Exploratory and Inferential Analysis of Benchmark Experiments

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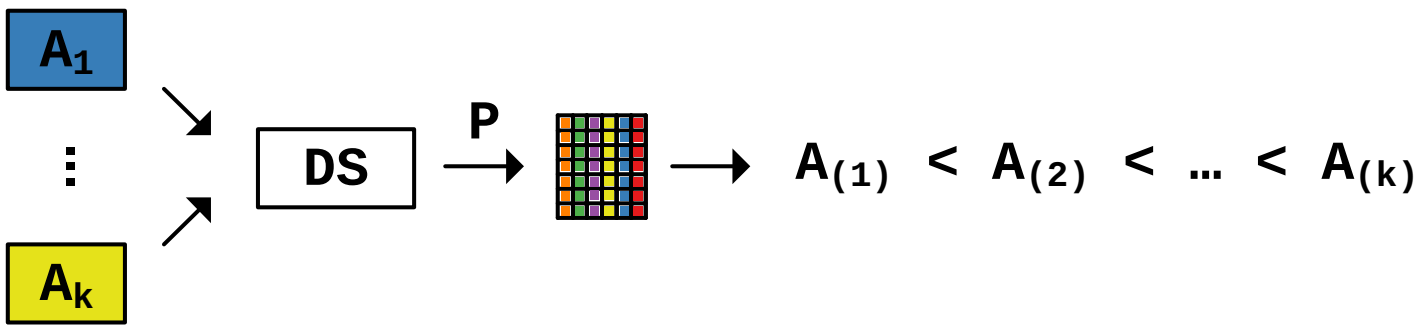
useR!, 2008

Benchmark experiments

Most popular scenario:



Benchmark experiments

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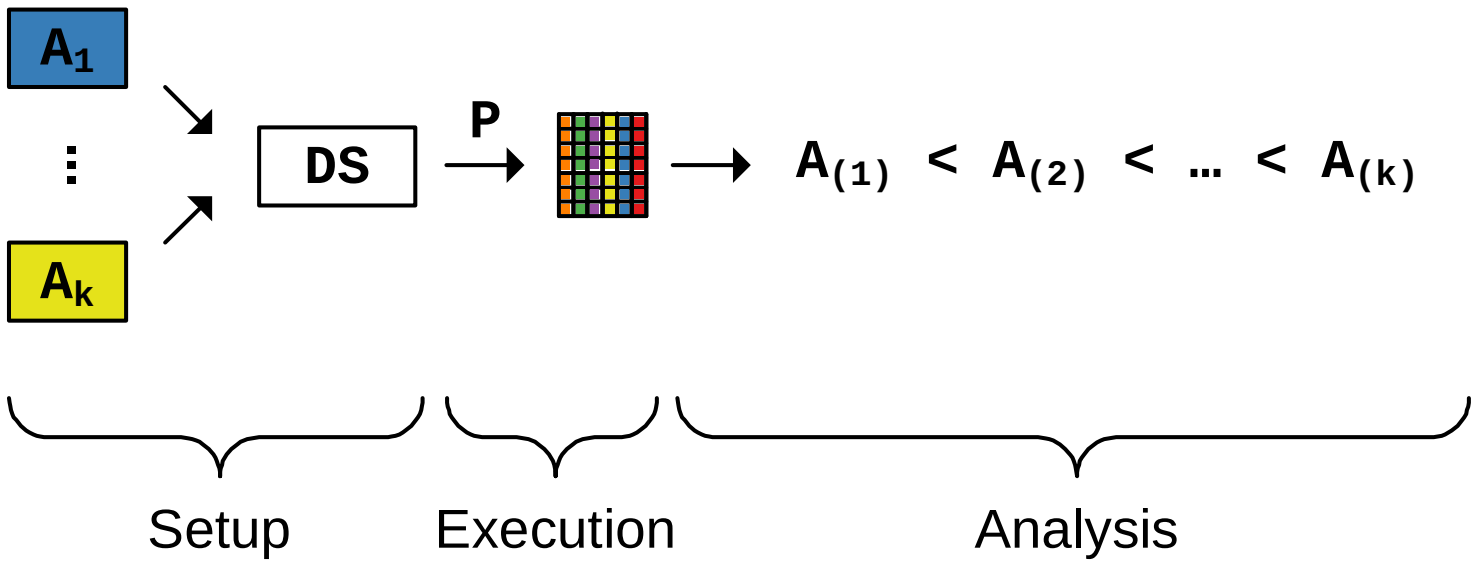


