Imperial College London

Image search through browsing using NN^k networks

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TRECVID 2003

Overview

- Image and Collection Preprocessing
- Search and Relevance Feedback
- Temporal Browsing and **NN^k Browsing**
- TVID Results

Preprocessing

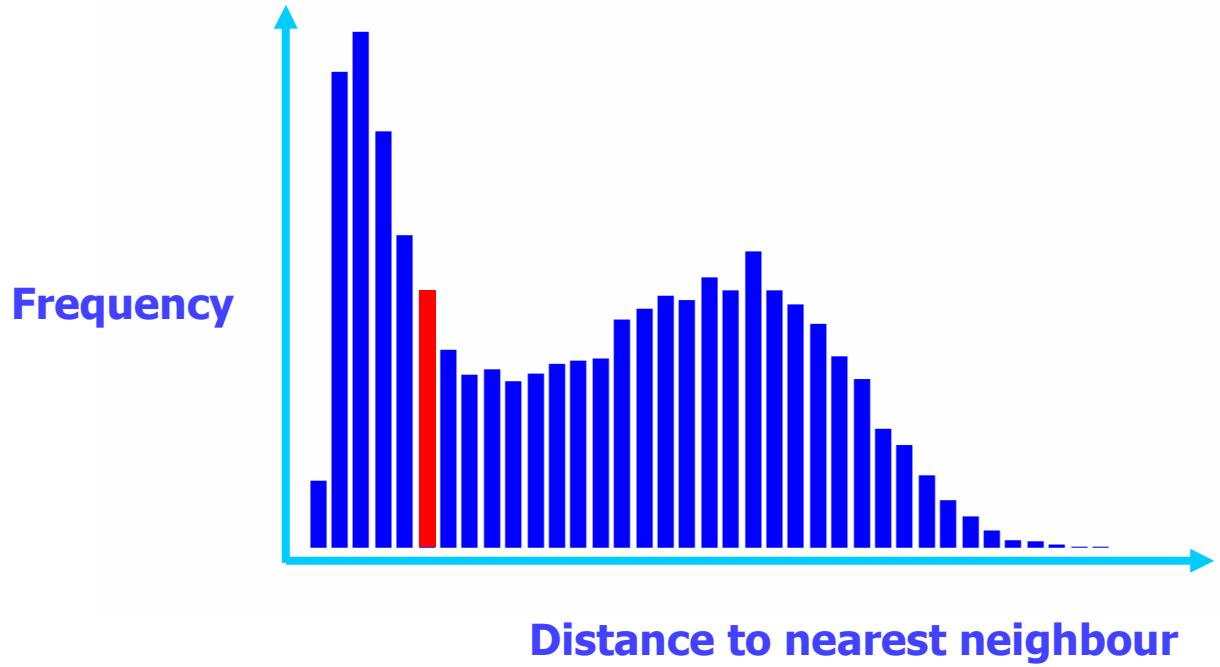
- Use only common keyframes + LIMSI transcript
- Removal of bottom 51 lines

11 Primitive Features

- 4 Colour
  - global HSV, centre HSV, marginal RGB colour moments, colour structure descriptor
- 2 Structure
  - convolution map features on grey image
- 3 Texture
  - simple features on image tiles
- 1 Annotation
  - Bag of stemmed-words (tf-idf)
- 1 Localisation
  - Thumbnail of grey image

44x27 Thumbnail: Ad detection

- average pixel difference between two thumbnails



Distance of topic Q to image i given feature f

- $dist_f$: Manhatten
- KNN distance
  - positive examples (set Q)
  - negative examples (set N, random)

$$d_f(Q, i) = \frac{\sum_{n \in N} (dist_f(n, i) + \varepsilon)^{-1}}{\sum_{q \in Q} (dist_f(q, i) + \varepsilon)^{-1} + \varepsilon}$$

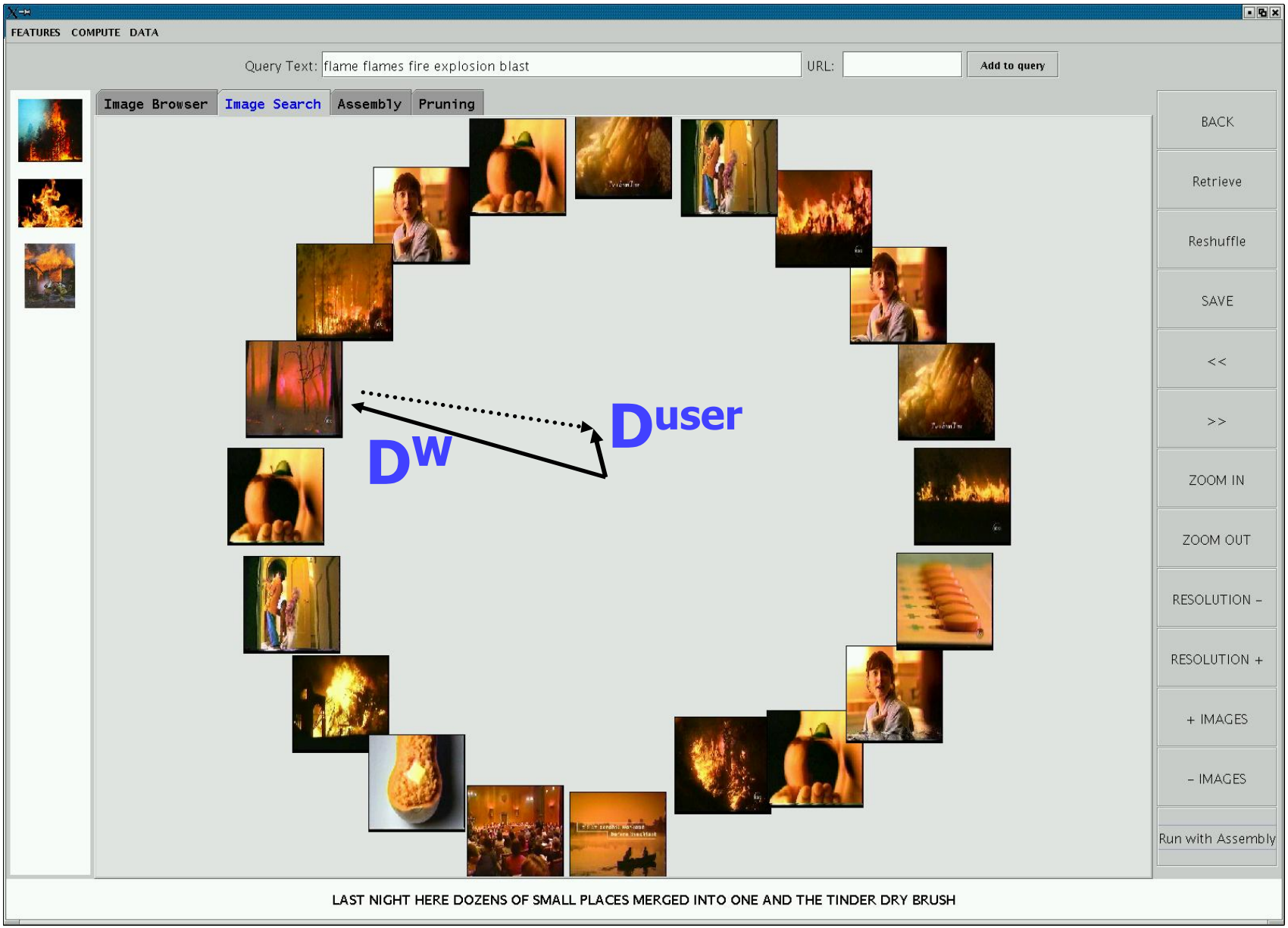
Fusion of features

- Convex combination

$$D^{w}(Q, i) = \sum_{f} w_f d_f(Q, i)$$

- **w** is the “plasticity” of our retrieval system

Relevance Feedback



Relevance Feedback

- Minimize

$$\sum_i \left(D^{user}(Q,i) - D^{w}(Q,i)\right)^2$$

with respect to **w** and convexity constraint.

