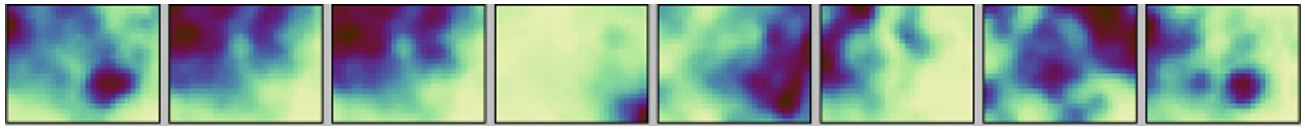
International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision '2008



An Image-Based Approach to Visual Feature Space Analysis

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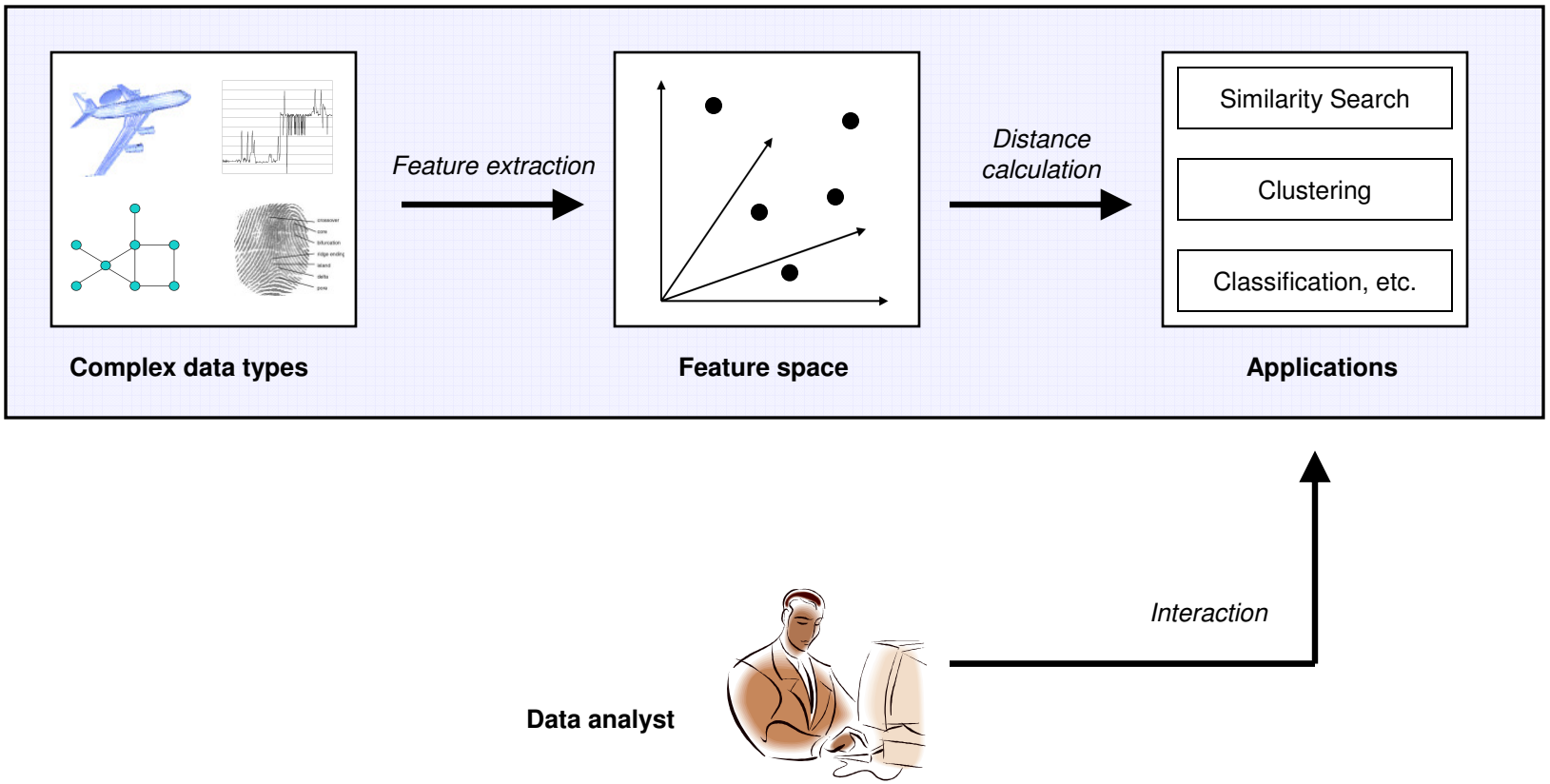
University of Konstanz, Germany

