MATH:7450 (22M:305) Topics in Topology: Scientific and Engineering Applications of Algebraic Topology

Sept 18, 2013: javaPlex

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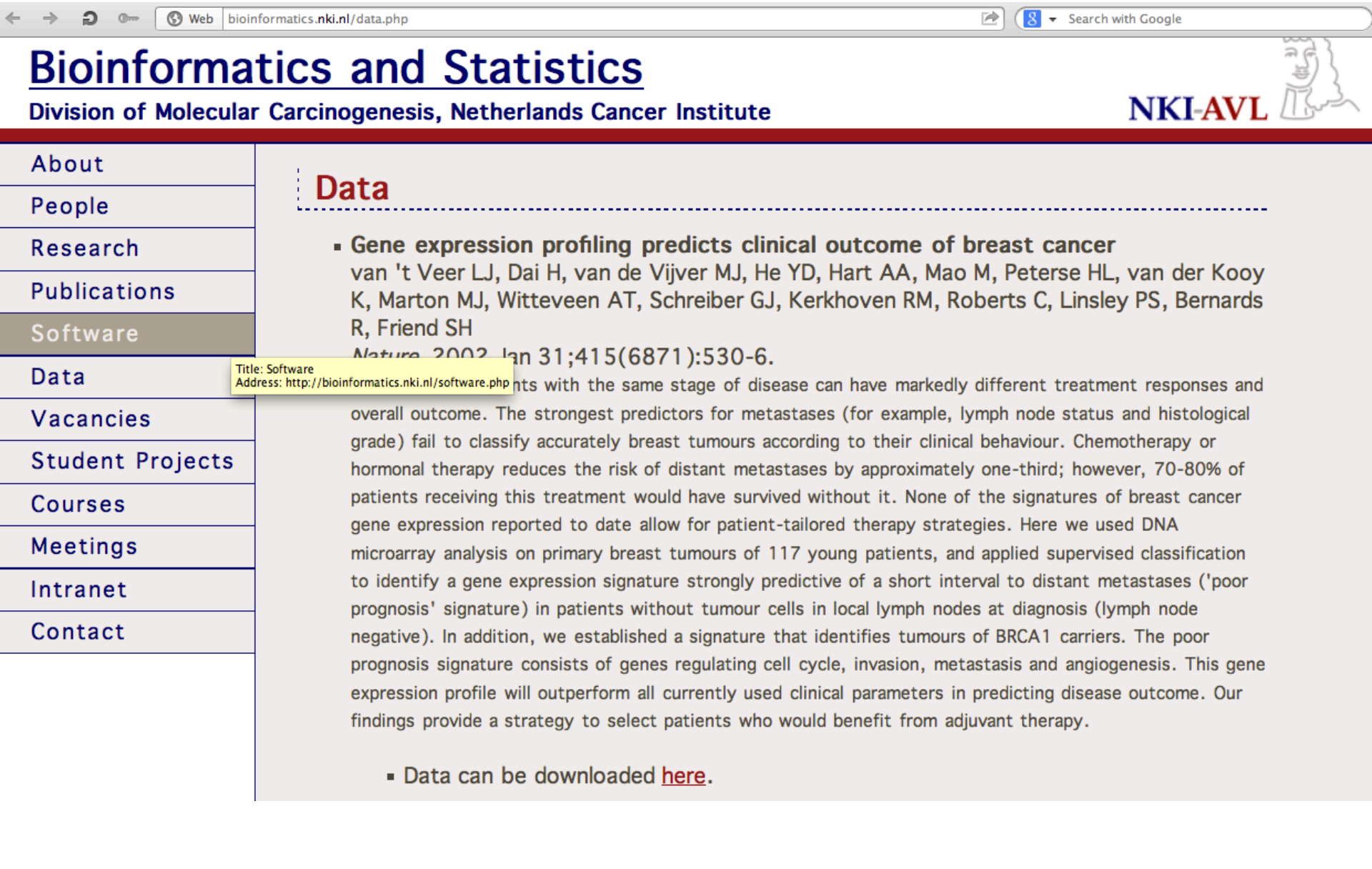
http://www.math.uiowa.edu/~idarcy/AppliedTopology.html

http://bioinformatics.nki.nl/data.php



3 columns = patient

middle column (ratio) = data point

log10(Intensity)	Log10(ratio)	P-value
-1.66	-0.299	6.72E-01
-1.55	0.093	8.93E-01
-1.71	-0.215	8.36E-01
-1.46	-0.566	2.83E-01
-1.08	-0.596	1.17E-01
-1.61	-0.195	8.14E-01
0.69	0.039	5.25E-01