Browsing

- Hierarchical (not yet)
- In ranked list (not shown)
- Temporal
- Lateral

Temporal Browsing

- Movement along a sequence of shots

Temporal Browsing

- Movement along a sequence of shots

Temporal Browsing

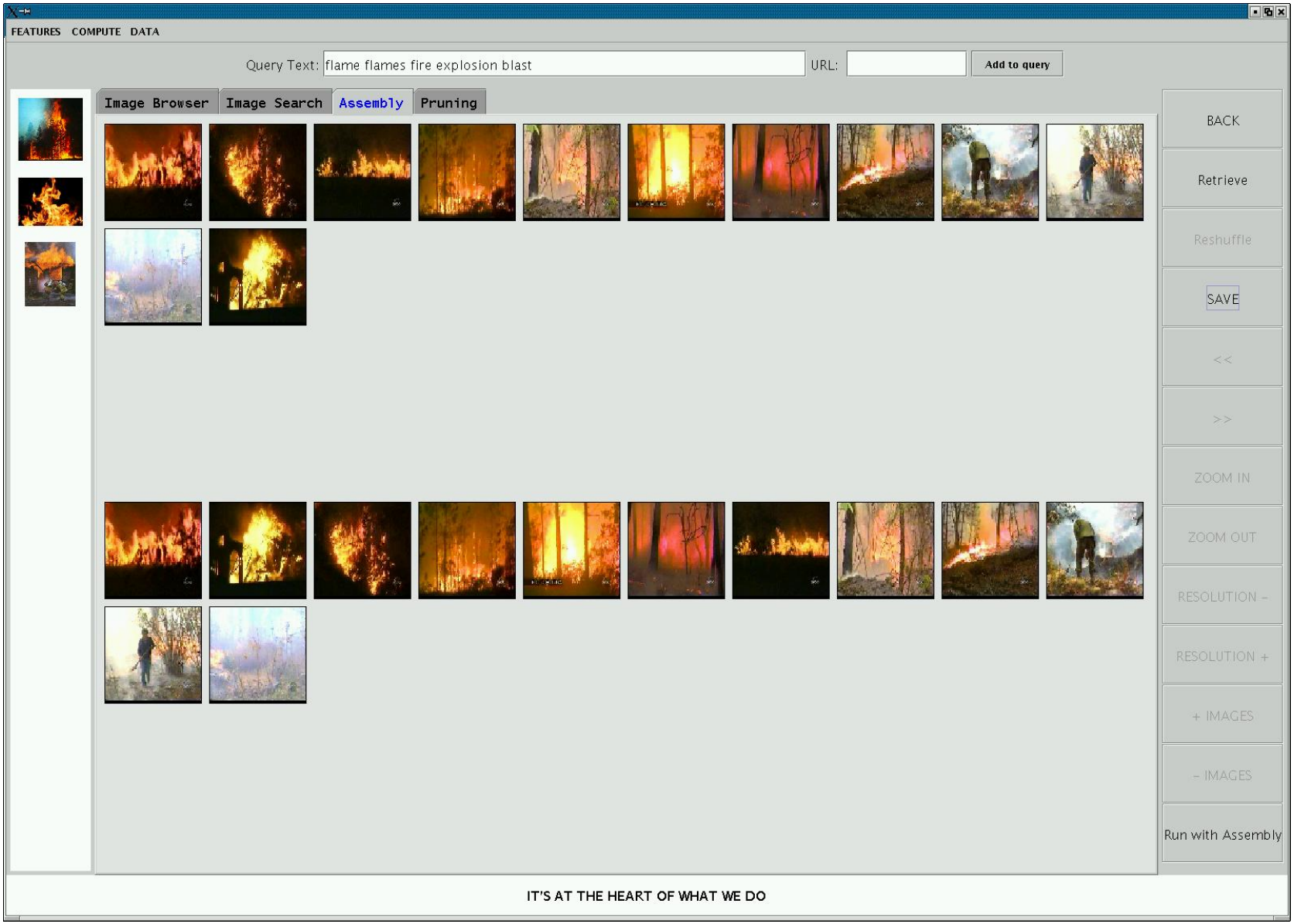
- Movement along a sequence of shots

Temporal Browsing

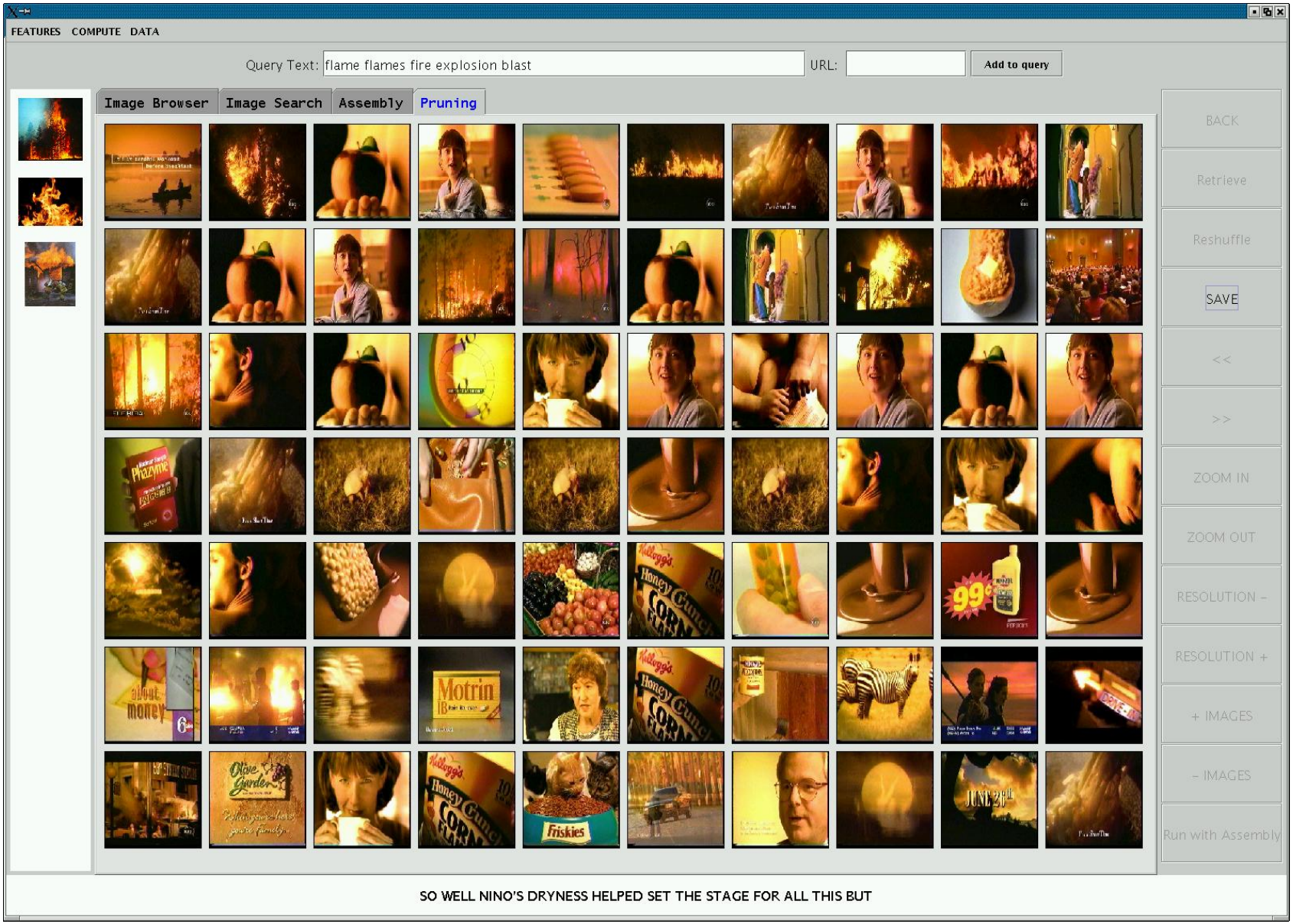
- Movement along a sequence of shots

- Q: Add to query panel
- A: Add to assembly panel

Assembly panel



Pruning Panel



Lateral Browsing

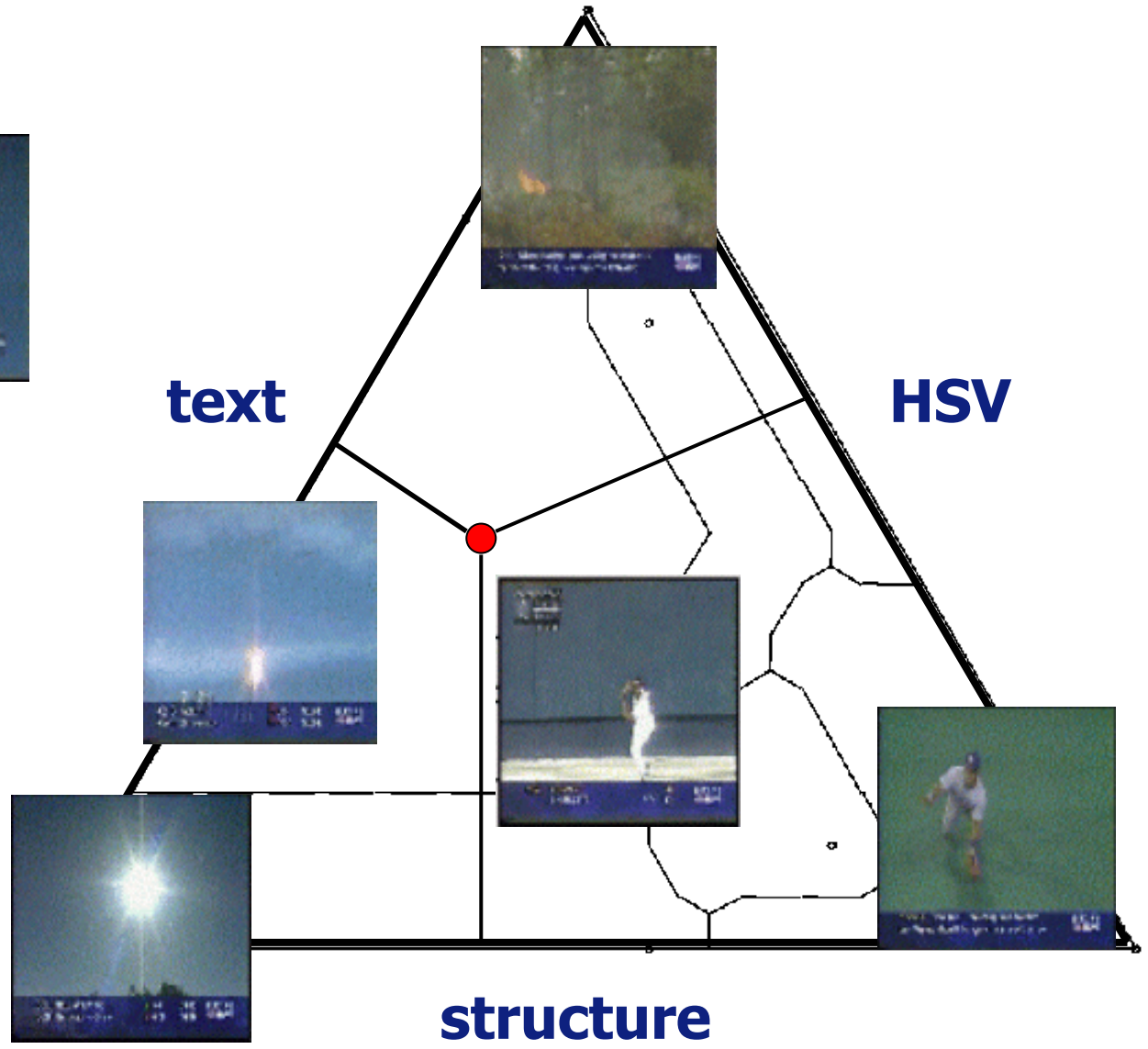
- Images as vertices in a directed graph
- Instantiate arc (i,j) iff there is a feature combination w such that j is closest to i
- NN^k network

NN^k Network construction

- For each image
  - for each *w* determine nearest neighbour and compute corresponding proportion of weight space (= edge weight)
  - store adjacent images and edge weights

Sampling the weight space

query



Rationale

- exposure of semantic richness
- user decides which image meaning is the correct one
- network precomputed -> interactive
- supports search without query formulation

Properties

- small average distance between any two vertices (three nodes for 32,000 images)
- high clustering coefficient: an image´s neighbours are likely to be neighbours themselves
- vertex degrees follow power-law distribution