1. Introduction (1)



1. Introduction (2)

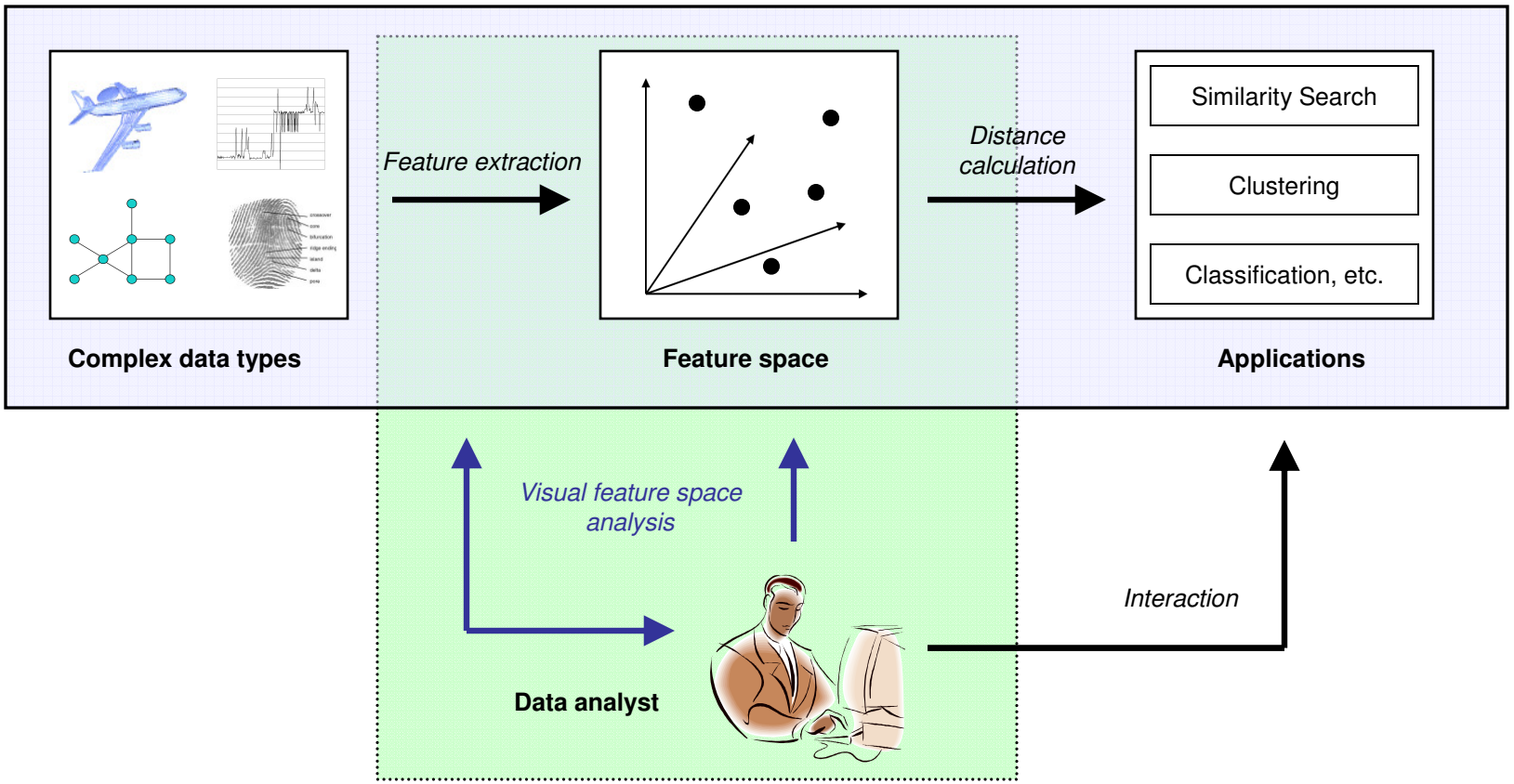
Feature extraction

- Features usually heuristically introduced
- Abundance of features in many domains
  - →What are the most effective features?
  - →What is the most efficient representation?

