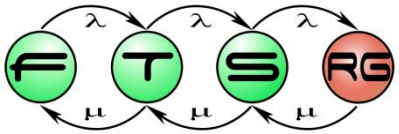
Outlierdetektálás

Salánki Ágnes

salanki@mit.bme.hu

Budapest University of Technology and Economics
Fault Tolerant Systems Research Group



Definíció

- Kevés van belőlük
- „Gyanús”, hogy **más** a generáló folyamat/forrás

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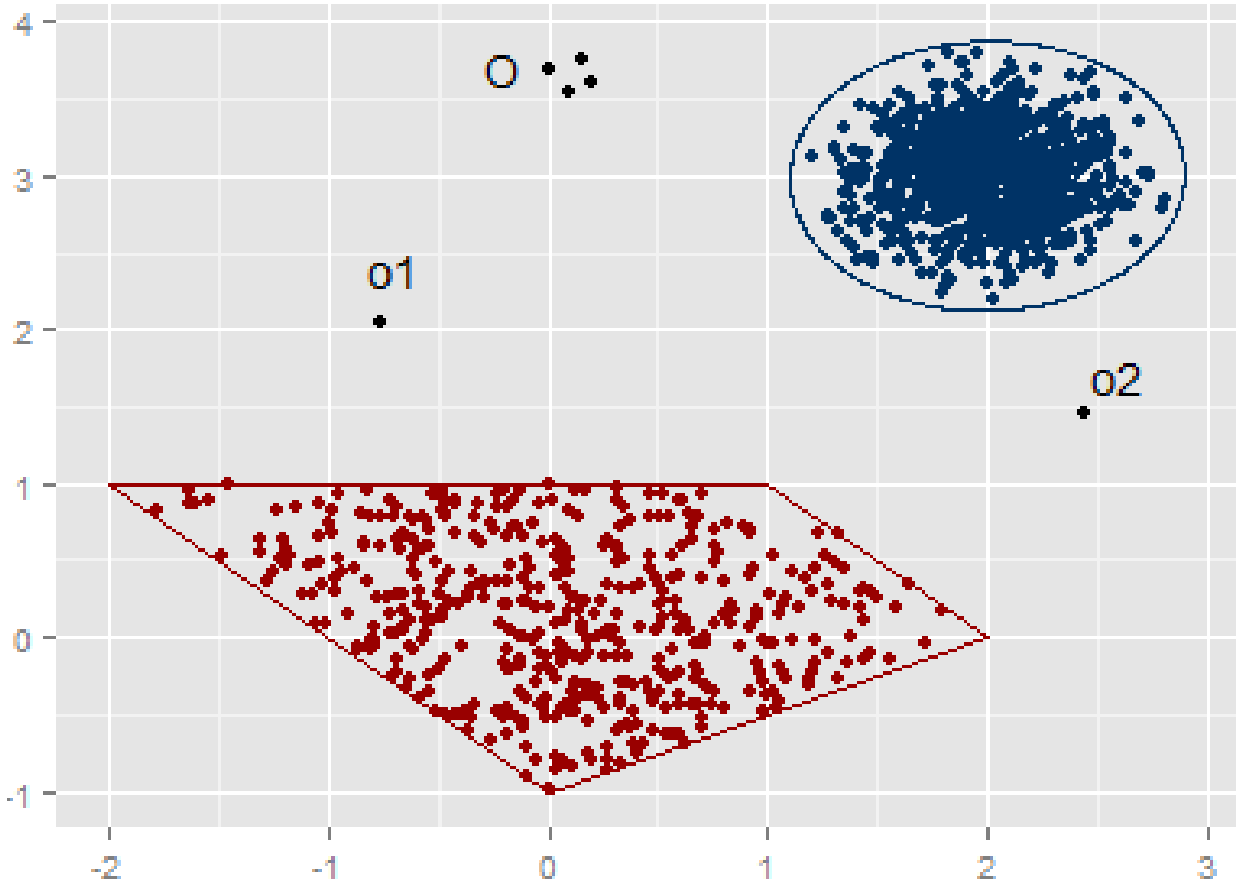
- Kevés van belőlük
- „Gyanús”, hogy **más** a generáló folyamat/forrás
  - Все счастливые семьи похожи друг на друга, каждая несчастливая семья несчастлива **по-своему**.
  - Happy families are all alike;
    every unhappy family is unhappy **in its own way**.
  - A boldog családok mind hasonlók
    egymáshoz, minden boldogtalan család **a maga módján** az.

(Tolsztoj: Anna Karenina)

Pont- és kollektív anomála

- Pontanomália



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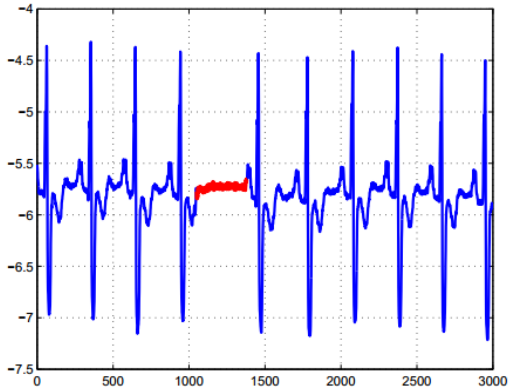

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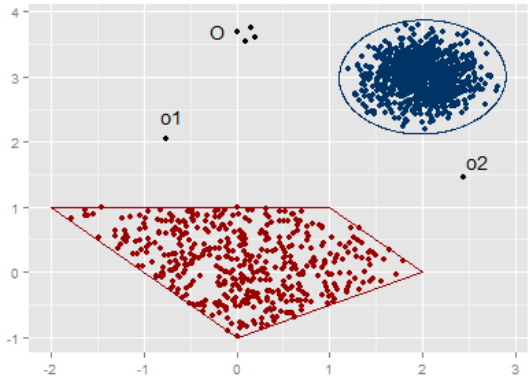

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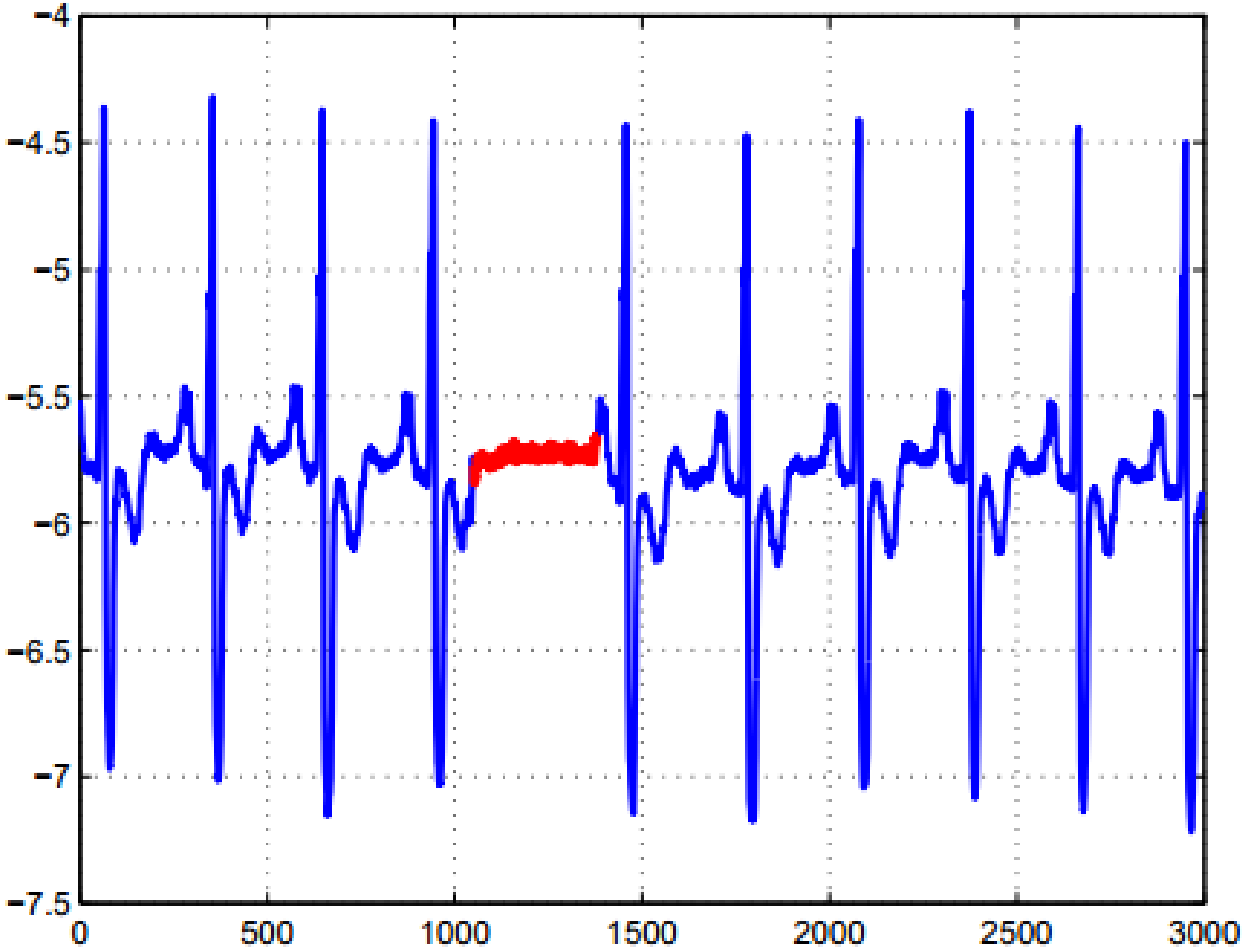

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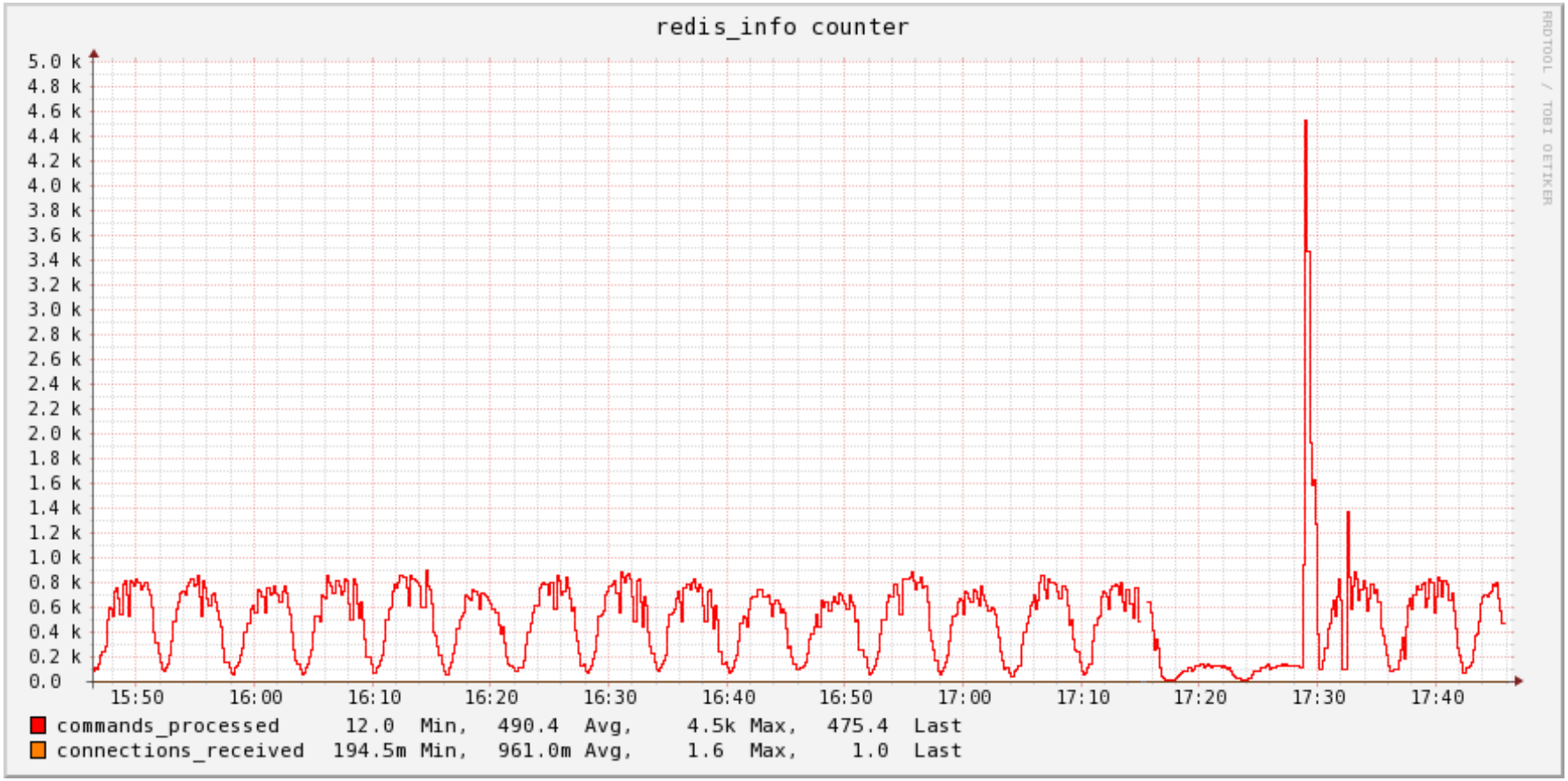

Viselkedési és kontextusanomália

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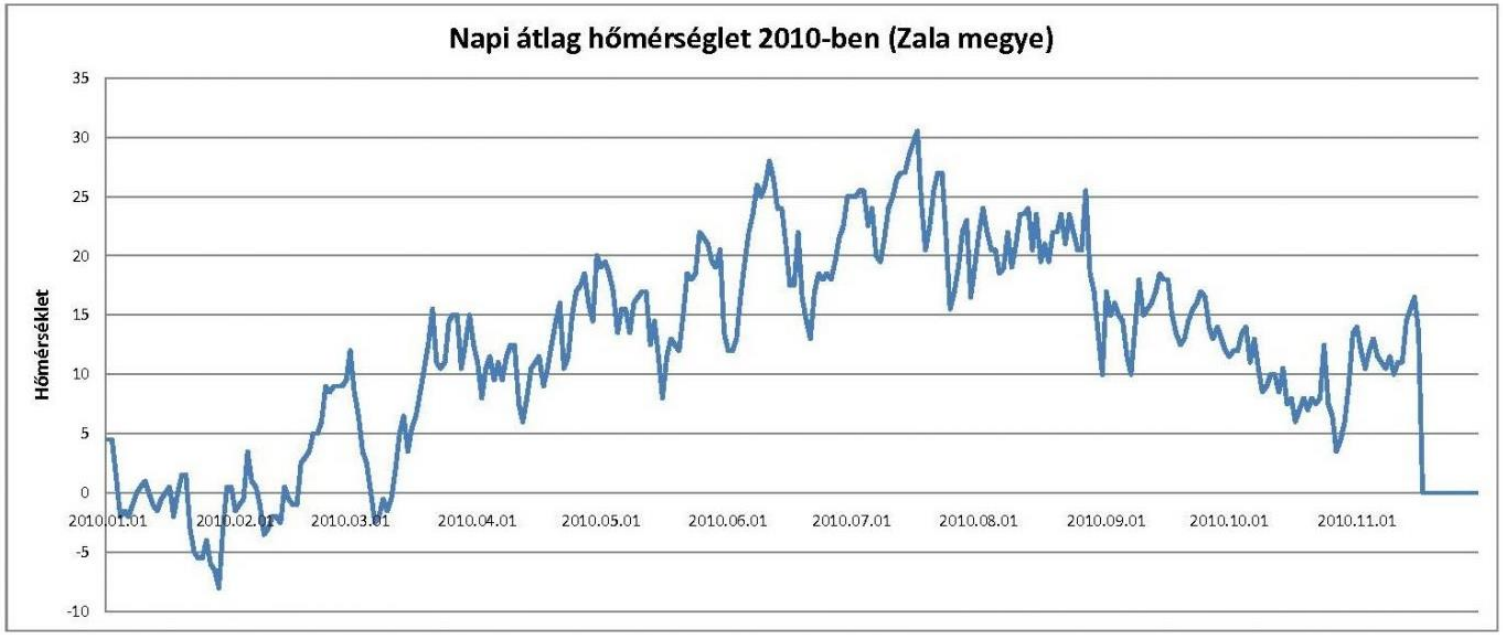
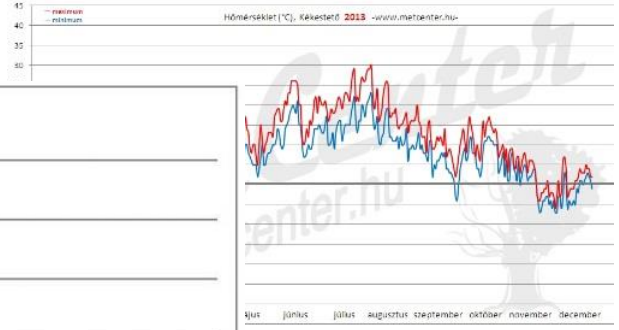
- Kontextus





Ábrák forrása: http://www.baki-agrocentrum.hu/hu/szakmai-anyagok/agronomiai-informaciok/az-eghajlatvaltozas-zala-megye-szivebol-nezve
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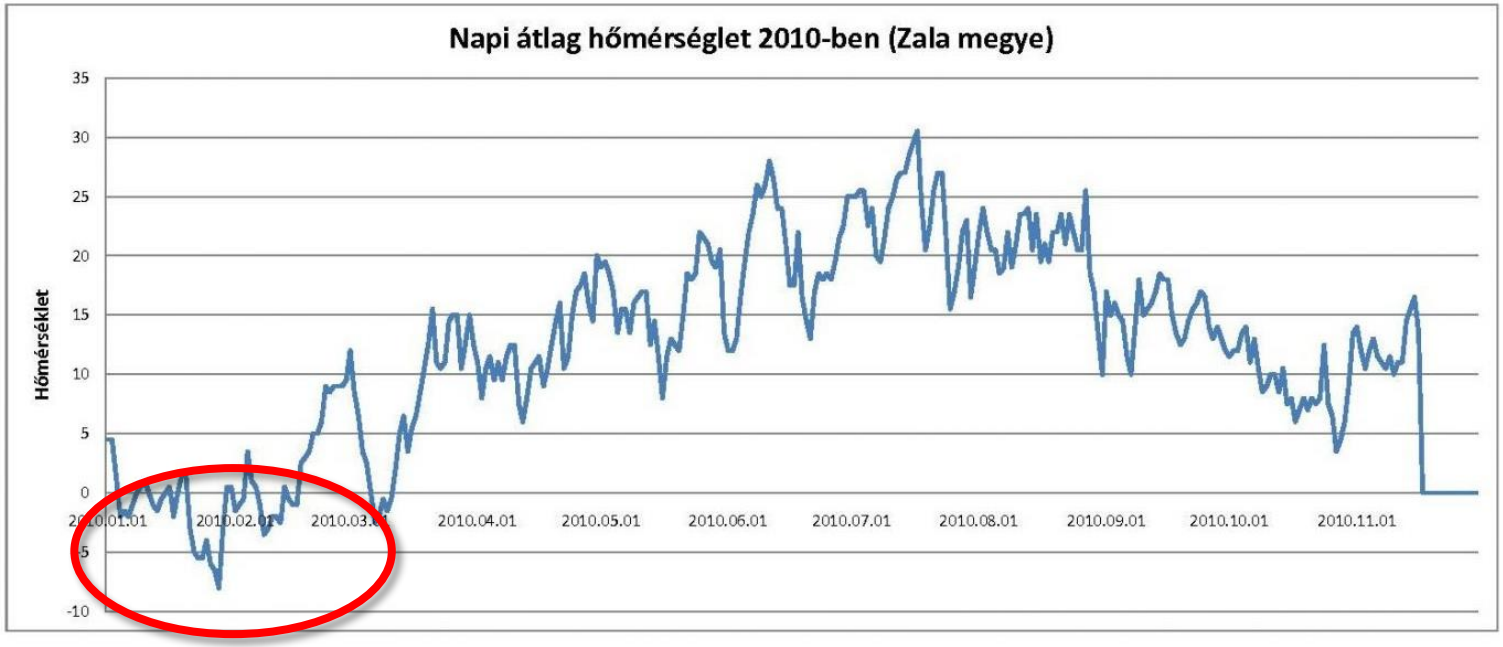

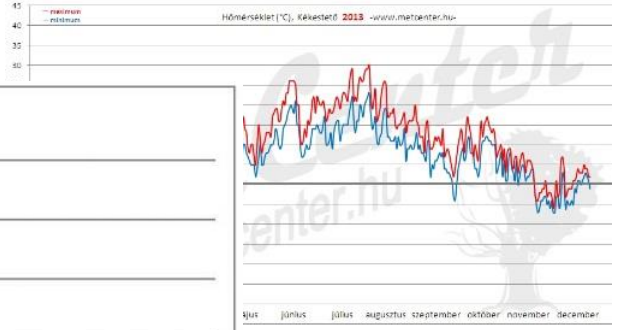

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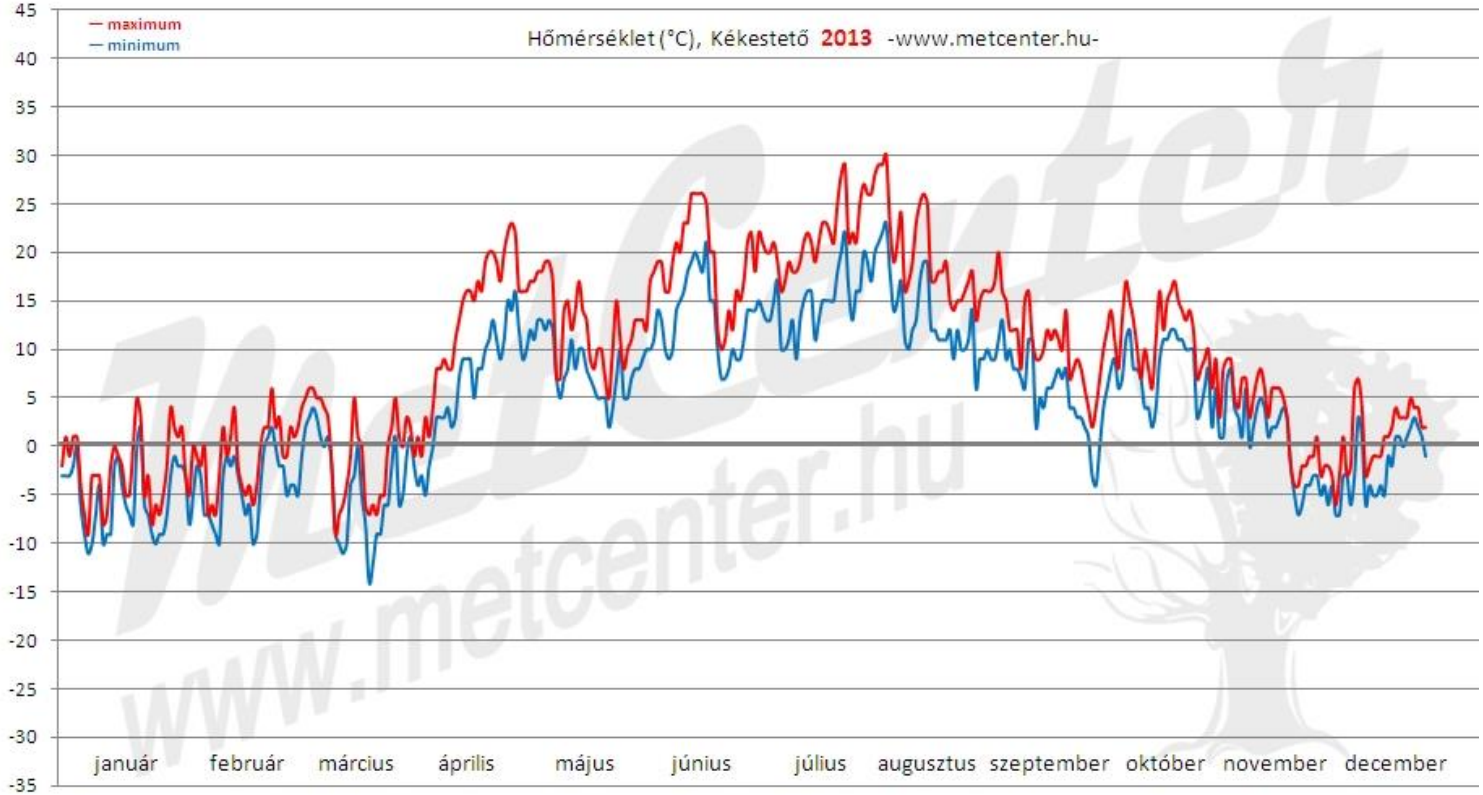

