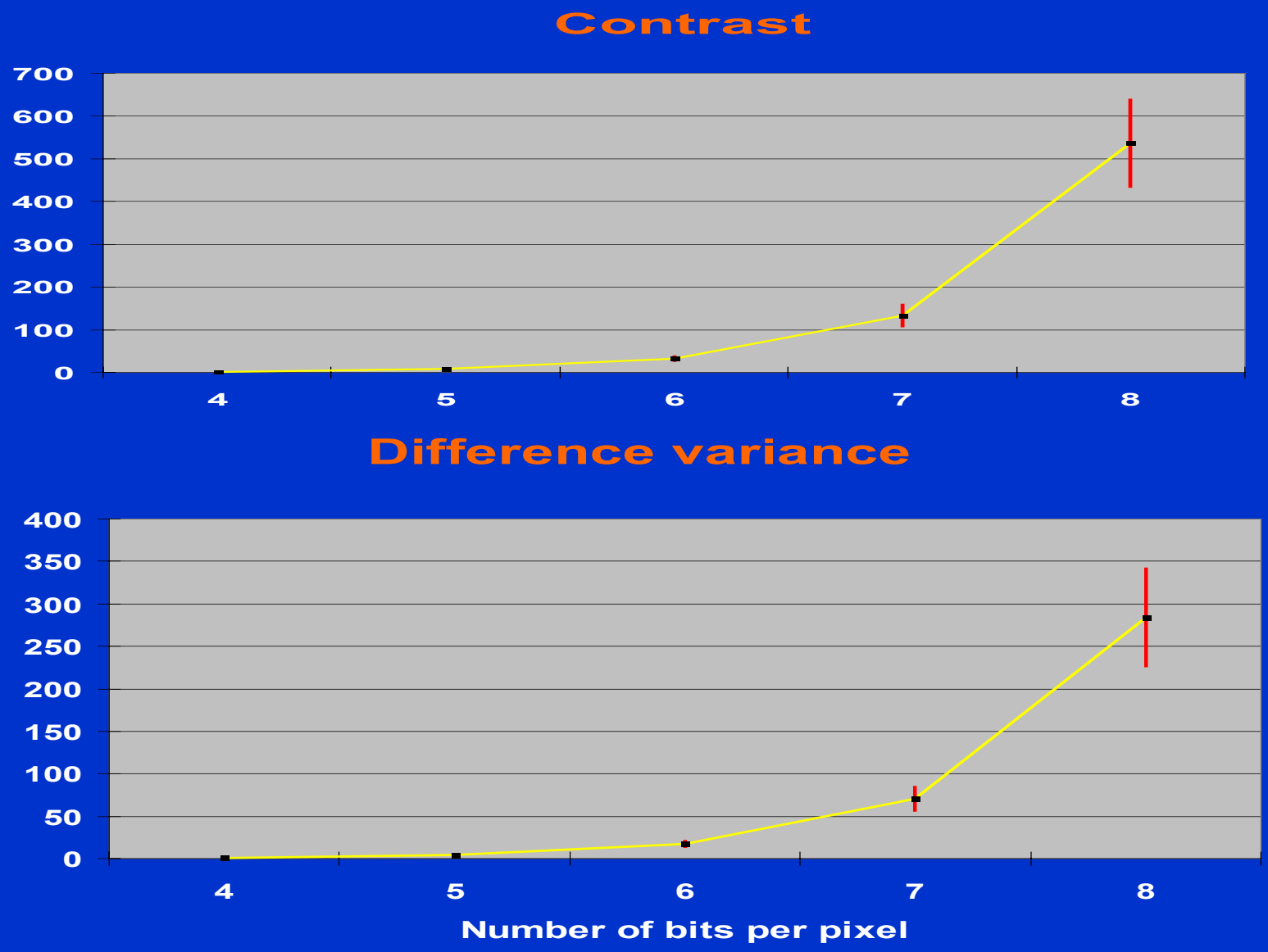


foam001

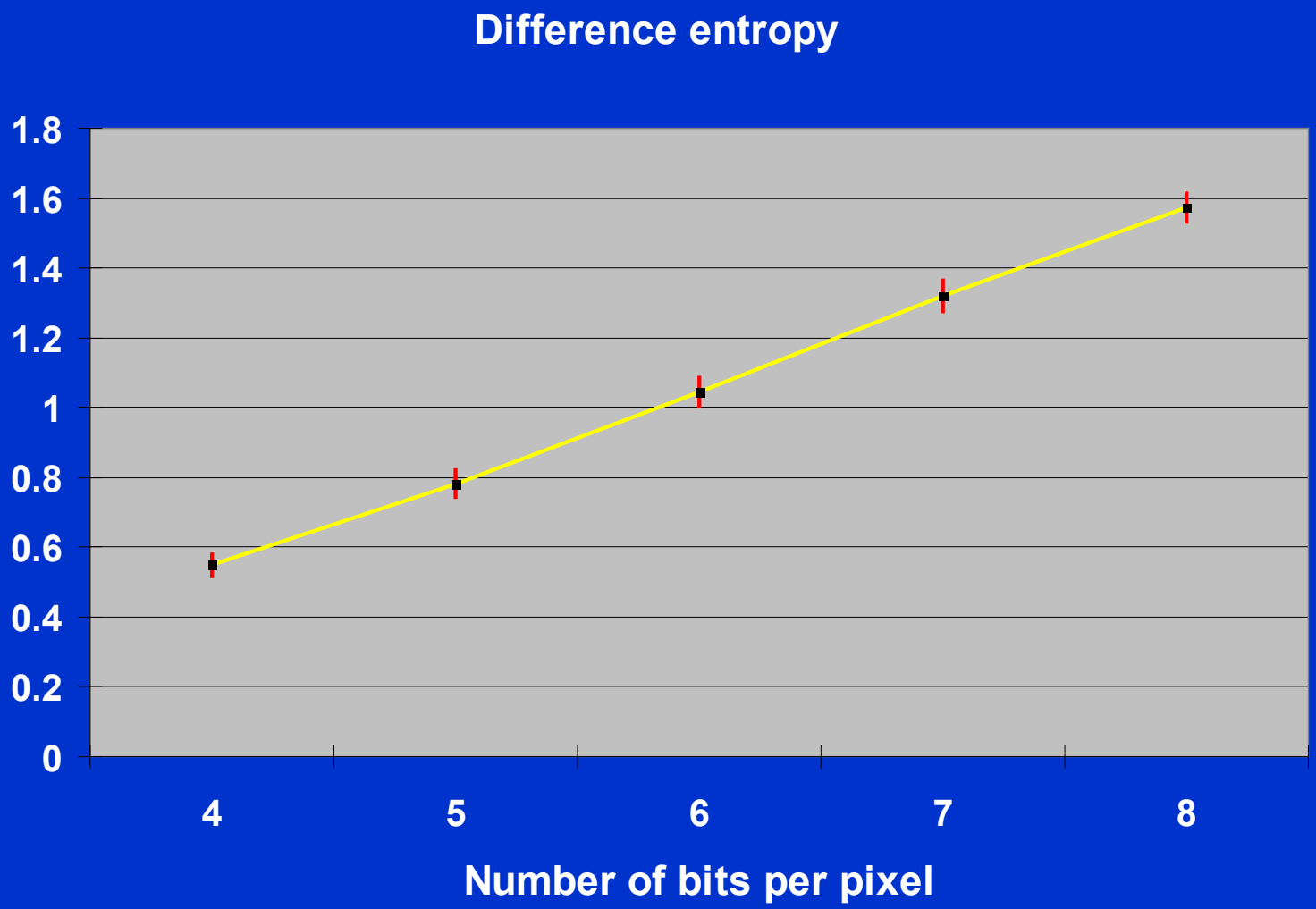
F(#bits) for Raffia and foam001



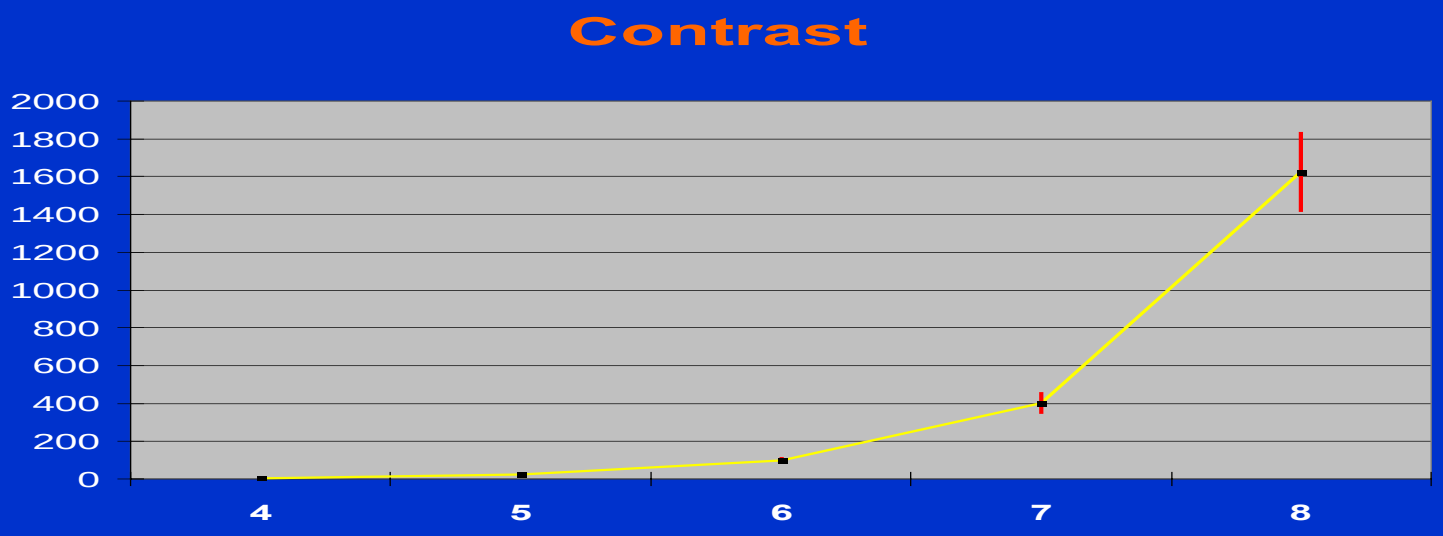
Features for Raffia with F>3

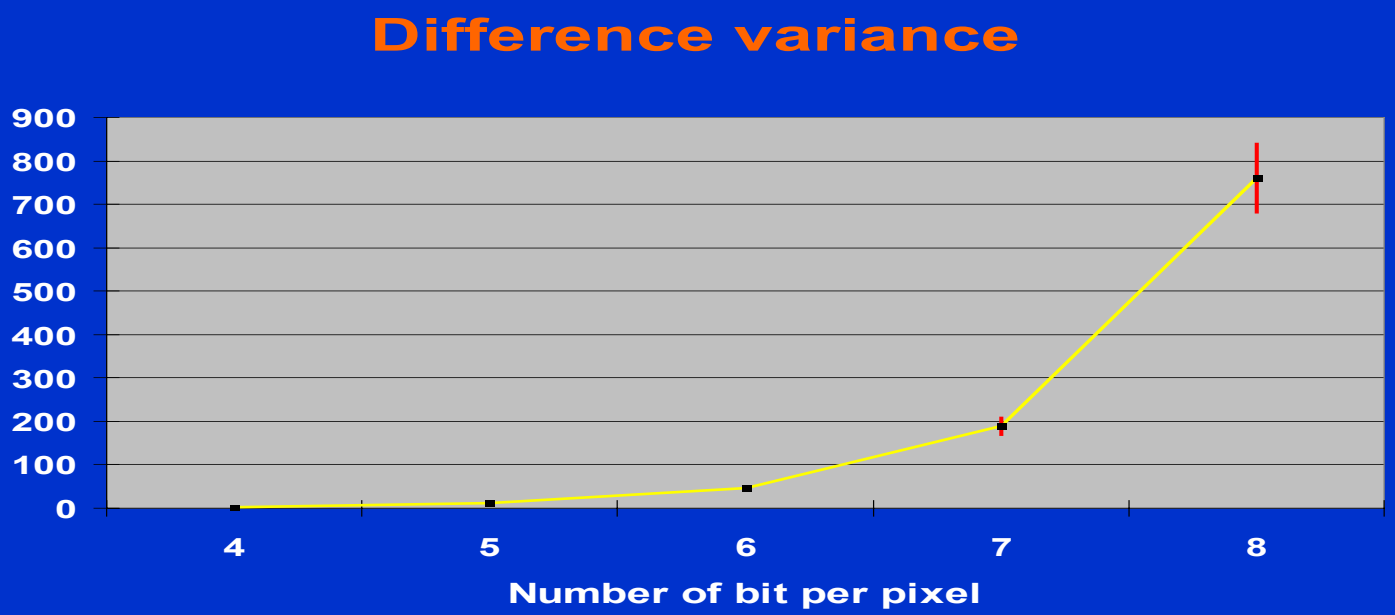


Features for Raffia with F>3