Benchmarking

- Select features using labeled training data base
- Problem: Data-dependent, may be instable [M02]
- Idea: semi-supervised visual feature space analysis

1. Introduction (3)

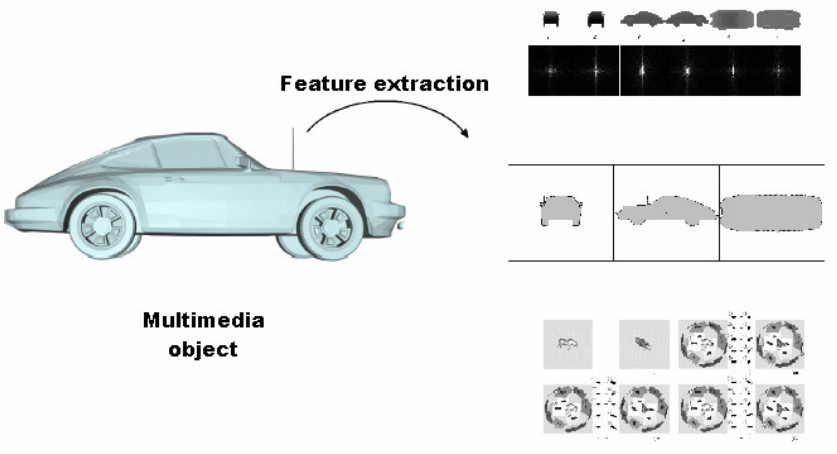


2. Background (1)

Visual feature space analysis?

3D model retrieval project [BKSSV05, BKSSV06]

- Implemented many (global image-, surface, volume-based) 3D descriptors
- Benchmarking experiments (PSB, PESB, Konstanz, ...)
- User interface based on Self-Organizing Map (SOM) algorithm



FV name	dim.	R-prec.
DSR	472	42.61%
DBF	259	31.16%
VOX	343	31.13%
SIL	375	28.15%
CPX	169	27.08%
3DDFT	173	25.08%
GRAY	120	22.54%
RIN	155	22.52%
H3D	128	20.20%
SD2	130	18.36%
COR	30	15.75%
PMOM	52	14.82%

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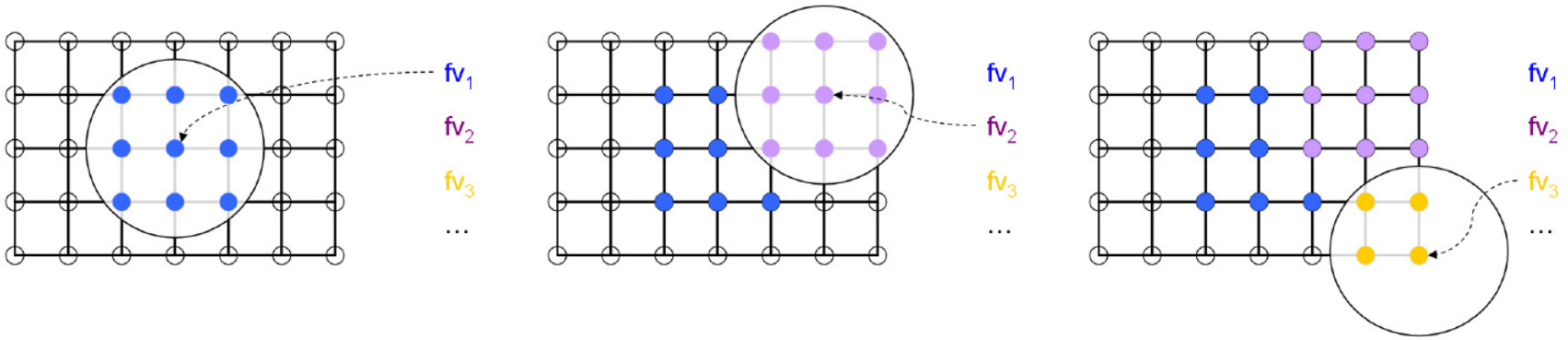