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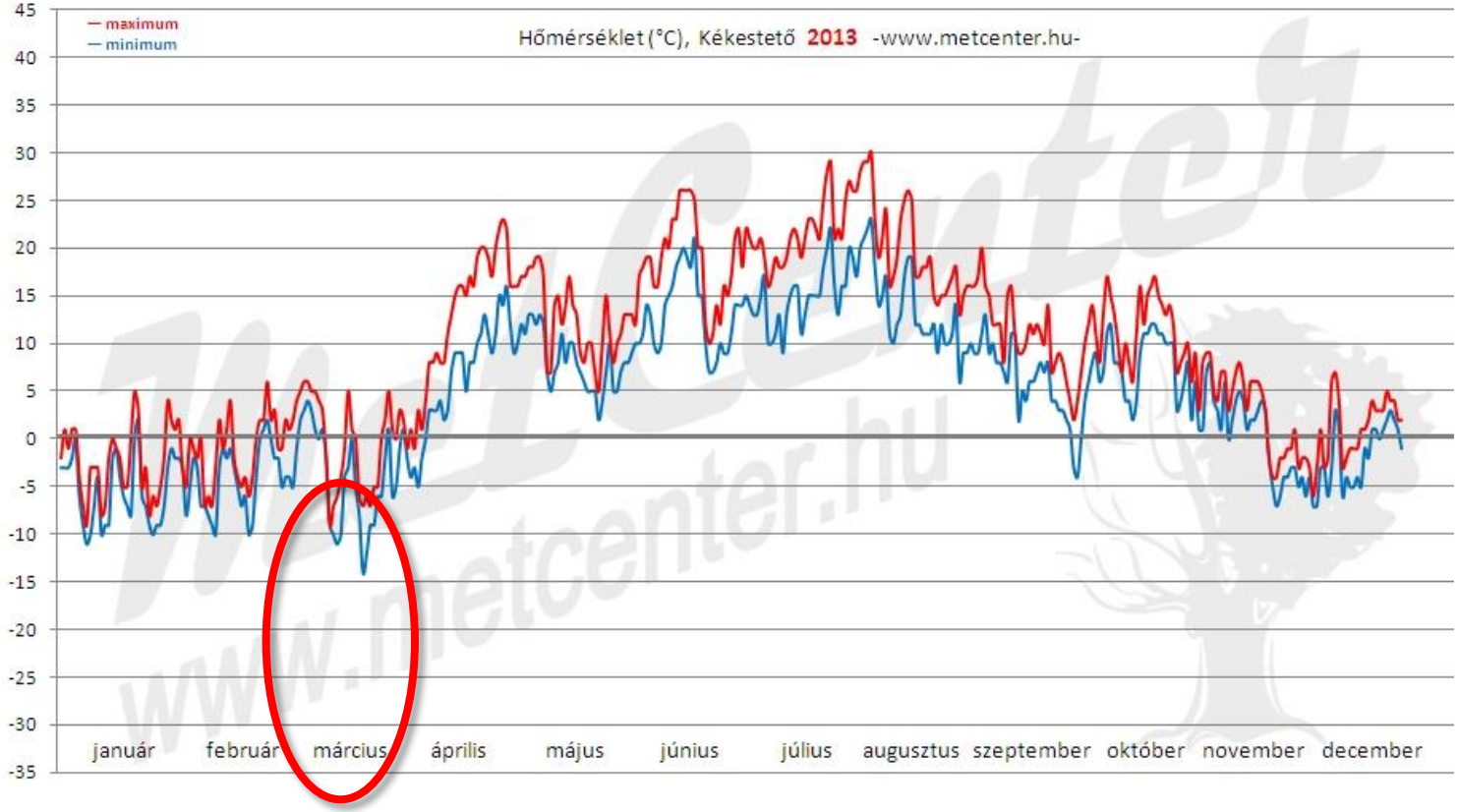

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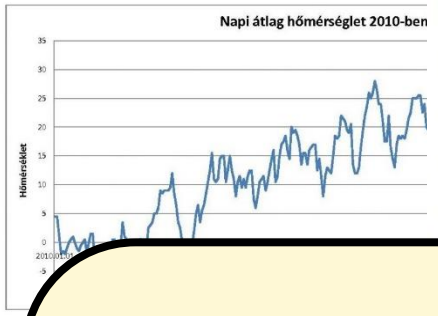

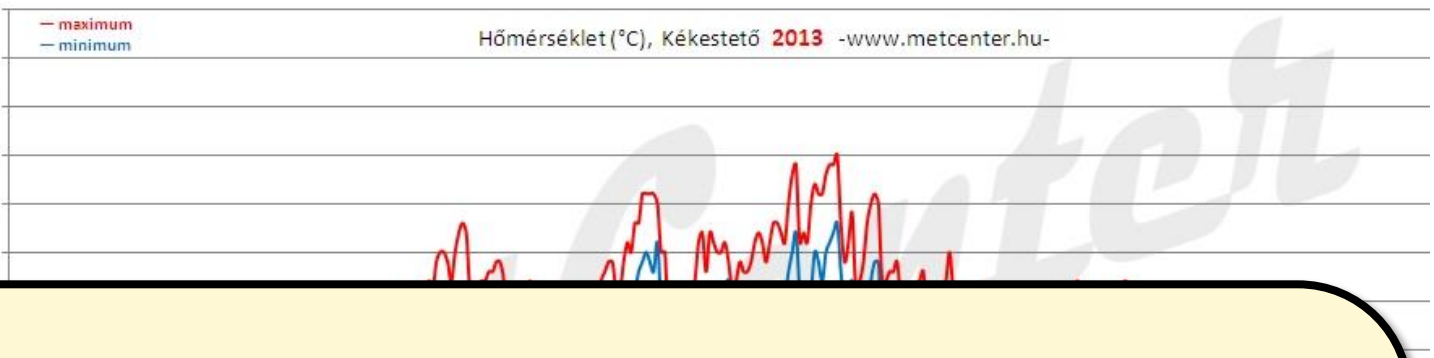

Itt: viselkedési és pontanomáliák

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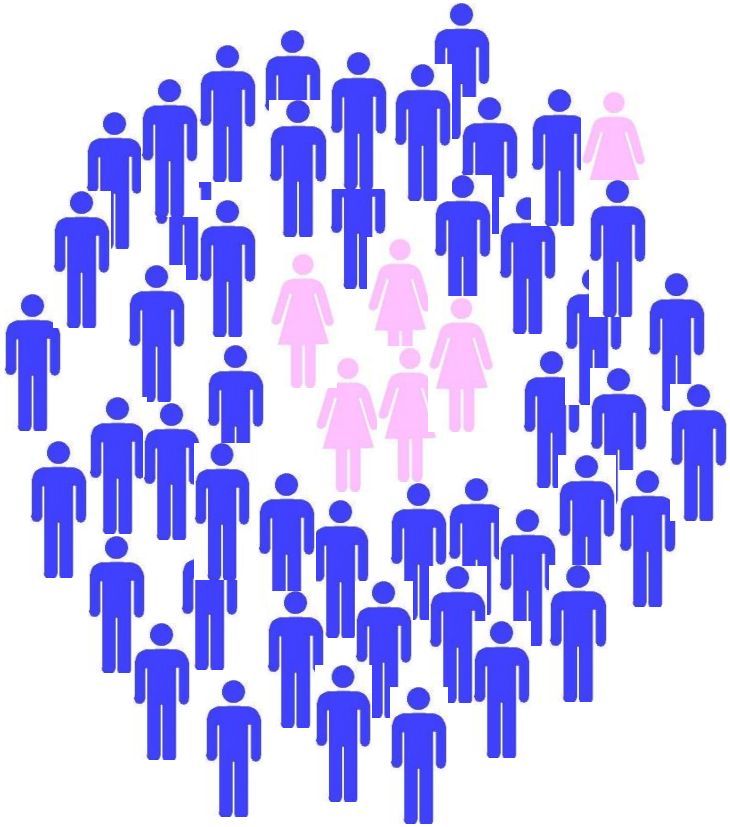
Megközelítések

- Globális outlierek



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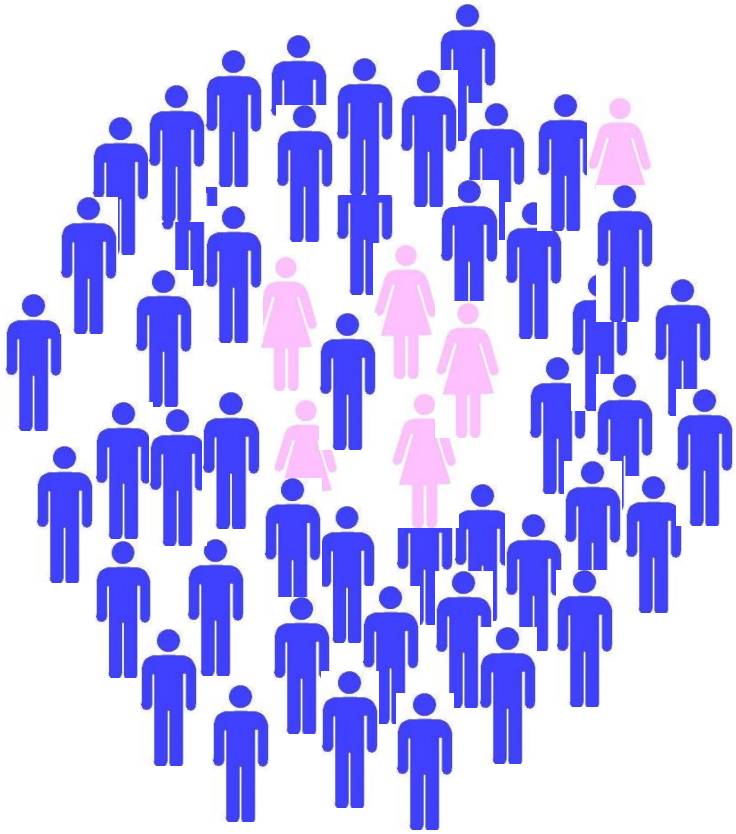

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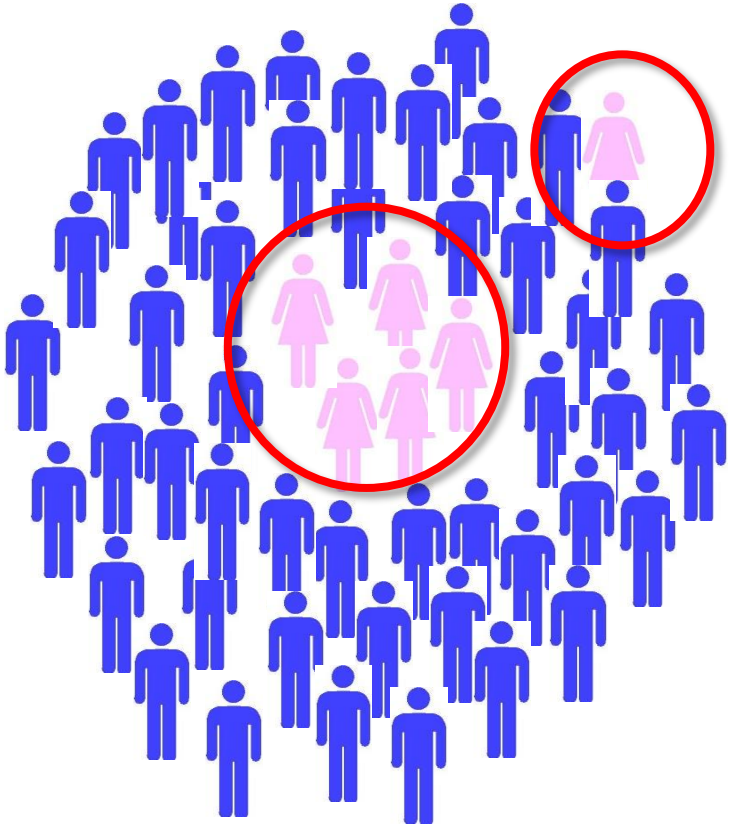

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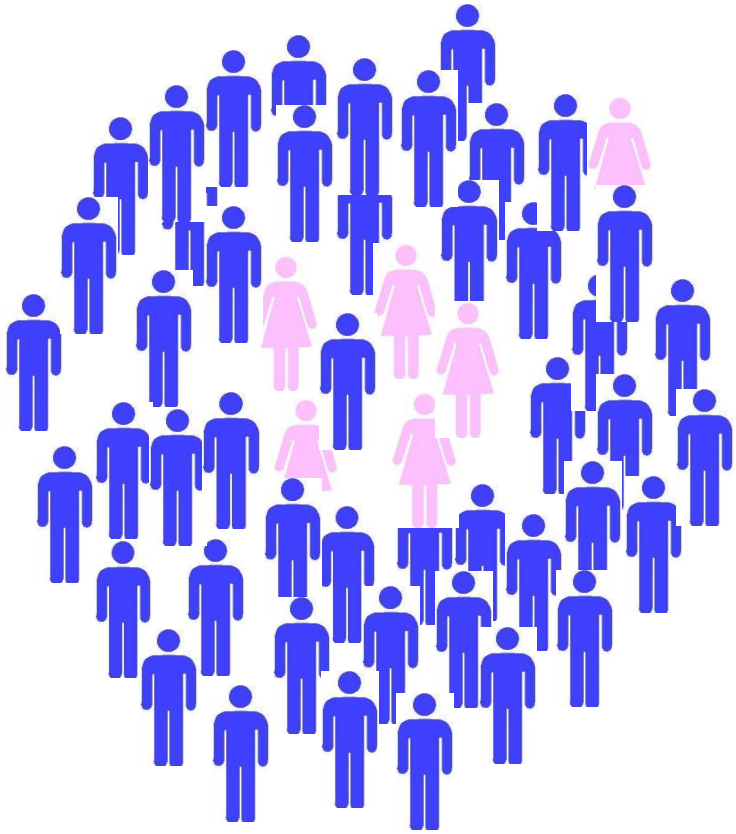

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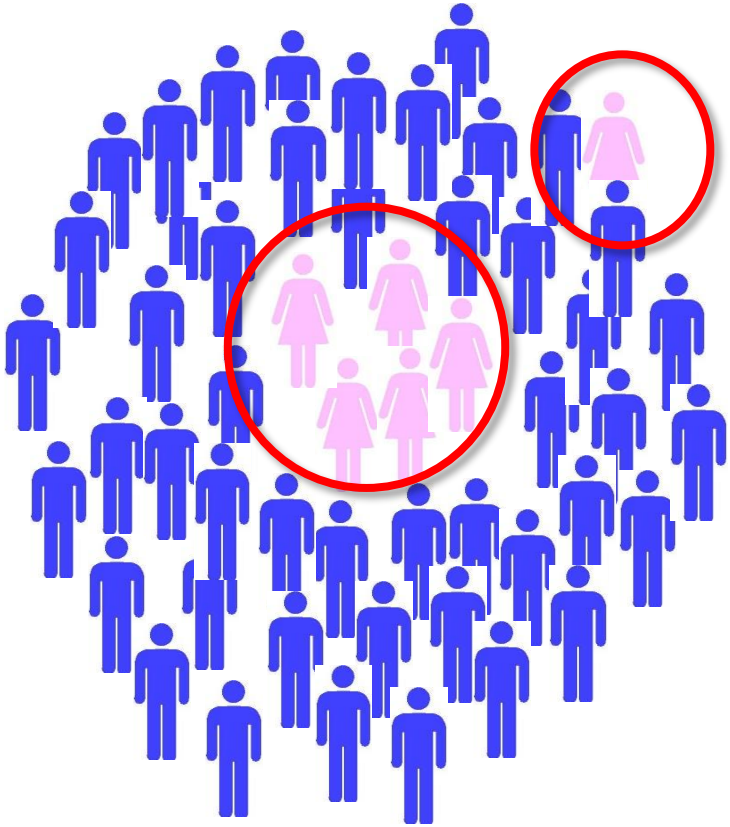

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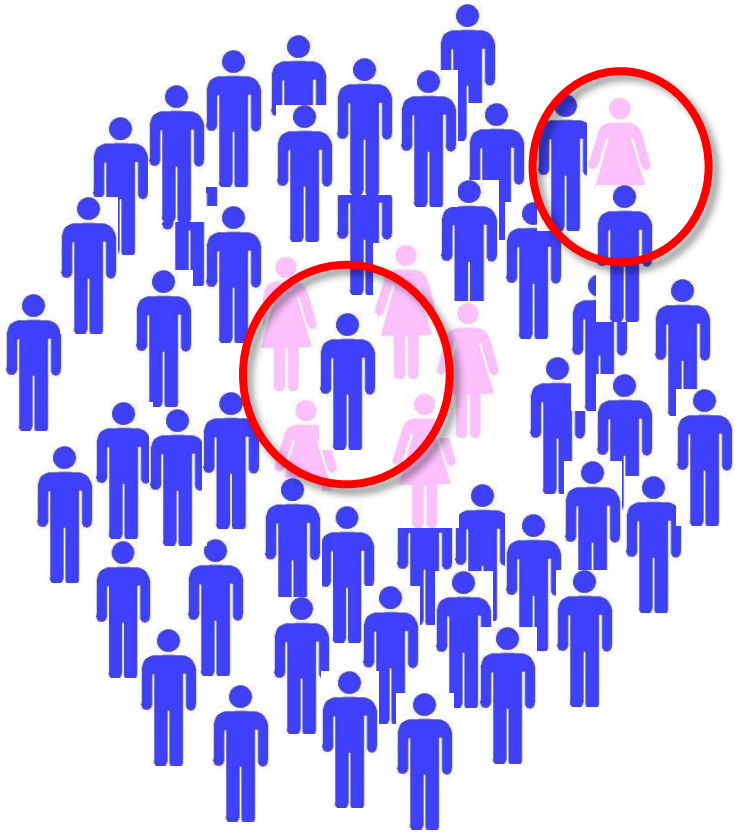

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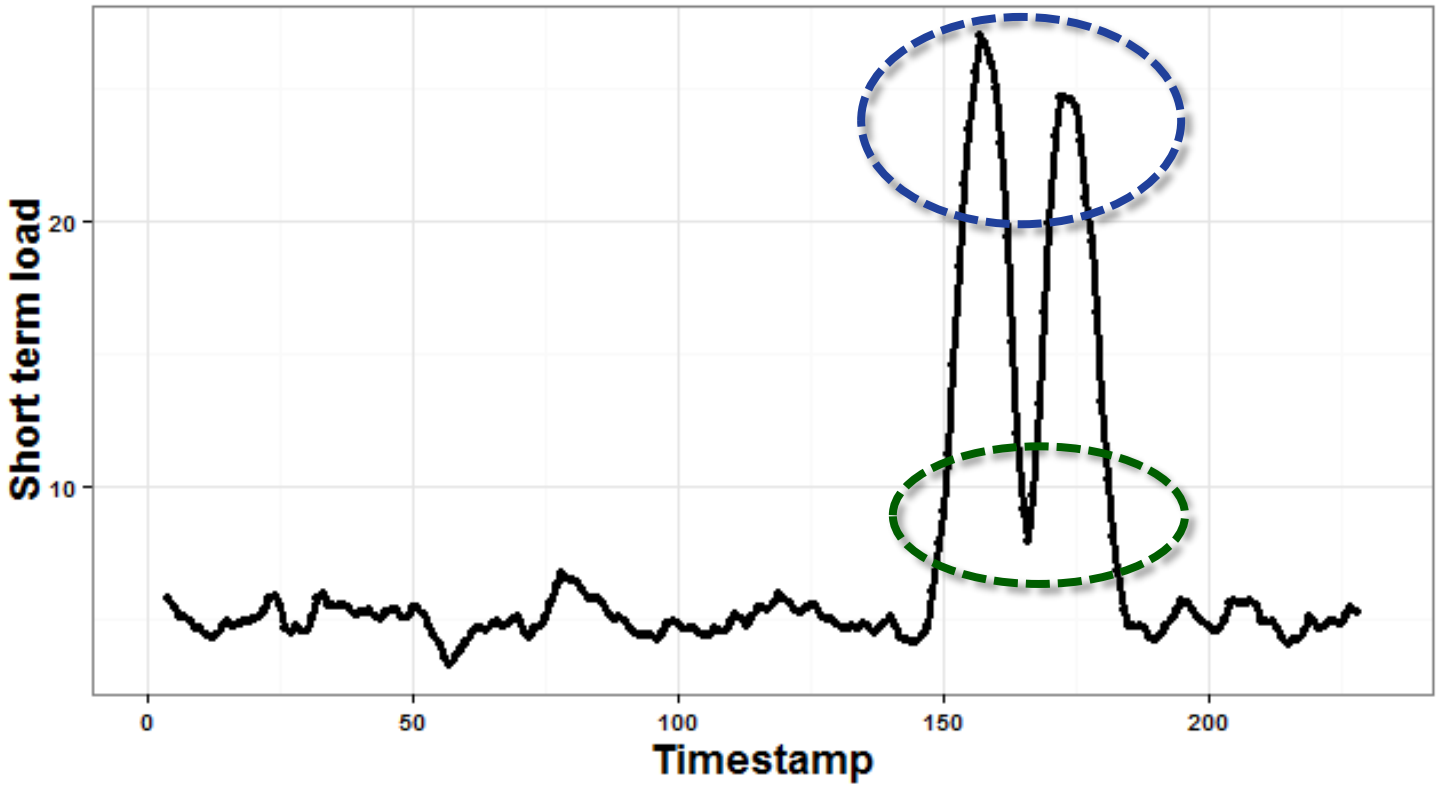