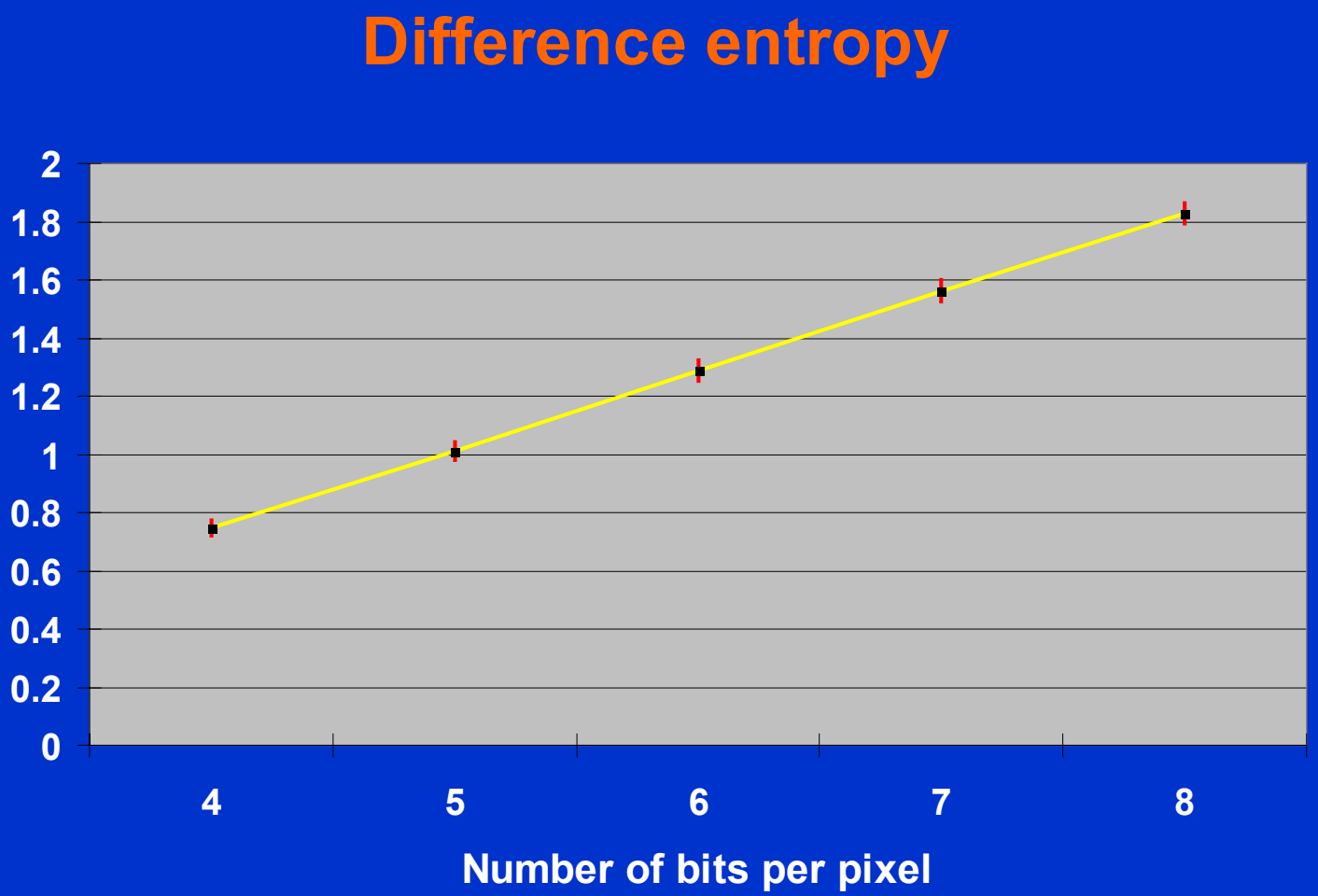


Features for Foam001 with F>3

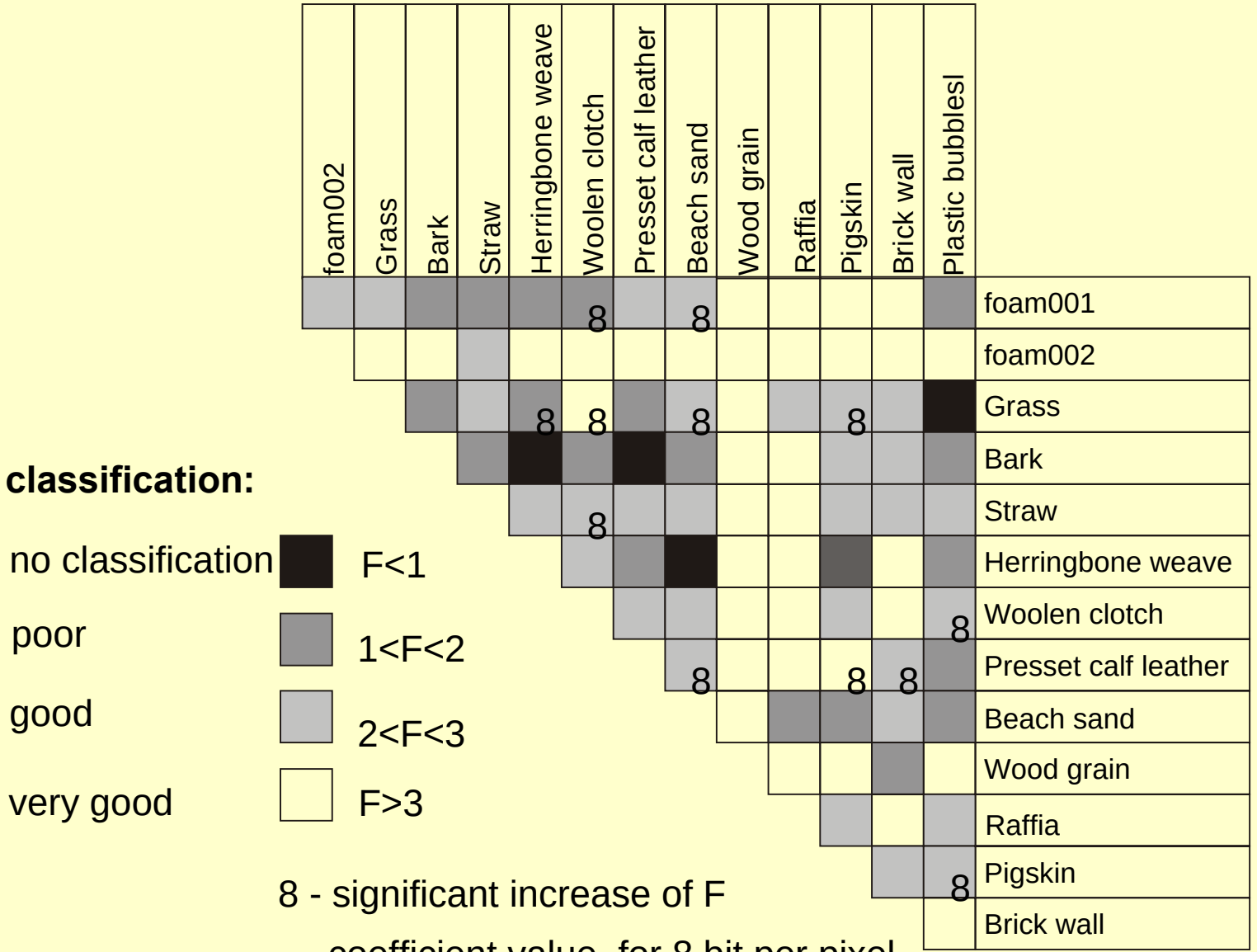




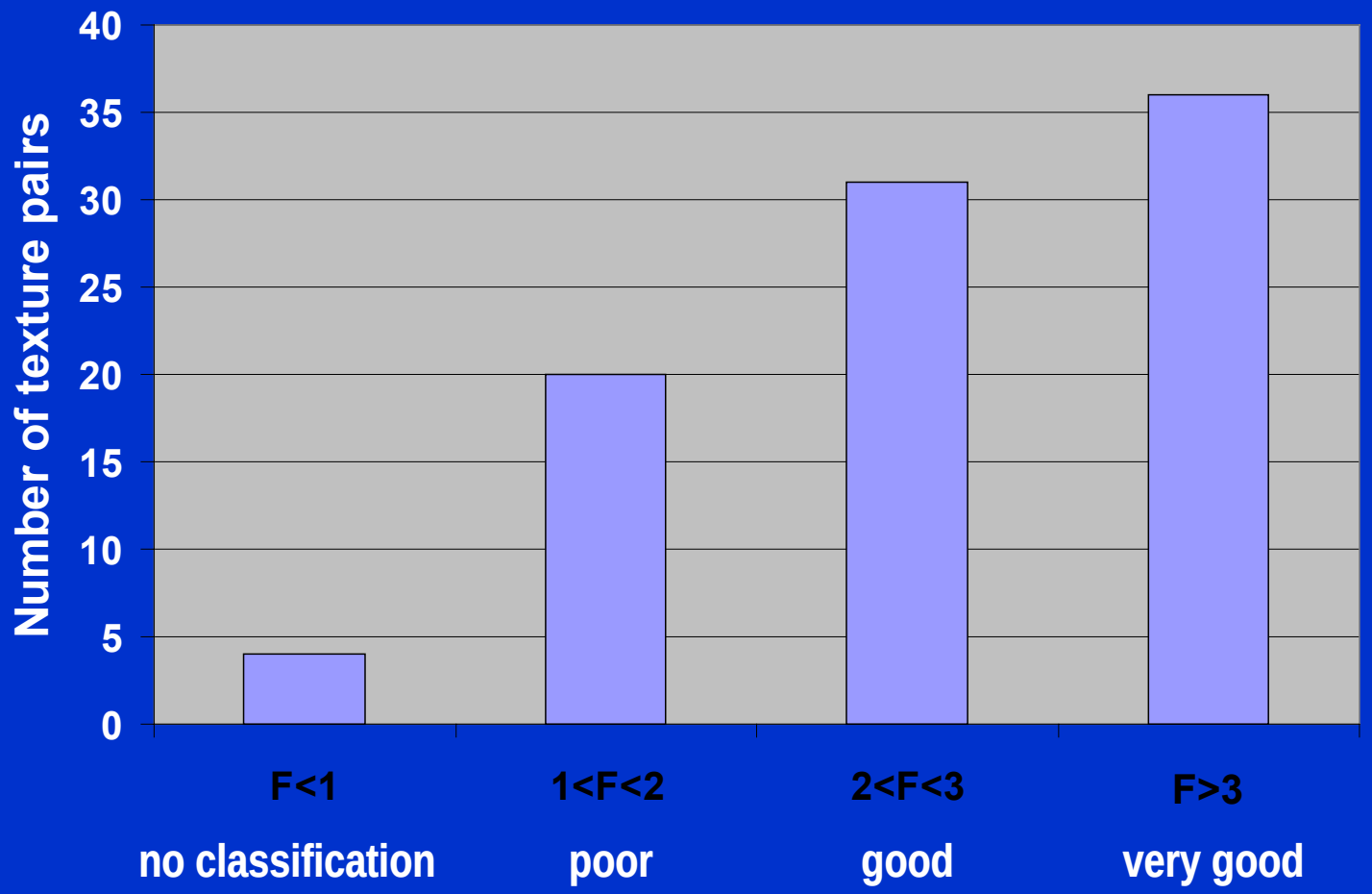
Features for Foam001 with F>3



F range for analysed pairs of textures



Distribution of F for analysed textures



Properties of considered features

No	Feature name	F value variability
1	angular second m.	no specific trend observed
2	contrast	constant value not dependent on word length
3	correlation	constant value not dependent on word length
4	sum of squares	constant value not dependent on word length, F<1
5	inverse difference m.	no specific trend observed
6	sum average	constant value not dependent on word length, F<1
7	sum variance	constant value not dependent on word length
8	sum entropy	no specific trend observed
9	entropy	no specific trend observed
10	difference variance	constant value not dependent on word length
11	difference entropy	no specific trend observed

Conclusions

- CO features (distance=1) are a powerful tool for texture separation, however not all texture pairs were separated well.
- The followed features: sum of squares and sum average are useless for texture classification.
- For the features: contrast, correlation, sum variance and difference variance F value does not depend on the number of bits used for image brightness coding.
- Discriminative power of the other CO features depends on particular textures considered.