(a) Step 1 (b) Step 2 (c) Step 3

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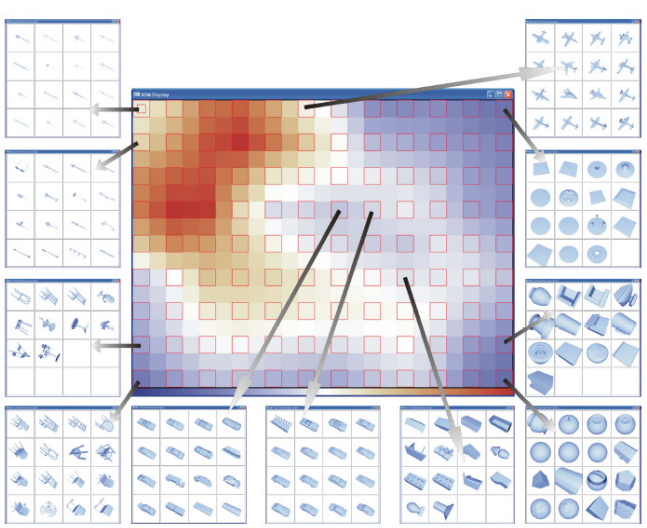
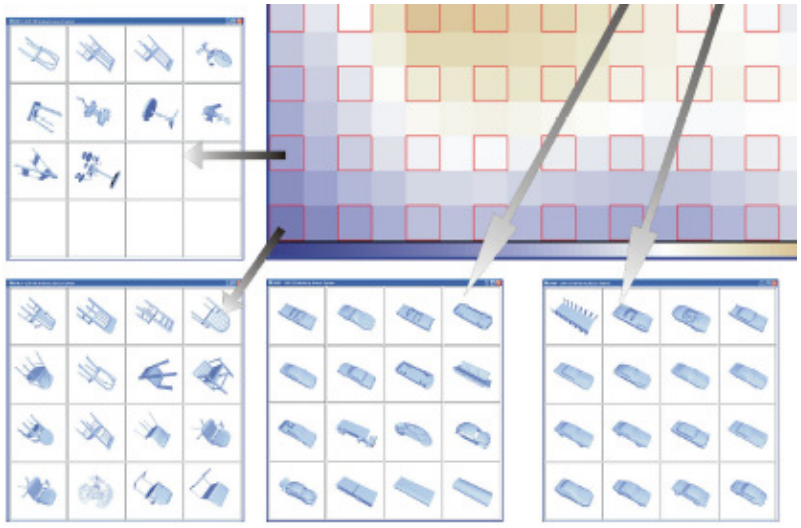
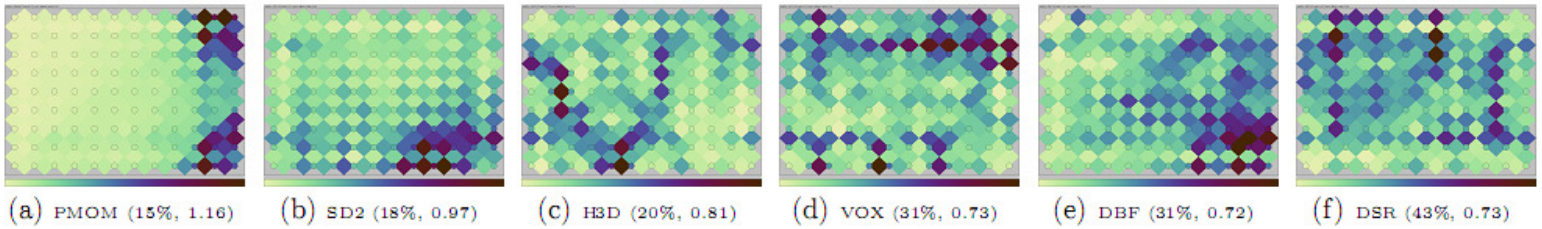




2. Background (2)

Observations made in SOM space

- Distribution of distances between SOM cluster prototypes correlates with discrimination power of feature vectors
- Experiments on the Princeton Shape Benchmark and competing global 3D descriptors and synthetic data [SPK06, SFK08]