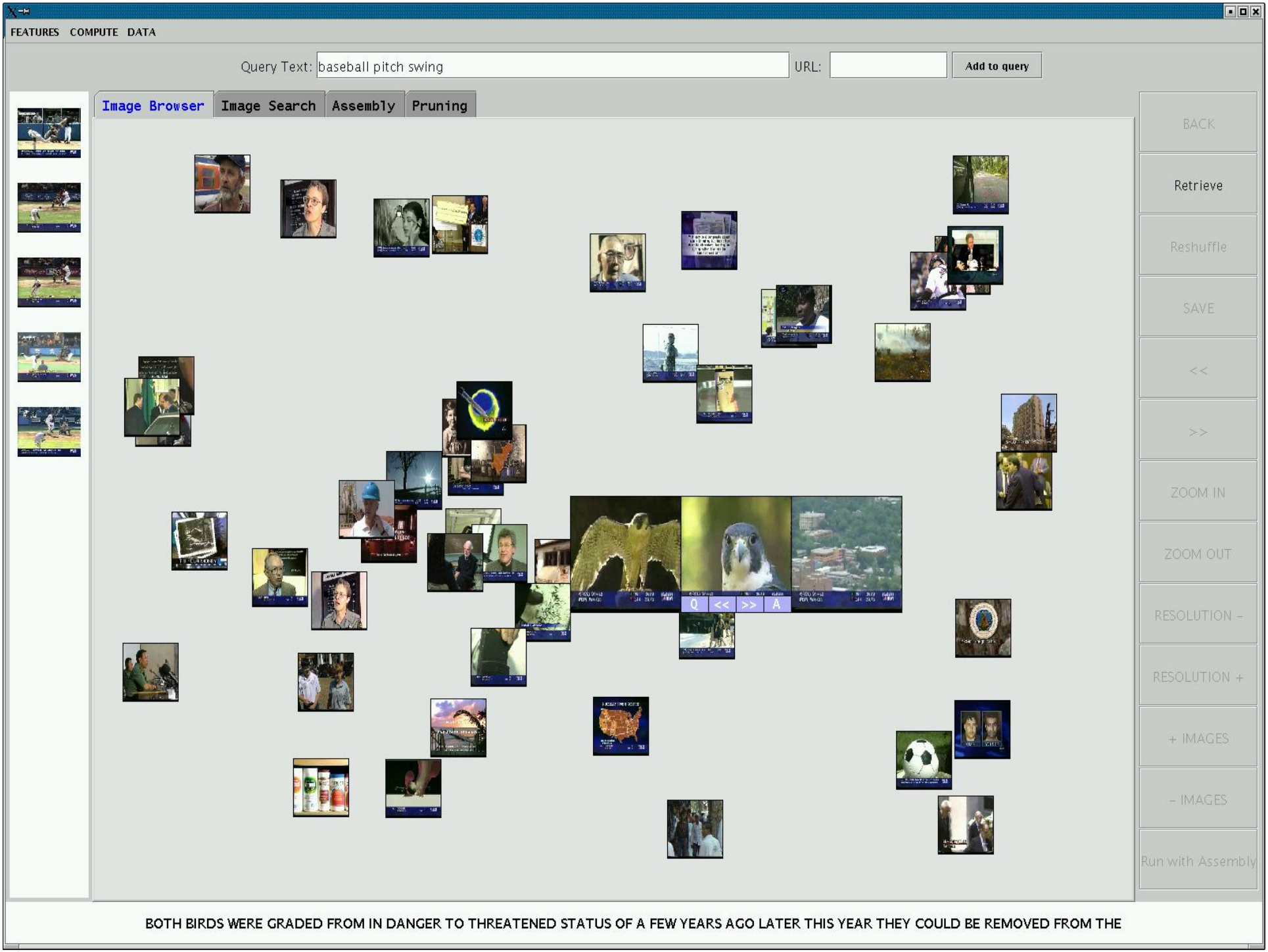
-> scale-free small-world graph

Browsing interface

- Initial display:

query-by-example retrieval result
OR
high connectivity nodes (hubs)

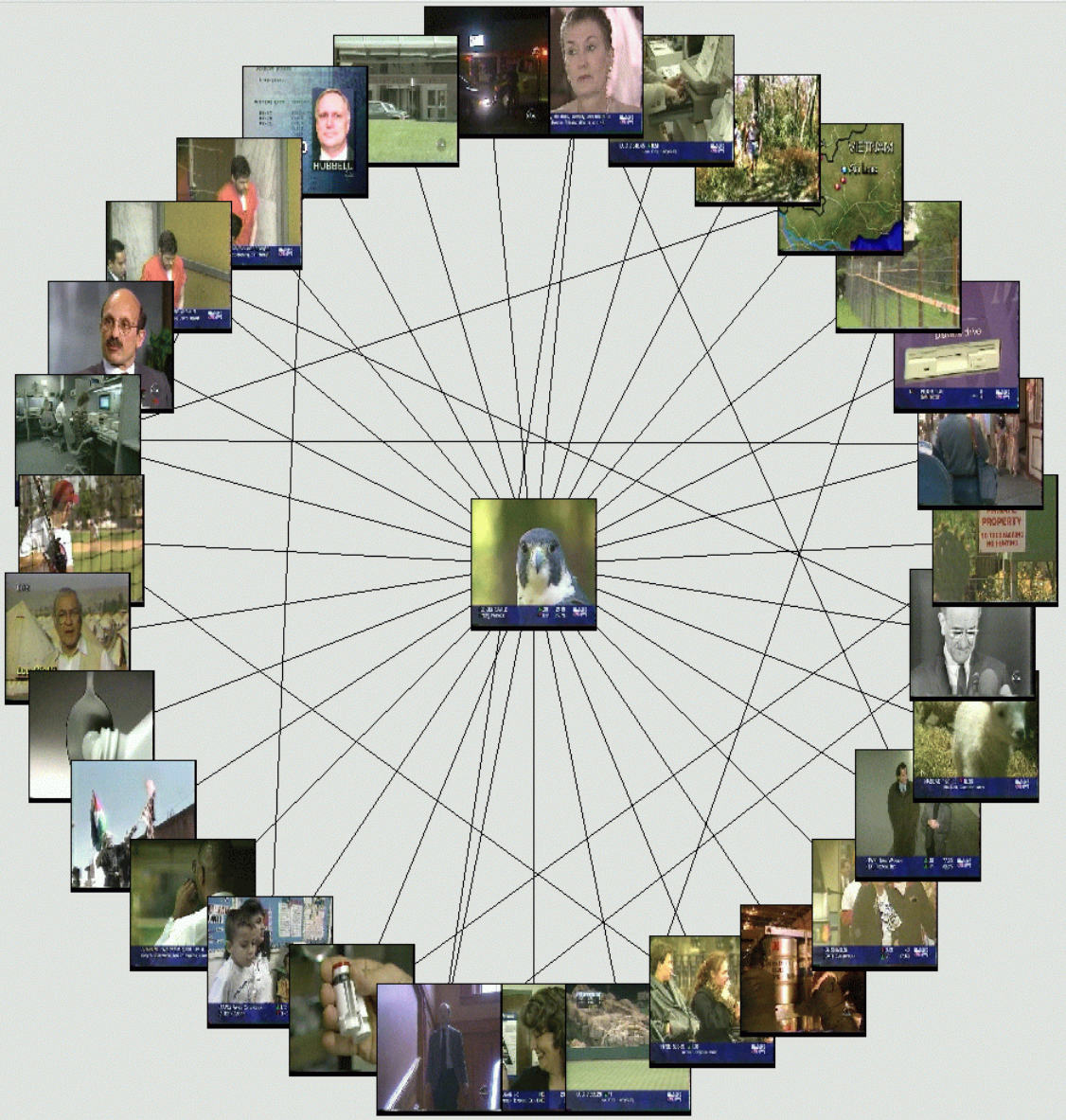
- Clicking on an image moves it into the center and displays all adjacent nodes in the network


