



# One Click Mining

## Interactive Local Pattern Discovery through Implicit Preference and Performance Learning\*

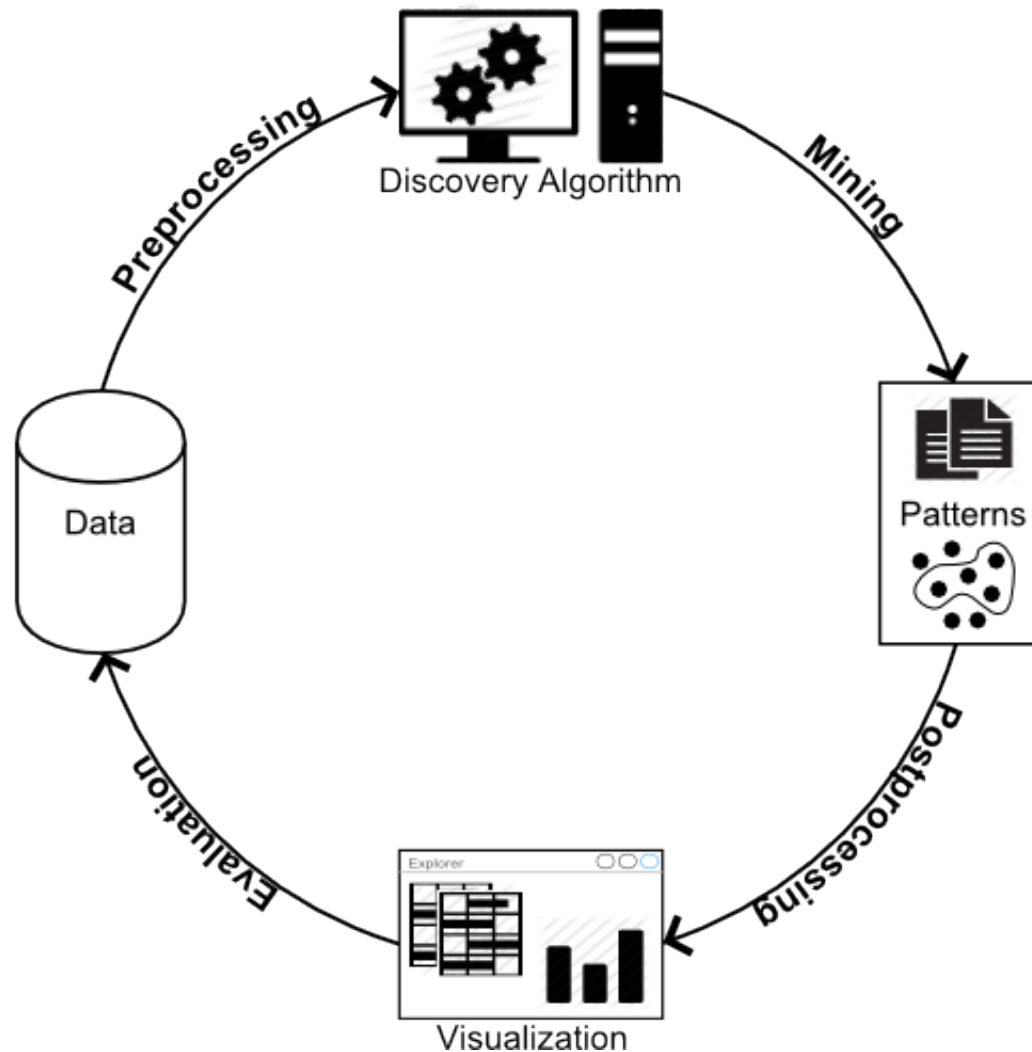
Mario Boley, Michael Mampaey, Pavel Tokmakov, **Bo Kang**, Stefan Wrobel  
Fraunhofer IAIS / University of Bonn



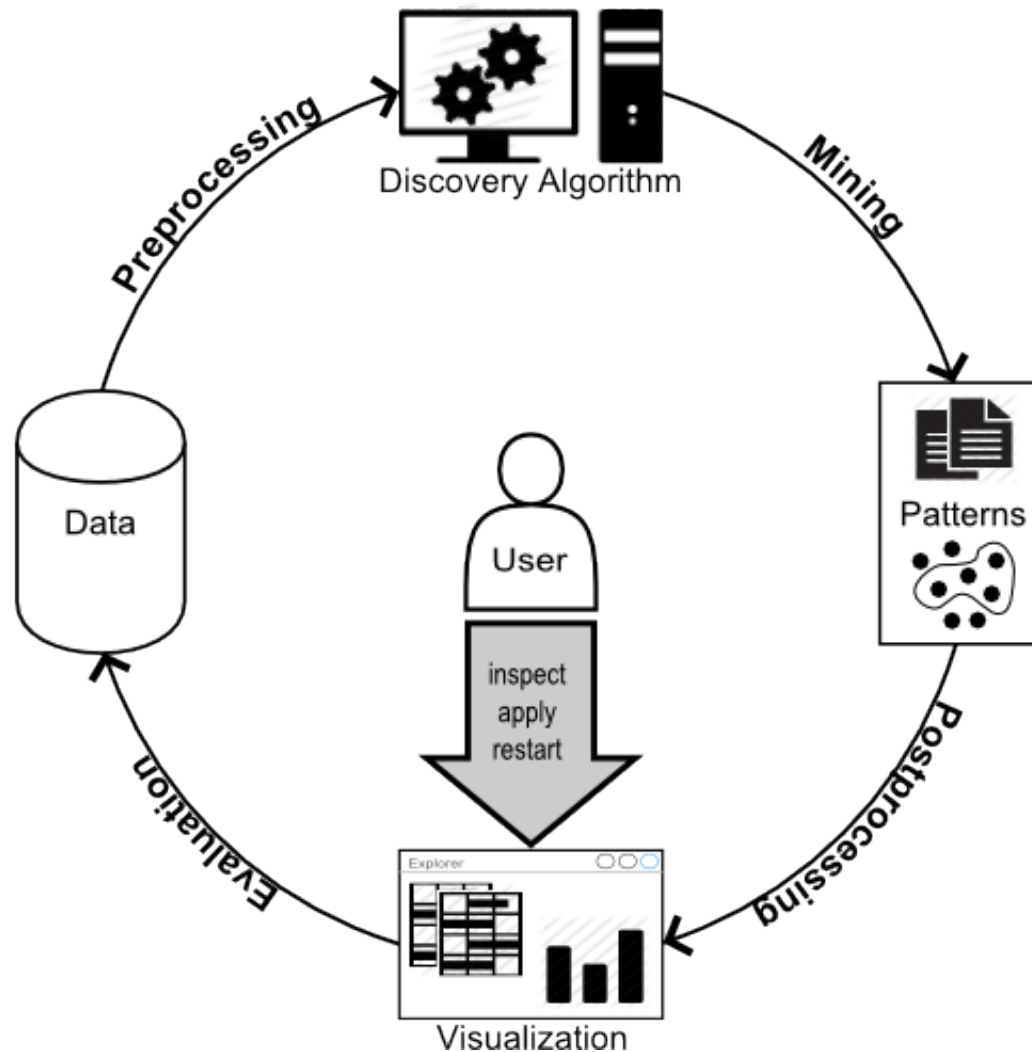
\*Slides based on Mario Boley, IDEA 2013 at KDD, Chicago

- **Build tools, refine them, make life easier**
- **Making coffee using coffee machine**
  - Beans, water as input
  - Press the run button
  - Get a nice cup of coffee as output
- **Subroutines are encapsulated for solving complex problems**

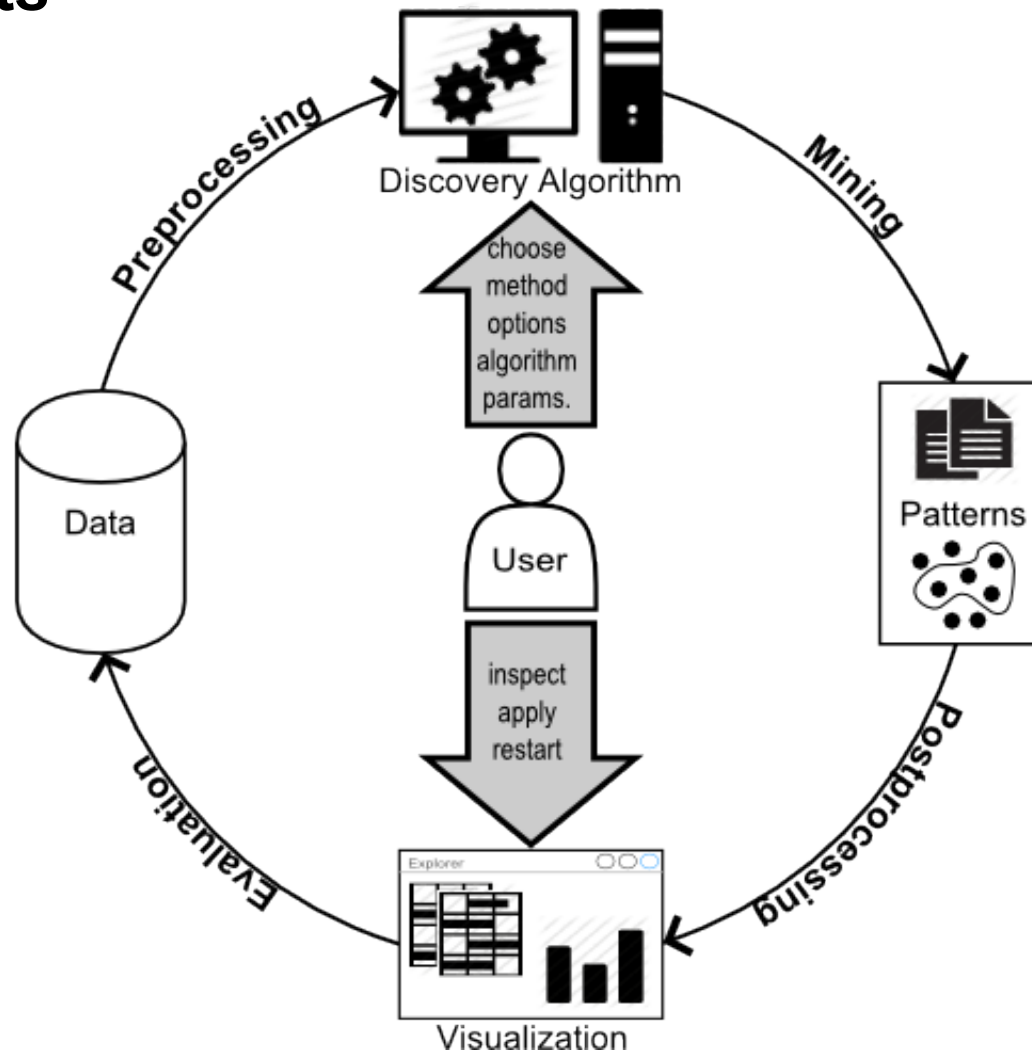
# Knowledge Discovery has iterative workflow