Esettanulmány: PISA 2012

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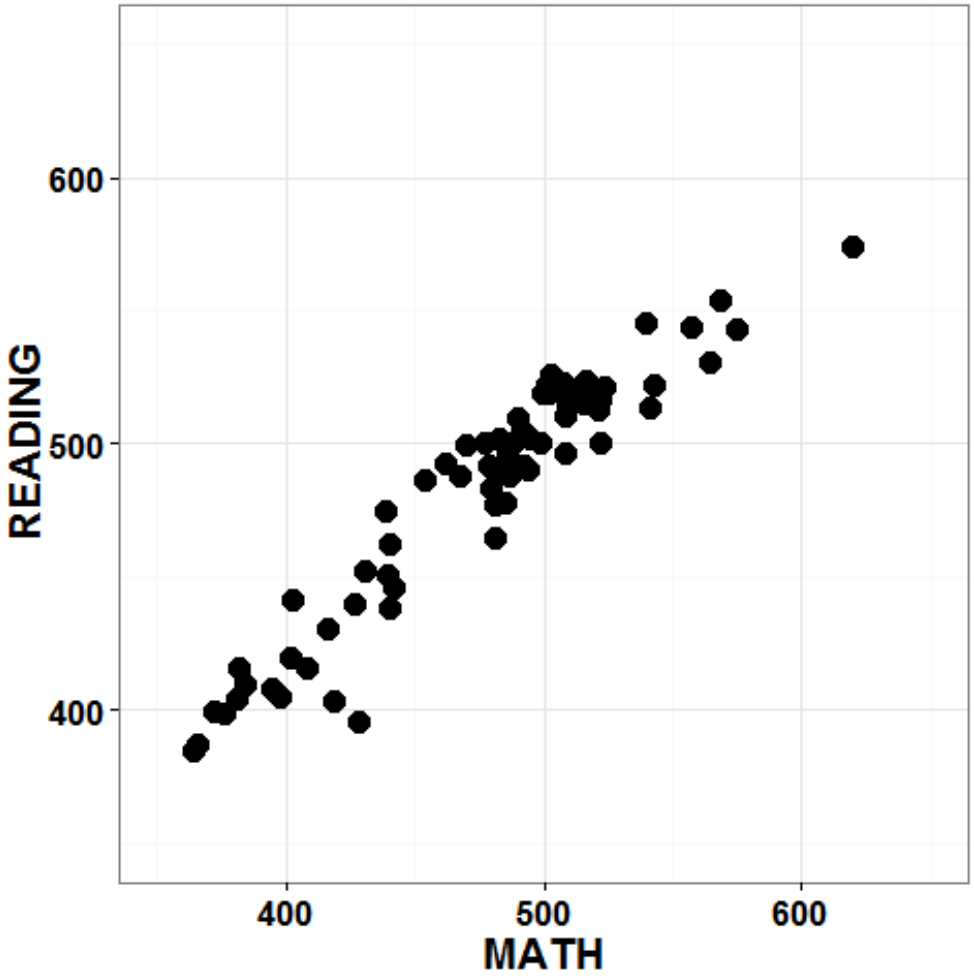

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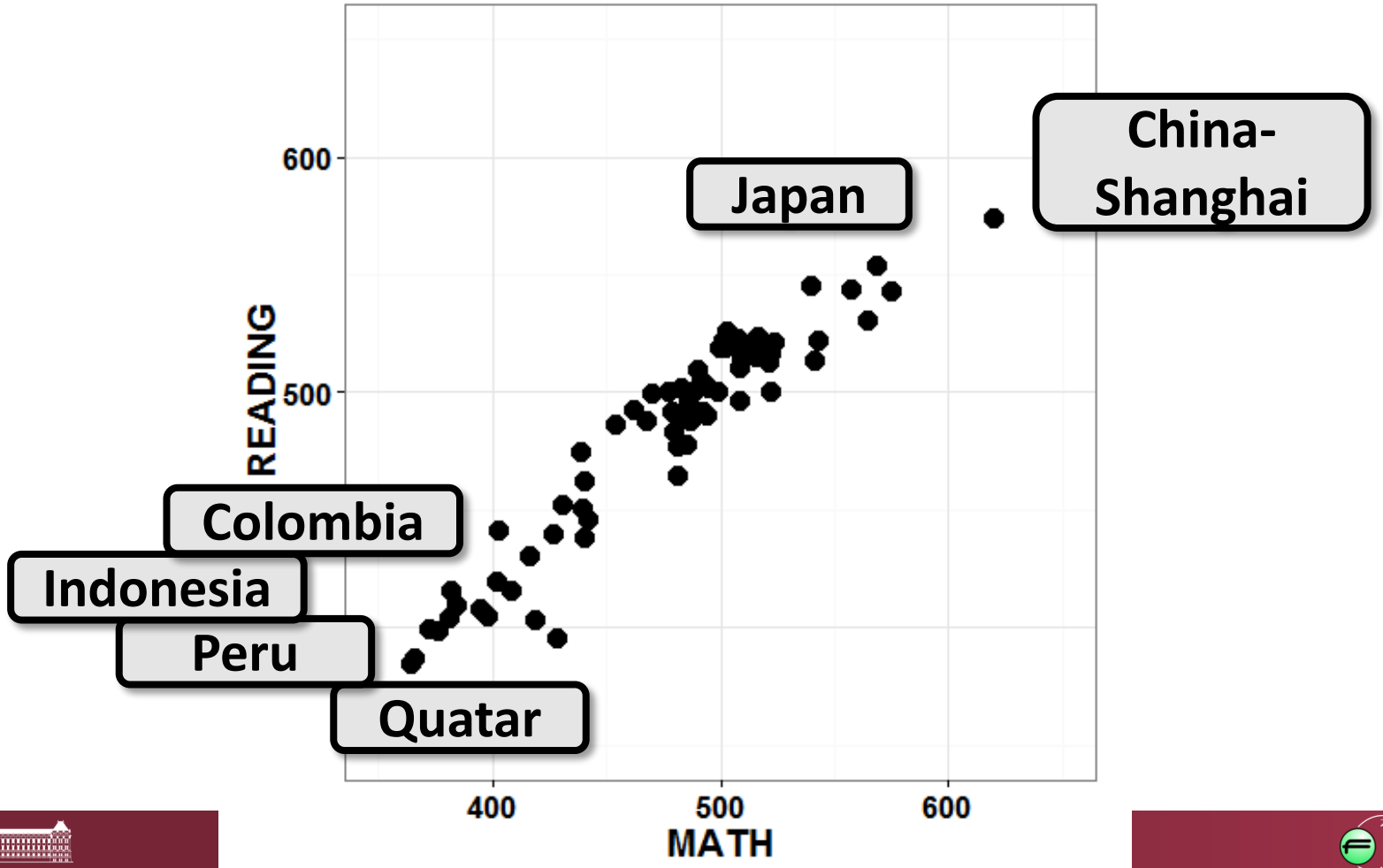
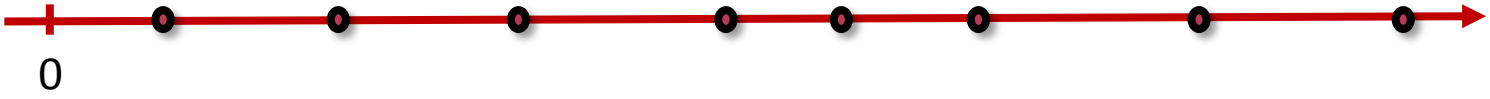


Befoglaló burok

- Féltér-mélység: Tukey, 1974



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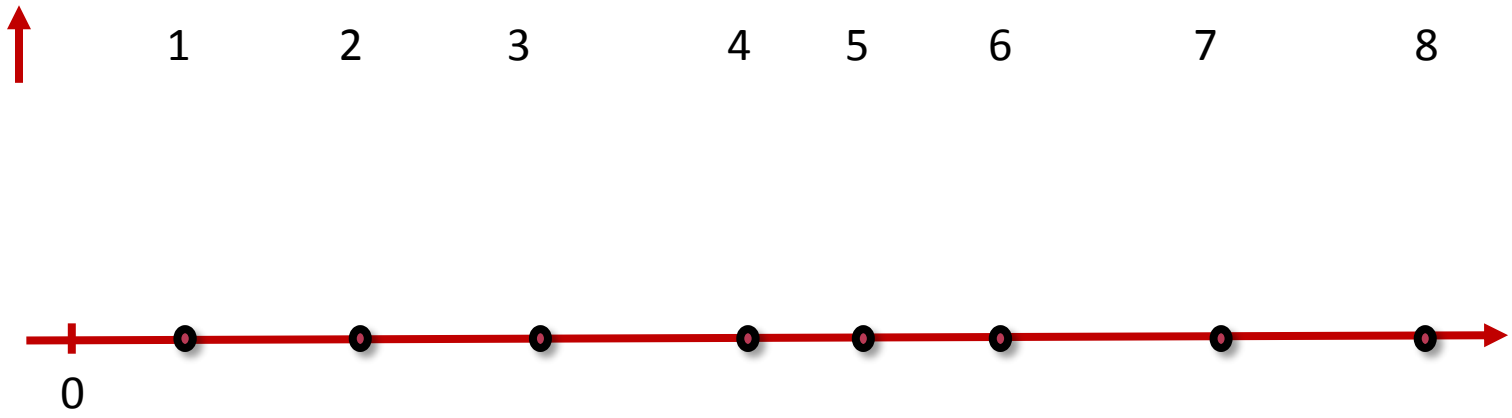

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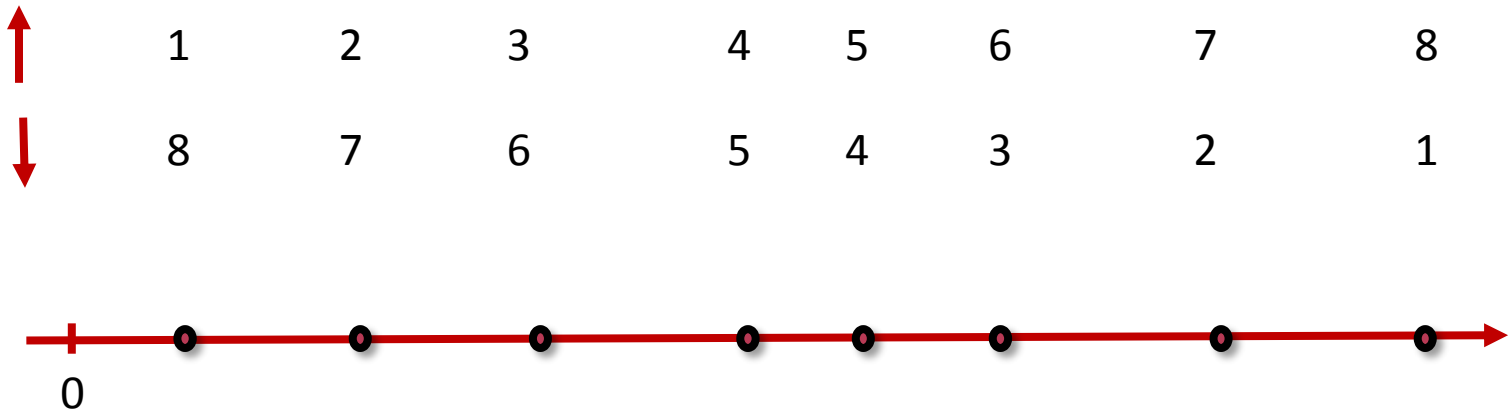

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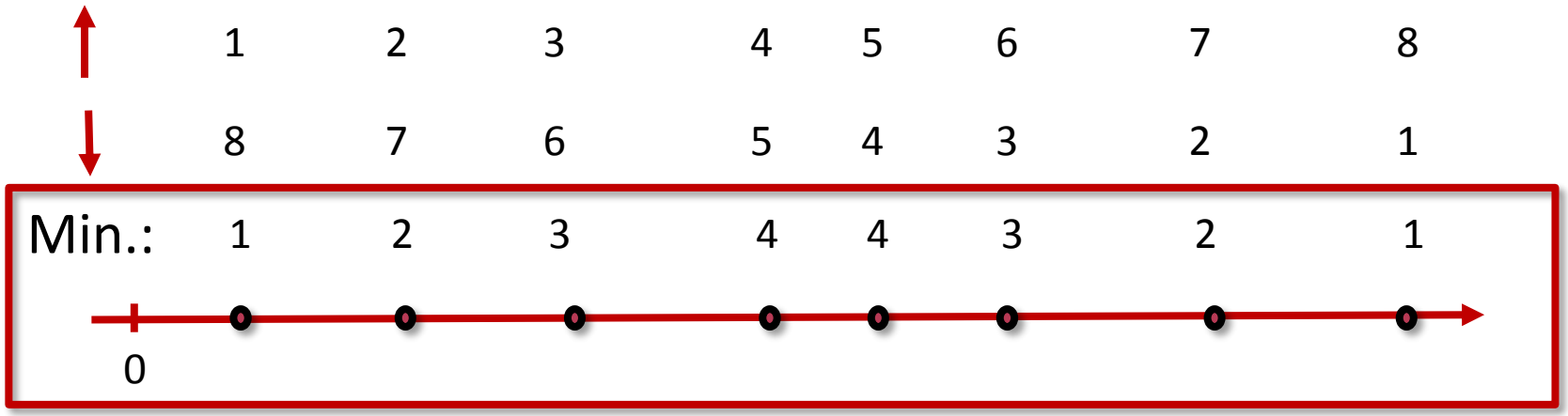

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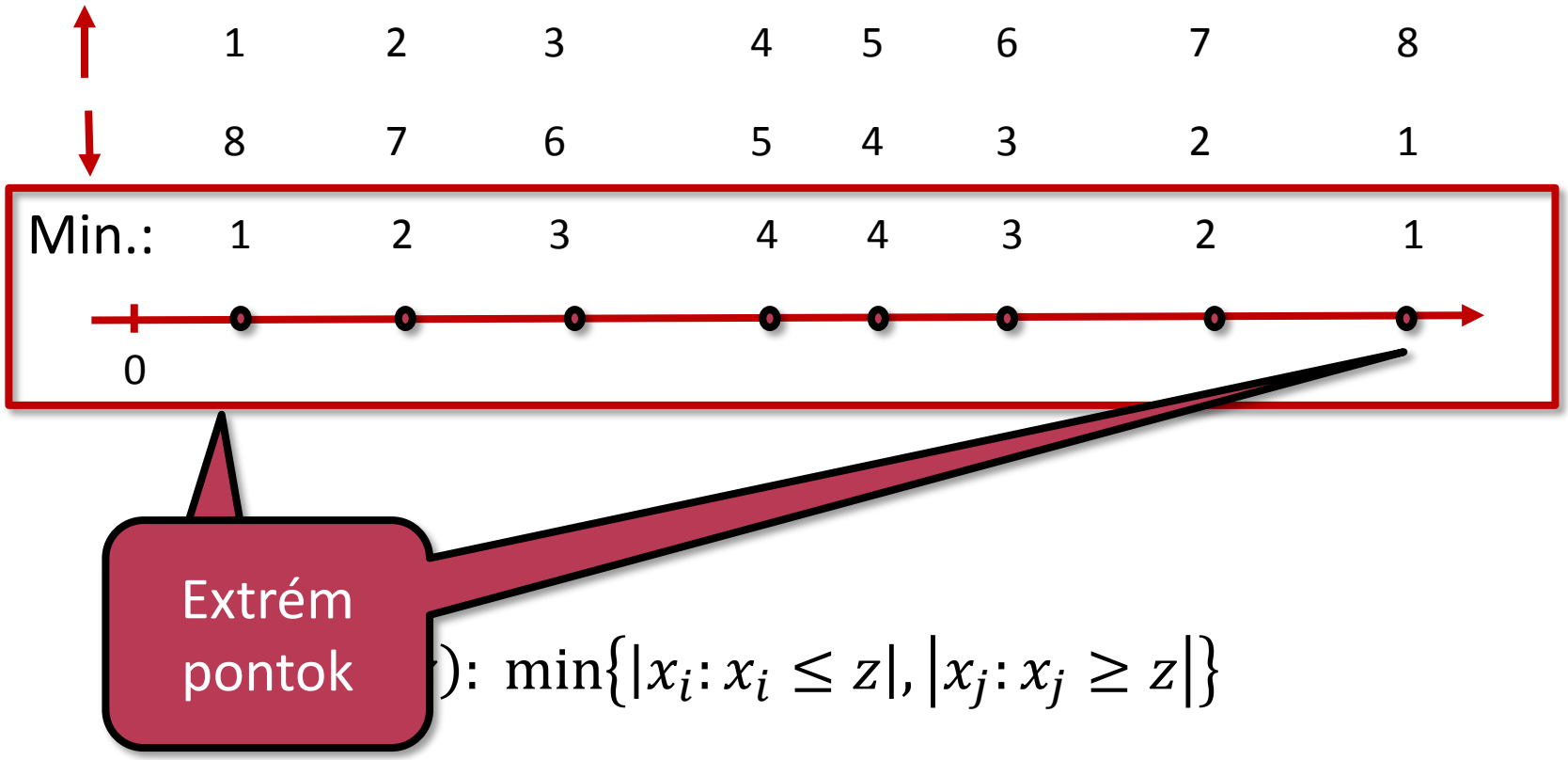

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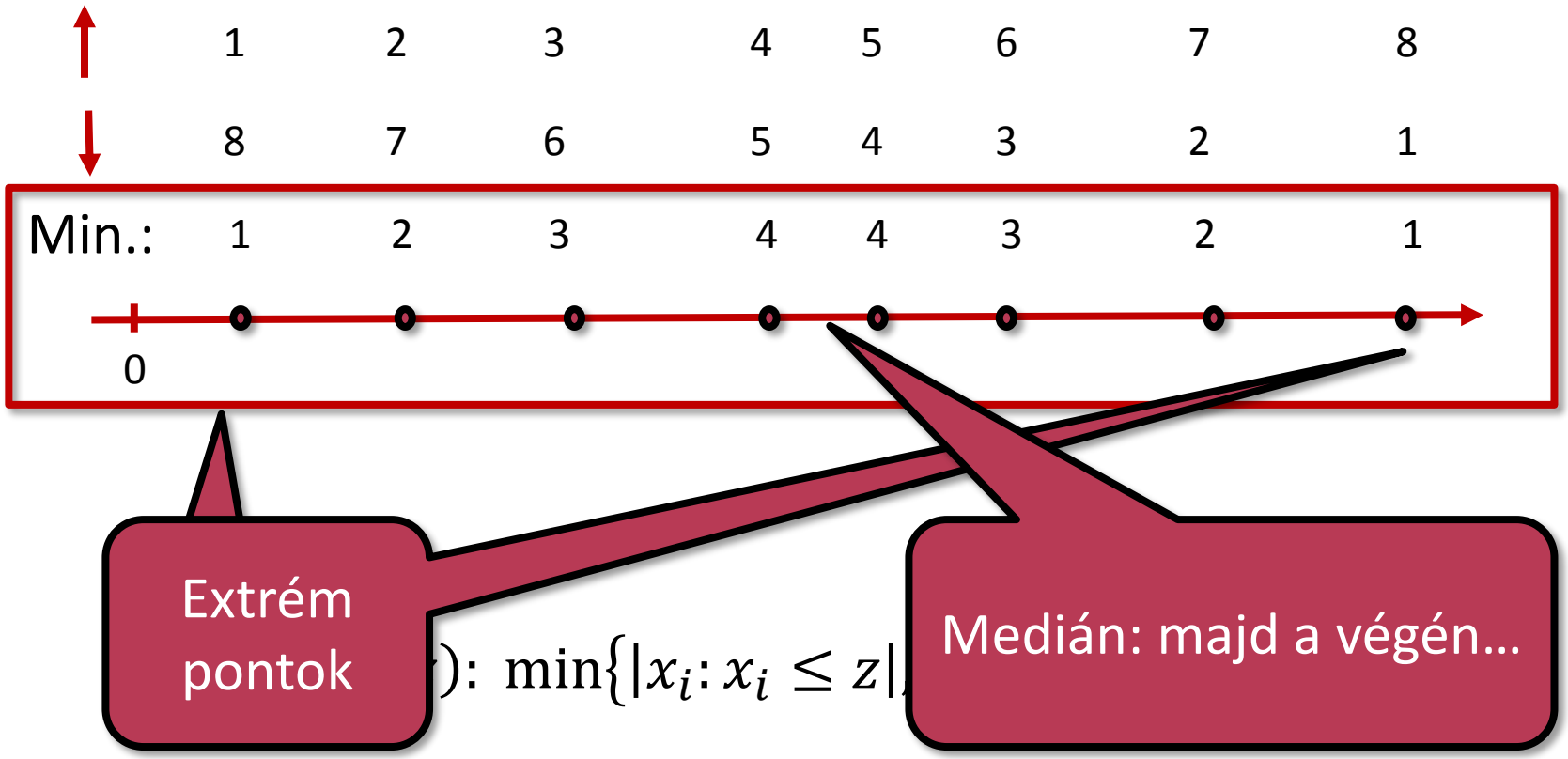

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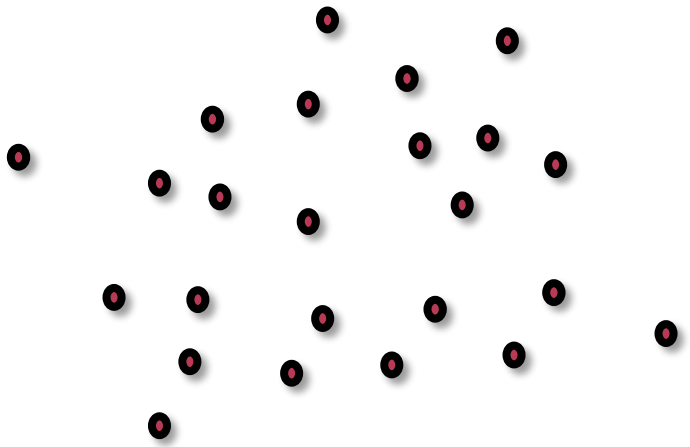

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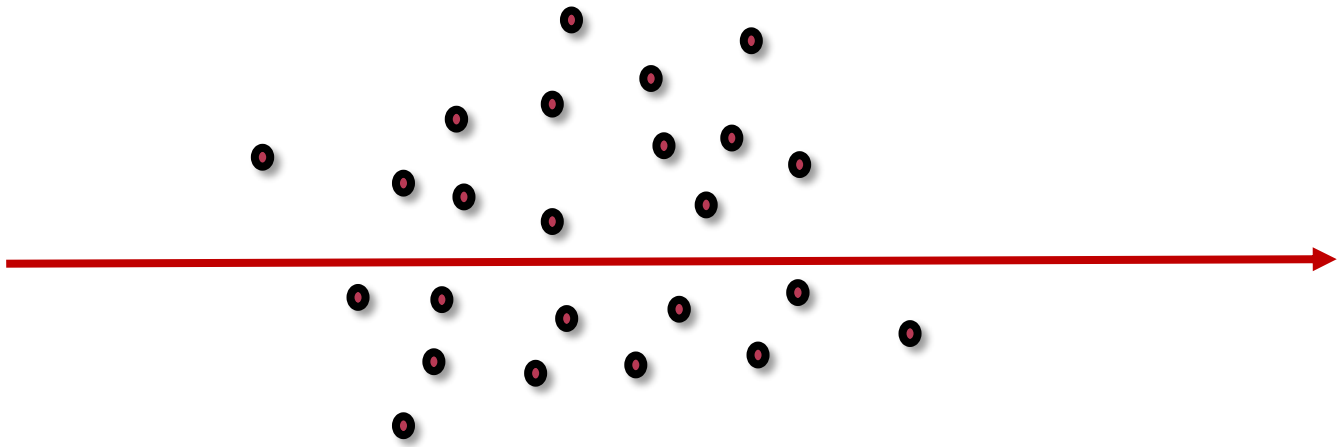