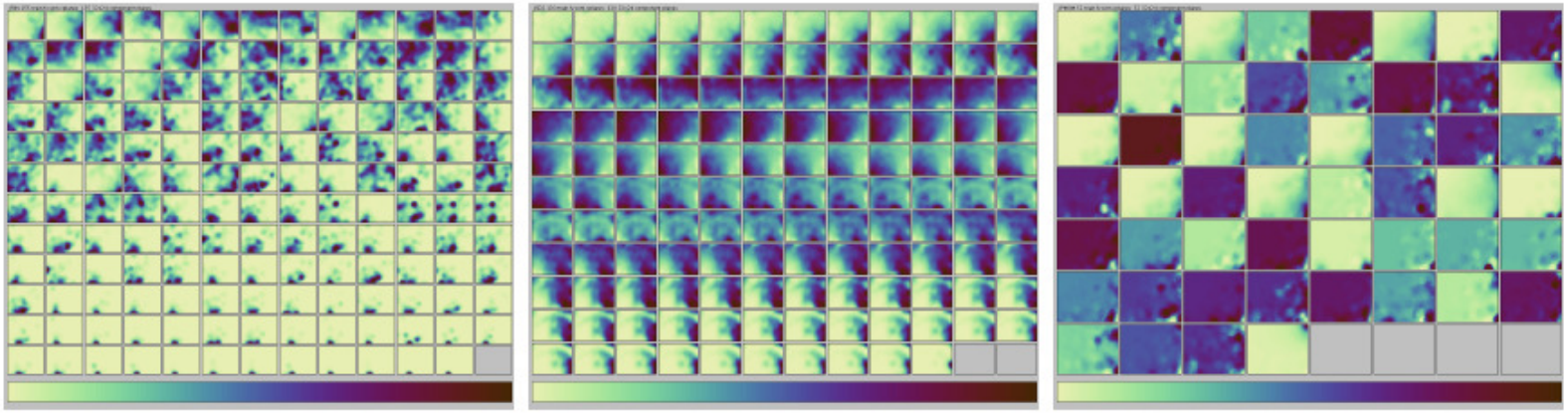


- This work: analysis function based on distribution of SOM cluster prototype components

3. Component-Based Analysis (1)

Visual component space analysis

- Distribution of components
- Correlation of components
- Visual analysis for anomalies

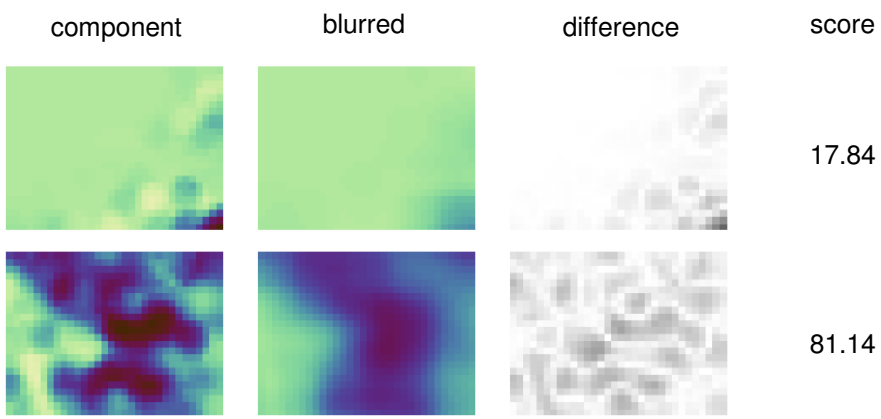


(j) RIN (228.07, 22.52%) (k) SD2 (178.24, 18.36%) (l) PMOM (70.89, 14.82)

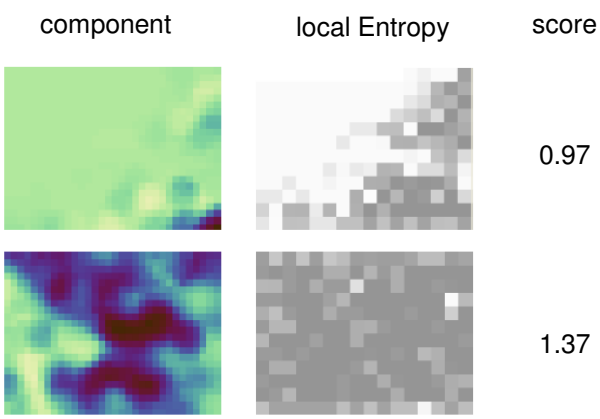
3. Component-Based Analysis (2)