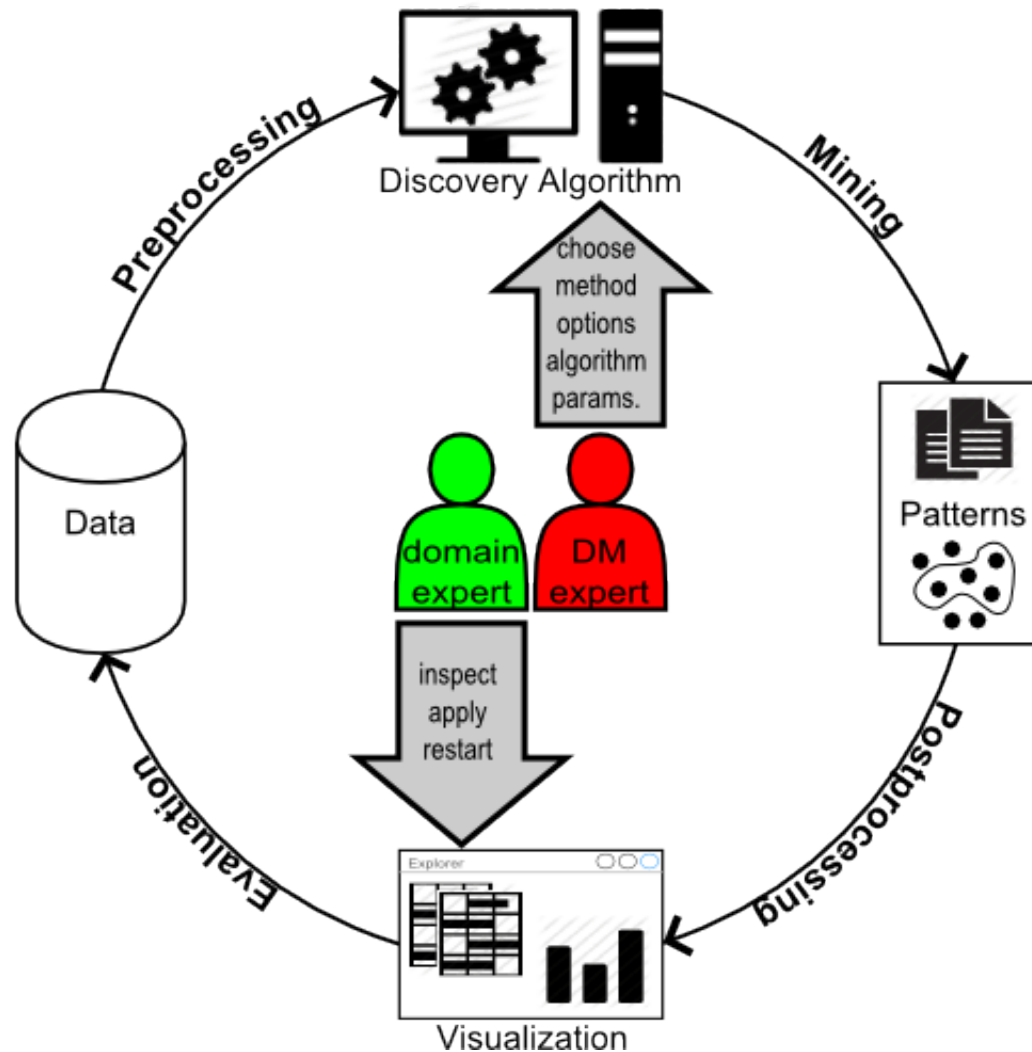
# User is required for evaluation



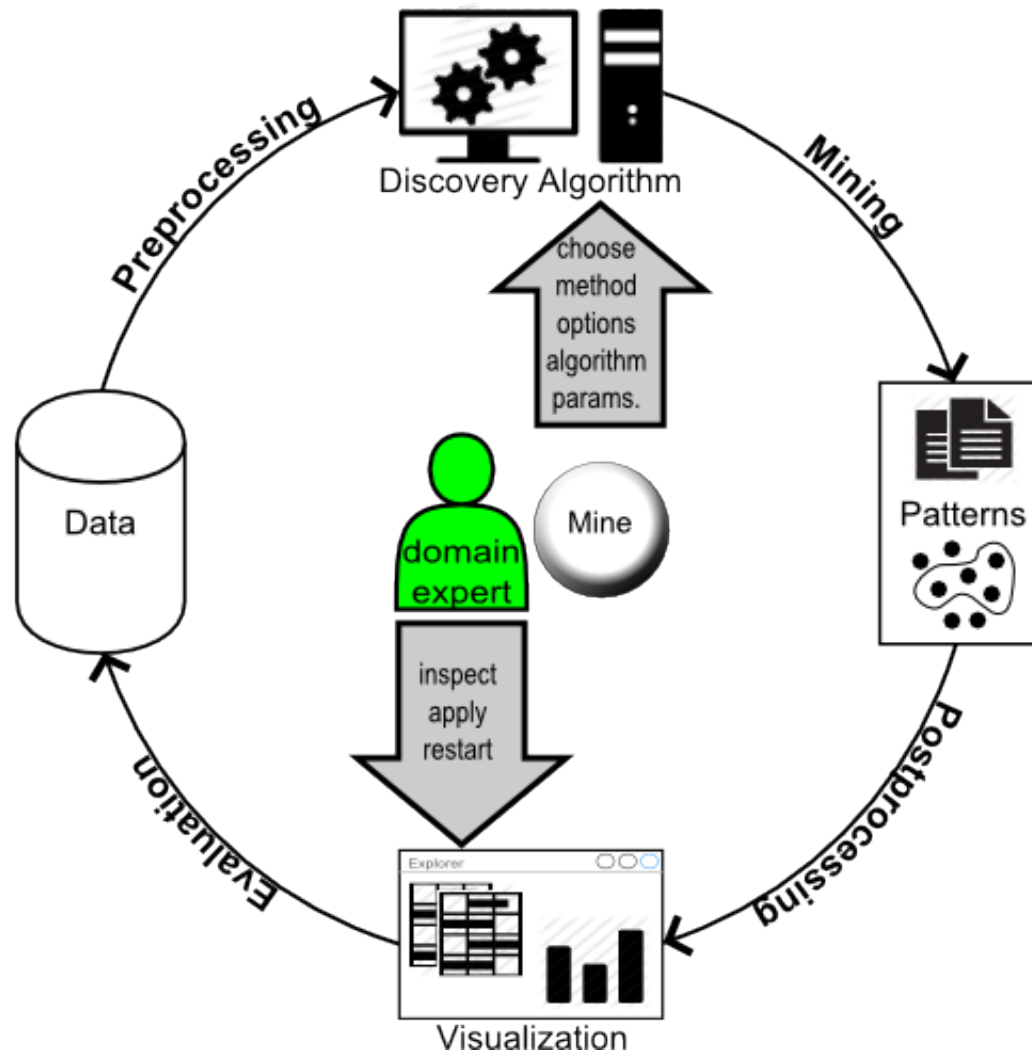
# In current tools she is also required to control technical components



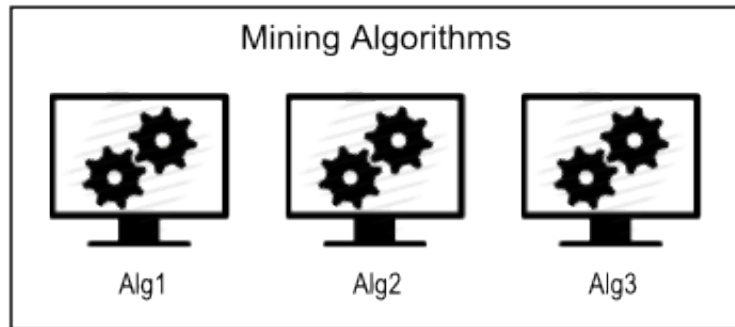
# Hence, user actually has two different roles



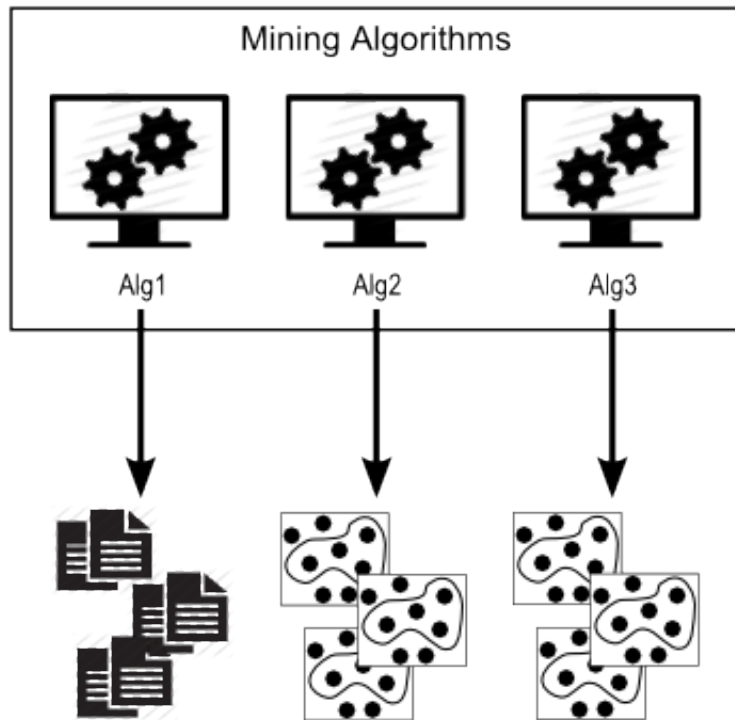
# One-click-mining aims to eliminate the technical role



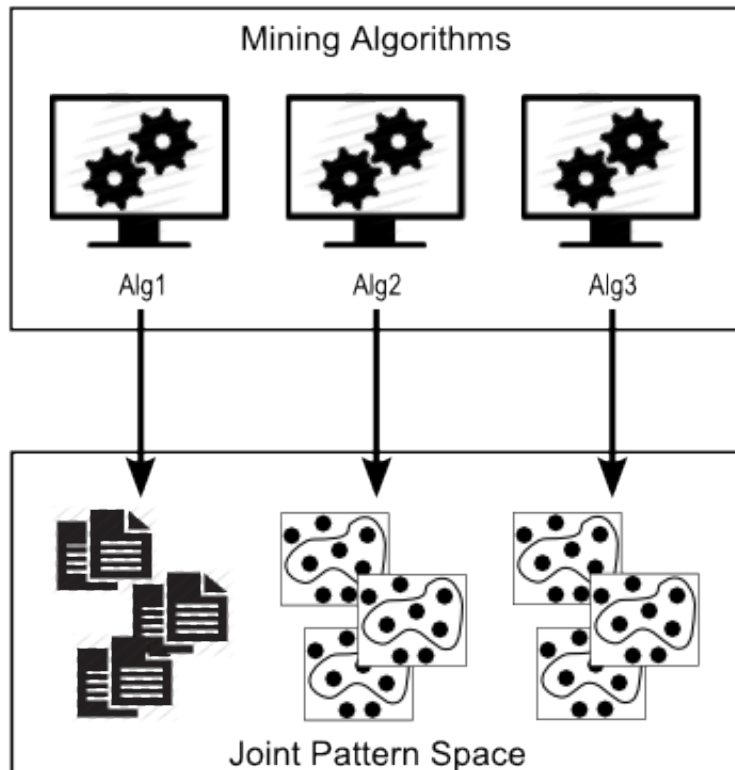
# Design of one-click-mining system starts with the algorithms to be included



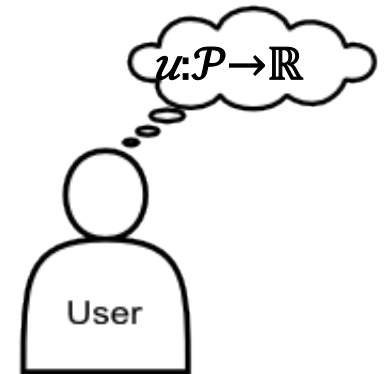
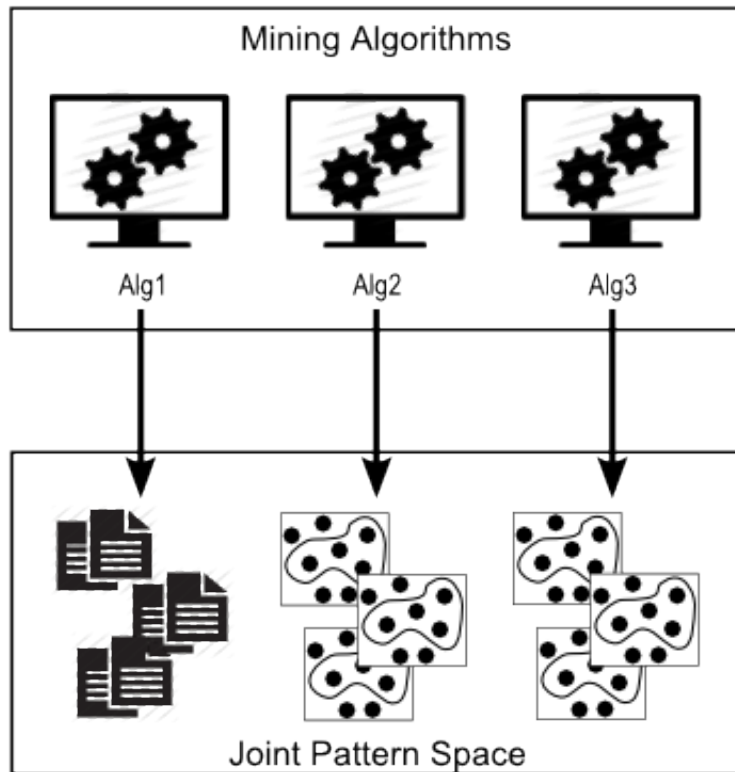
# Diverse set of algorithm from different method classes are possible