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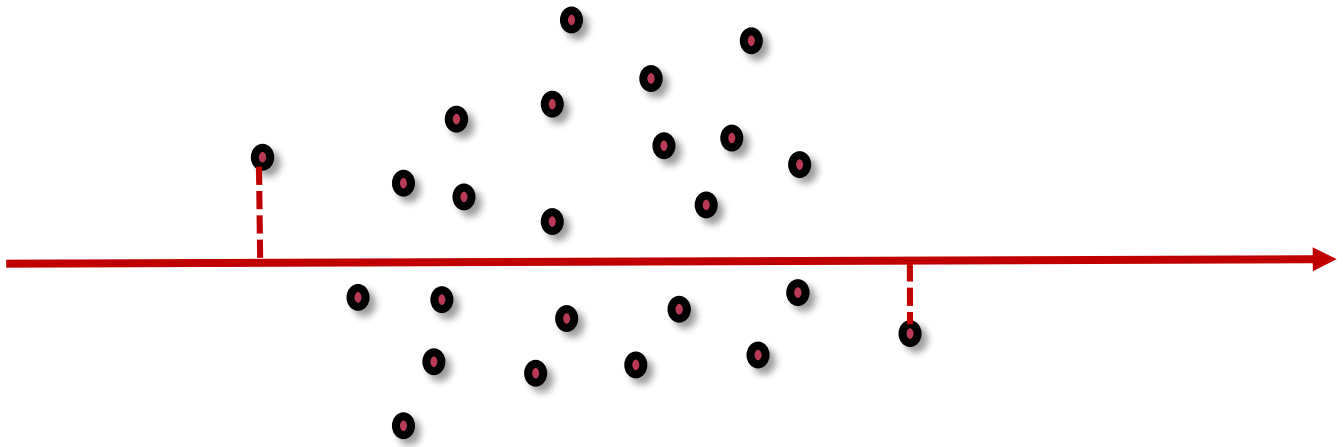

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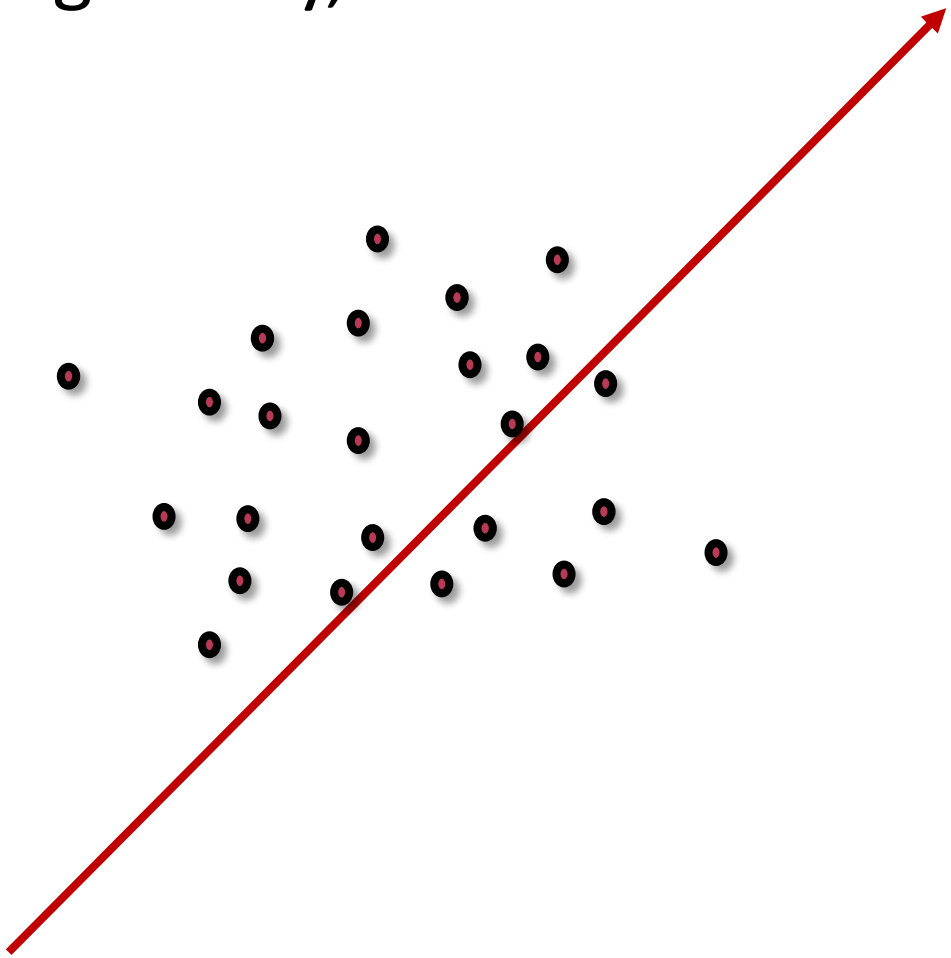

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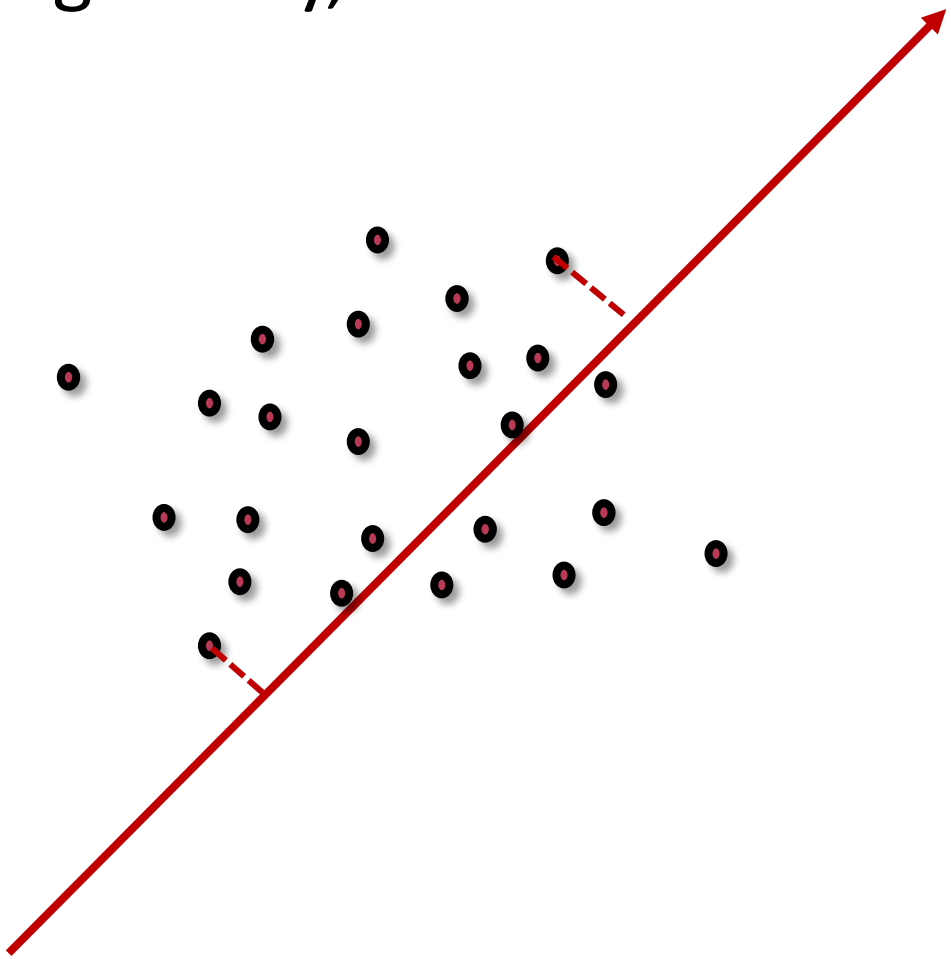

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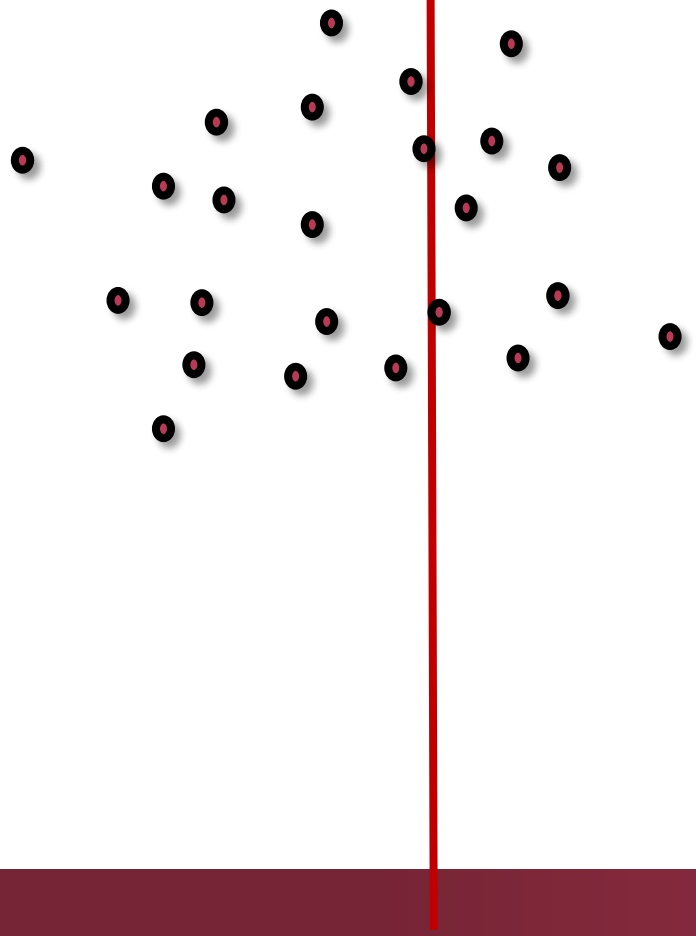

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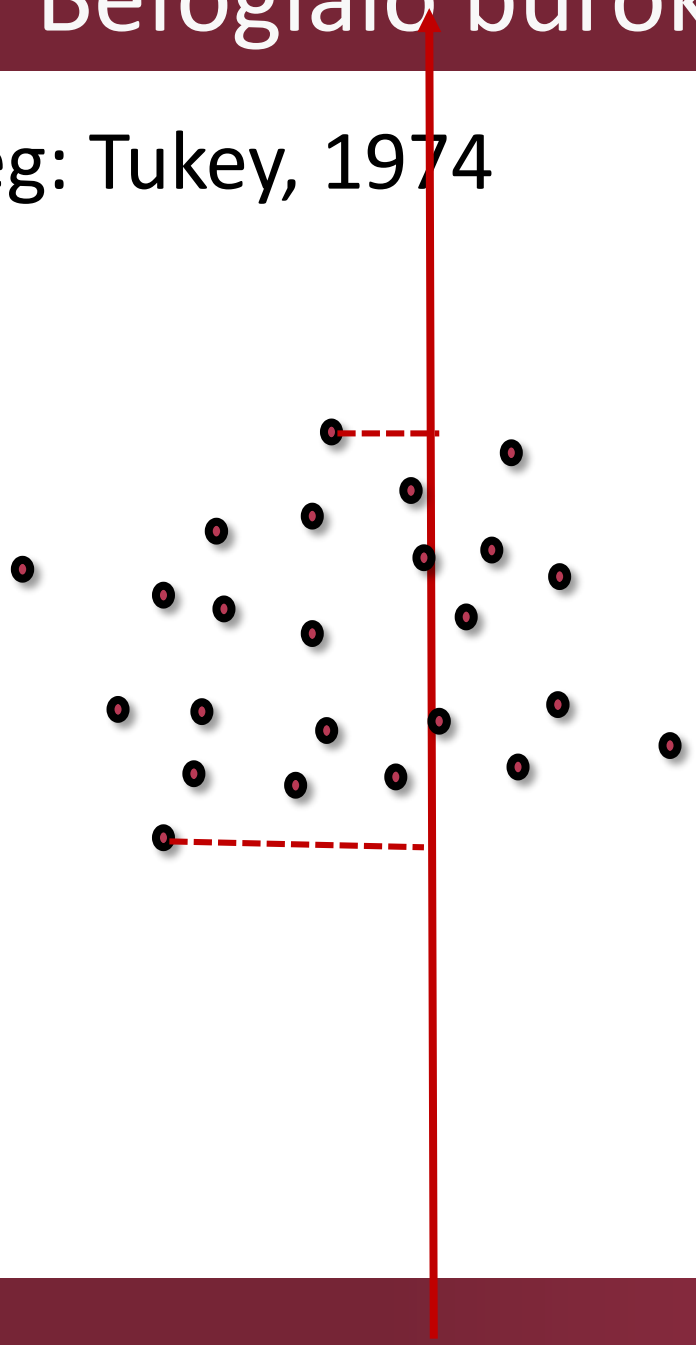

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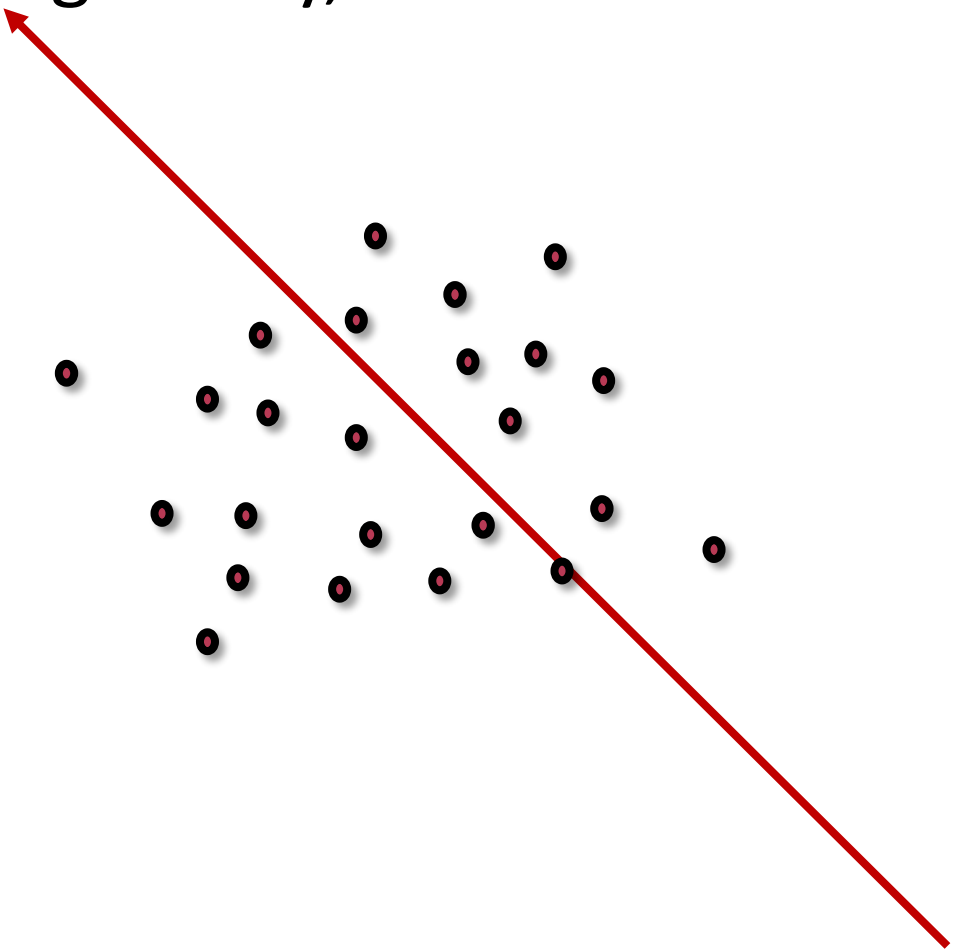

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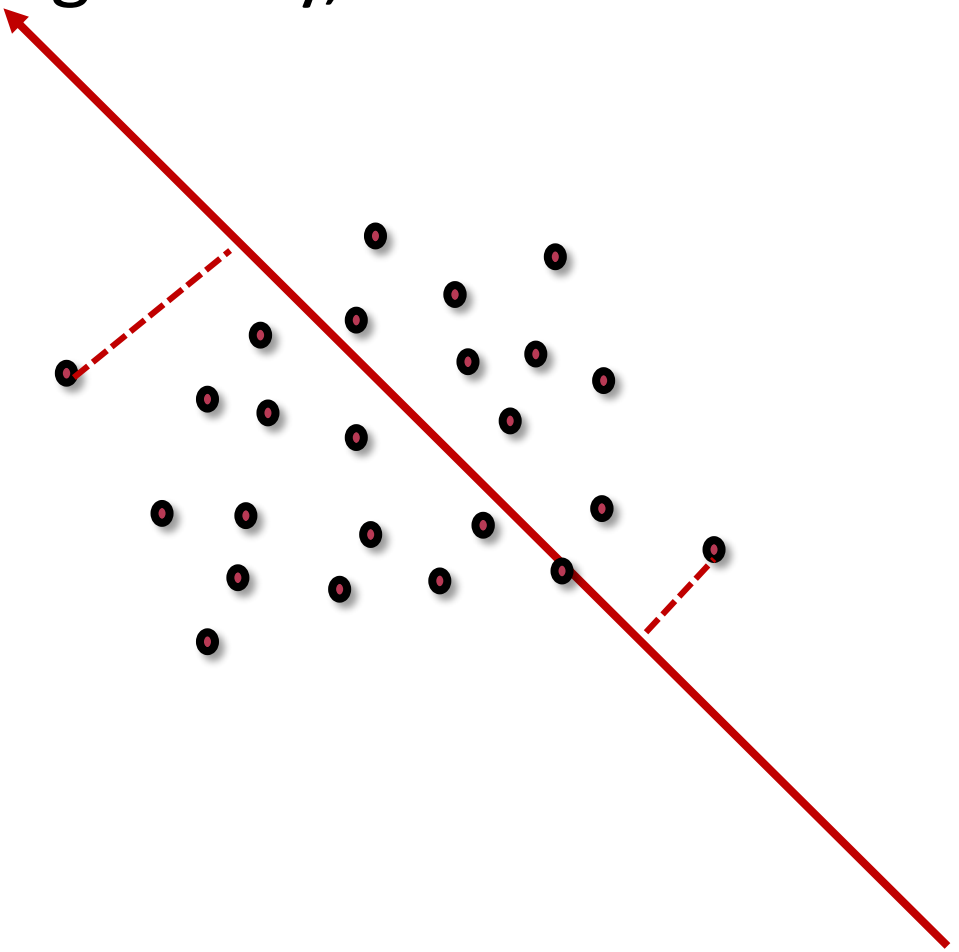

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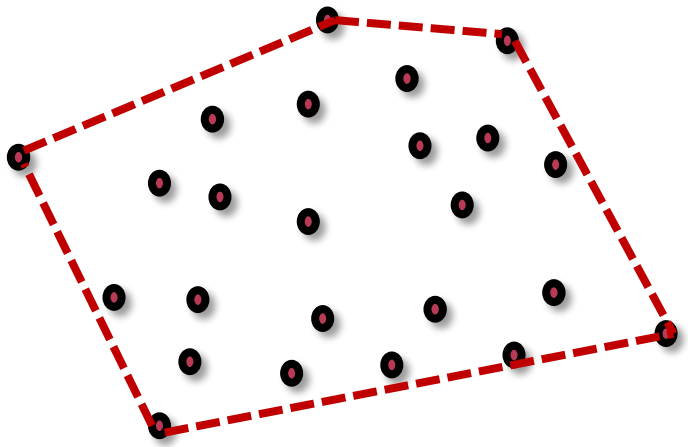
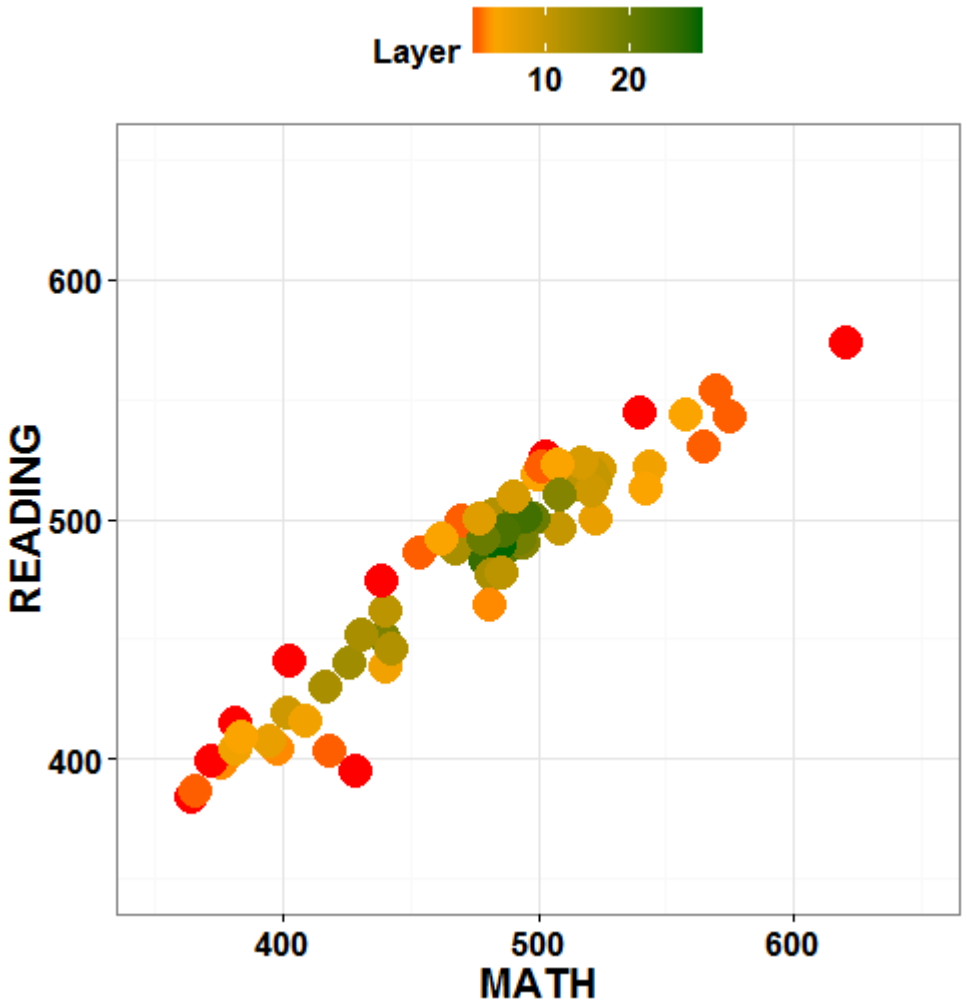


Isodepth (Depth-Based)