FEATURES COMPUTE DATA
Query Text: baseball pitch swing
URL:
Add to query
Image Browser
Image Search
Assembly
Pruning
BACK
Retrieve
Reshuffle
SAVE
<<
>>
ZOOM IN
ZOOM OUT
RESOLUTION -
RESOLUTION +
+ IMAGES
- IMAGES
Run with Assembly
Q
<<
>>
A
BOTH BIRDS WERE GRADED FROM IN DANGER TO THREATENED STATUS OF A FEW YEARS AGO LATER THIS YEAR THEY COULD BE REMOVED FROM THE

FEATURES COMPUTE DATA

Query Text: baseball pitch swing URL: Add to query

Image Browser | Image Search | Assembly | Pruning



BACK

Retrieve

Reshuffle

SAVE

<<

>>

ZOOM IN

ZOOM OUT

RESOLUTION –

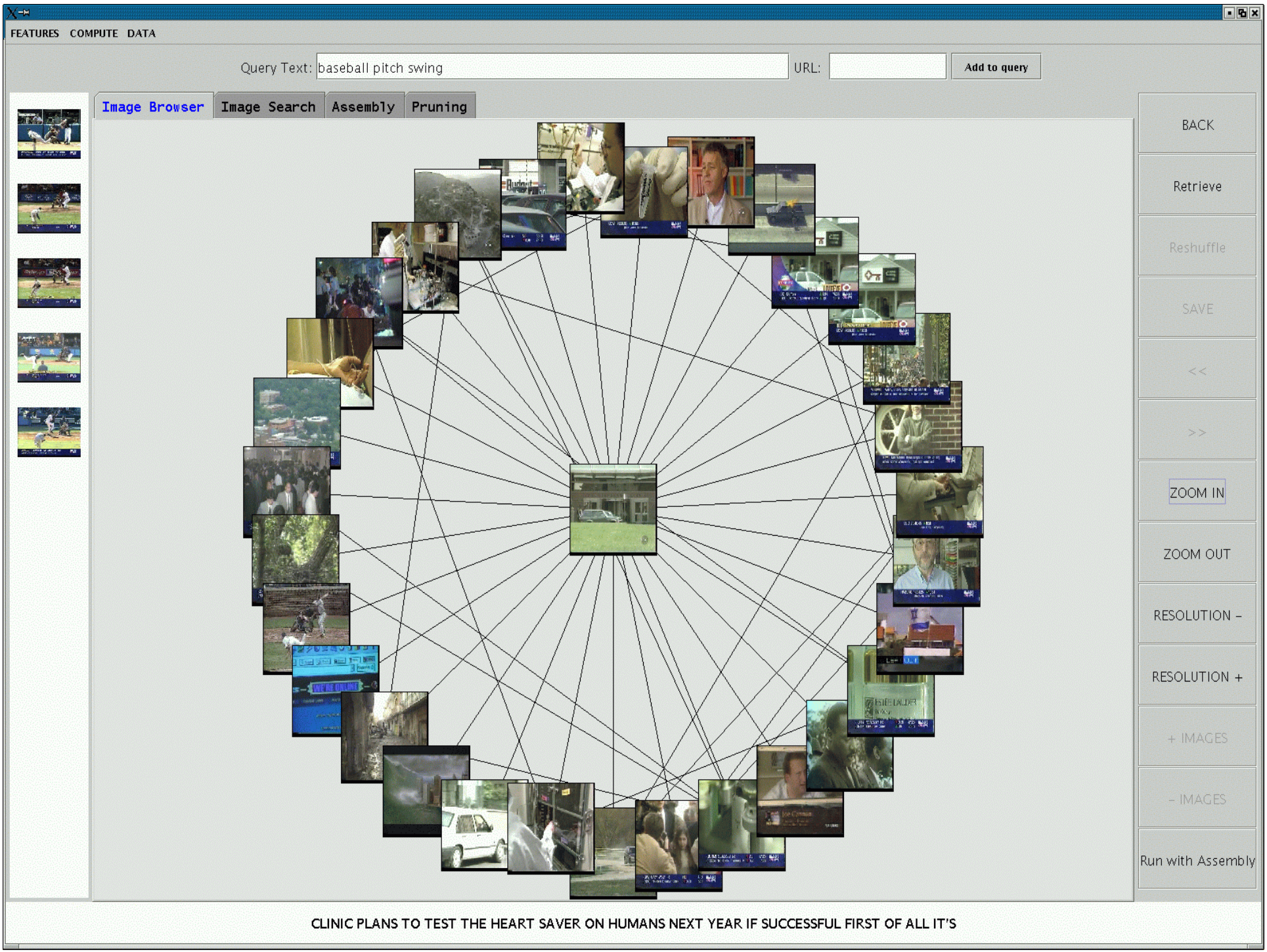
RESOLUTION +

+ IMAGES

– IMAGES

Run with Assembly

BOTH BIRDS WERE GRADED FROM IN DANGER TO THREATENED STATUS OF A FEW YEARS AGO LATER THIS YEAR THEY COULD BE REMOVED FROM THE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SAVE
<<
>>
ZOOM IN
ZOOM OUT
RESOLUTION –
RESOLUTION +
+ IMAGES
– IMAGES
Run with Assembly
CLINIC PLANS TO TEST THE HEART SAVER ON HUMANS NEXT YEAR IF SUCCESSFUL FIRST OF ALL IT'S