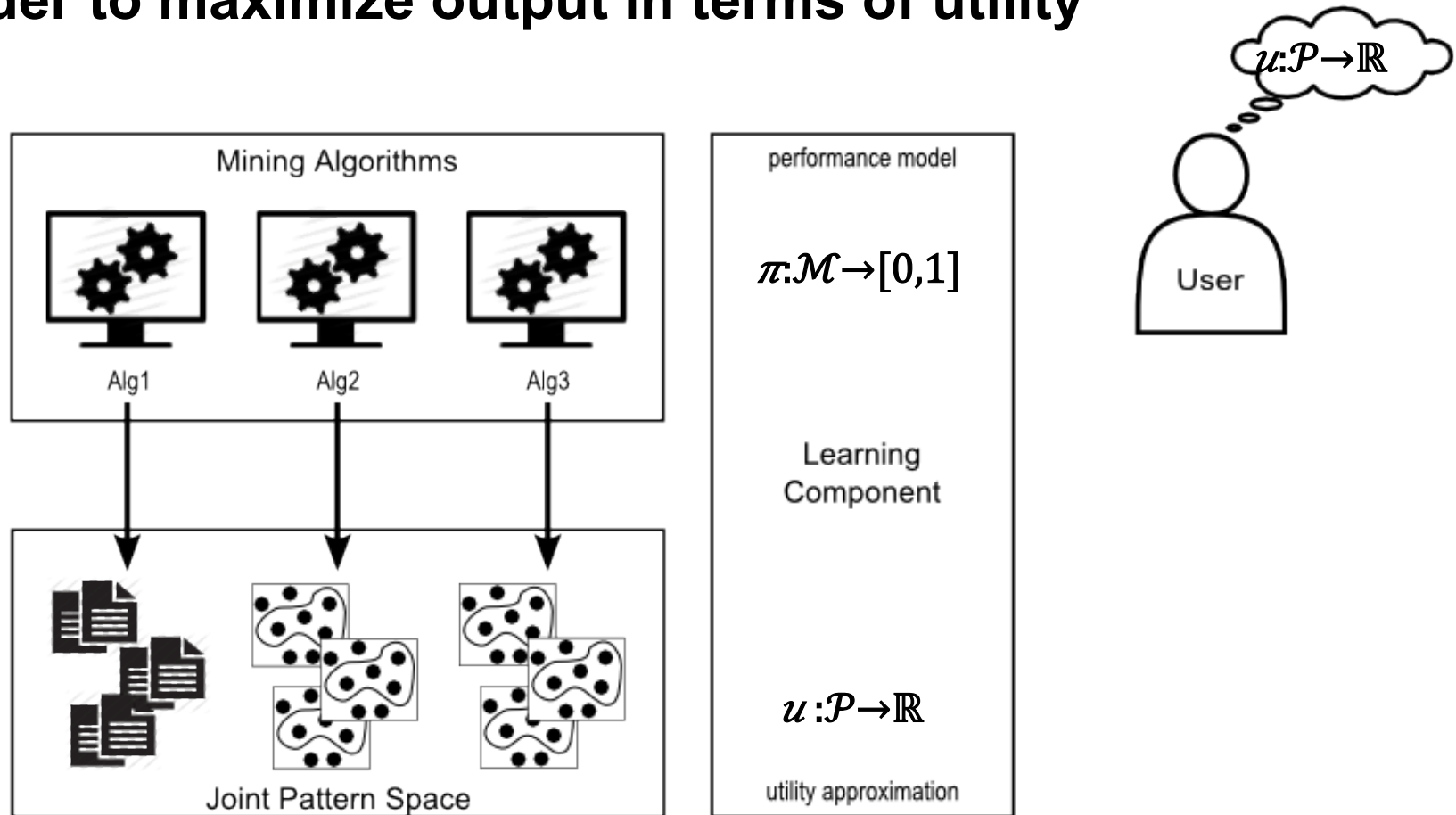
# Together they define space of patterns that can potentially be discovered by the system



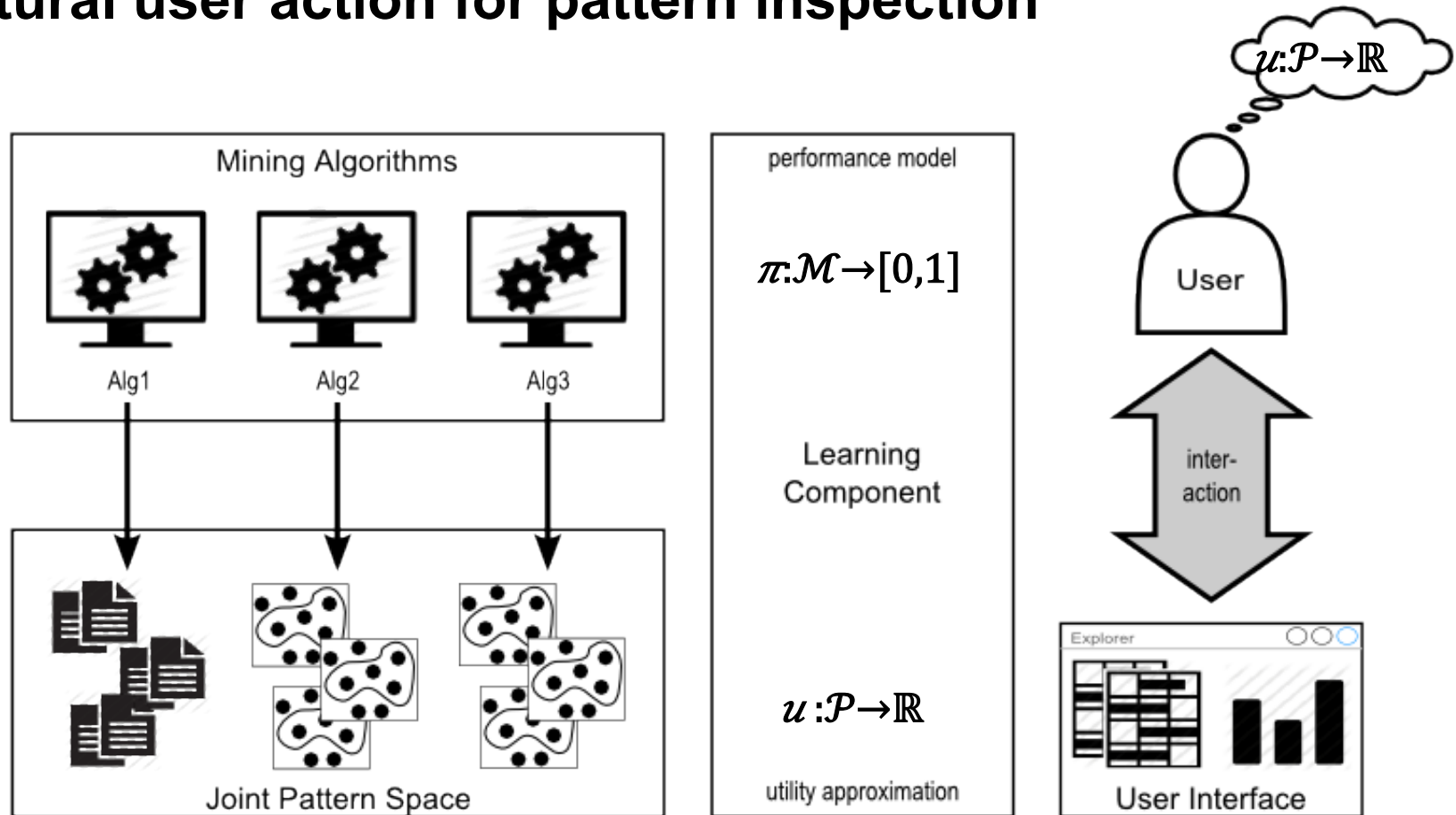
# User brings some latent utility notion



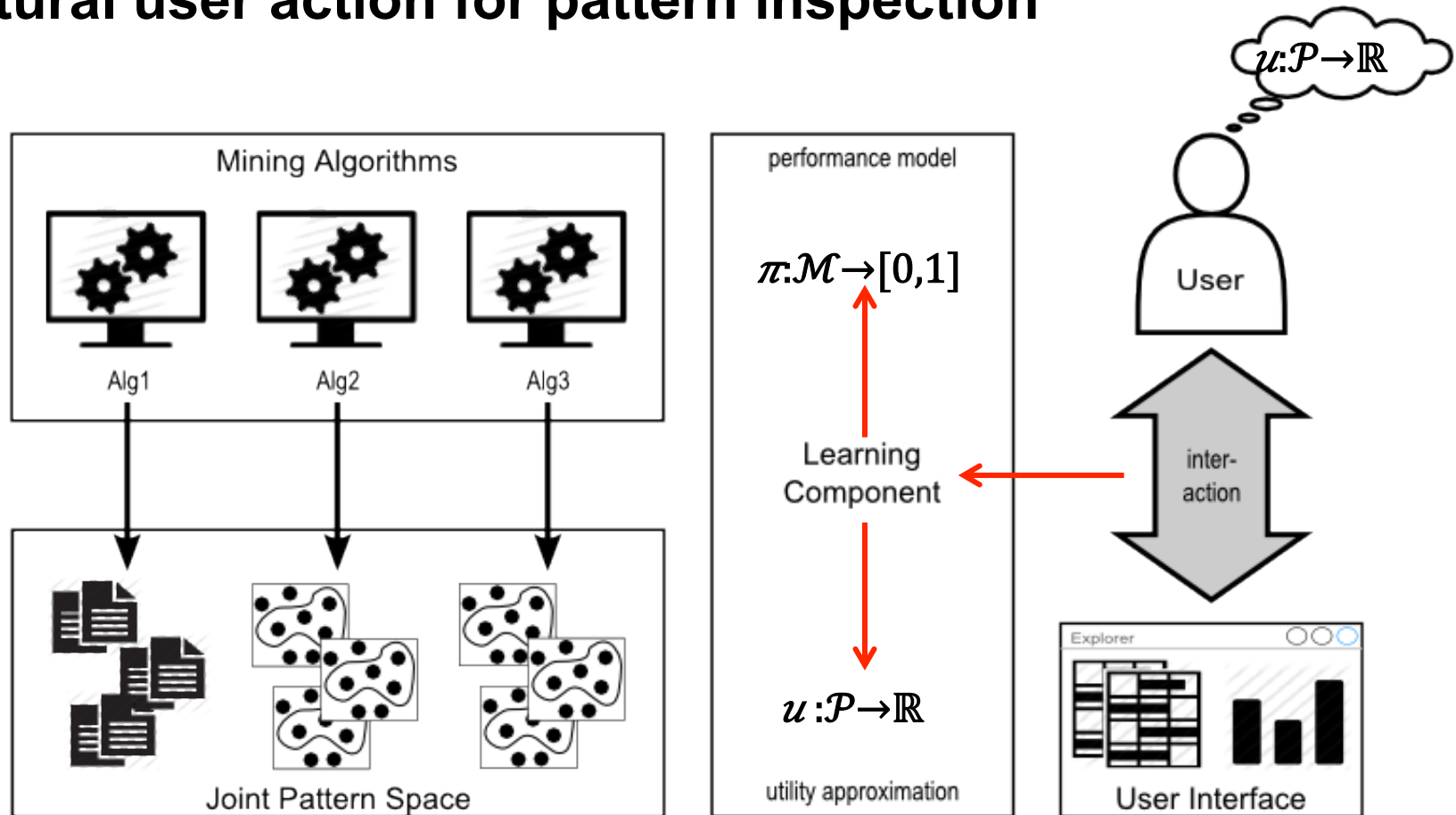
# Learning component controls mining algorithms in order to maximize output in terms of utility