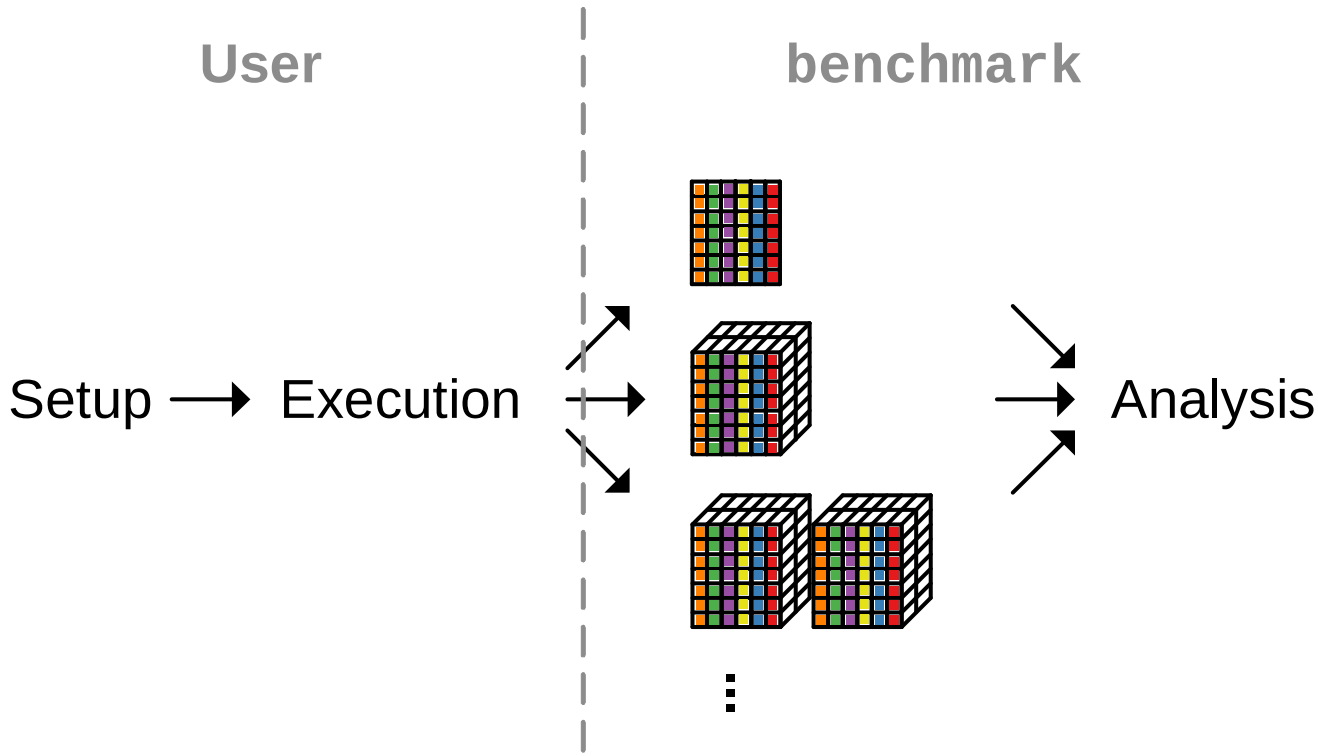
Implementation

Setup and Execution layers

Domain-specific language to describe the elements of benchmark experiments using small bricks.

But ... even in our working group we have *supervised*, *cluster* and *bicluster* problems and until now it seems to be hard to reconcile them in "one language". We have developed some rudiments, but it seems to be more manageable if the user writes the concrete problem-specific "loop" by his own.