FEATURES COMPUTE DATA

Query Text: baseball pitch swing URL: Add to query

Image Browser | Image Search | Assembly | Pruning

BACK

Retrieve

Reshuffle

SAVE

<<

>>

ZOOM IN

ZOOM OUT

RESOLUTION –

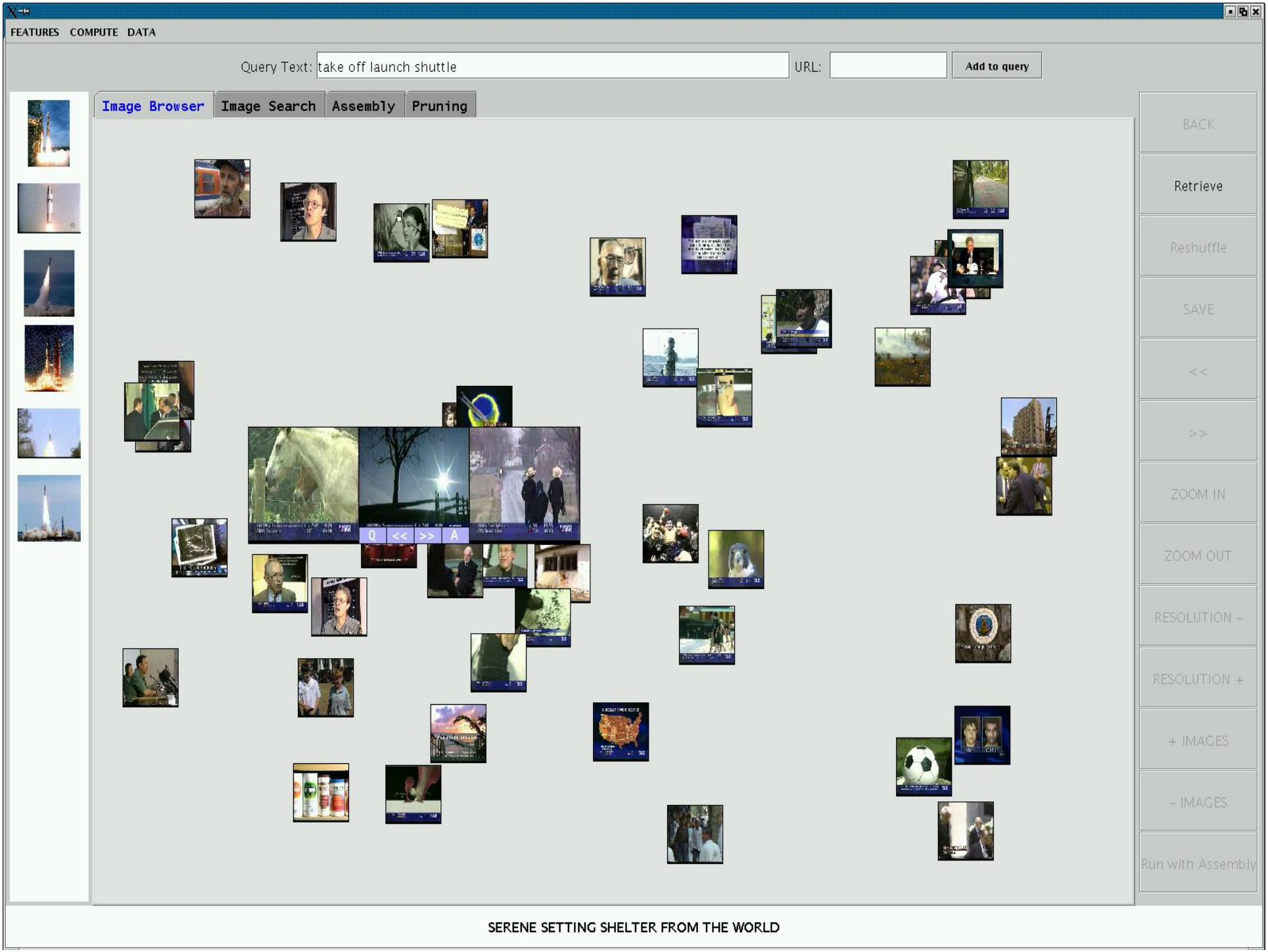
RESOLUTION +

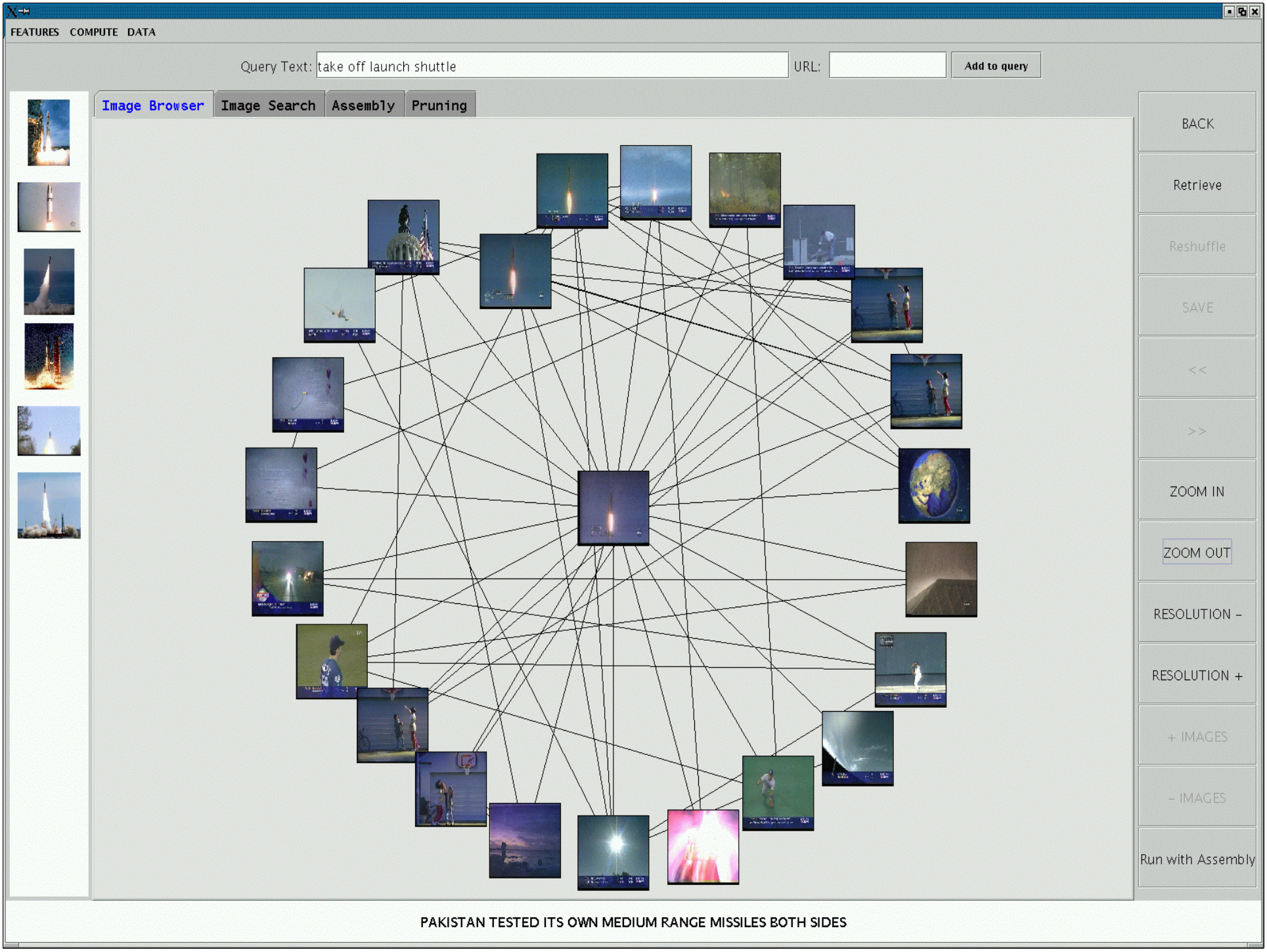
+ IMAGES

– IMAGES

Run with Assembly

BEING VERY FRUSTRATED IN YEARS PAST THAT THEY NEVER OF MASS PRODUCE THE CONCEPT CARS WE SO