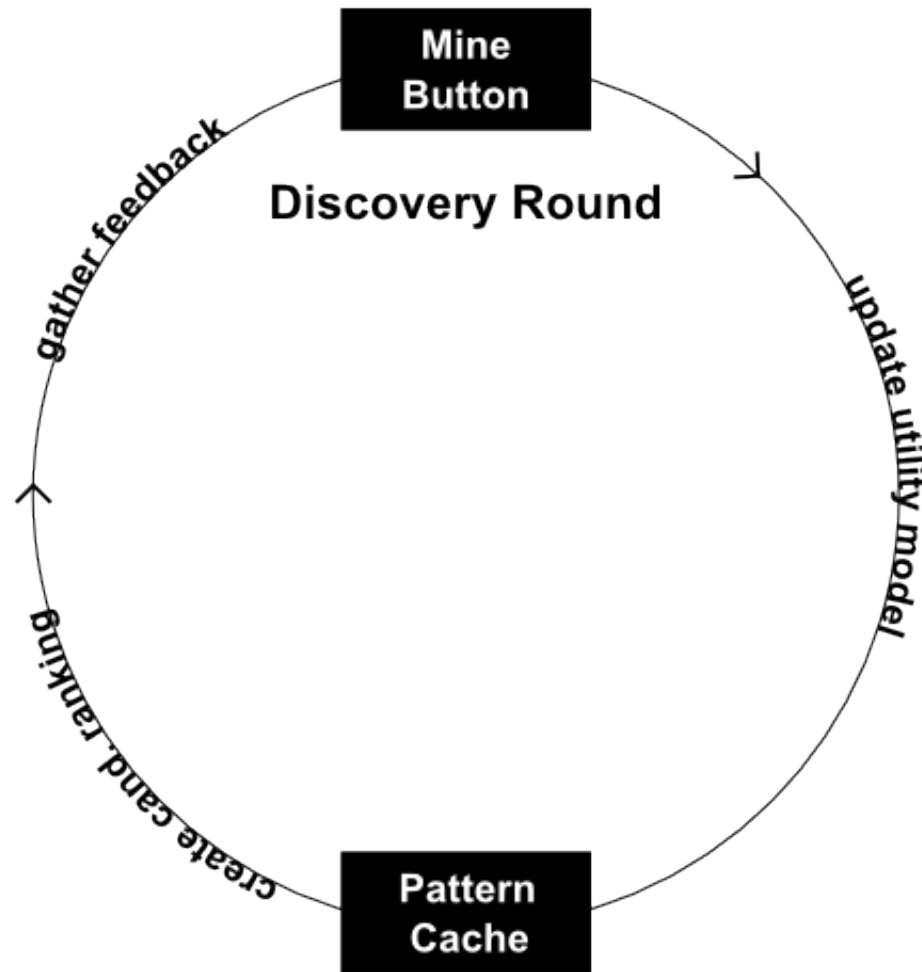
# Learning component updates models only based on natural user action for pattern inspection



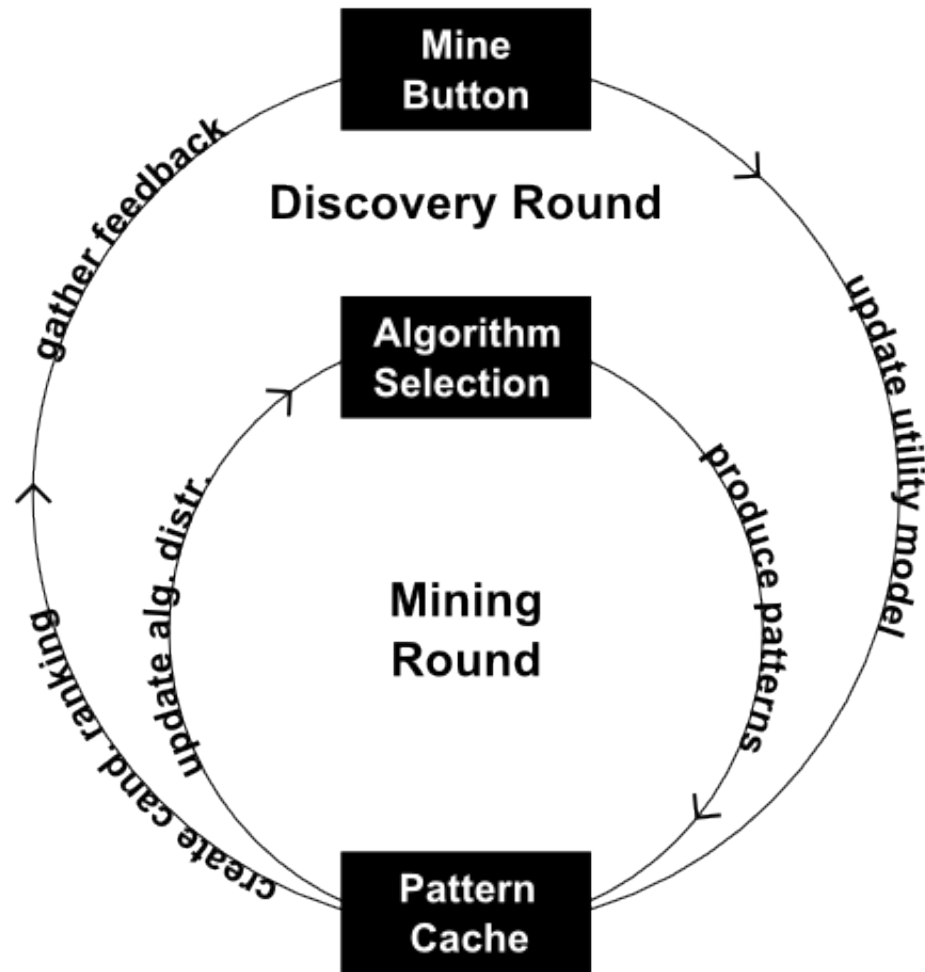
# Learning component updates models only based on natural user action for pattern inspection



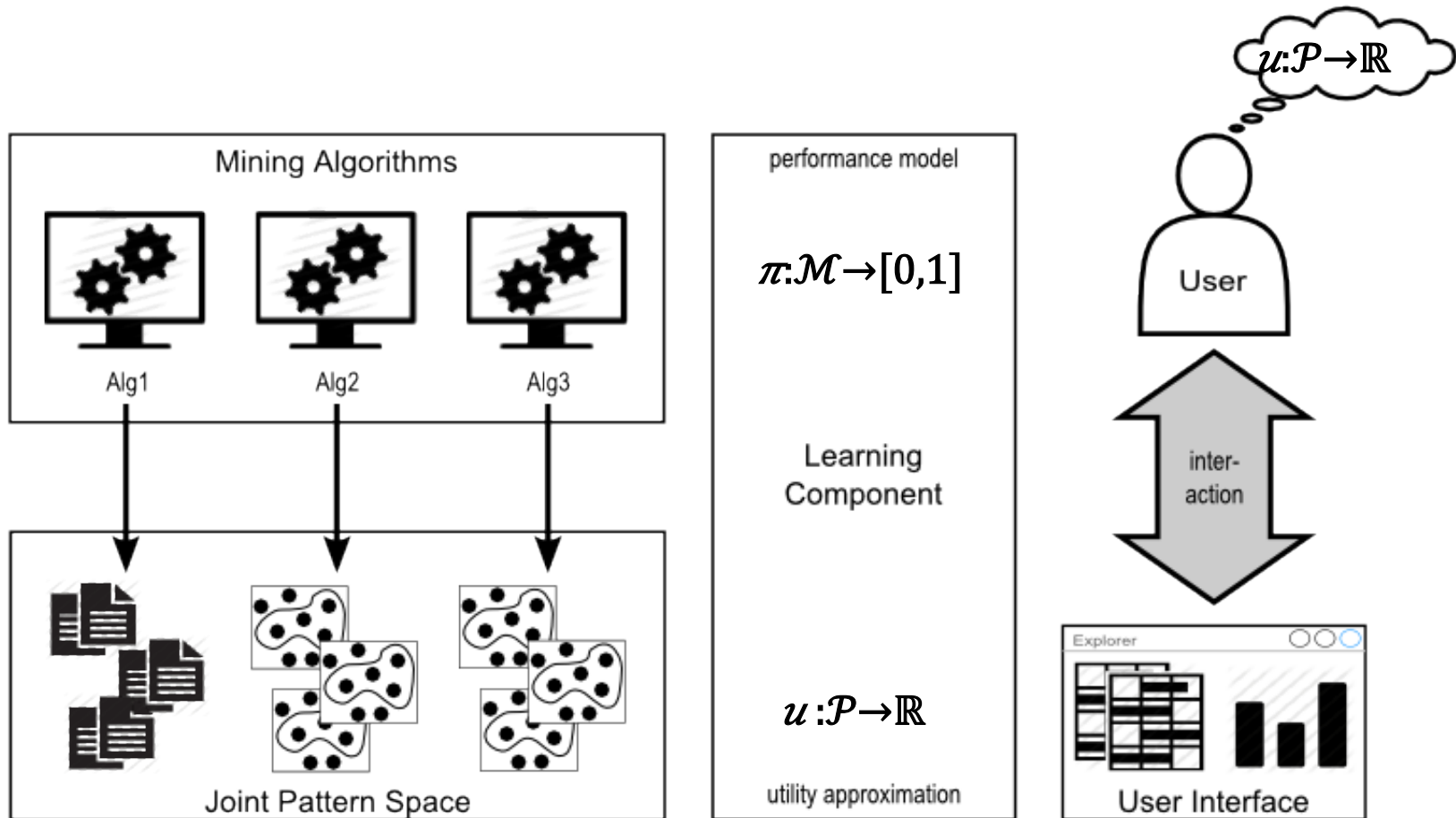
One cycle of the kd process corresponds to the period between two *mine* clicks



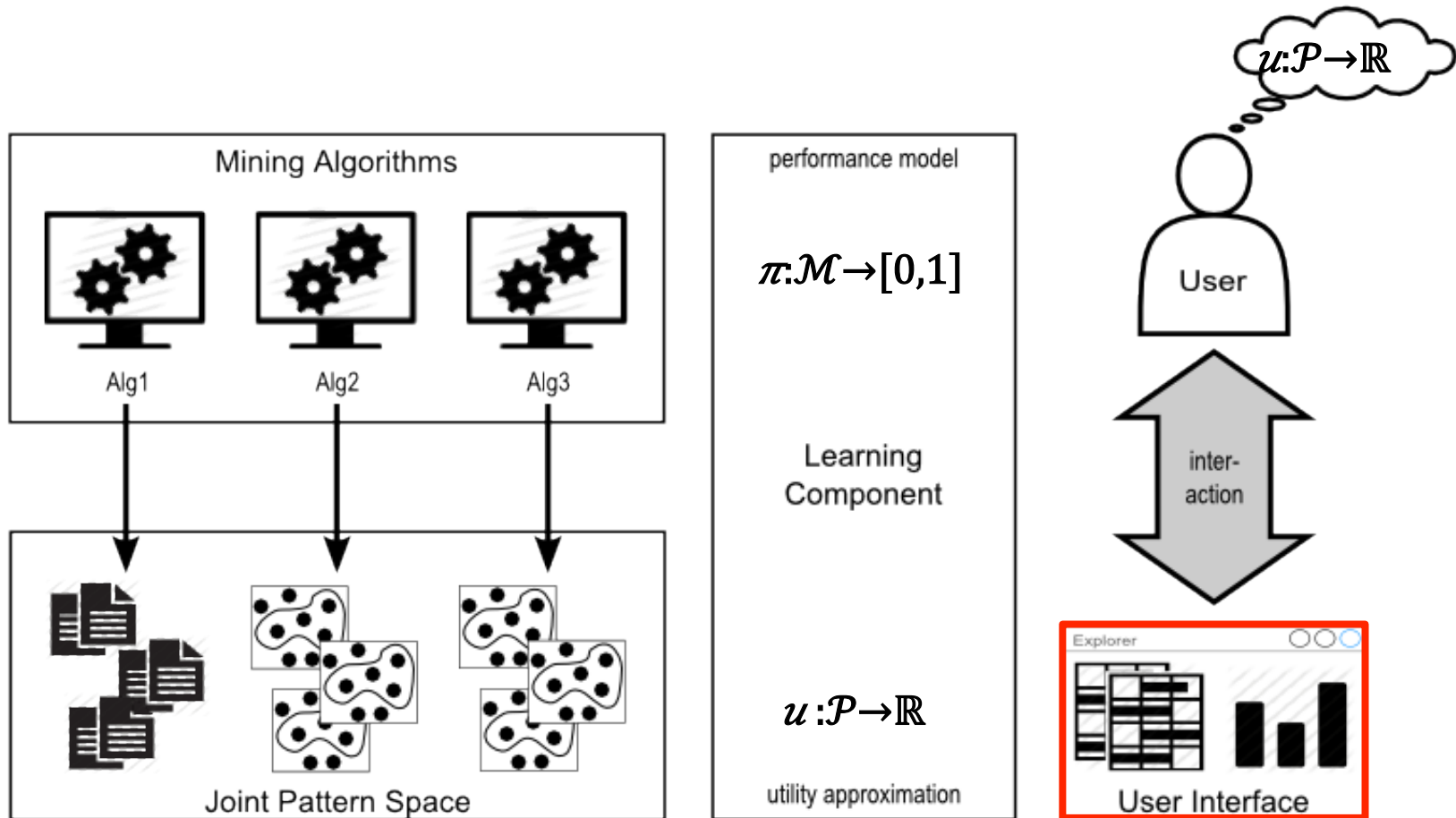
**During one user discovery round many mining rounds can be executed in the background**