Automatic component space analysis

- Inspired by image processing
- Measure information contained in component images
- Estimate discrimination power from these measures



Measure 1: Difference to blurred (dtb)



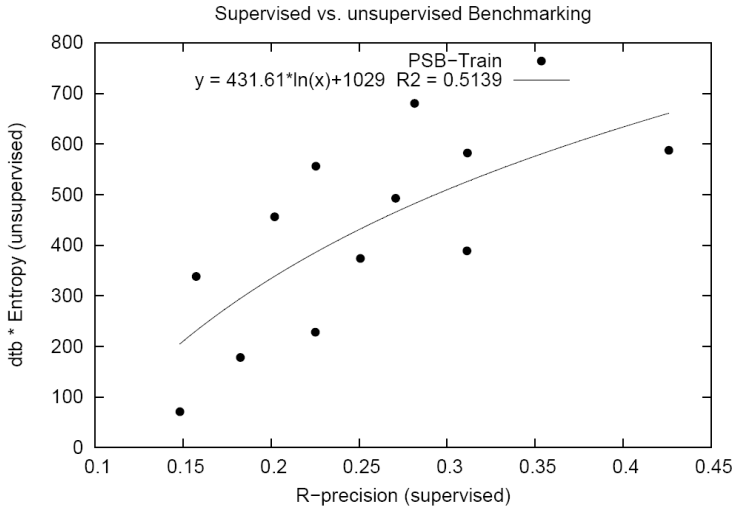
Measure 2: Local entropy (E)

3. Component-Based Analysis (3)

Evaluation on PSB benchmark in 12 FV spaces

- Generate 32x24 SOMs, extract dtb and E scores from CPA images
- Correlate with supervised scores

FV name	dim.	R-prec.	dtb	E	comb.
DSR	472	42.61%	28.33	20.73	587.23
DBF	259	31.16%	27.15	21.46	582.30
VOX	343	31.13%	25.29	15.38	388.94
SIL	375	28.15%	31.94	21.30	680.26
CPX	169	27.08%	26.01	18.93	492.50
3DDFT	173	25.08%	20.41	18.31	373.76
GRAY	120	22.54%	28.66	19.41	556.22
RIN	155	22.52%	15.53	14.68	228.07
H3D	128	20.20%	25.07	18.19	456.06
SD2	130	18.36%	11.74	15.18	178.24
COR	30	15.75%	17.83	18.97	338.24
PMOM	52	14.82%	12.22	5.80	70.89

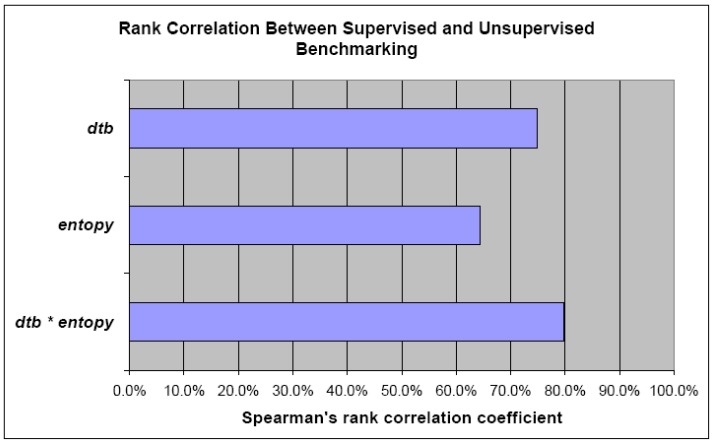


3. Component-Based Analysis (4)

Evaluation on PSB benchmark in 12 FV spaces

- Generate 32x24 SOMs, extract dtb and E scores from CPA images
- Correlate with supervised scores

FV name	R-prec.	dtb	E	comb.
DSR	1	+2	+2	+1
DBF	2	+2	-1	+1
VOX	3	+3	+6	+4
SIL	4	-3	-2	-3
CPX	5	0	+1	0
3DDFT	6	+2	+1	+2
GRAY	7	-5	-3	-3
RIN	8	+2	+3	+2
H3D	9	-2	-1	-3
SD2	10	+2	0	+1
COR	11	-2	-6	-2
PMOM	12	-1	0	0