FEATURES COMPUTE DATA
Query Text: take off launch shuttle
URL:
Add to query
Image Browser
Image Search
Assembly
Pruning
BACK
Retrieve
Reshuffle
SAVE
<<
>>
ZOOM IN
ZOOM OUT
RESOLUTION -
RESOLUTION +
+ IMAGES
- IMAGES
Run with Assembly
SERENE SETTING SHELTER FROM THE WORLD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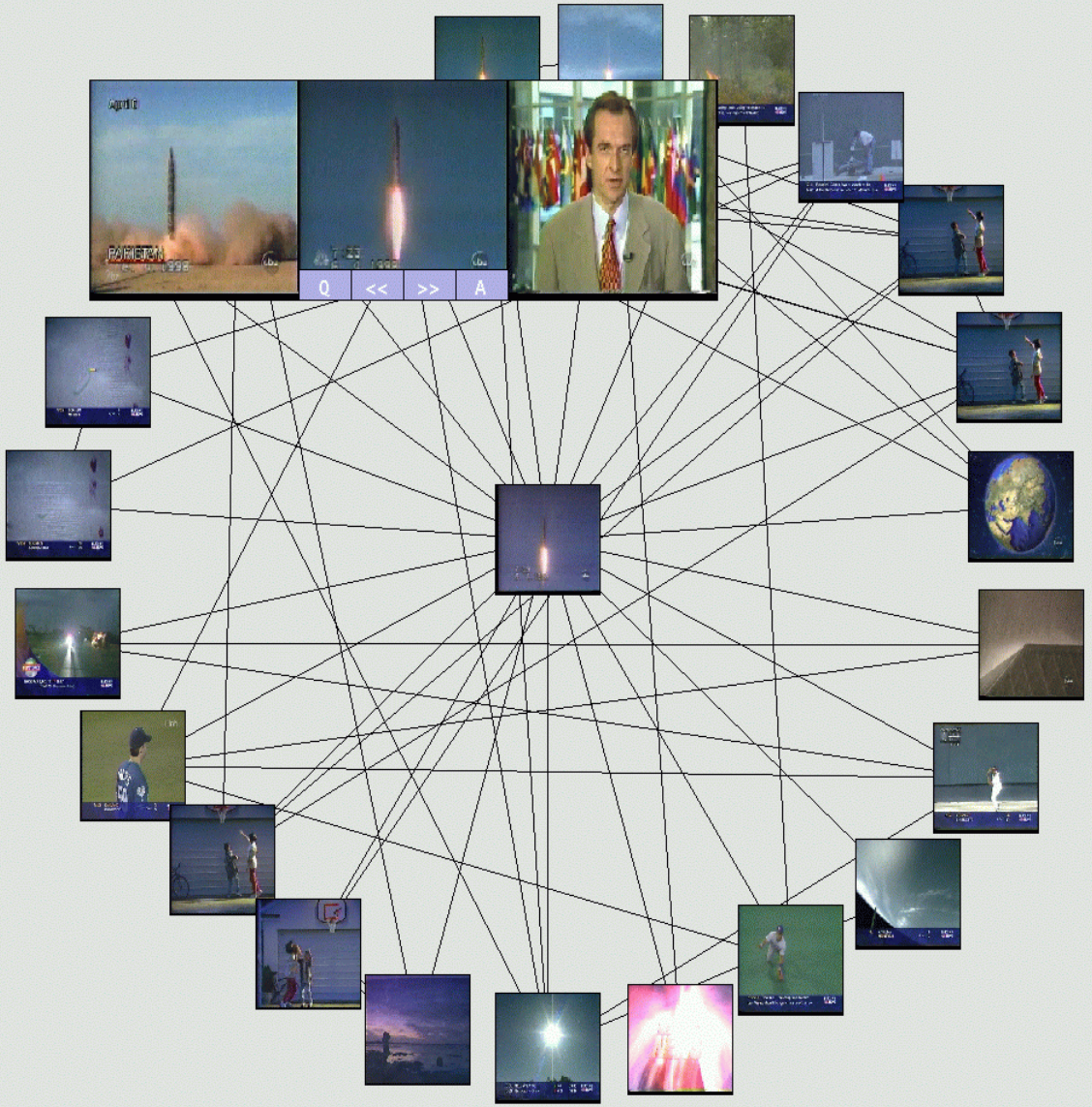
– IMAGES
Run with Assembly
PAKISTAN TESTED ITS OWN MEDIUM RANGE MISSILES BOTH SIDES