# Overview



# Interface



# Implicit feedback can be gathered by simple UI

Bonn Click Mining

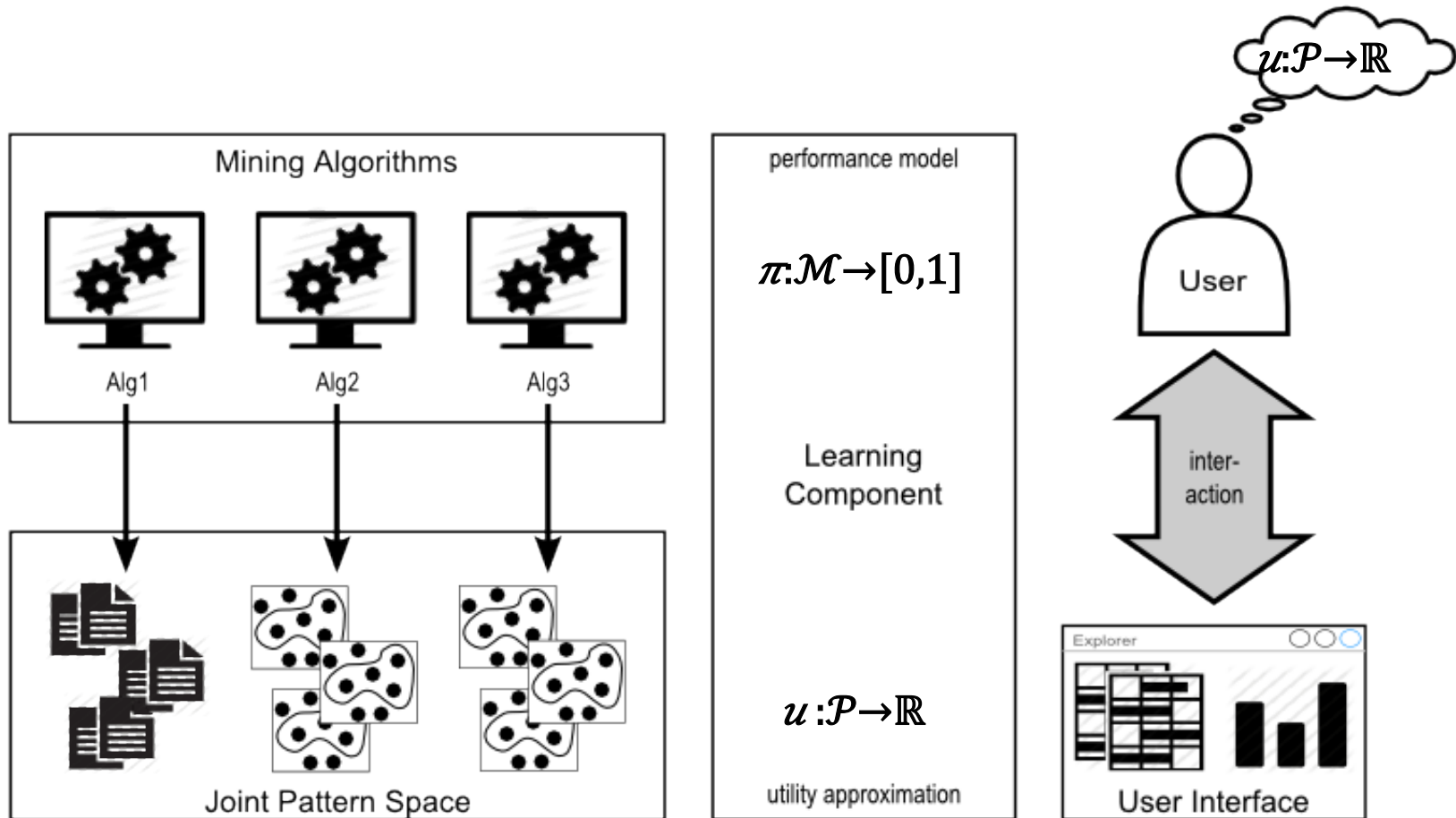
[Login](#)  
[Researcher view](#)

A One-Click Mining Prototype by [KDML Group](#), University of Bonn and Fraunhofer IAIS.

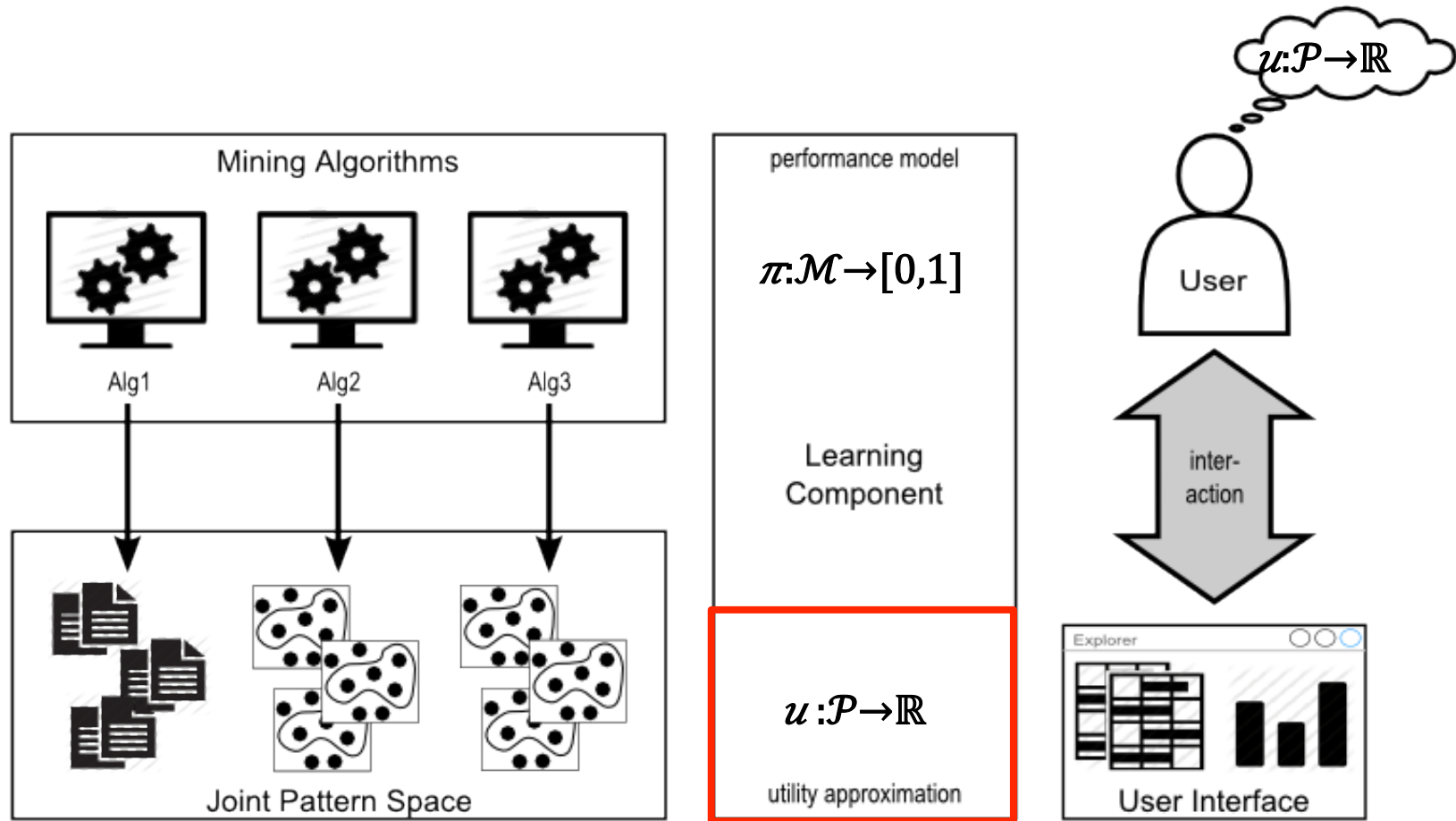
You are working on table: Socio-economics of Germany

| Area Code | Area Name                | Type  | State              | Region | CDU Gain | SPD Gain | FDP Gain | GREEN Gain | LEFT Gain | Elect. Participtn. Gain | CDU  | SPD  | FDP  | GREEN | LEFT | Elect. Participtn |
|-----------|--------------------------|-------|--------------------|--------|----------|----------|----------|------------|-----------|-------------------------|------|------|------|-------|------|-------------------|
| 9173      | Bad Toelz-Wolfratshausen | Rural | Bavaria            | South  | -9.2     | -5.9     | 5.8      | 2.4        | 2.2       | -6.8                    | 46.7 | 12   | 17.1 | 11.2  | 4.6  | 73.1              |
| 9188      | Starnberg                | Rural | Bavaria            | South  | -7.7     | -6.2     | 6.3      | 2.2        | 1.6       | -4.3                    | 39.2 | 14.1 | 22.1 | 14.7  | 3.7  | 80                |
| 9175      | Ebersberg                | Rural | Bavaria            | South  | -7.9     | -7.5     | 5.3      | 2.8        | 1.7       | -5.9                    | 42.4 | 14.9 | 16.9 | 13.1  | 4.2  | 77.7              |
| 9172      | Berchtesgadener Land     | Rural | Bavaria            | South  | -7.9     | -6.9     | 5        | 4          | 2.1       | -8.5                    | 50.7 | 12.3 | 13.2 | 10.6  | 4.9  | 68.2              |
| 9177      | Erding                   | Rural | Bavaria            | South  | -9.5     | -7.9     | 5.3      | 4.6        | 1.9       | -6.2                    | 45.5 | 12.4 | 14.7 | 12    | 4.8  | 73.3              |
| 9184      | Munich (district)        | Rural | Bavaria            | South  | -5.5     | -7.4     | 5        | 2.1        | 1.9       | -4.3                    | 39.8 | 16.7 | 19.6 | 12.7  | 4.5  | 79.1              |
| 9182      | Miesbach                 | Rural | Bavaria            | South  | -6.7     | -7       | 4.8      | 2.6        | 1.5       | -6.5                    | 48.1 | 12.2 | 17.6 | 10.2  | 3.9  | 73.8              |
| 9185      | Neuburg-Schrobenhausen   | Rural | Bavaria            | South  | -5.2     | -8.9     | 5.7      | 2.4        | 2.7       | -7.4                    | 52.6 | 13.2 | 13.5 | 7.2   | 5.7  | 70.1              |
| 9186      | Pfaffenhofen a.d.Ilm     | Rural | Bavaria            | South  | -4.8     | -10      | 4.8      | 2.7        | 2.4       | -6.7                    | 48.3 | 13.7 | 14.1 | 9.1   | 5.6  | 71.6              |
| 9572      | Erlangen-Hoechstadt      | Rural | Bavaria            | South  | -5.7     | -9.9     | 5.8      | 2.6        | 3         | -5.3                    | 39.1 | 20.5 | 15.1 | 11.5  | 6    | 77.3              |
| 9773      | Dillingen a.d.Donau      | Rural | Bavaria            | South  | -8       | -8.1     | 6.5      | 2.5        | 3         | -8.7                    | 47.3 | 13.2 | 16.2 | 7.5   | 6    | 68.4              |
| 8315      | Breisgau-Hochschwarzwald | Rural | Baden-Wuerttemberg | South  | -3.9     | -10.8    | 6.6      | 2.7        | 2.9       | -6.3                    | 34.1 | 19.8 | 17.4 | 16.7  | 6.4  | 74.7              |
| 9779      | Donau-Ries               | Rural | Bavaria            | South  | -7.8     | -8.7     | 6.2      | 2.6        | 3.3       | -7.1                    | 49.1 | 15.1 | 13.5 | 7.8   | 5.8  | 72.2              |
| 8337      | Waldshut                 | Rural | Baden-Wuerttemberg | South  | -4.7     | -11.5    | 8.3      | 2.6        | 3.2       | -7                      | 37.8 | 18.6 | 18.9 | 12.1  | 6.3  | 68.4              |
| 9174      | Dachau                   | Rural | Bavaria            | South  | -7.8     | -6.8     | 5.3      | 2.2        | 1.9       | -6                      | 45.9 | 14.7 | 15.5 | 10.6  | 4.6  | 75.1              |
| 9373      | Neumarkt i.d.OPf.        | Rural | Bavaria            | South  | -8.8     | -7.8     | 5.4      | 3.7        | 2.7       | -6.5                    | 49.3 | 13.4 | 12.9 | 8.9   | 5.7  | 73.7              |
| 9180      | Garmisch-Partenkirchen   | Rural | Bavaria            | South  | -8.6     | -5.5     | 5.5      | 2.1        | 1.5       | -6.8                    | 51.6 | 10.2 | 17.1 | 8.7   | 3.8  | 72.1              |