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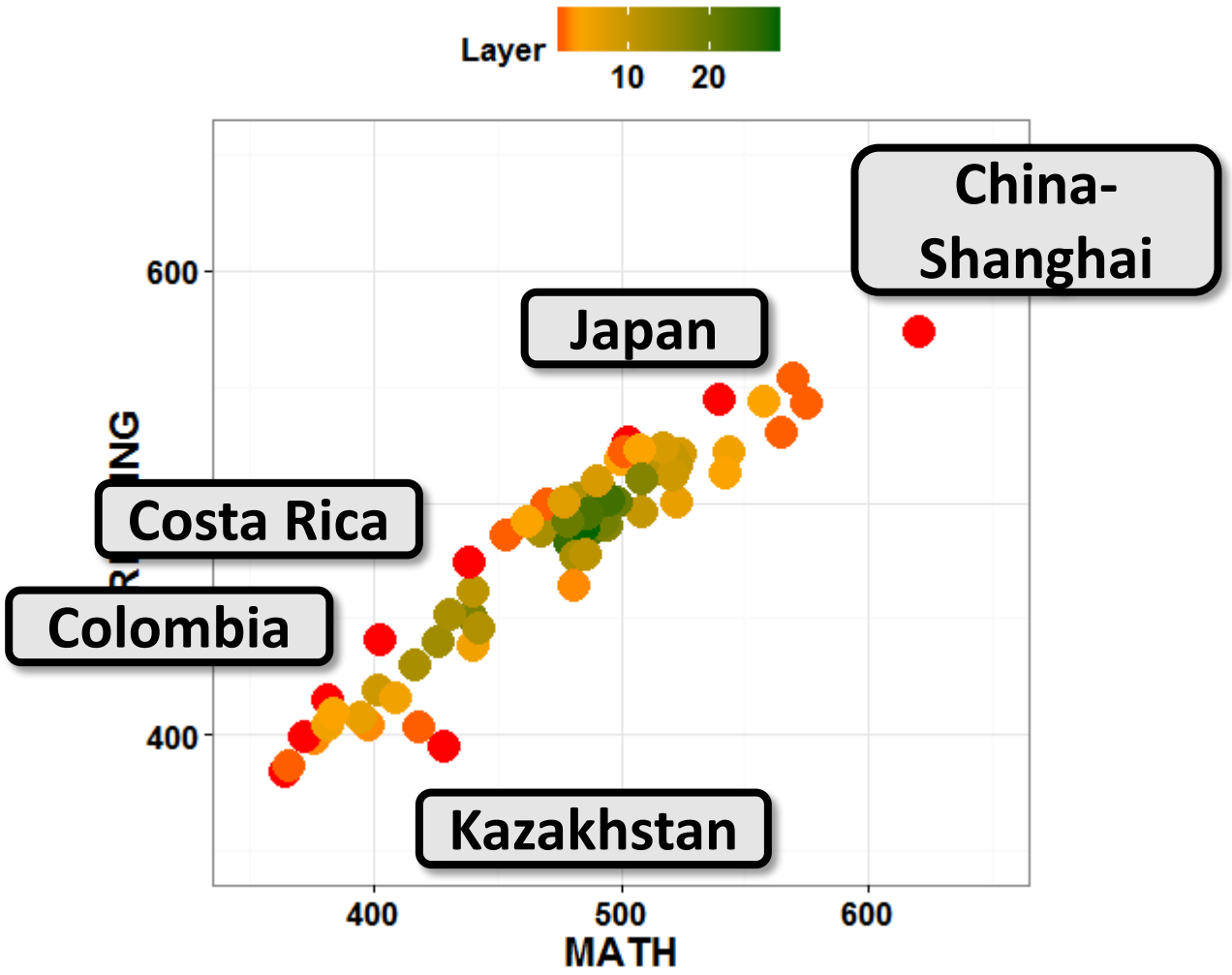
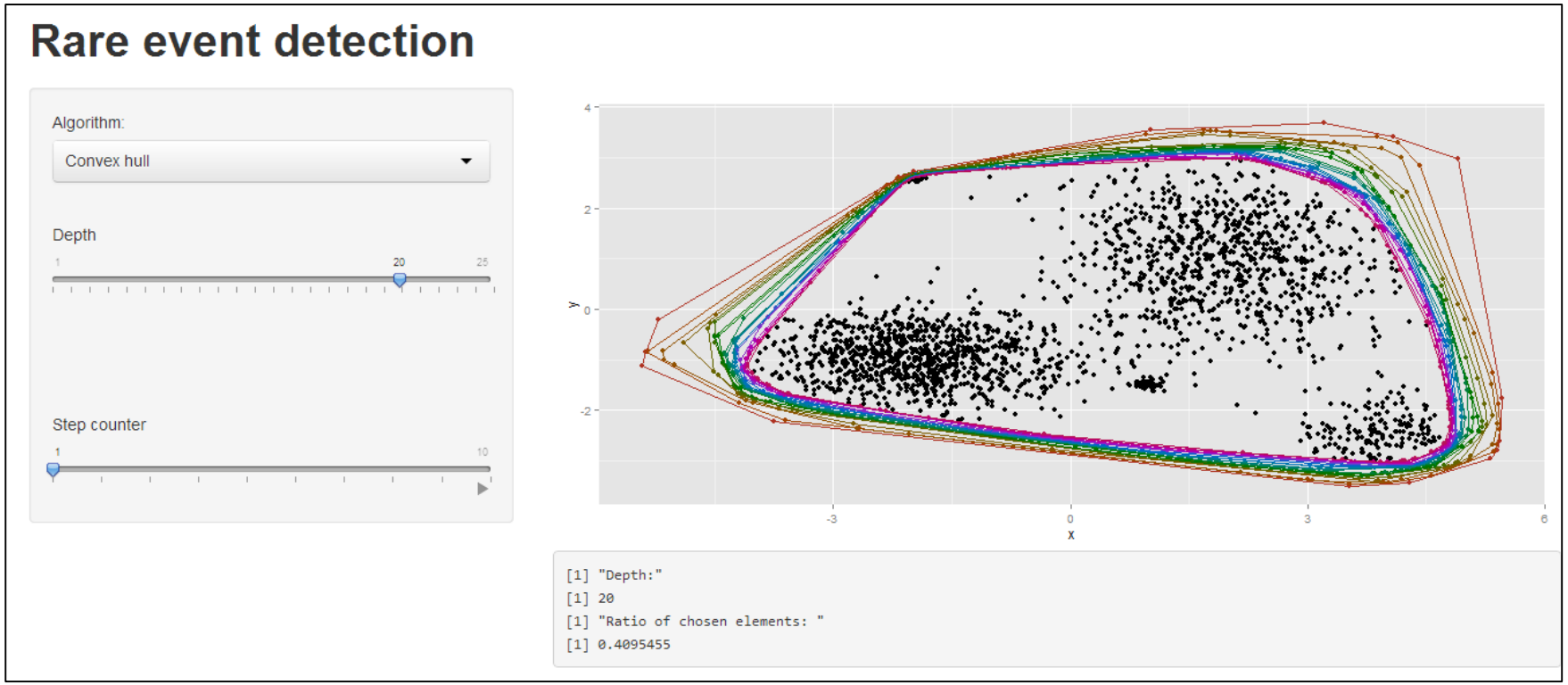


DEMO Befoglaló burok

- Csomag: *depth*
- Hasznos függvények: *depth, isodepth*
- Paraméterek: u pont, $dpth$ mélység

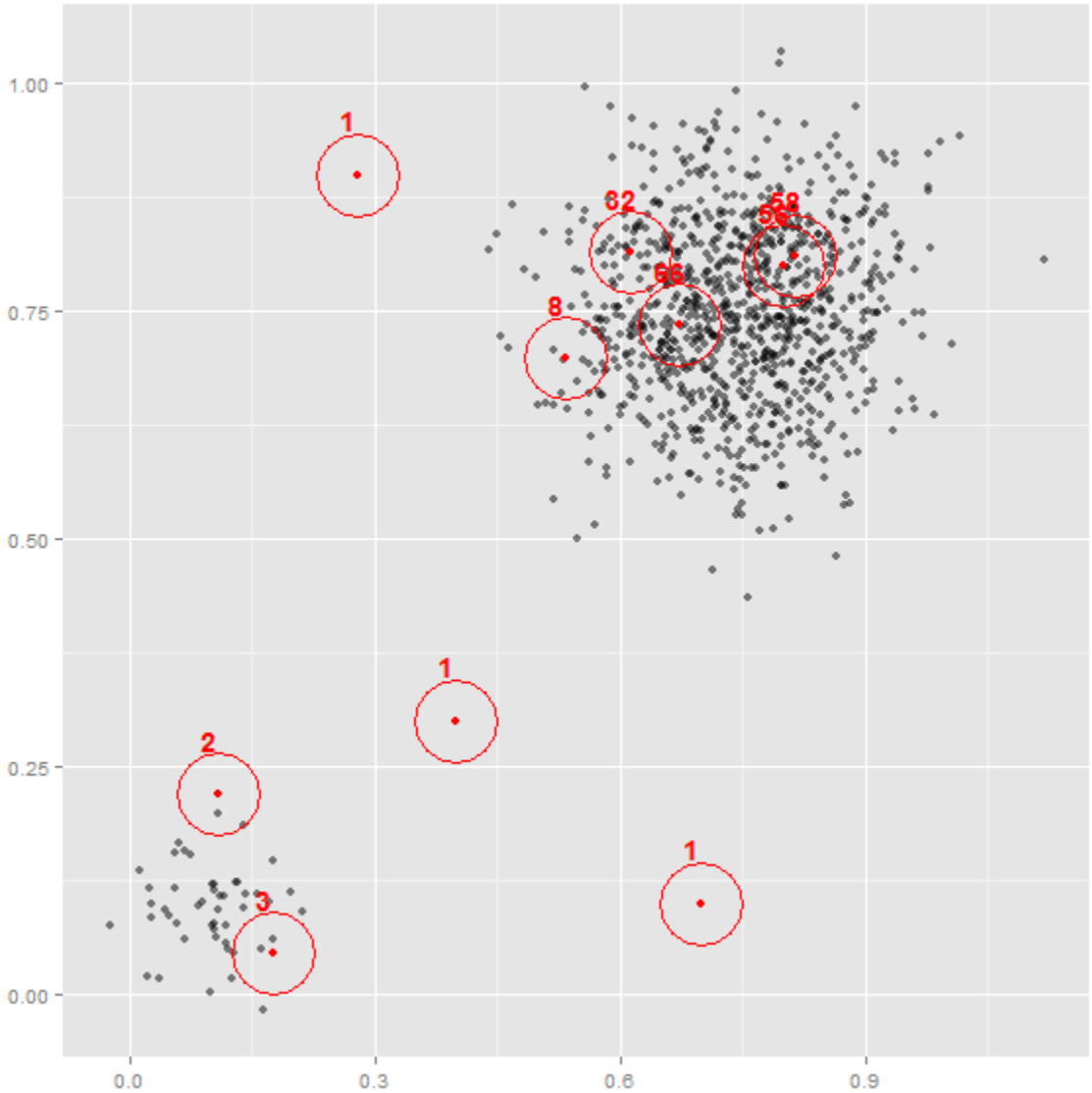


DB

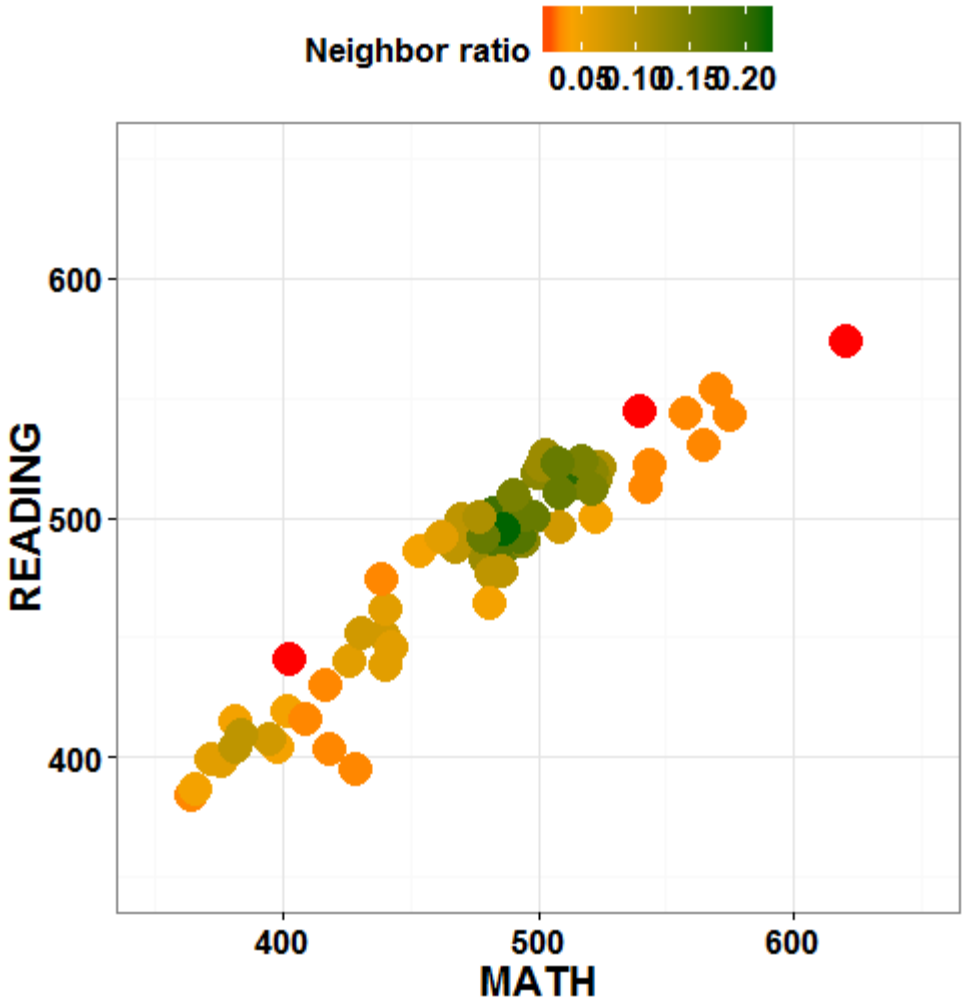
- Distance Based
- Outlier: szomszédok száma alacsony
- Paraméterek
  - r sugarú hipergömb
  - Szomszédok elvárt π aránya

DB

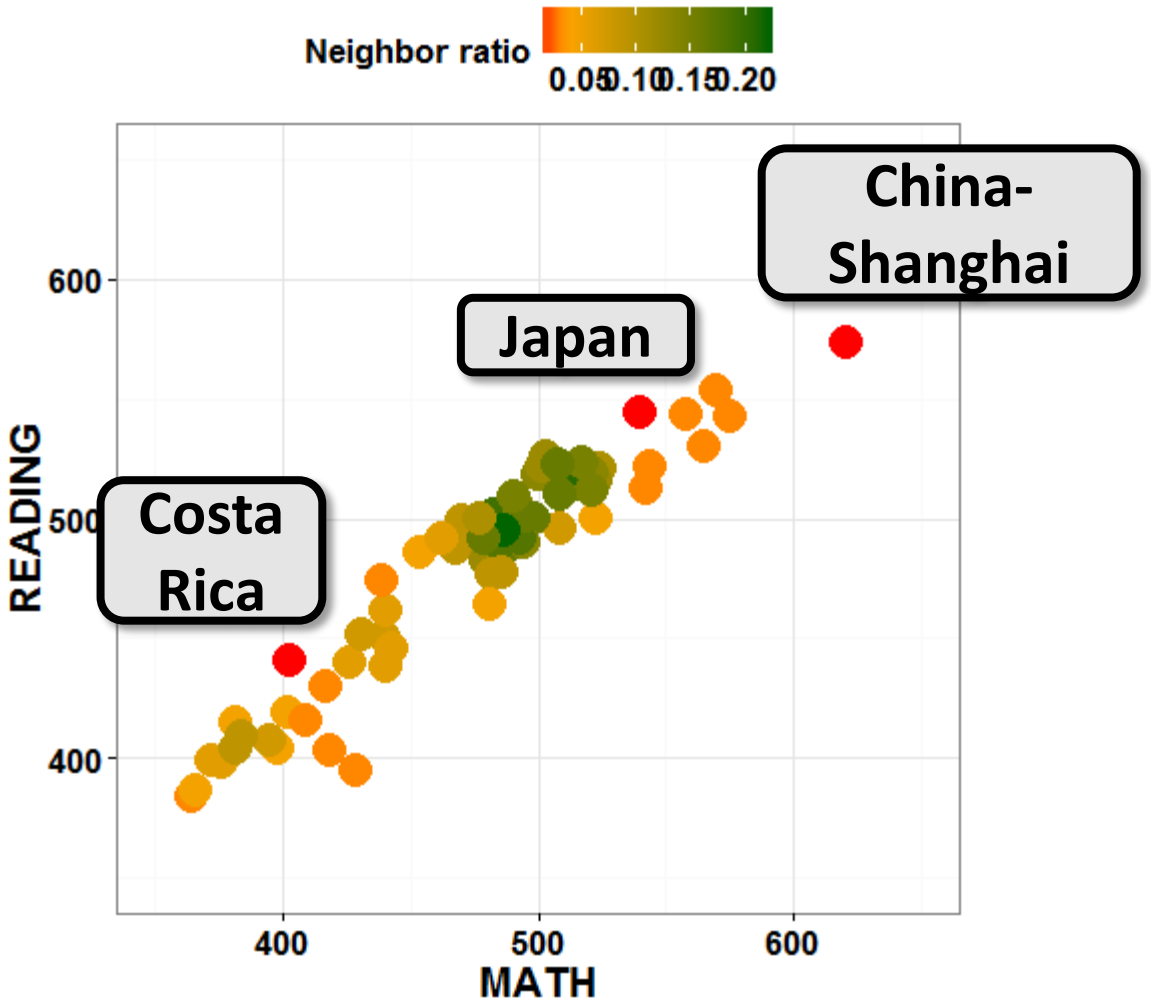
- Distanc
- Outlier
- Parame
  - r sug
  - Szom



db – Distance-Based

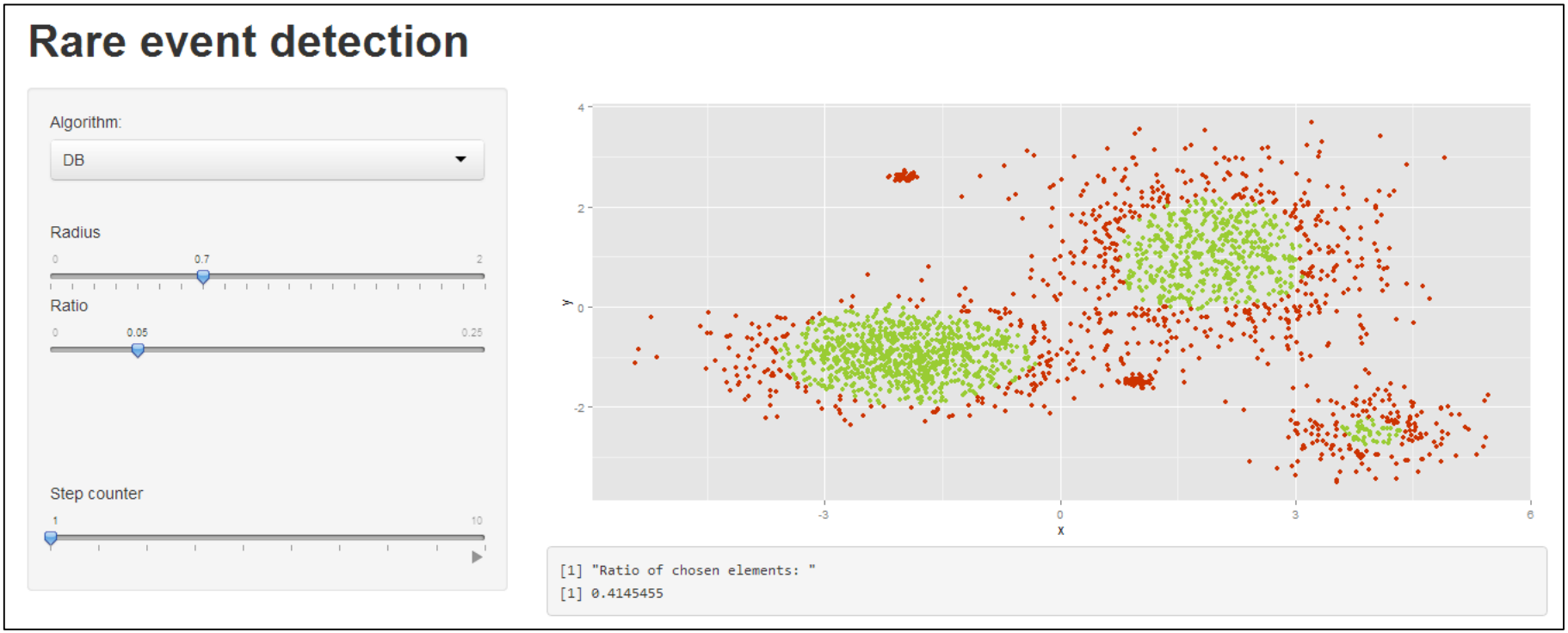


db – Distance-Based



DEMO DB

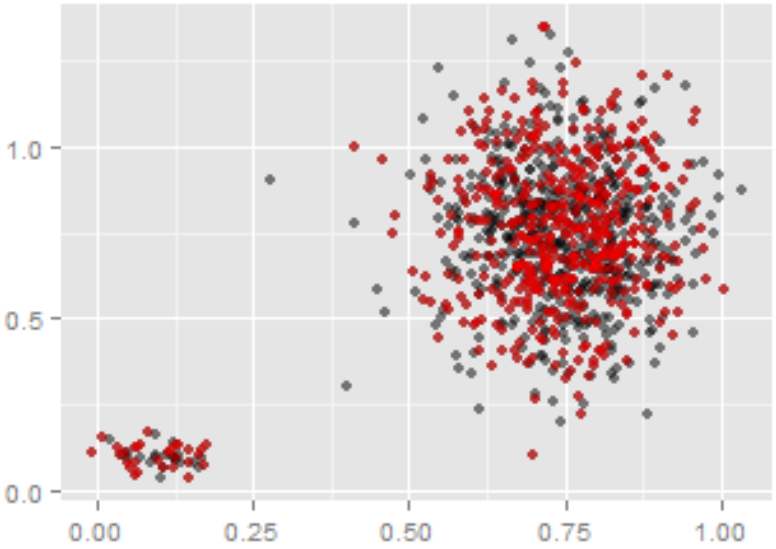
- Csomag: *fields*
- Függvény: *fields.rdist.near*
- Paraméterek: $delta$ sugár



MCD

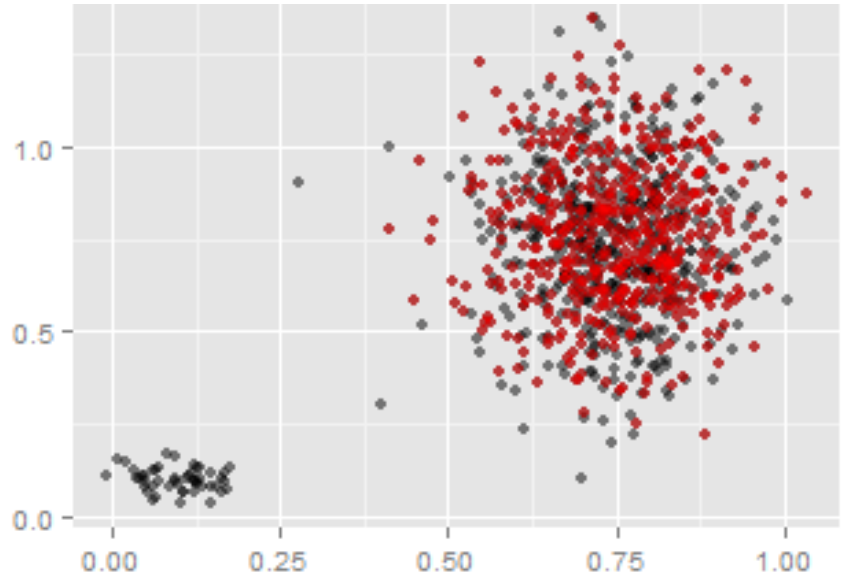
- Minimum Covariance Determinant
- Alapötlet
  - Keressük meg a legkompaktabb részhalmazt!