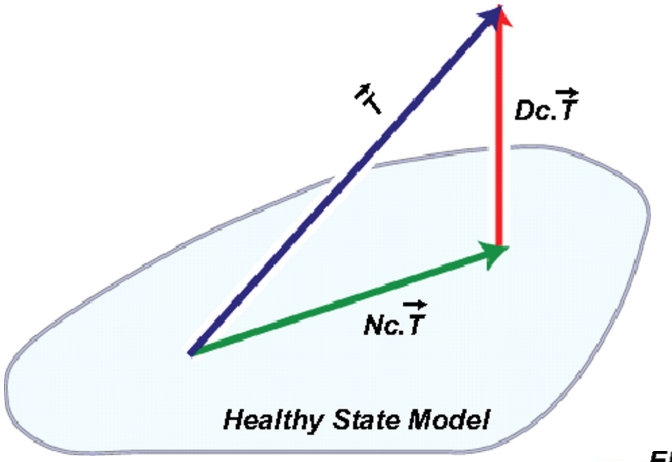
rows = genes

Create Data Matrix

```
load_javaplex

C = csvread('Array5yr.csv',2,1,[2,1,3,21])
C(1, 2)

for i = 1:7  D(:,i) = C(:,3*i-1); end
R = transpose(D)

size(R)
```

Use standard Euclidean Metric:

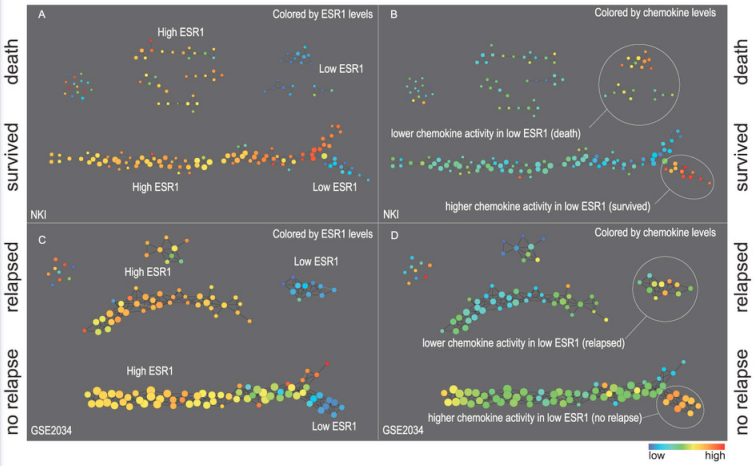
```
m_space = metric.impl.EuclideanMetricSpace(R);

m_space.getPoint(0)

m_space.distance(m_space.getPoint(0), m_space.getPoint(1))

sqrt([R(1,1) - R(2, 1)]^2 + [R(1,2) - R(2,2)]^2)
```