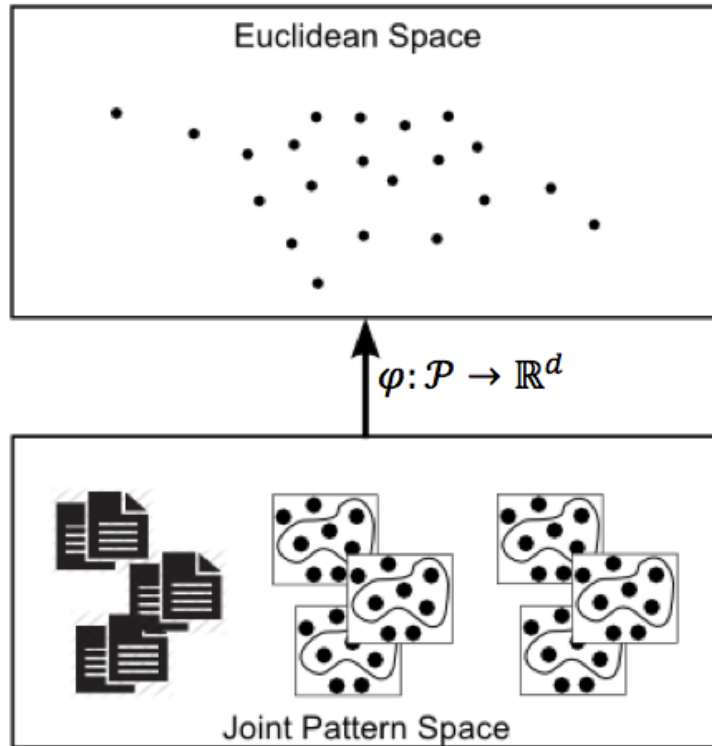
# Overview



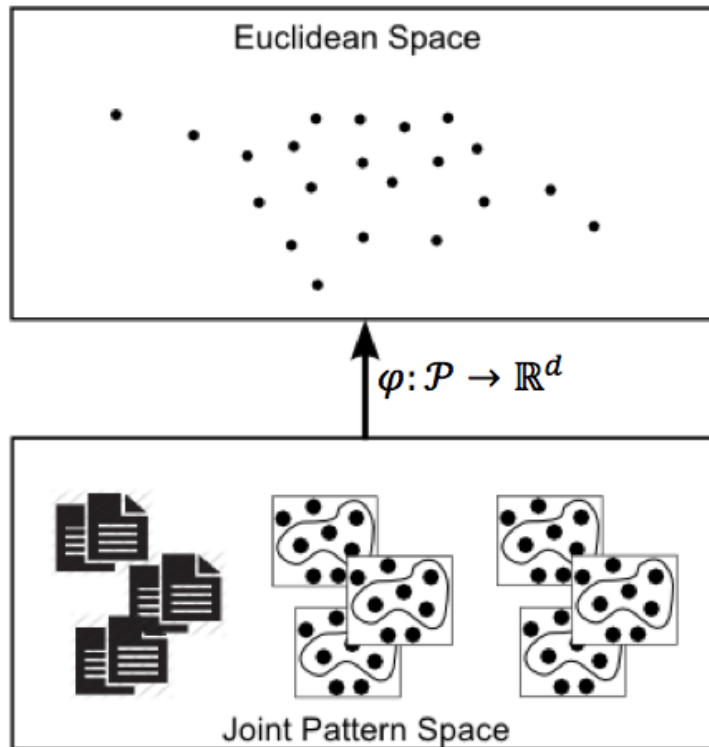
# Utility model



Can be solved as *online learning* problem with appropriate features

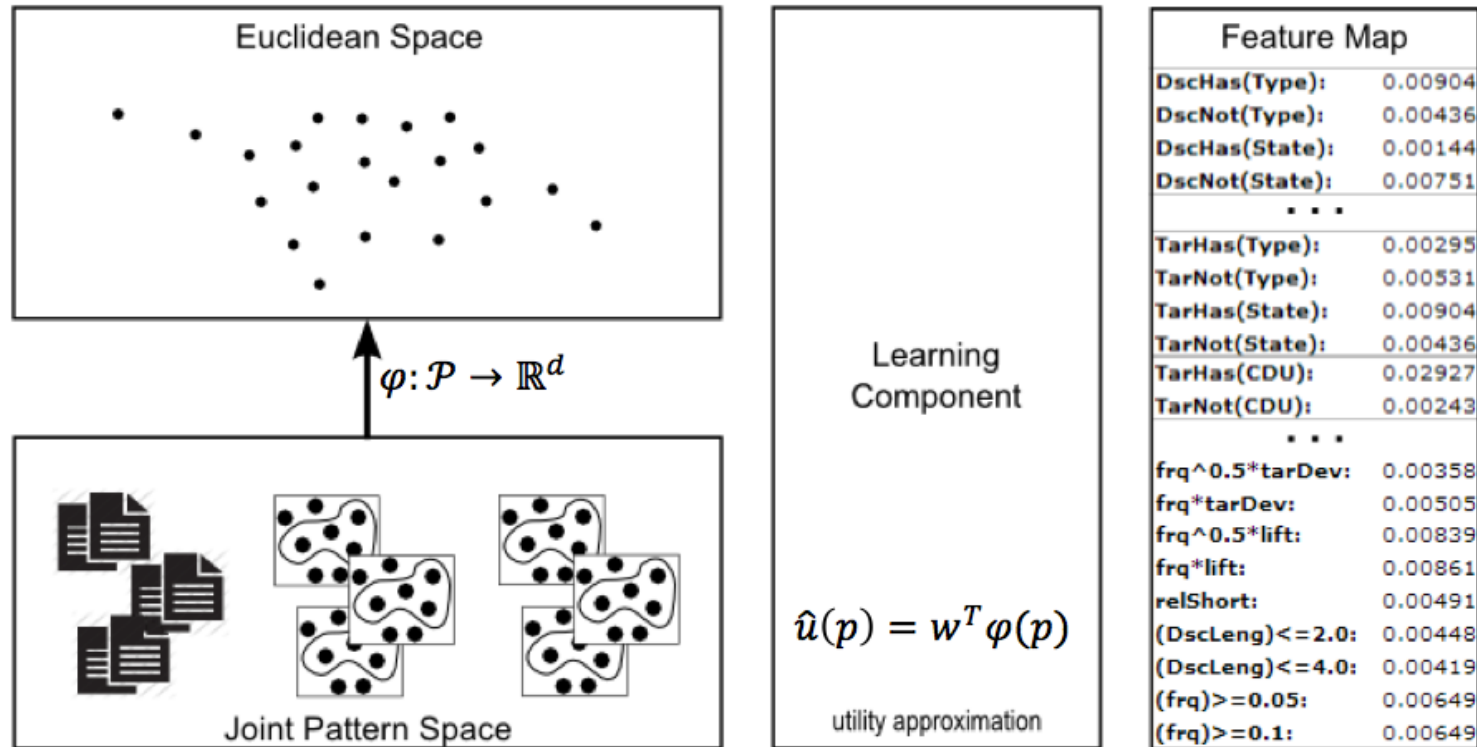


# Can be solved as *online learning* problem with appropriate features

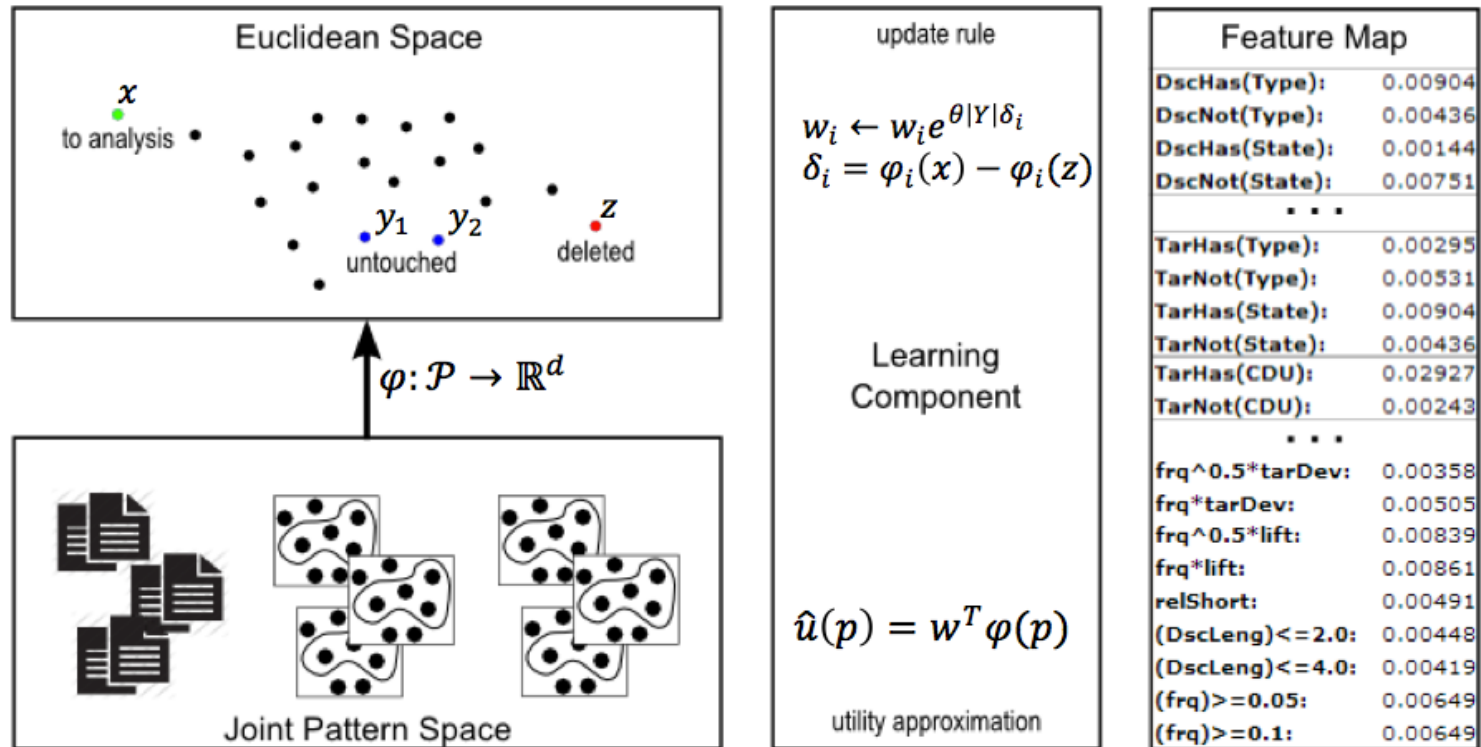


| Feature Map                 |         |
|-----------------------------|---------|
| DscHas(Type):               | 0.00904 |
| DscNot(Type):               | 0.00436 |
| DscHas(State):              | 0.00144 |
| DscNot(State):              | 0.00751 |
| ...                         |         |
| TarHas(Type):               | 0.00295 |
| TarNot(Type):               | 0.00531 |
| TarHas(State):              | 0.00904 |
| TarNot(State):              | 0.00436 |
| TarHas(CDU):                | 0.02927 |
| TarNot(CDU):                | 0.00243 |
| ...                         |         |
| frq <sup>0.5</sup> *tarDev: | 0.00358 |
| frq*tarDev:                 | 0.00505 |
| frq <sup>0.5</sup> *lift:   | 0.00839 |
| frq*lift:                   | 0.00861 |
| relShort:                   | 0.00491 |
| (DscLeng) ≤ 2.0:            | 0.00448 |
| (DscLeng) ≤ 4.0:            | 0.00419 |
| (frq) ≥ 0.05:               | 0.00649 |
| (frq) ≥ 0.1:                | 0.00649 |