4. Conclusions

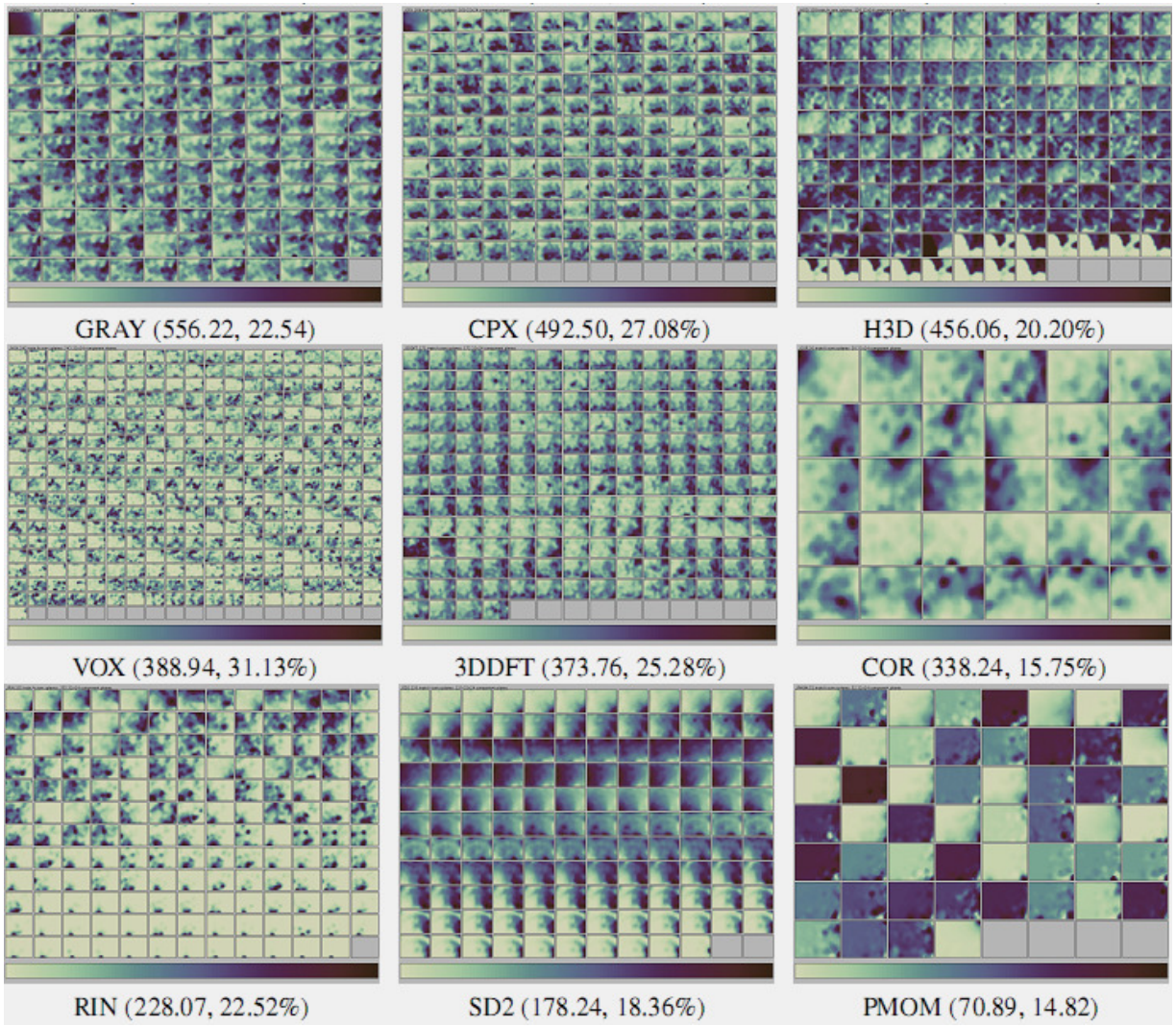
This work

- Visual feature space analysis to complement benchmarking
- Promising for interactive and automatic / (semi)unsupervised feature space benchmarking

Future work

- Elaborate on theoretical foundation and limitations
- More validation
- Apply on other data mining tasks
- Goal: Integrate visual feature space analysis into feature-based retrieval and minig applications

Thank you


GRAY (556.22, 22.54)
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