FEATURES COMPUTE DATA

Query Text: take off launch shuttle URL: Add to query

Image Browser | Image Search | Assembly | Pruning



BACK

Retrieve

Reshuffle

SAVE

<<

>>

ZOOM IN

ZOOM OUT

RESOLUTION –

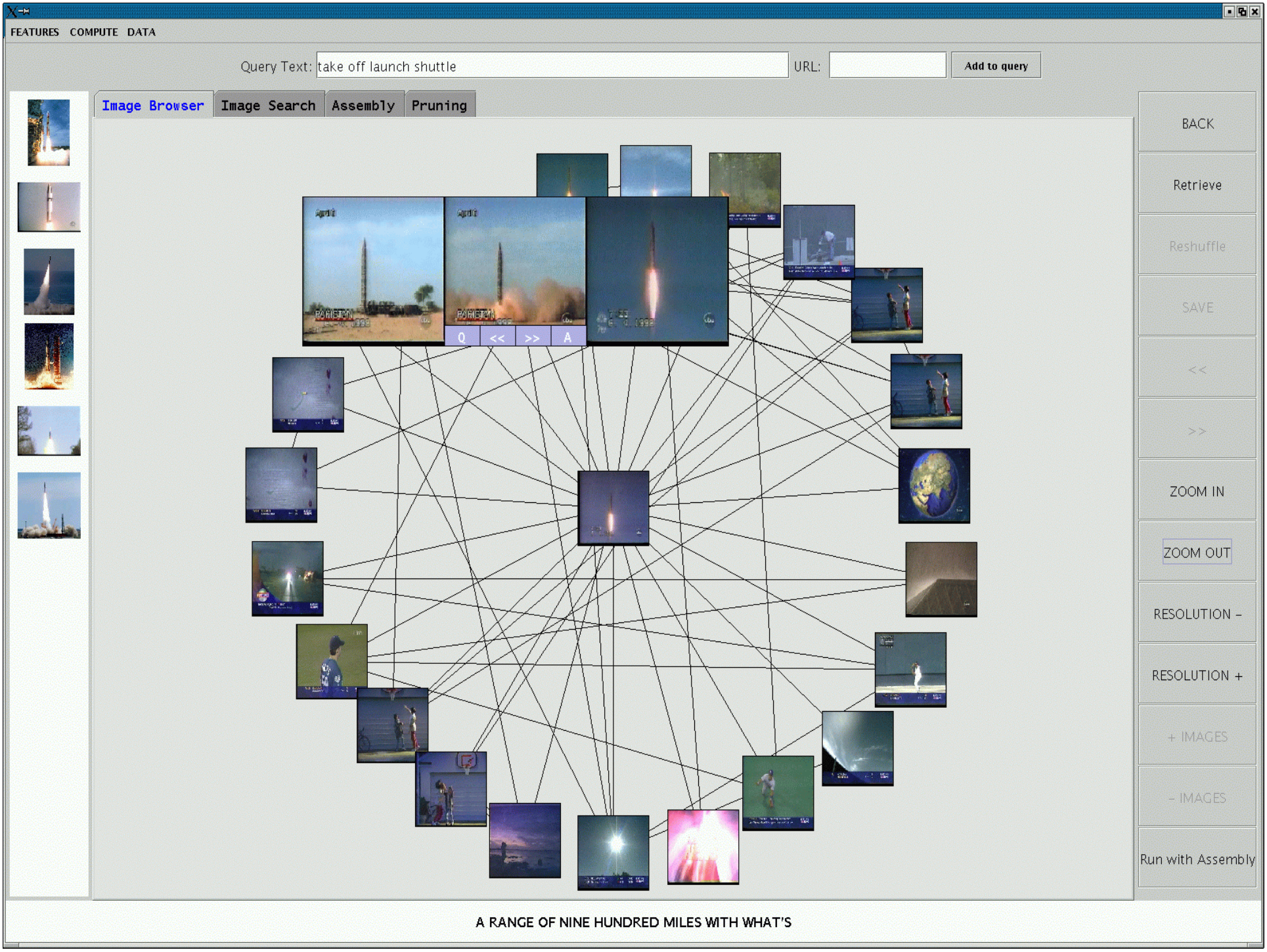
RESOLUTION +

+ IMAGES

– IMAGES

Run with Assembly

MOST MAJOR INDIAN CITIES WITHIN RANGE OF THAT MISSILE AND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Query Text: take off launch shuttle
URL:
Add to query
Image Browser
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ZOOM IN
ZOOM OUT
RESOLUTION –
RESOLUTION +
+ IMAGES
– IMAGES
Run with Assembly
A RANGE OF NINE HUNDRED MILES WITH WHAT'S

Observations

- Browsing can help to explore visual similarity
- Some task are impossible with browsing alone: find video shots with Senator Mark Sounder
- Browsing can be a fun activity

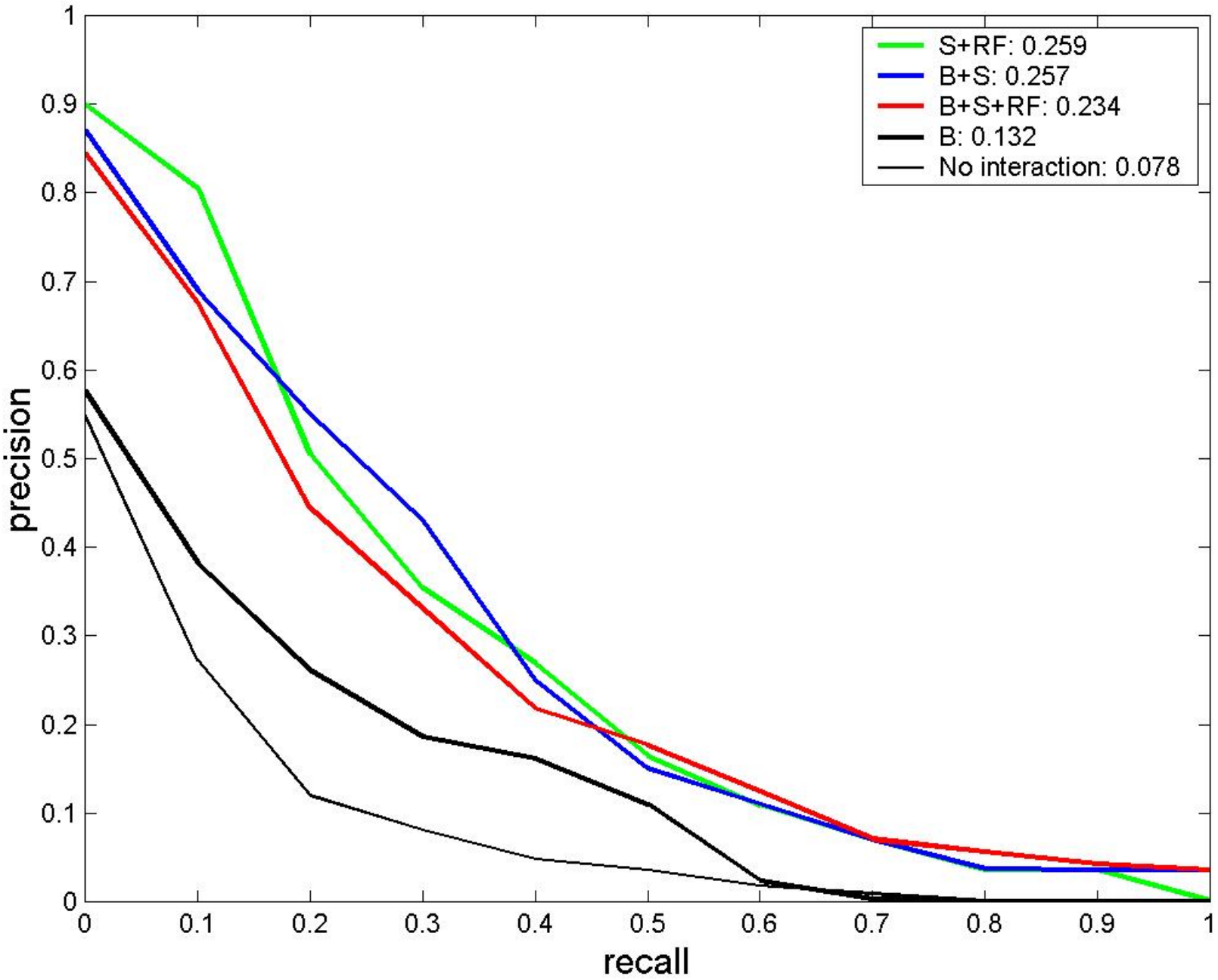
Interactive runs

Runs	Search	Relevance Feedback	Browsing
I	✓	✓	✓
II	✓	✓	
III	✓		✓
IV			✓

Experimental design

- 4 subjects, 4 runs -> square lattice design

	T1-6	T7-12	T13-18	T19-25
S1	I	II	III	IV
S2	IV	I	II	III
S3	III	IV	I	II
S4	II	III	IV	I


S+RF: 0.259
B+S: 0.257
B+S+RF: 0.234
B: 0.132
No interaction: 0.078
precision
recall
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Results

	MAP	RANK (out of 36)
Best	0.46	
Median	0.19	
Mean	0.18	
S + RF + B	0.26	5
S + RF	0.26	4
S + B	0.23	8
B	0.13	27

Conclusions

- Competitive system: Three out of four runs among the top 8 (of 36)
- “Search by browsing“ a viable alternative to traditional search by example for visual topics