MCD


1.0
0.5
0.0
0.00
0.25
0.50
0.75
1.00

De

ıpa


1.0
0.5
0.0
0.00
0.25
0.50
0.75
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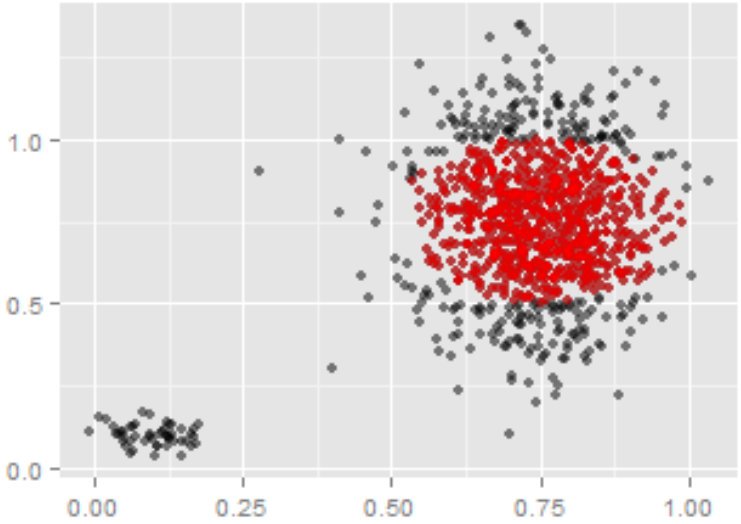
1.0
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MCD

De

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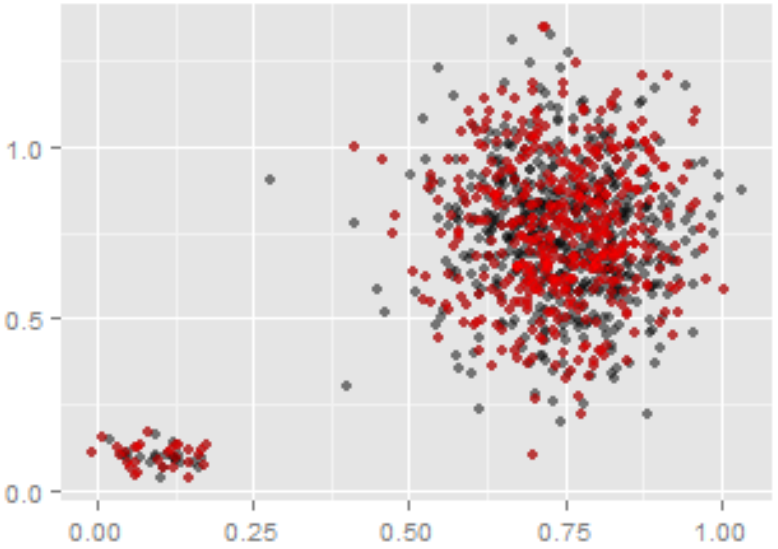
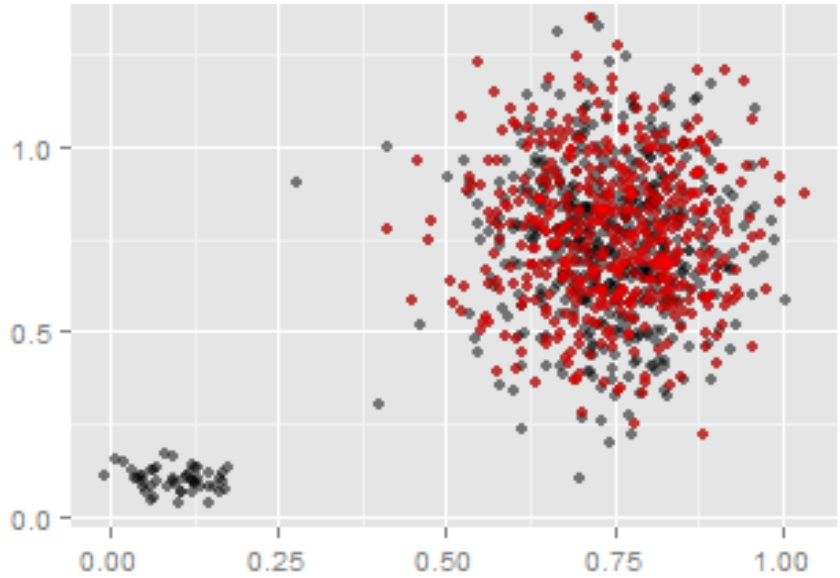
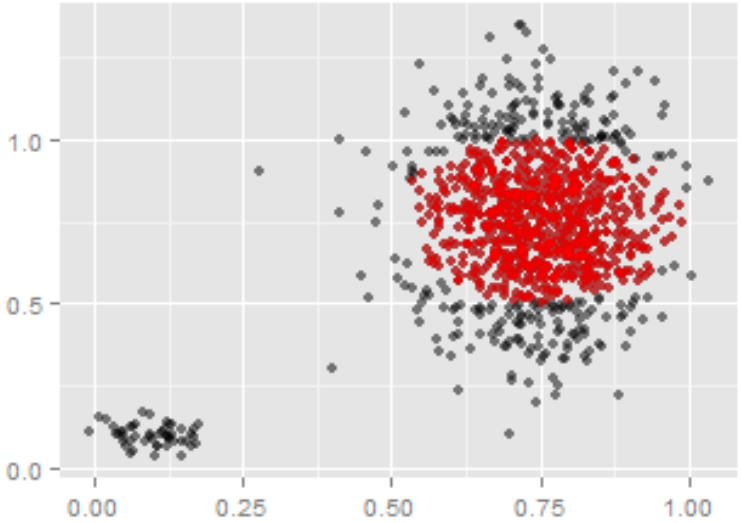


0.0014



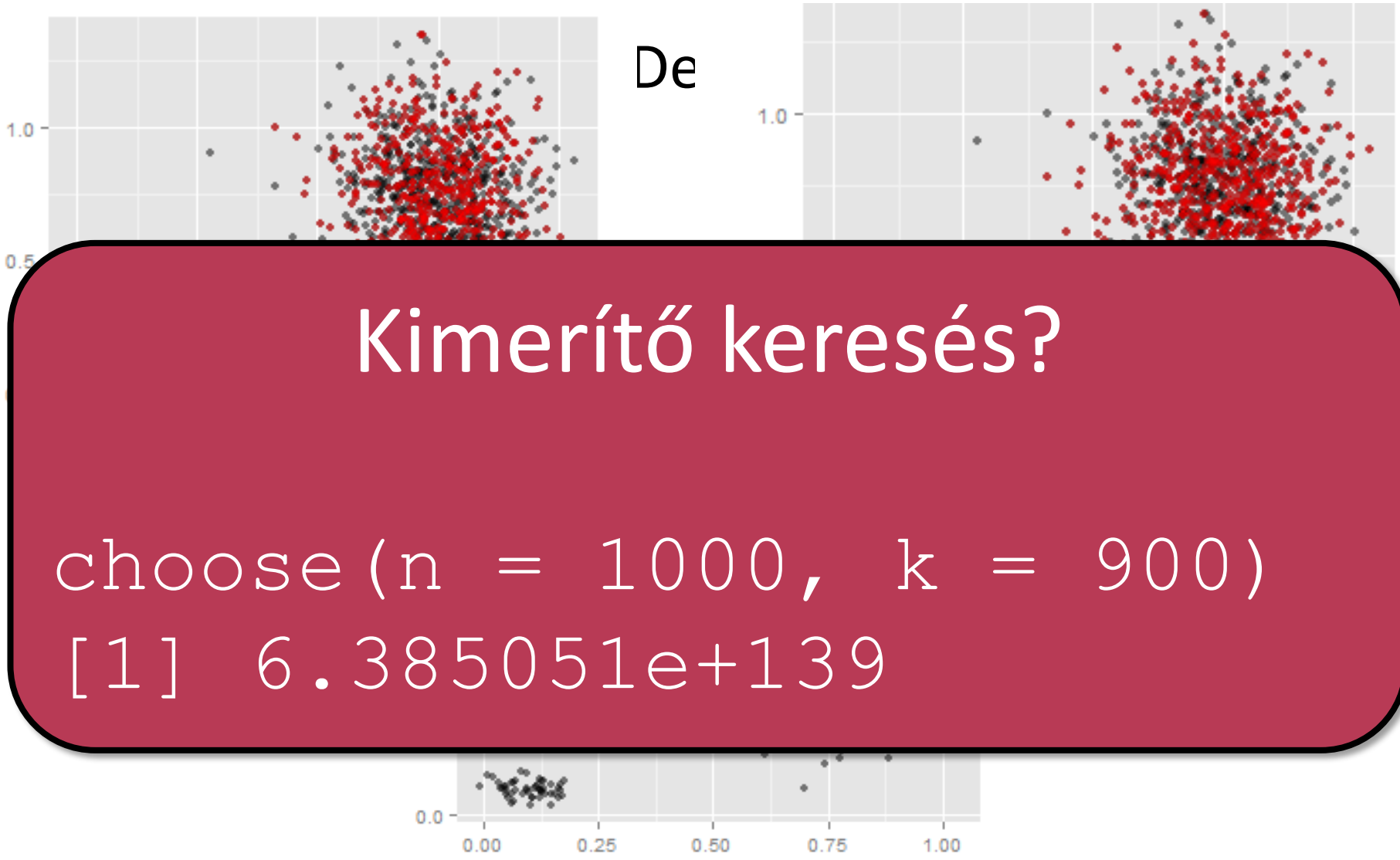
0.00041



0.00011

MCD

De



Kimerítő keresés?

```
choose(n = 1000, k = 900)
[1] 6.385051e+139
```

0.00011

FAST-MCD

- Közelítő algoritmus
- Véletlenszerűen választott kezdőhalmaz
- Iteratív
- Legközelebbi pontok kiválasztása
  - Mahalanobis távolság alapján

Mahalanobis távolság

- $D(x, M) = \sqrt{(x - \vartheta)^T S^{-1} (x - \vartheta)}$
  - S – kovarianciamátrix
  - ϑ – súlypont

Ábra forrása: http://stats.stackexchange.com/questions/62092/bottom-to-top-explanation-of-the-mahalanobis-distance

Mahalanobis távolság

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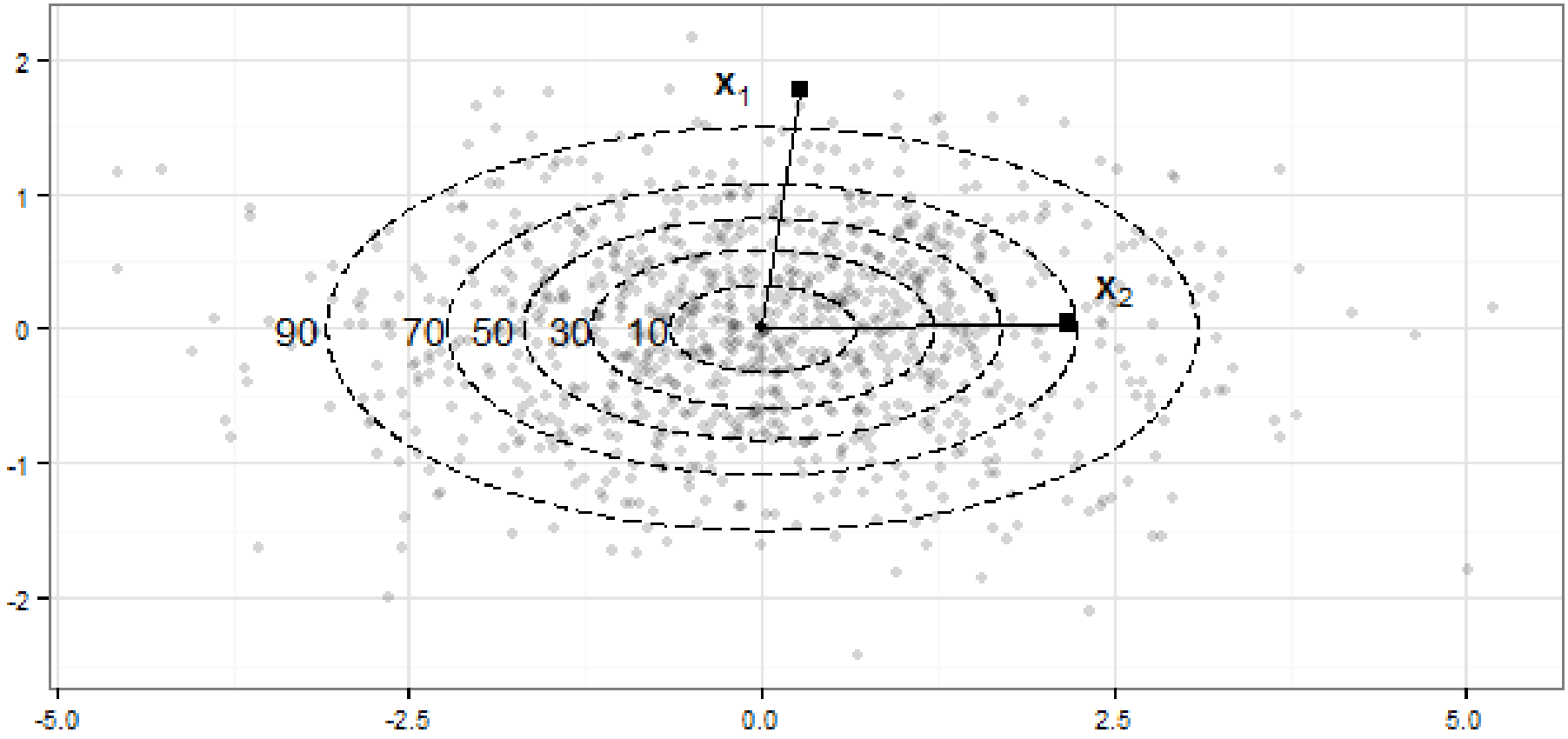
  - S – kovarianciamátrix



Ábra forrása: http://stats.stackexchange.com/questions/62092/bottom-to-top-explanation-of-the-mahalanobis-distance

FAST-MCD

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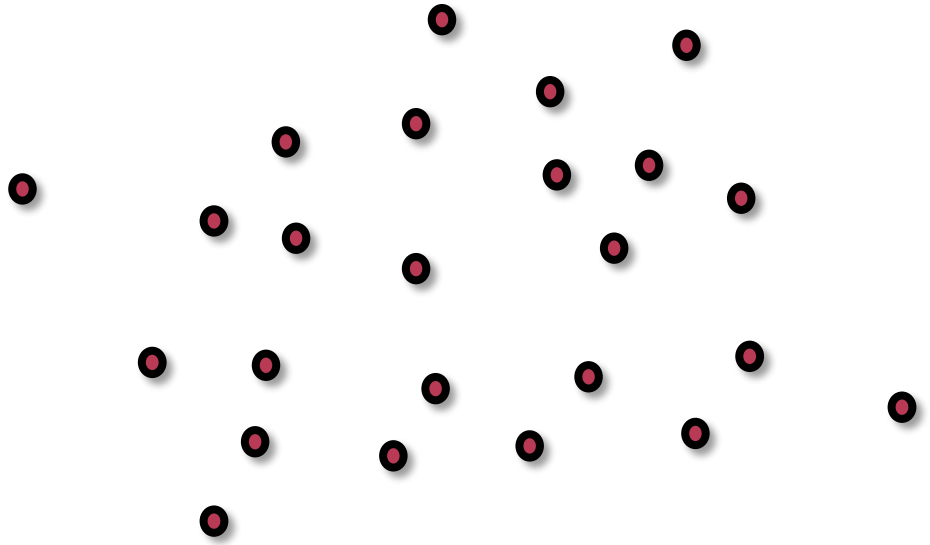
- Véletlenszerűen választott kezdőhalmaz
- Iteratív



- Legközelebbi pontok kiválasztása
  - Mahalanobis távolság alapján
  - Legközelebbi $x\%$

FAST-MCD

- Közelítő algoritmus
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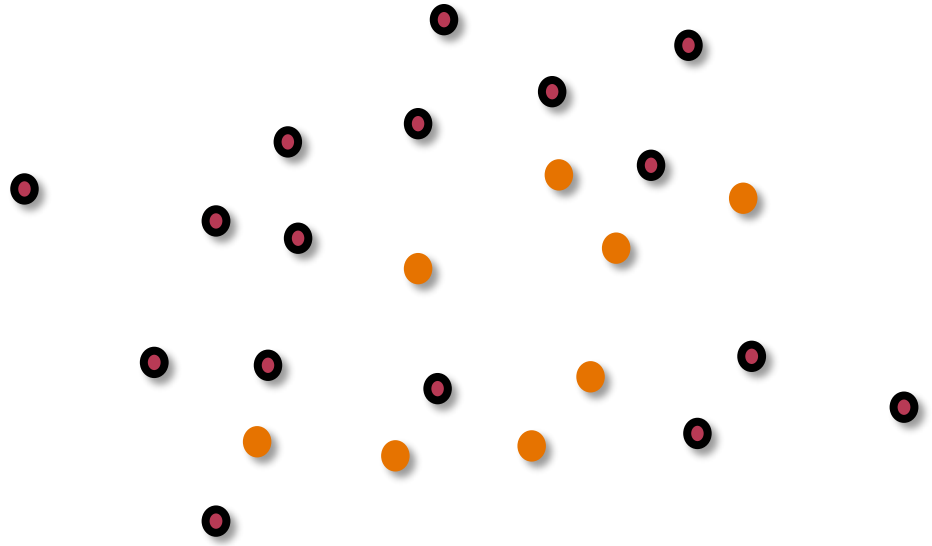

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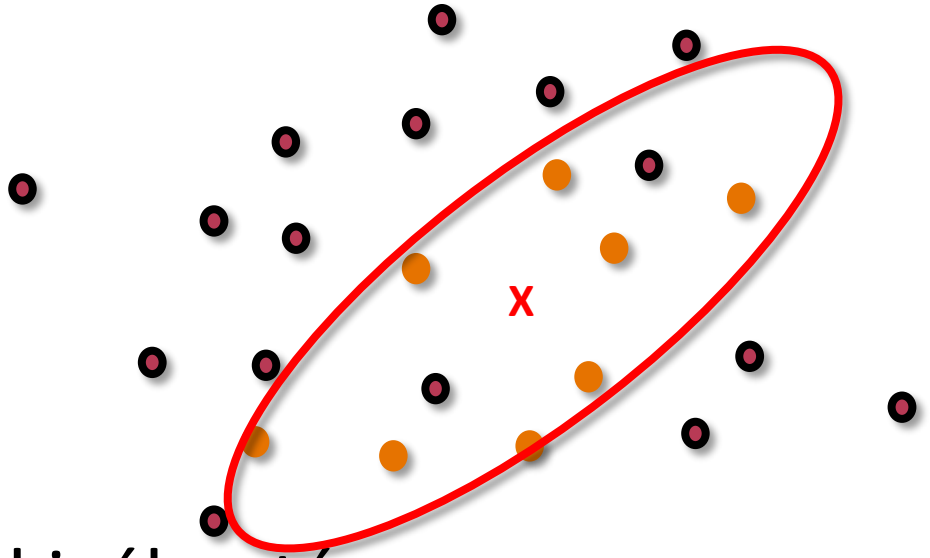

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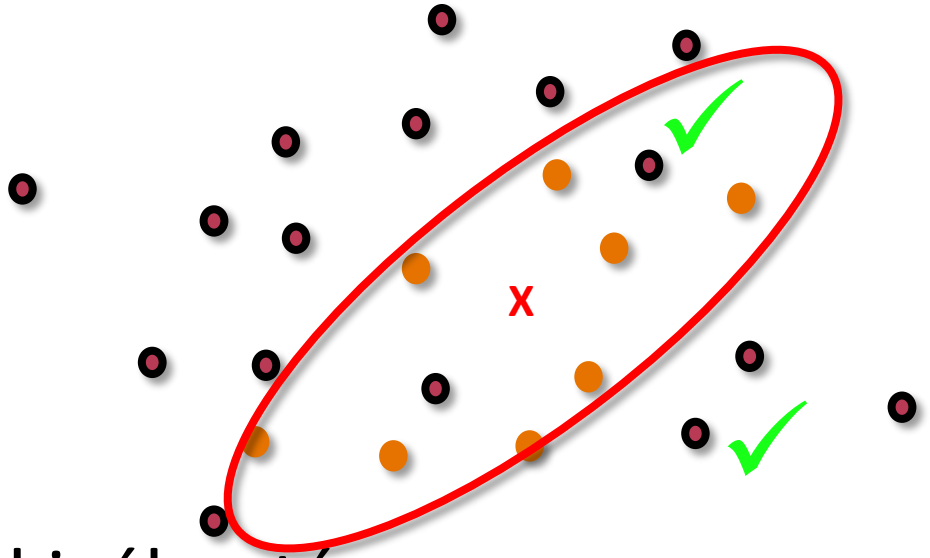
- Véletlenszerűen választott kezdőhalmaz
- Iteratív



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  - Mahalanobis távolság alapján
  - Legközelebbi $x\%$

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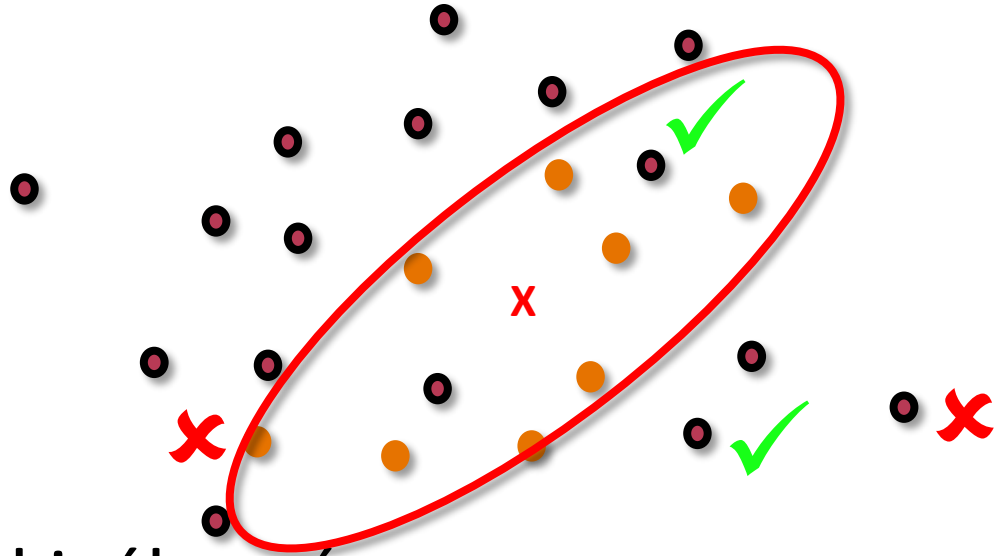
- Közelítő algoritmus
- Véletlenszerűen választott kezdőhalmaz
- Iteratív



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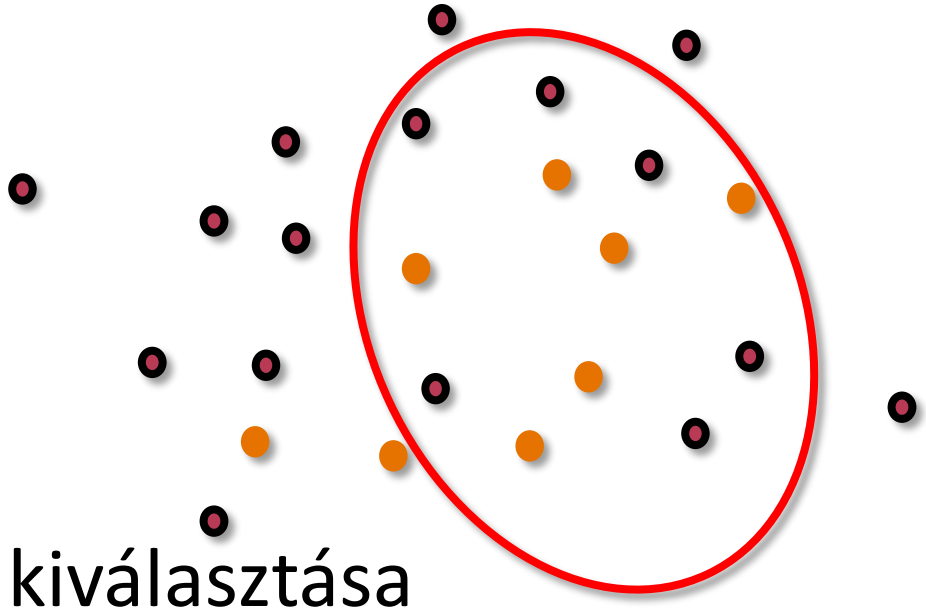