$$[\Sigma\ |x_i|^p]^{k/p}$$

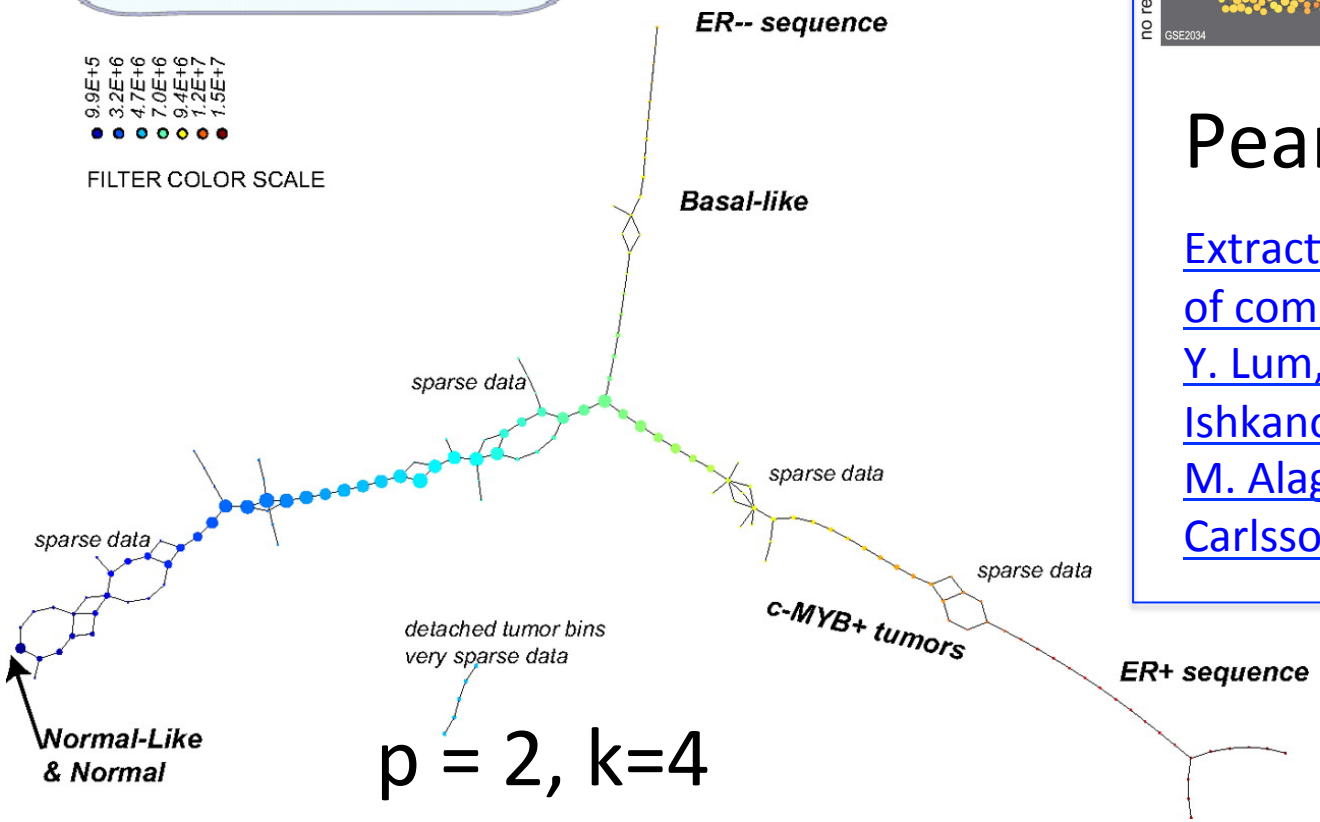
$$k = 1\ldots10$$

$$p = 1\ldots5$$



Pearson correlation

[Extracting insights from the shape of complex data using topology P. Y. Lum, G. Singh, A. Lehman, T. Ishkanov, M. Vejdemo-Johansson, M. Alagappan, J. Carlsson, G. Carlsson (2013)]



$$p = 2,\ k=4$$

Topology based data analysis identifies a subgroup of breast cancers with a unique mutational profile and excellent survival
Monica Nicolau, Arnold J. Levineb,1, and Gunnar Carlsson, PNAS 2011

Choose your own distance matrix:

```
dist = ones(7) - eye(7)

dist_space = metric.impl.ExplicitMetricSpace(dist);

dist_space.distance(0,1)
```

Calculate Vietoris Rips Complex

```
max_dimension = 3;
max_filtration_value = 4;
num_divisions = 100;

stream = api.Plex4.createVietorisRipsStream(R,
max_dimension,max_filtration_value, num_divisions);
```

$$t \in \left\{ 0,\ \frac{t_{max}}{N-1},\ \frac{2t_{max}}{N-1},\ \frac{3t_{max}}{N-1},\ \cdots,\ \frac{(N-2)t_{max}}{N-1},\ t_{max} \right\}$$

Calculate Persistence

```
persistence
=api.Plex4.getModularSimplicialAlgorithm(max_dimension, 2);

intervals = persistence.computeIntervals(stream)

intervals = persistence.computeAnnotatedIntervals(stream)

betti_numbers_array = infinite_barcodes.getBettiSequence()

betti_numbers_string = infinite_barcodes.getBettiNumbers()
```

```
options.filename = 'small_data'
options.max_filtration_value = max_filtration_value
options.max_dimension = max_dimension – 1
plot_barcodes(intervals, options)
```

Run on entire set:

```
load_javaplex;
clear C; clear D; clear R;
C = csvread('Array5yr.csv',2,1);
for i = 1:35  D(:,i) = C(:,3*i-1); end
R = transpose(D);
stream = api.Plex4.createVietorisRipsStream(R,
max_dimension,max_filtration_value, num_divisions);

persistence
=api.Plex4.getModularSimplicialAlgorithm(max_dimension, 2);

intervals = persistence.computeIntervals(stream)
options.filename = ’data’;
options.max_filtration_value = max_filtration_value;
options.max_dimension = max_dimension - 1;
plot_barcodes(intervals, options)
```