Package coverage



"Enter the benchmark"

Benchmark experiment:

(1) classification problems {`BreastCancer`, `monks3`, `musk`}; **(2)** algorithms {`lda`, `naiveBayes`, `knn`, `rpart`, `svm`, `nnet`}; **(3)** misclassification; **(4)** bootstrap 250 samples; **(5)** out-of-bootstrap samples;

List of performance matrices:

```
> uciraw$monks3

        lda     nb    knn  rpart    svm   nnet
[1,] 0.0390 0.0390 0.0488 0.0195 0.0195 0.0195
[2,] 0.0498 0.0498 0.0299 0.0149 0.0149 0.0149

...
```

“Enter the benchmark”

```
> library(benchmark)

Loading required package: reshape
Loading required package: relations
Loading required package: sets
Loading required package: lattice
```

“Enter the benchmark”

```
> uci <- as.bench(uciraw, perf='Misclassification')

Benchmark experiment

     samples   algorithms performances    data sets
         250            6            1            3
```

Coercing: as.bench tries to capture the manifoldness of raw benchmark experiment data.

The `bench` object

Subsets: [*samp*, *alg*, *perf*, *ds*] or `subset`.

```
> monks3 <- uci[,,,'monks3']
```

```
Benchmark experiment

     samples   algorithms performances    data sets
        250            6            1            1
```

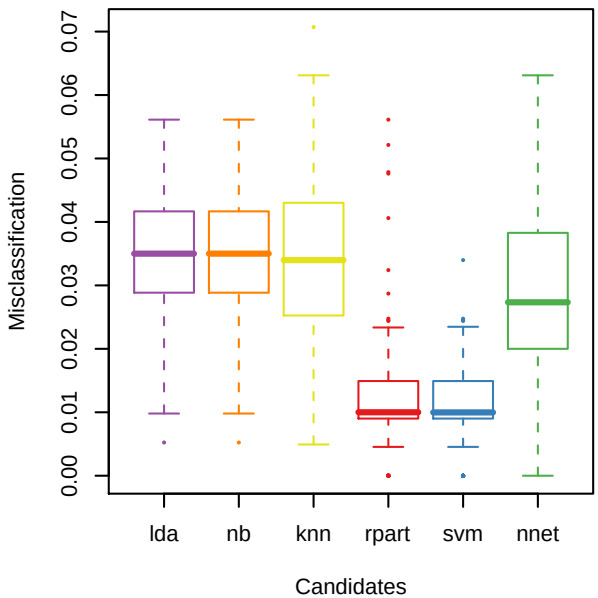
Reshape: `melt` melts an object into a form suitable for easy casting (see `reshape` package).

```
> melt(monks3)
```

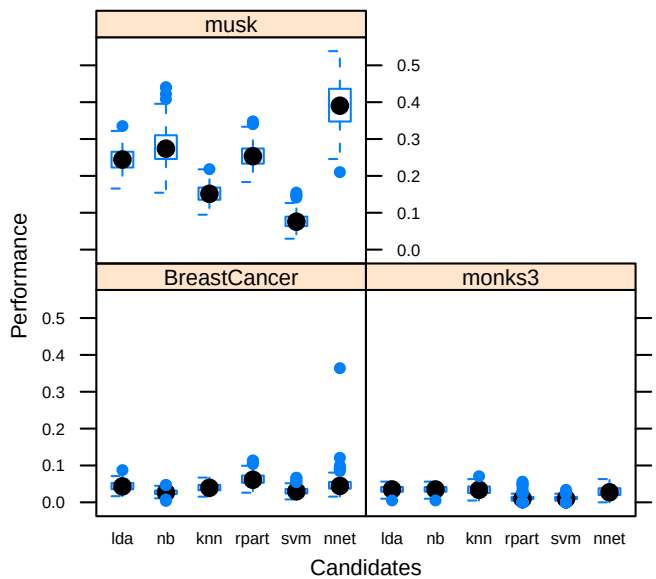
```
  samp alg              perf     ds  value
1    1 lda Misclassification monks3 0.0390
2    2 lda Misclassification monks3 0.0498

...
```