- Legközelebbi pontok kiválasztása
  - Mahalanobis távolság alapján
  - Legközelebbi $x\%$

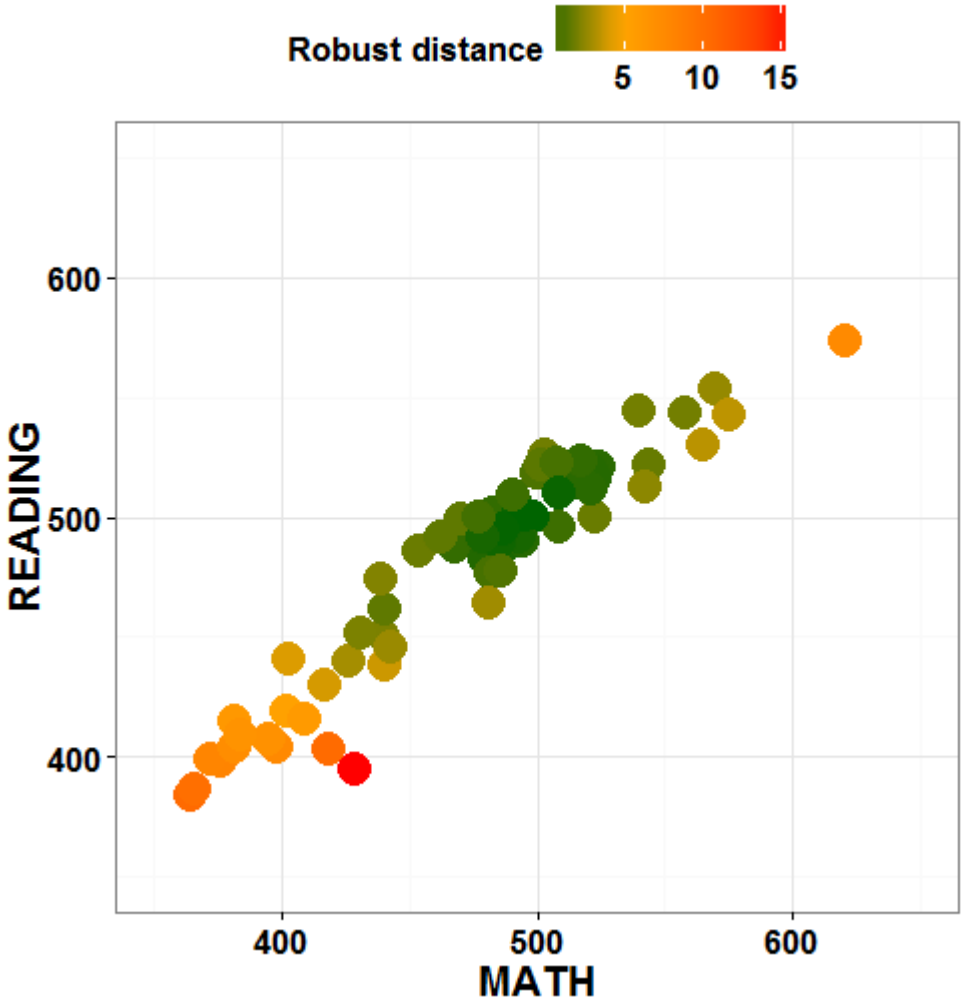
BACON

- Blocked Adaptive Computationally Efficient Outlier Nominators

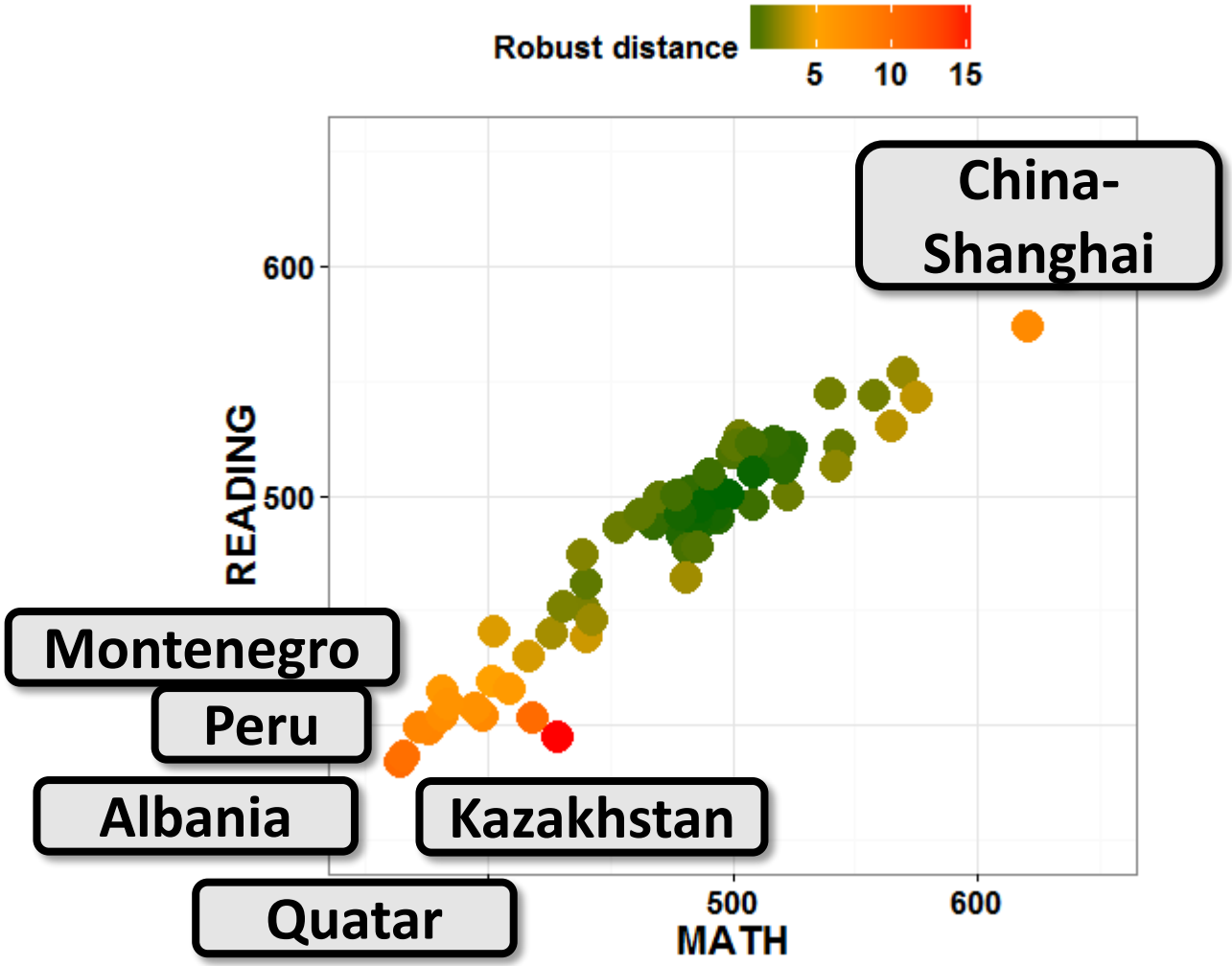
- Kiinduló halmaz félig felügyelt módban is!

- Új halmaz: küszöbérték alapján

BACON



BACON

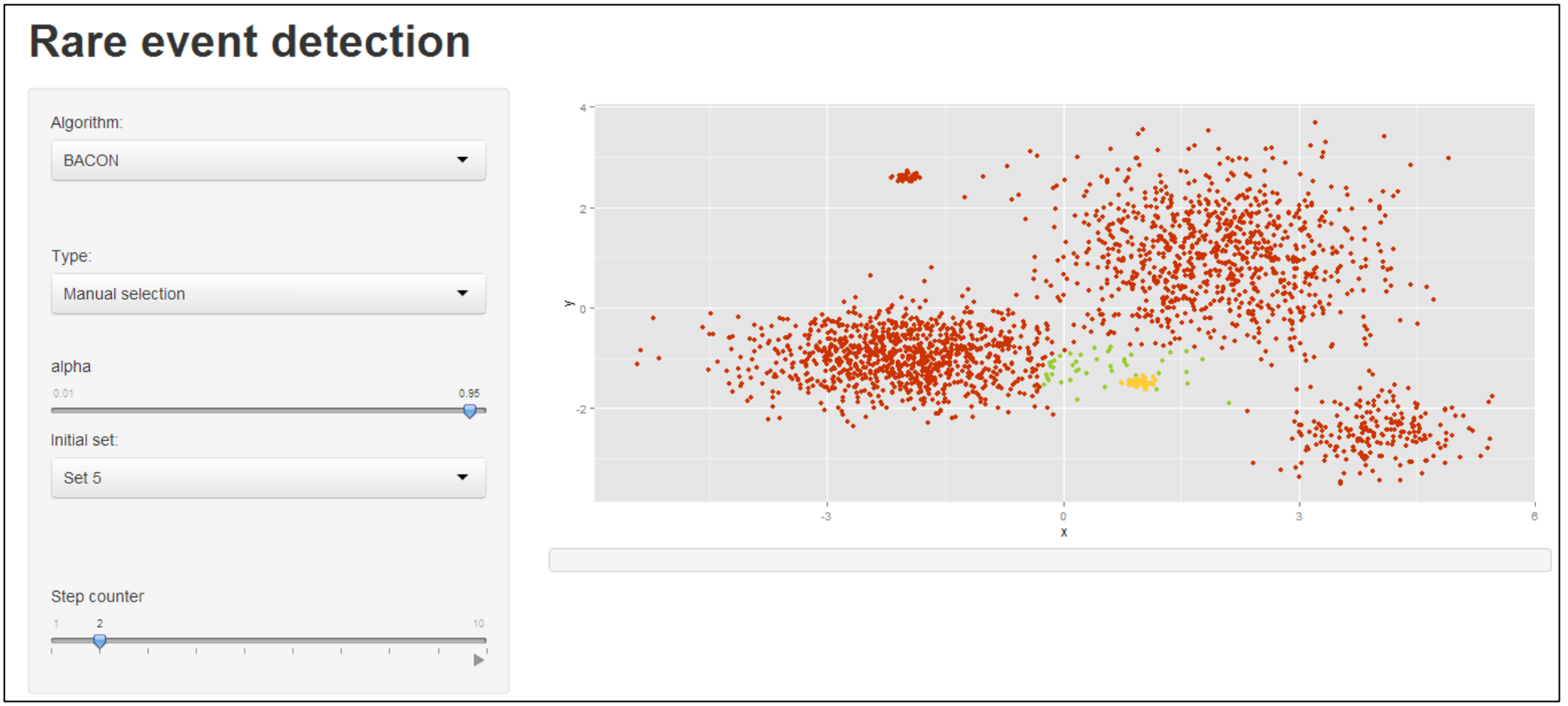

Robust distance
5
10
15
China-
Shanghai
600
500
READING
Montenegro
Peru
Albania
Kazakhstan
Quatar
500
600
MATH

DEMO BACON

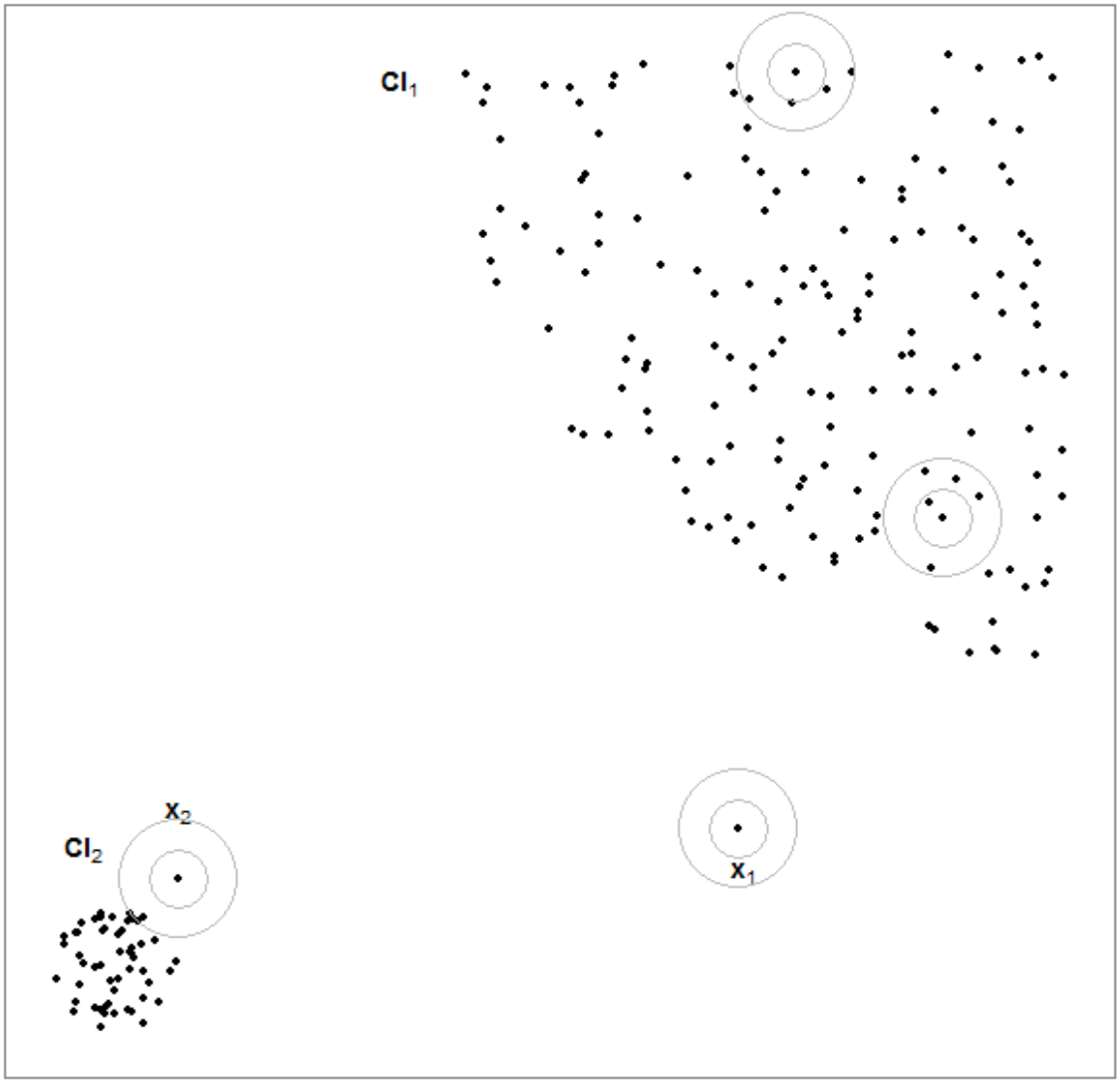
- Csomag: *robustX*
- Függvény: *mvBACON*
- Paraméterek
  - $init.sel$ kezdőhalmaz
    - „manual” – $man.sel$ kezdőhalmaz
    - „Mahalanobis”, „dUniMedian” – m kezdőhalmaz mérete

DEMO BACON

- Csomag: *robustX*



LOF motiváció



LOF

- Local Outlier Factor

- Alapötlet
  - csak a szomszéd számít
  - a távolság is módosul
  - lokális sűrűség

- Outlier kritérium
  - a lokális sűrűség jóval kisebb, mint a szomszédaimnak átlagosan

LOF

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  - csak a szomszéd számít
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- Outlier kritérium
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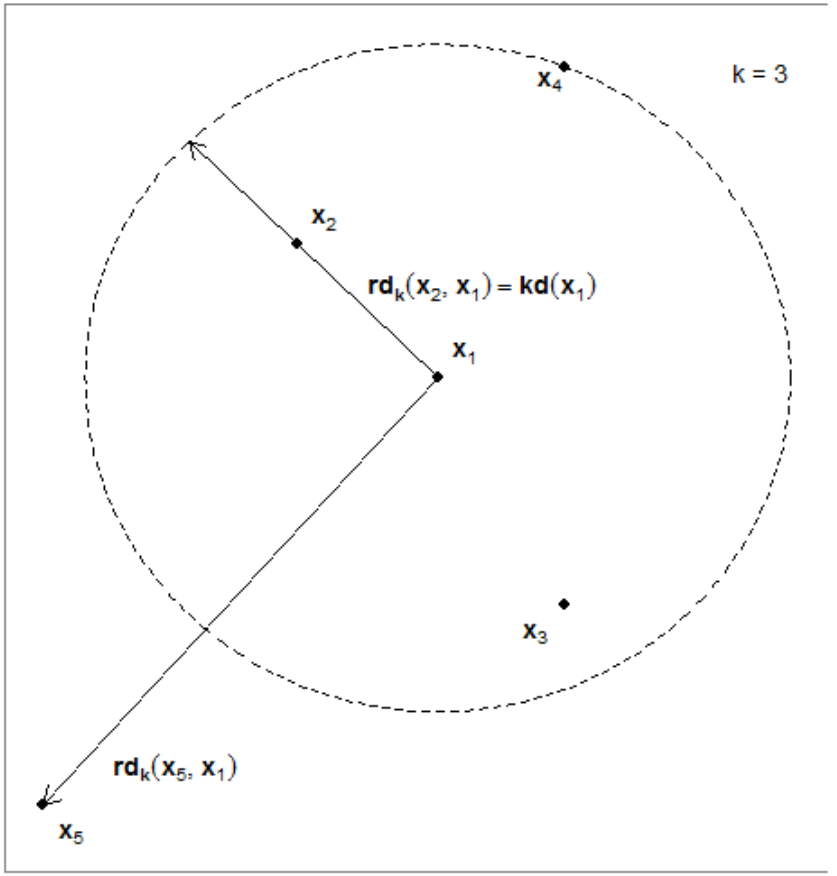

LOF

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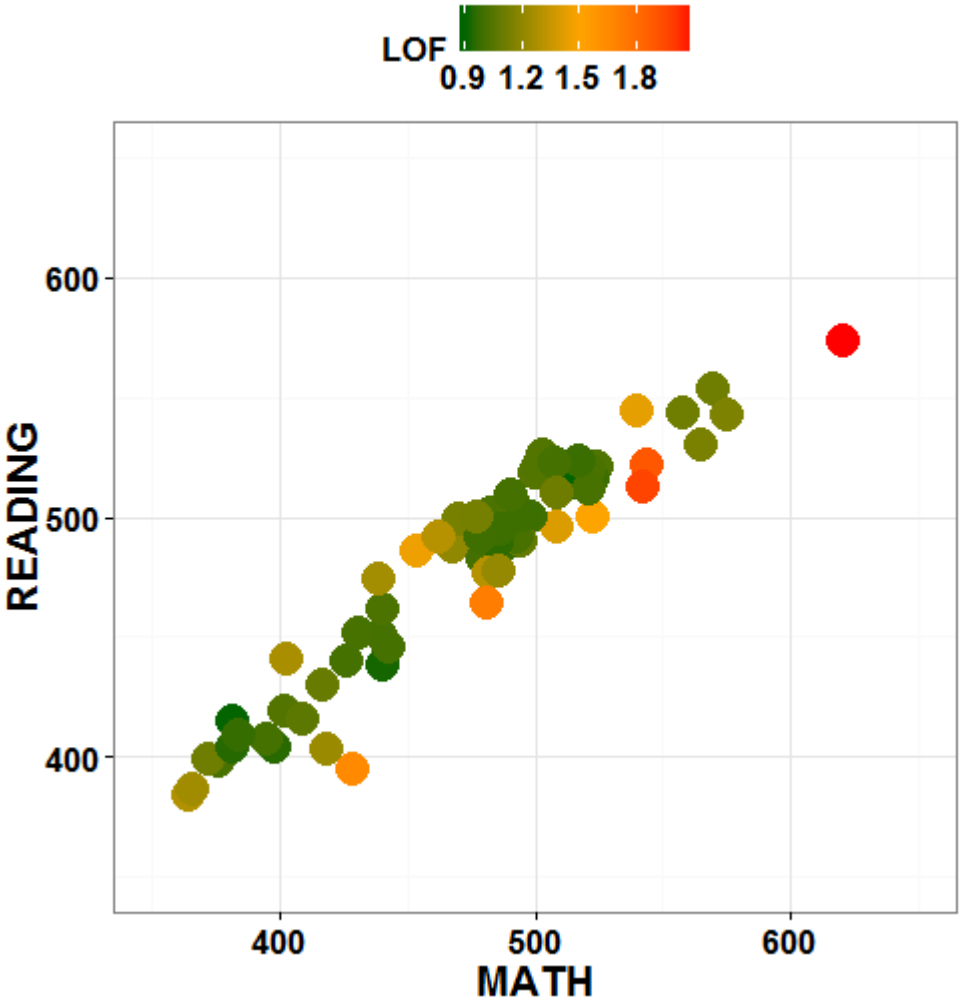
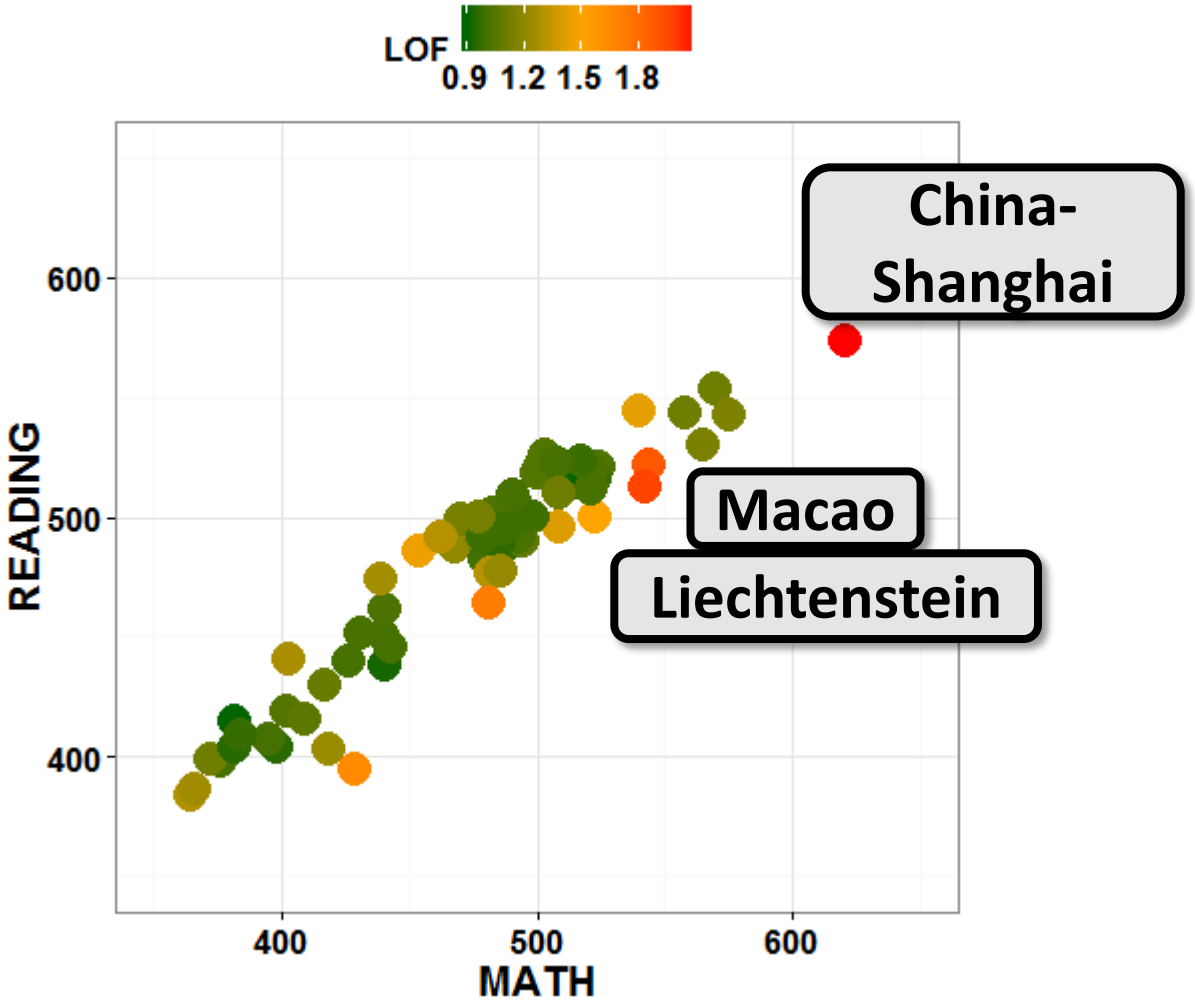
LOF