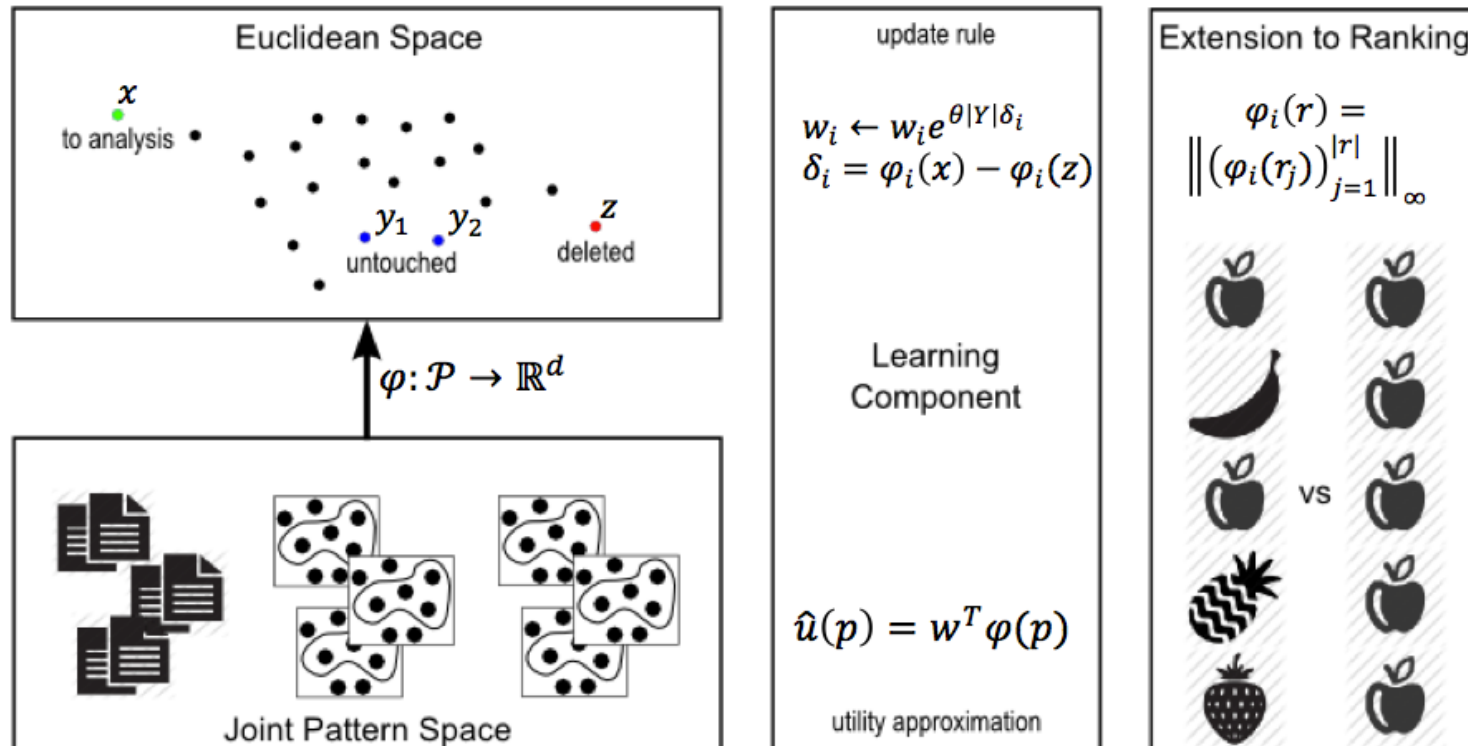
# Can be solved as *online learning* problem with appropriate features



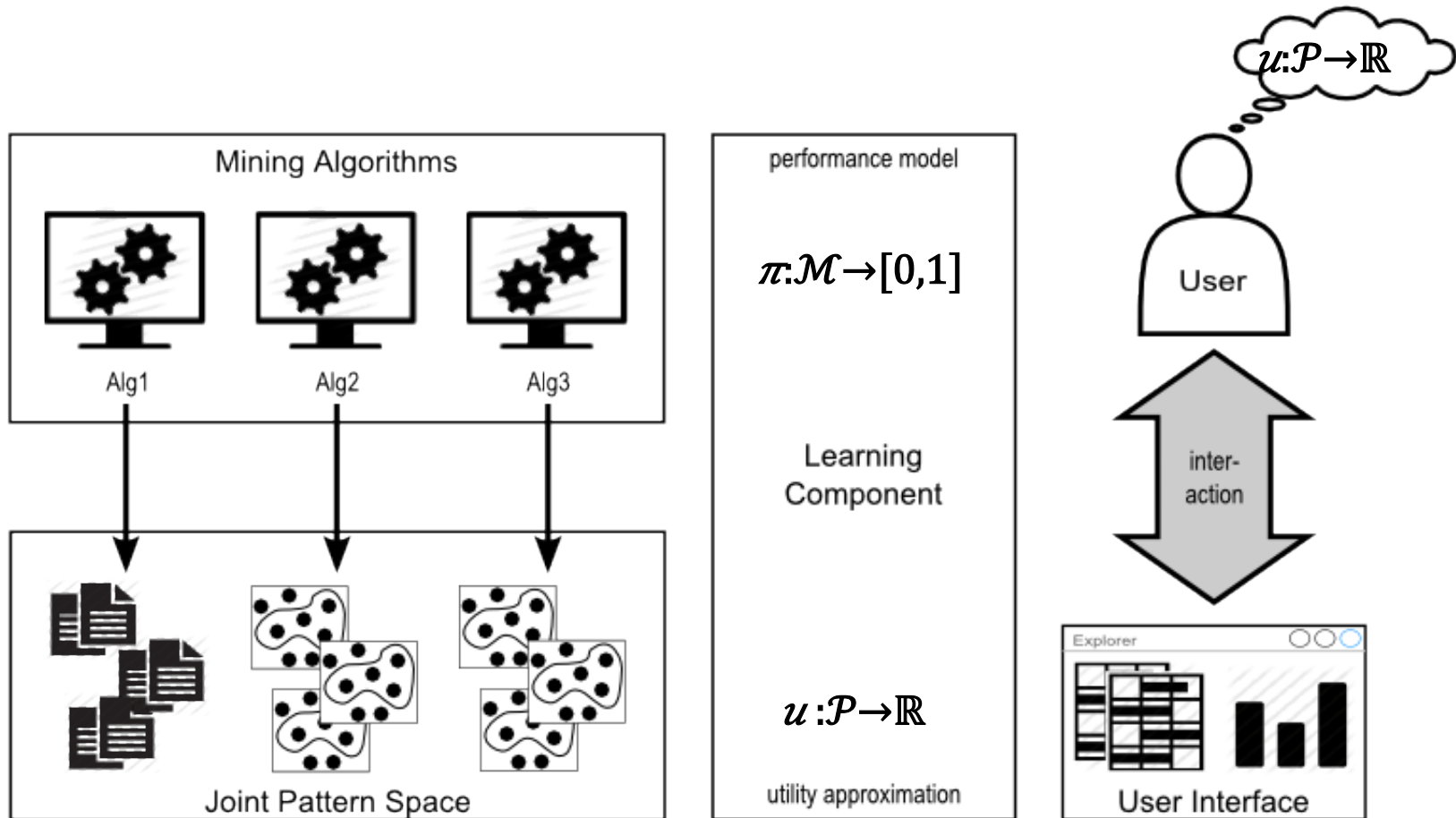
# Can be solved as *online learning* problem with appropriate features



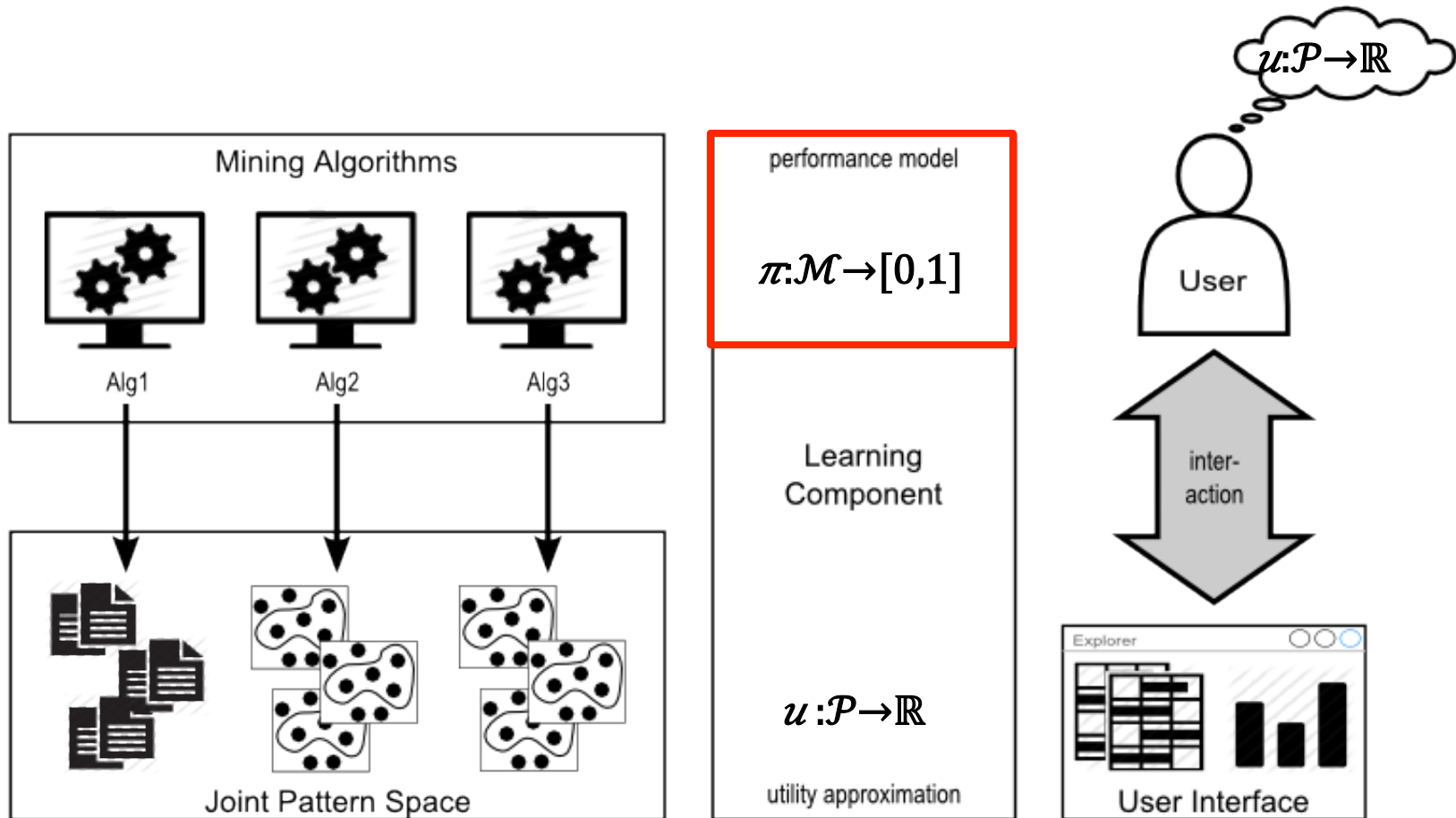
# Ranking score that balances *relevance* and *diversity* is crucial within user-supported search



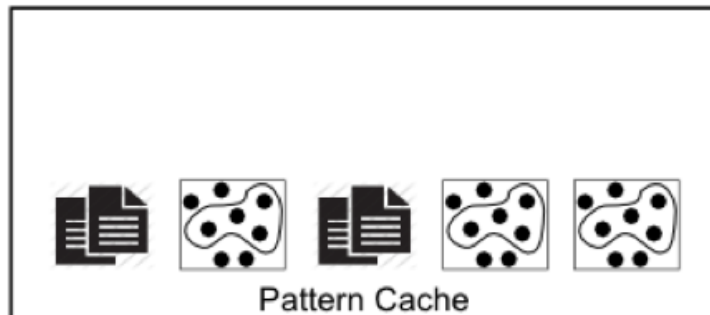
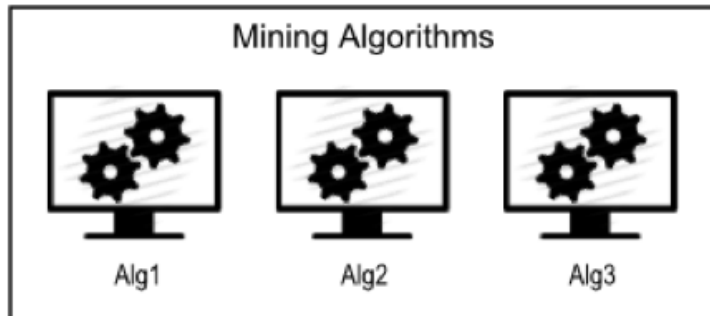
# Overview