Basic plots

```
> boxplot(monks3)
```



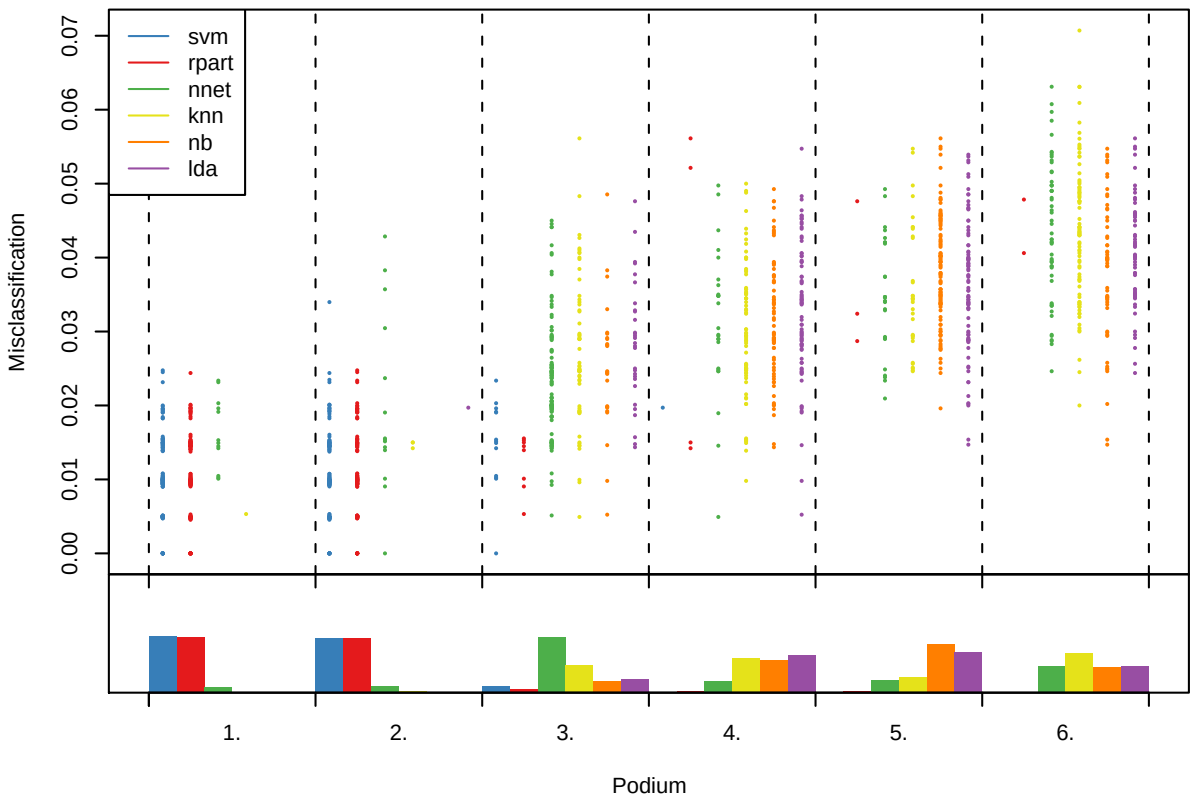

```
> bwplot(uci)
```



Other basic plots: `densityplot` and `stripplot`.

