

# Elements of Computational Intelligence

## Data Envelopment Analysis

### Case study report

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## 1 Analyzed problem

Given is a set of 18 countries for which we need to evaluate their scientific wealth. They are evaluated using 3 inputs and 2 outputs described below:

### Inputs:

- i1** - GDP (in 10<sup>9</sup> dollars)
- i2** - active population (in millions)
- i3** - R&D expenditure (in 10<sup>6</sup> dollars)

### Outputs:

- o1** - number of publications in the SCI (1993)
- o2** - number of patents granted by the European Patent OfficeS(1993)

## 2 Chosen model

The problem stated above has been solved using Charnes, Cooper and Rhones (CCR) Data Envelopment Analysis model.

### 3 Efficiency scores

Efficiency scores obtained by model for all countries are presented in the table below.

Country	Efficiency
Austria	0.9801283
Belgium	0.3644829
Denmark	0.4627883
Finland	0.3308322
France	0.5301964
Germany	1
Ireland	0.458212
Italy	0.3952348
Netherlands	0.9138391
Norway	0.2287916
Spain	0.08821843
Sweden	0.4305553
Switzerland	1
U. Kingdom	0.3912678
Australia	0.1388172
Canada	0.1381905
Japan	0.3504877
USA	0.2752869

### 4 Efficient units

There are 2 countries that perform efficiently:

- Germany
- Switzerland

## 5 Inefficient units

There are 16 inefficient countries. To make them efficient they need to reduce their inputs by the following values:

Country	GDP	Population	R&D
Austria	3.656389	77.10211	39.24657
Belgium	139.1782	2692.686	2026.664
Denmark	76.28406	1559.525	1185.089
Finland	72.9393	1674.258	1519.68
France	622.02	11925.97	13580.61
Ireland	27.0894	744.9585	161.9946
Italy	740.2326	14036.6	8581.618
Netherlands	27.5715	604.0744	480.8642
Norway	87.14655	1658.869	1504.628
Spain	433.0962	14315.88	3745.599
Sweden	139.514	2429.251	3944.543
U. Kingdom	638.5601	17362.87	12871.64
Australia	253.1877	7578.409	3701.364
Canada	486.0605	12845.27	7414.147
Japan	2375.916	43160.09	67253.75
USA	4314.217	96005.65	100919.9