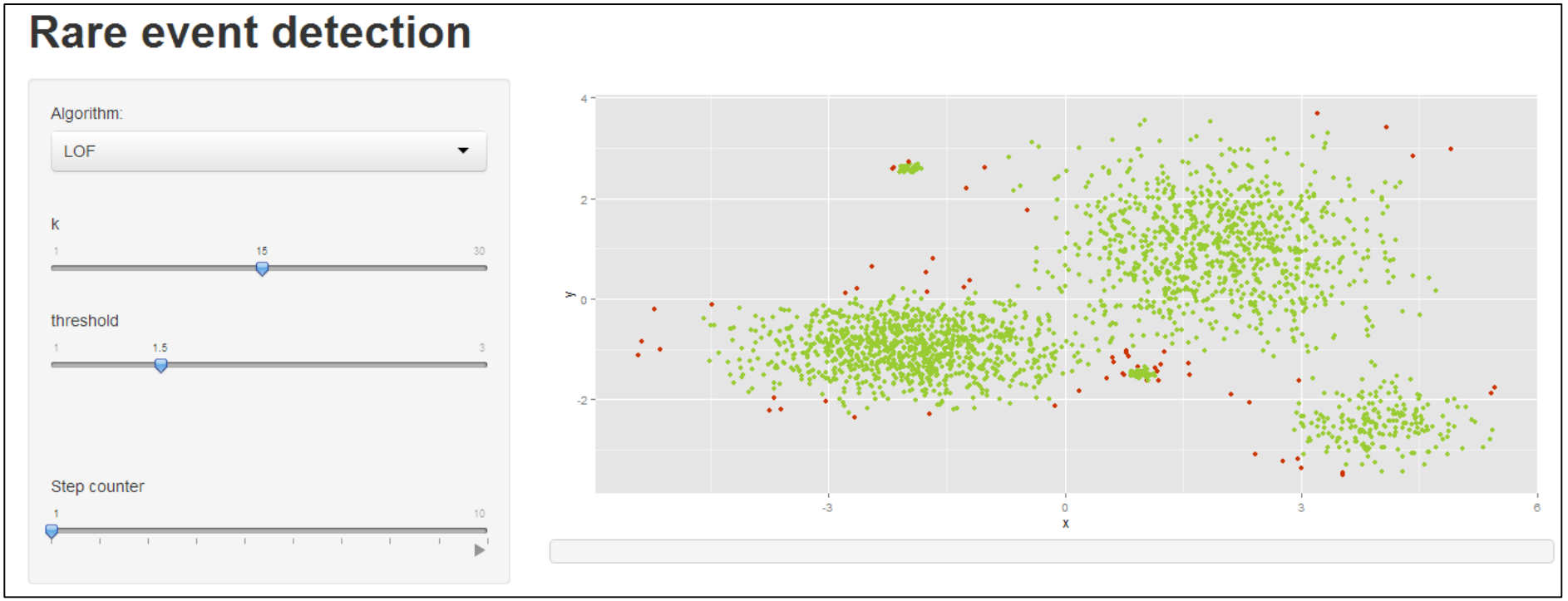


LOF


LOF
0.9 1.2 1.5 1.8
China-
Shanghai
Macao
Liechtenstein
READING
600
500
400
400
500
600
MATH

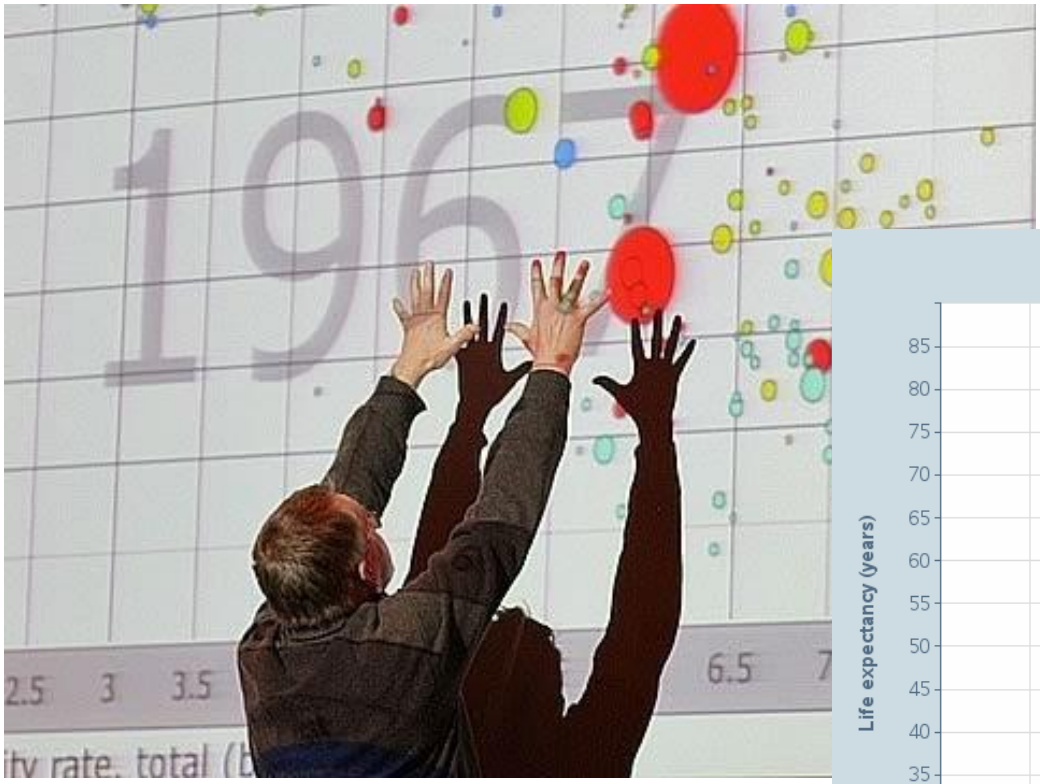
DEMO LOF

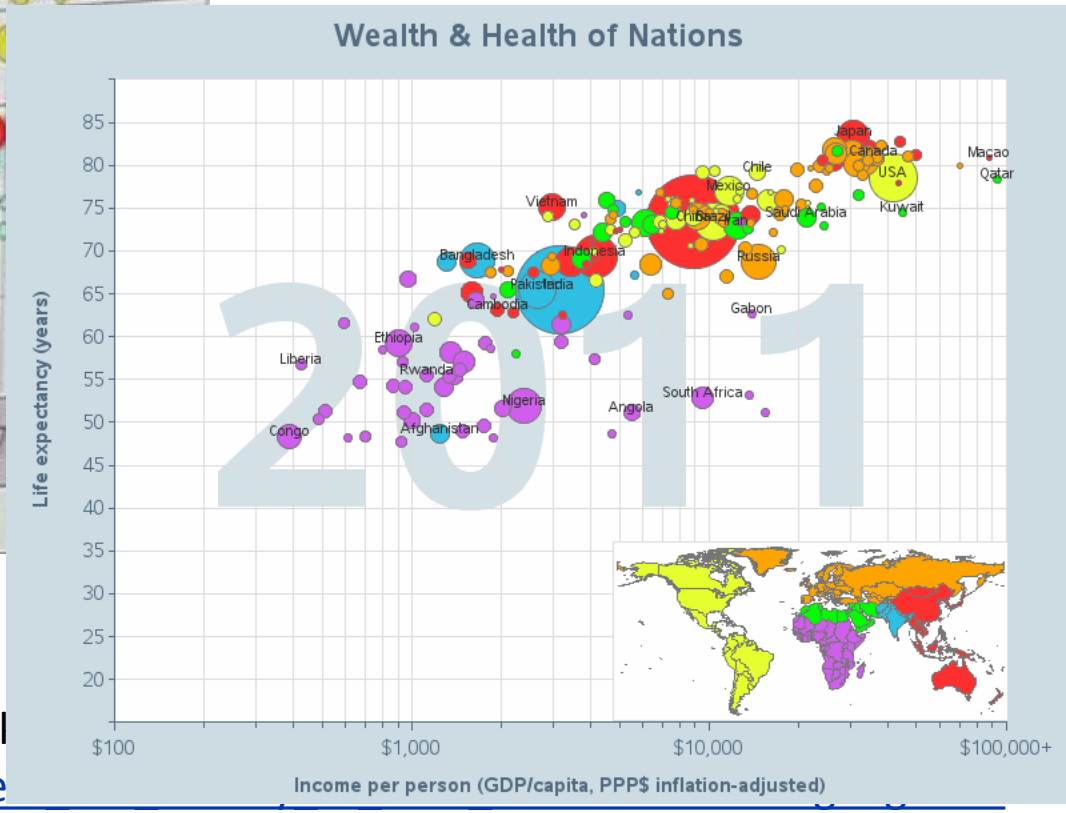
- Csomag: *DMwR* (Data Mining with R)
- Függvény: *lofactor*
- Paraméterek: k szomszédság mérete



Esettanulmány: wealth & health of nations

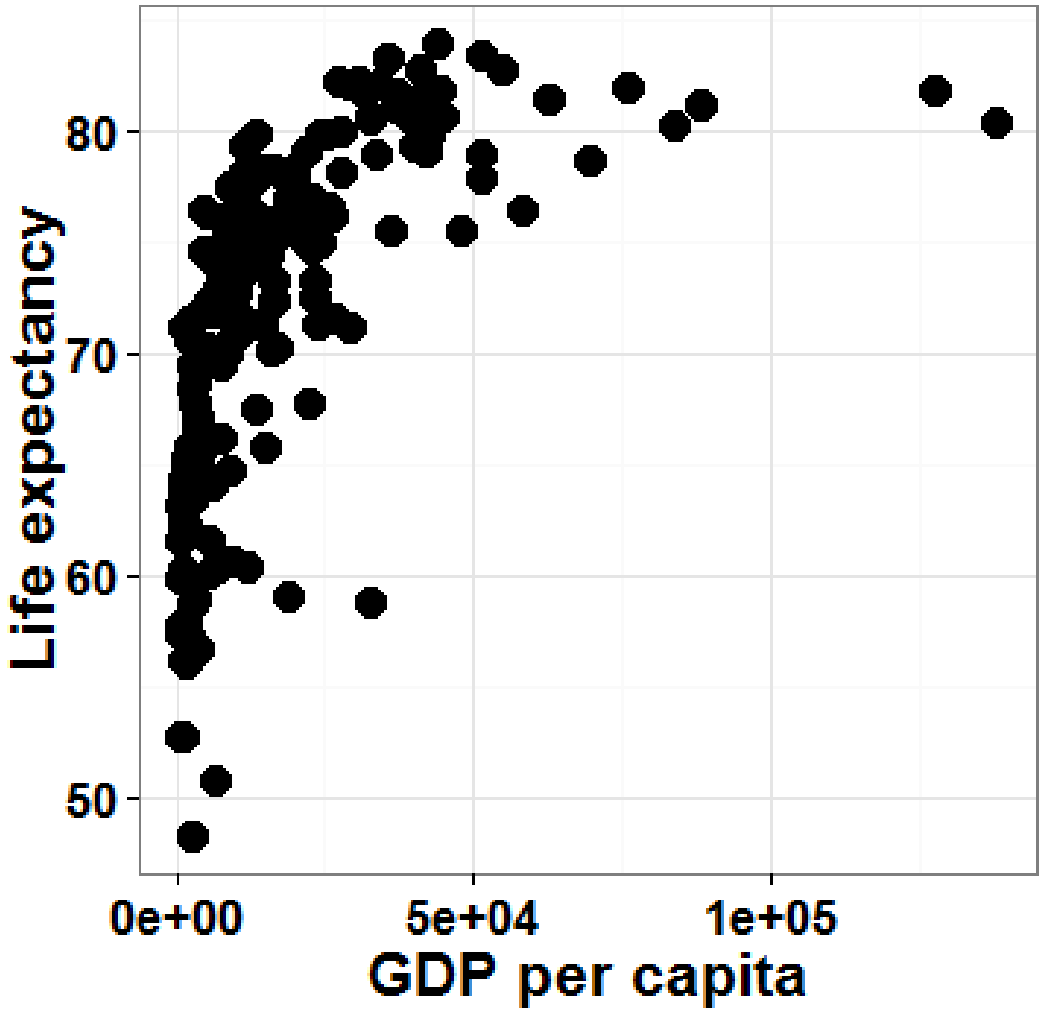
- Hans Rosling 2006-os TED talkja



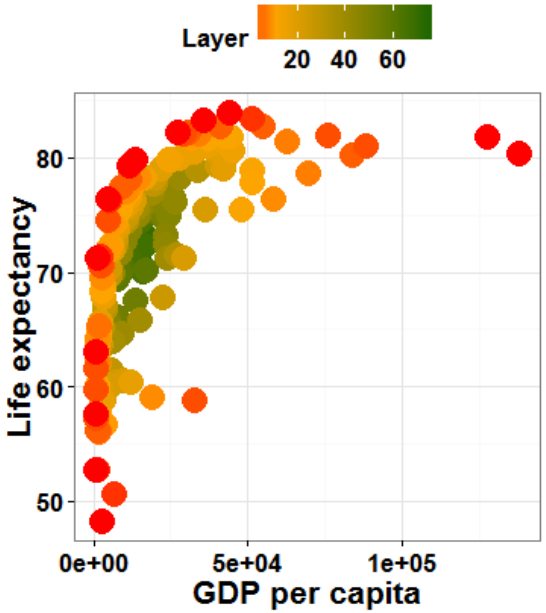


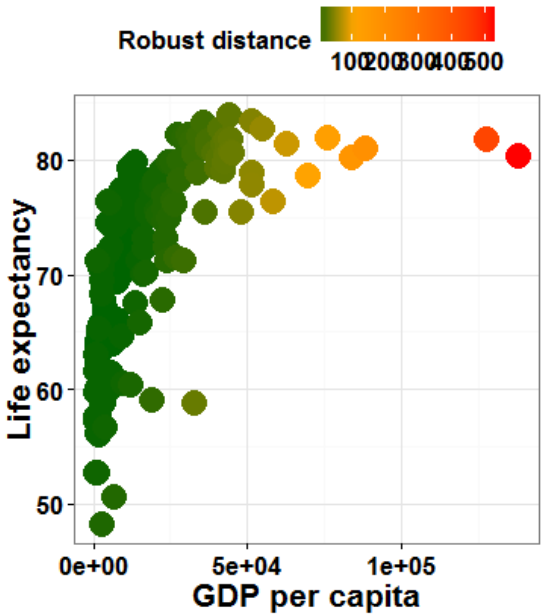
A másik teljesen irreleváns kedvenc TED tall
http://www.ted.com/talks/david_mccandle

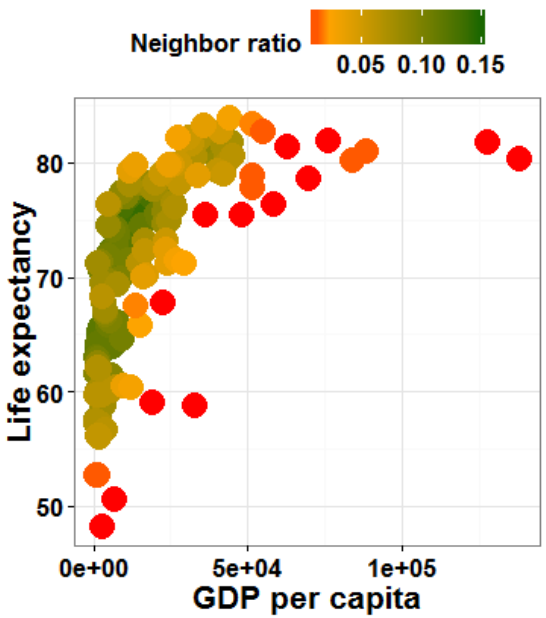
Wealth and health of nations

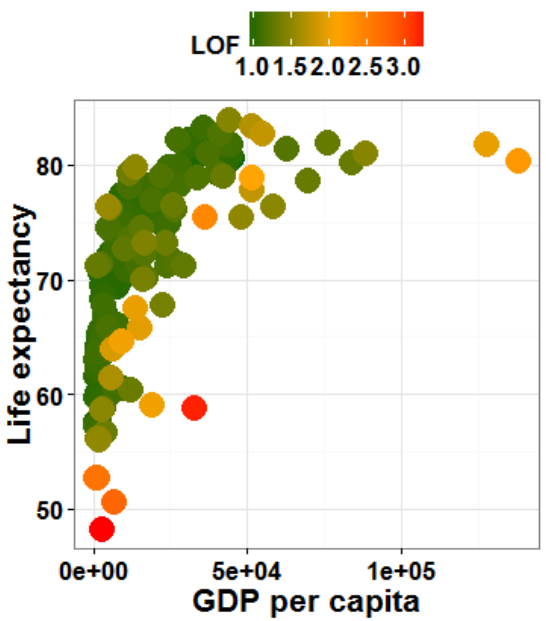


Wealth and health of nations



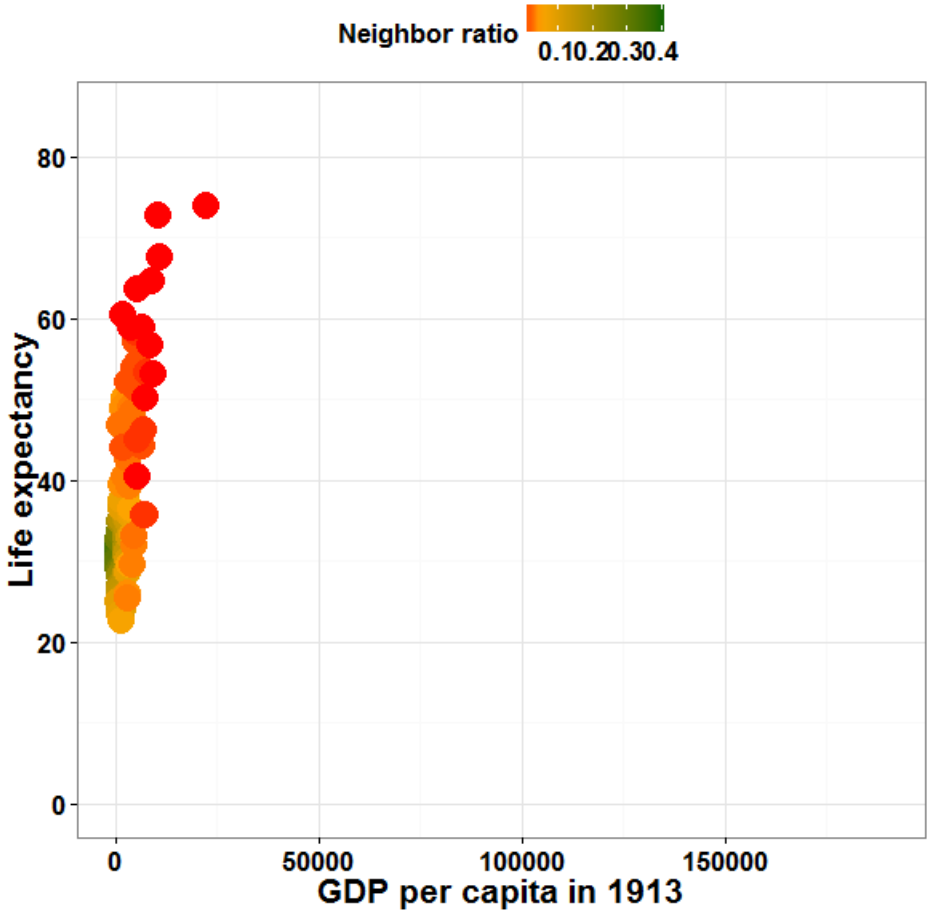


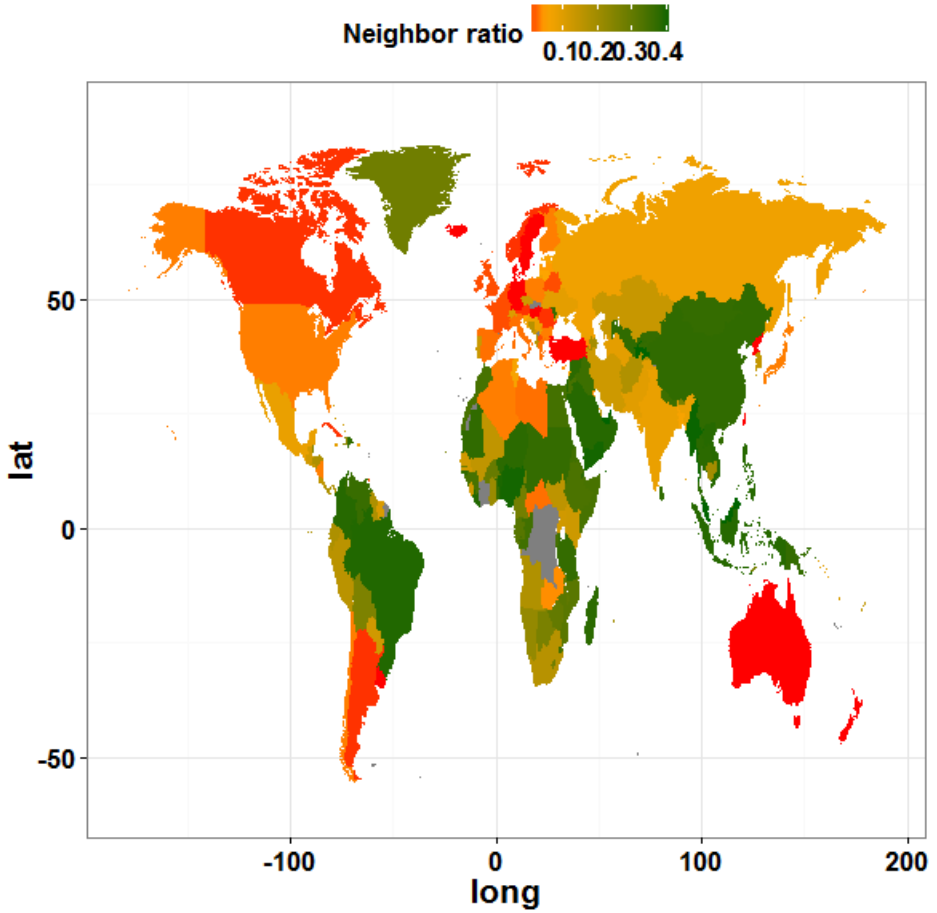




Happy families are all alike;
every unhappy family is unhappy **in its own way**.

Wealth and health of nations időbeli változás





Hivatkozásjegyzék

- Outlier Detection alapmű
  - Varun Chandola, Arindam Banerjee, and Vipin Kumar. Anomaly detection: A survey. ACM Computing Surveys (CSUR), 41(3):15, 2009
- Outlier Detection demo
  - https://github.com/FTSRG/BigDANTE/tree/master/RareEventDetectionDemo