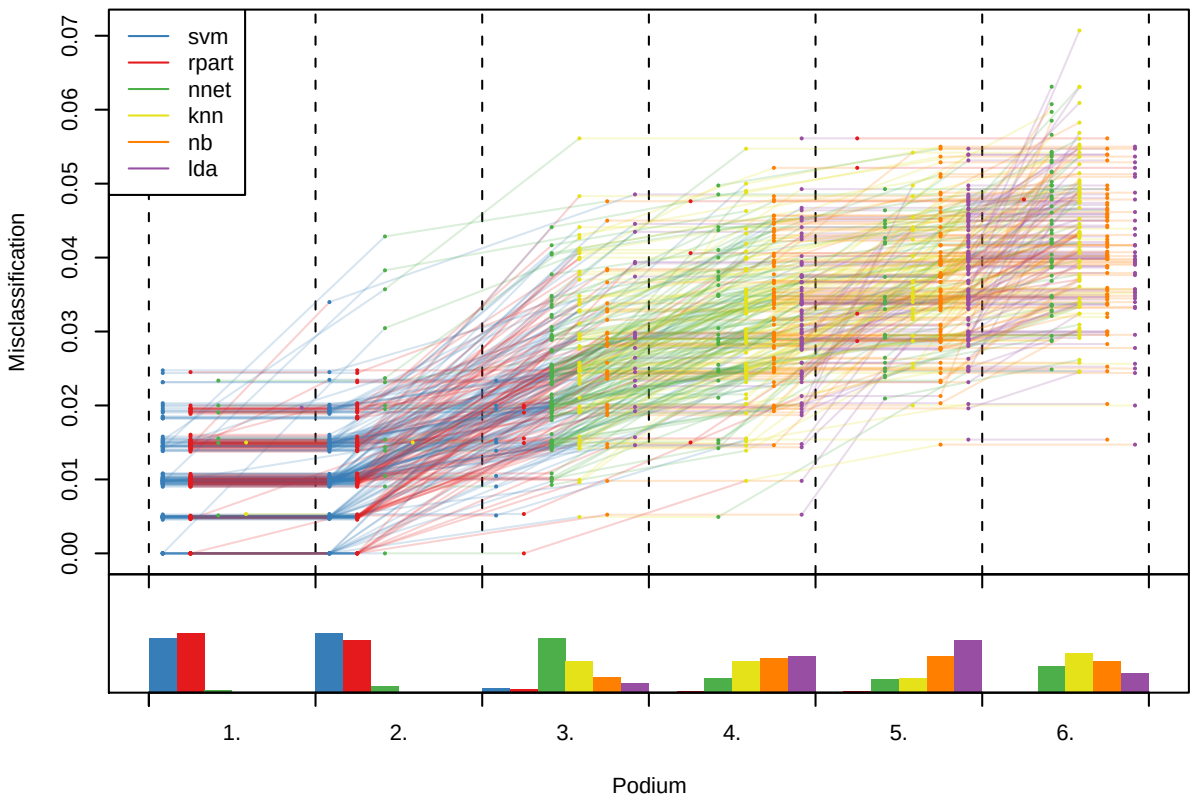
Benchmark experiment plot

```
> beplot(monks3)
```



Benchmark experiment plot

```
> beplot(monks3, lines.show=TRUE)
```



Simple rankings

Mean performance:

```
> m <- apply(monks3, 'alg', mean)
```

```
   lda     nb    knn  rpart    svm   nnet
0.0352 0.0353 0.0344 0.0116 0.0110 0.0293
```

```
> as.ranking(m)
```

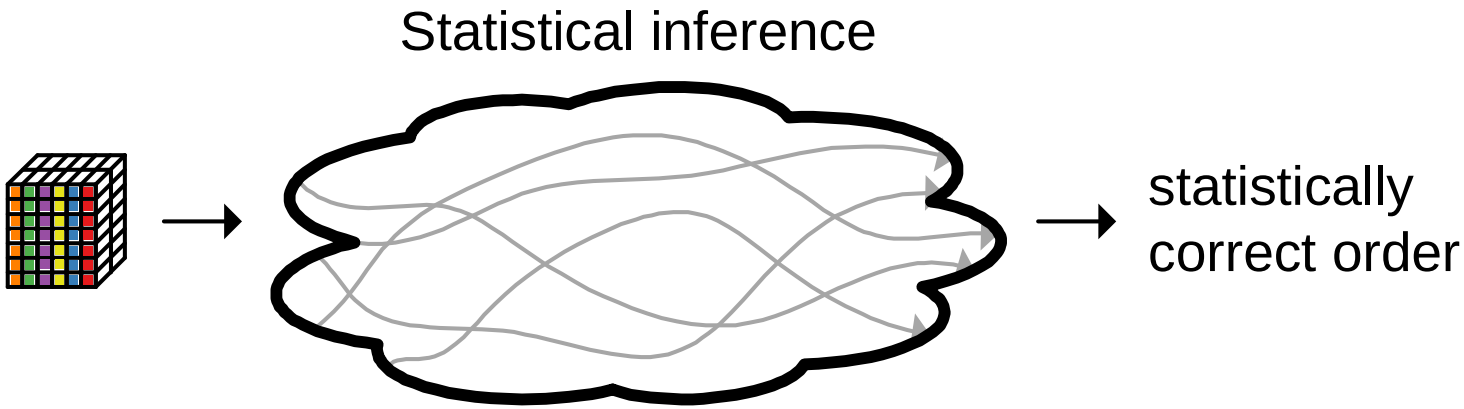
```
  svm rpart  nnet   knn   lda    nb
    1     2     3     4     5     6
```

Minimax:

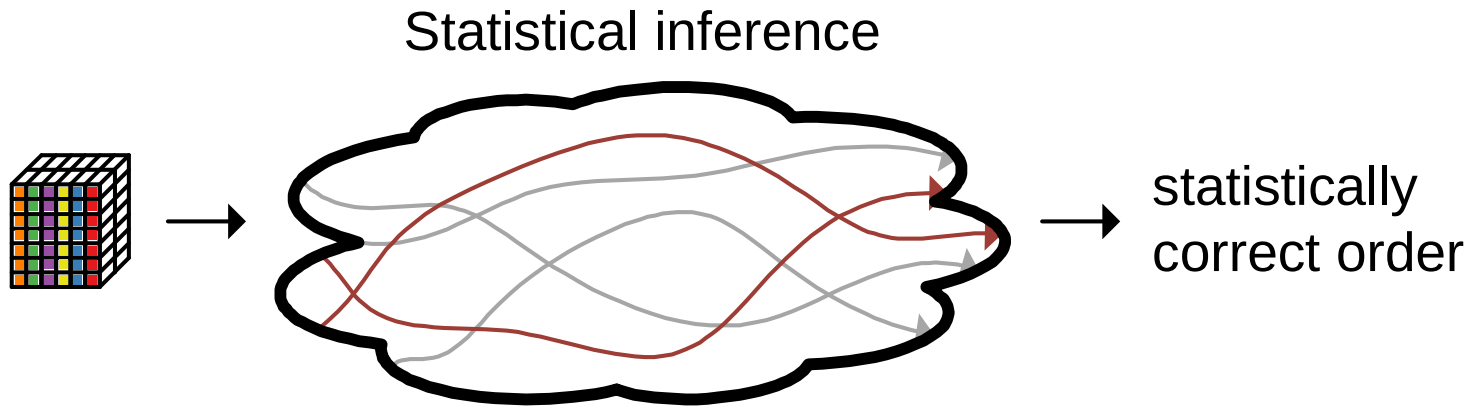
```
> as.ranking(apply(monks3, 'alg', max))
```

```
  svm   lda    nb rpart  nnet   knn
    1     2     2     2     5     6
```

Inferential analysis



Inferential analysis



Implemented "paths":

1. based on linear mixed effects models.
2. based on Friedman-based rank tests.

The `ibea` object

The *inferential benchmark experiment analysis* frameworks encapsulate functions belonging to one "paths".

```
> ibea <- make.lmer.ibea()
```

```
Loading required package: lme4
Loading required package: Matrix
Loading required package: multcomp
Loading required package: mvtnorm
```

The “lmer-path”

```
> summary(ibea)

Lmer inferential benchmark experiment analysis framework:

Available functions are
 *  model : function (bench)
 *  relation : function (x, alpha)
 *  relation.pairwise : function (test, alpha)
 *  test.global : function (model)
 *  test.pairwise : function (model)
```

The “lmer-path”

Individual steps:

1. `model(bench)` $\longrightarrow$ `lme4::mer`
2. `test.pairwise(lme4::mer)` $\longrightarrow$ `multcomp::glht`
3. `relation.pairwise(multcomp::glht, alpha)` $\longrightarrow$ `relations::relation`

All-in-one:

```
> rel <- ibea$relation(monks3, 0.05)
```

```
A binary relation of size 6 x 6.
```

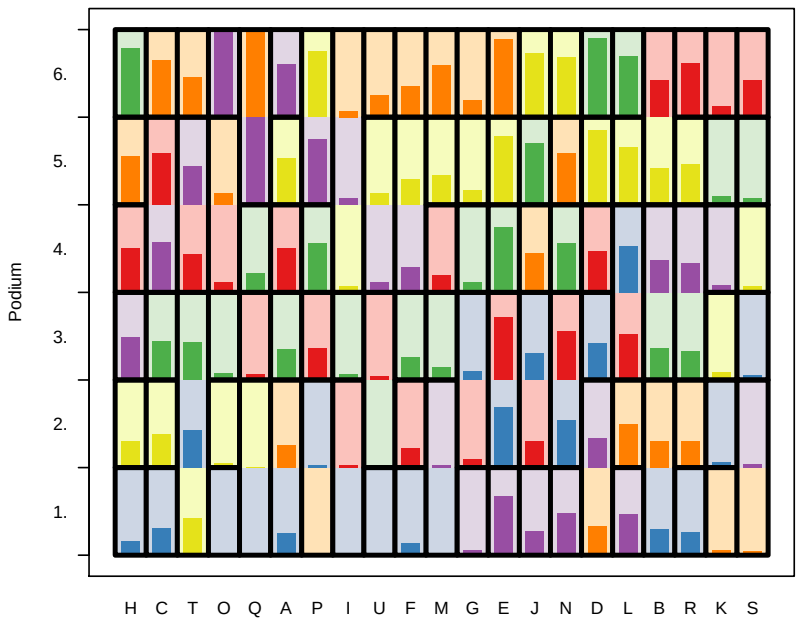
The “lmer-path”

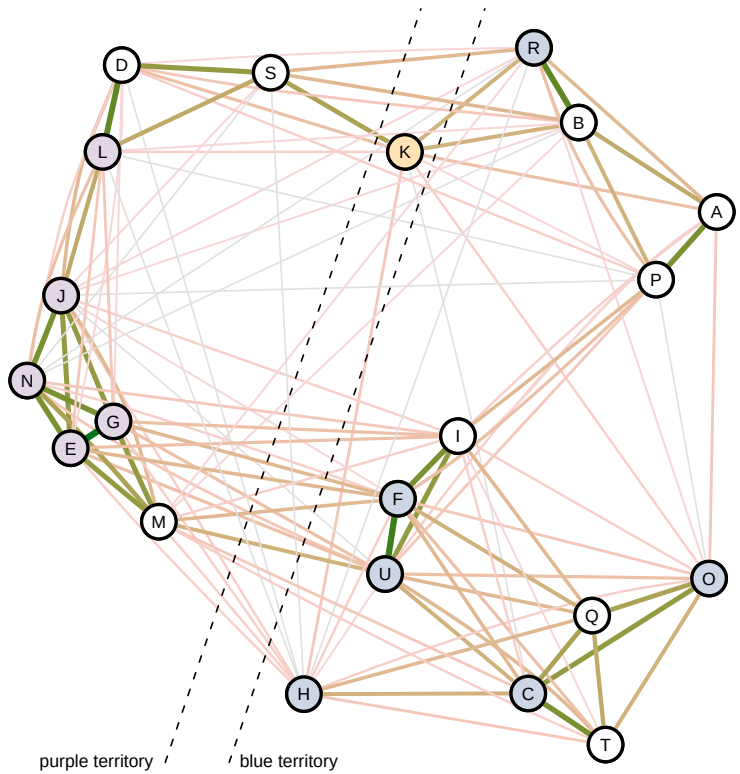
Statistically correct order:

```
> ord <- tsort(rel)

 rpart - svm < nnet < knn - lda - nb

> as.ranking(ord)

rpart   svm  nnet   knn   lda    nb
    1     1     3     4     4     4
```

Further `benchmark` functionality

Exploratory and inferential analysis assistance for benchmark experiments with more than one performance measure and/or more than one data set.





“Enter the `benchmark`”?!?

Take the red pill ...

... at `http://statistik.lmu.de/~eugster/benchmark/`.

Package:

`benchmark` version 0.01 – useR! 2008 source code release.

Reports:

Exploratory and Inferential Analysis of Benchmark Experiments.
Manuel J. A. Eugster, Torsten Hothorn and Friedrich Leisch. Technical Report 30, LMU Munich. **R supplement "The *uci621* benchmark experiment"**.