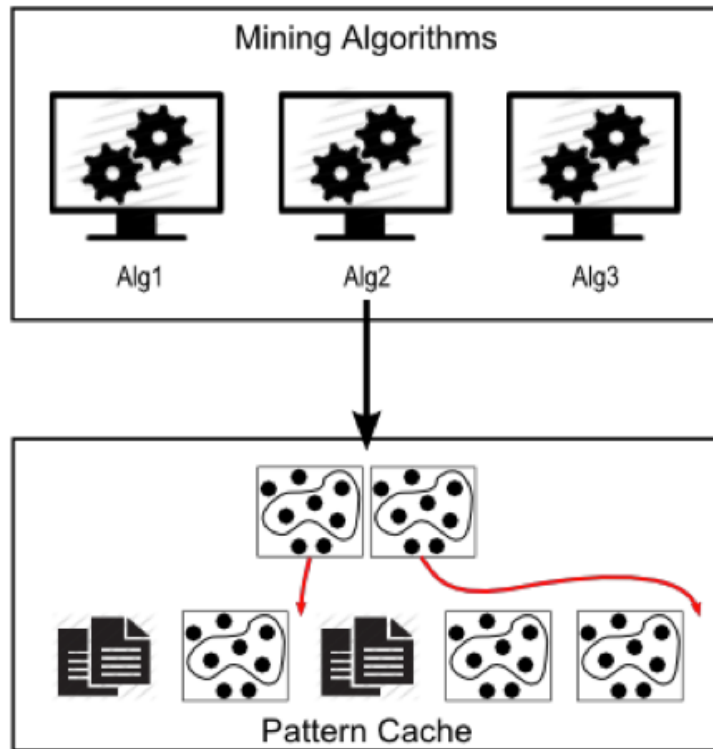
# Performance model



# Algorithm management can be modeled as *multi-armed bandit problem* with shifting rewards

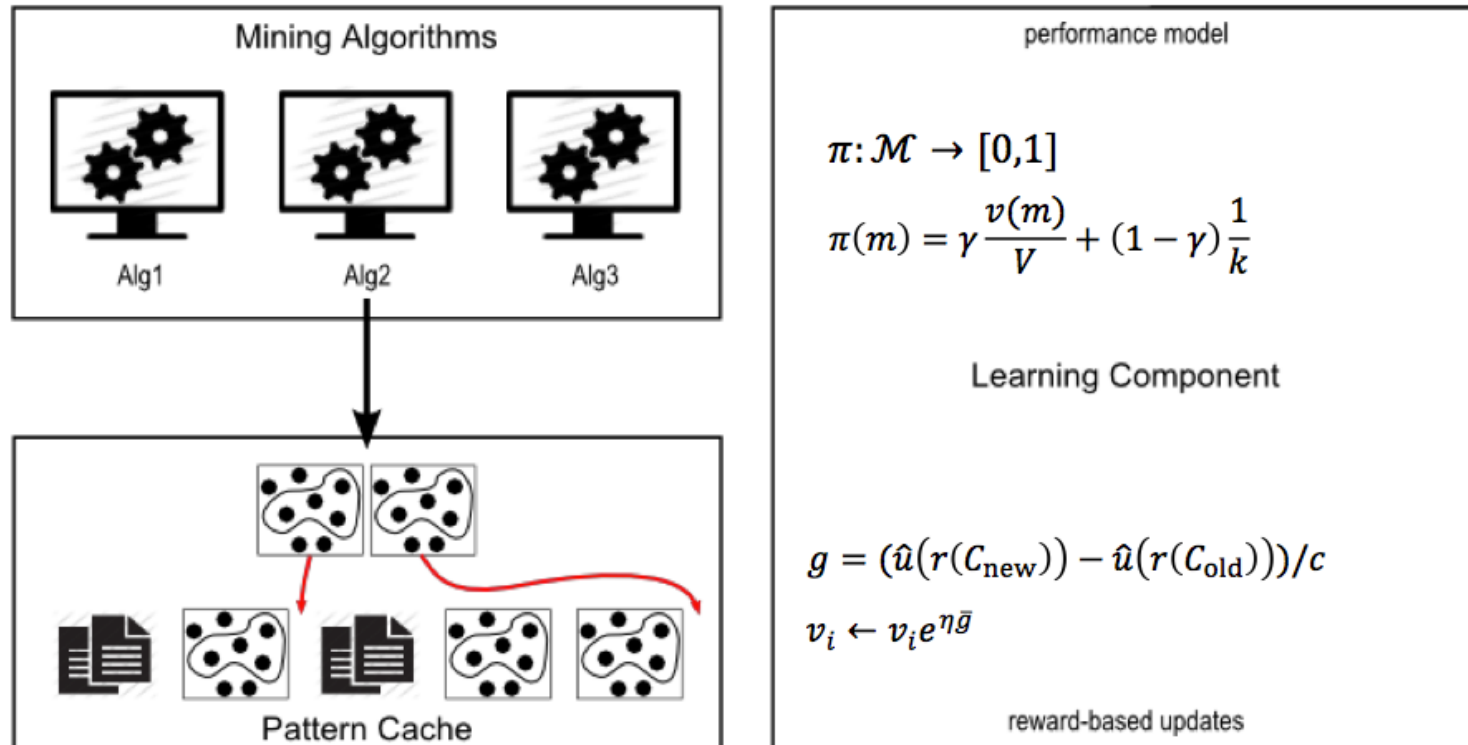


# Algorithm management can be modeled as *multi-armed bandit problem* with shifting rewards

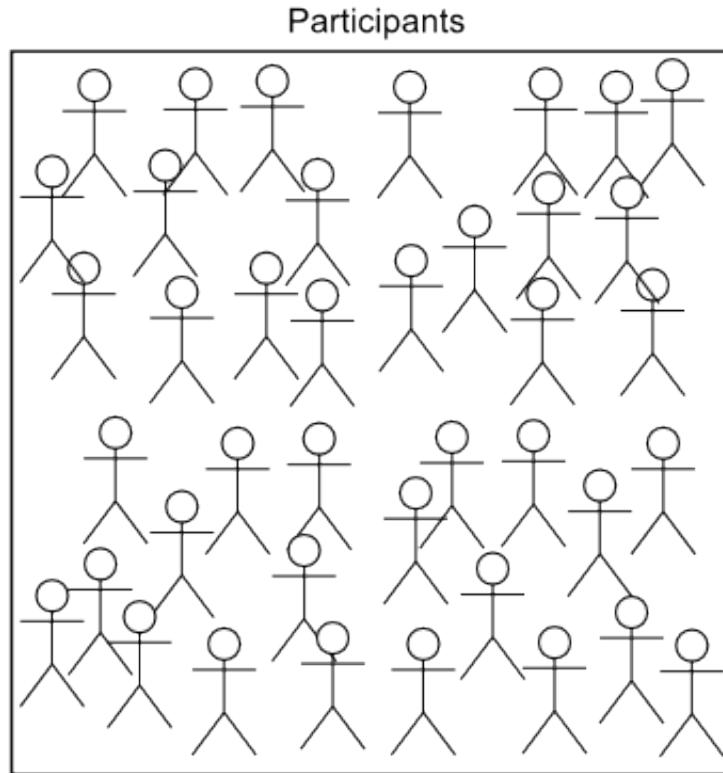


$$g = (\hat{u}(r(C_{\text{new}})) - \hat{u}(r(C_{\text{old}})))/c$$

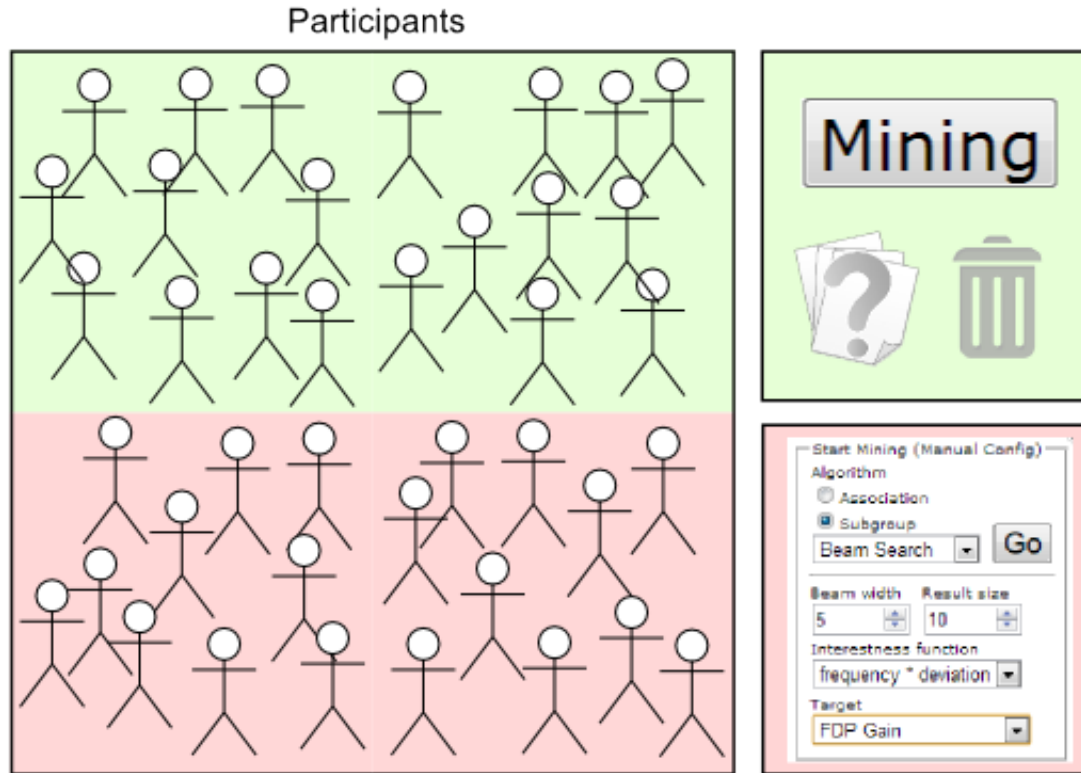
# Algorithm management can be modeled as *multi-armed bandit problem* with shifting rewards



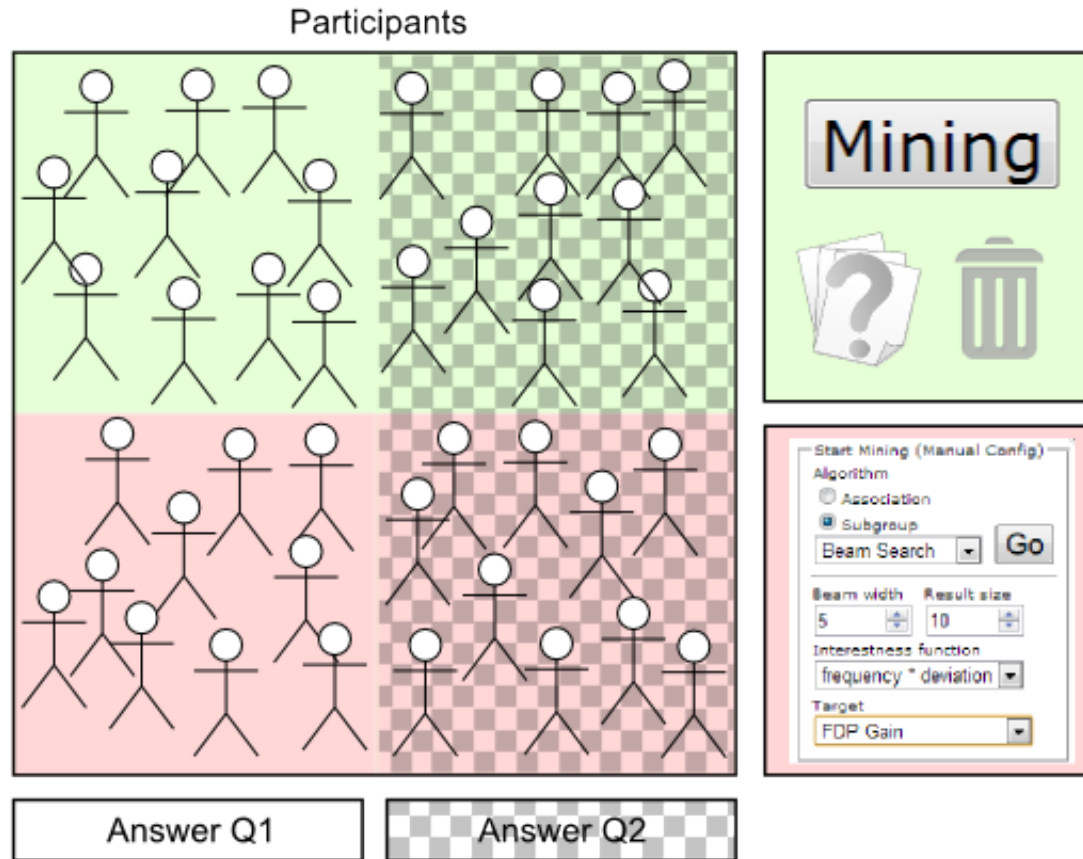
# Controlled experiment with real users is planned to evaluate effectiveness of approach



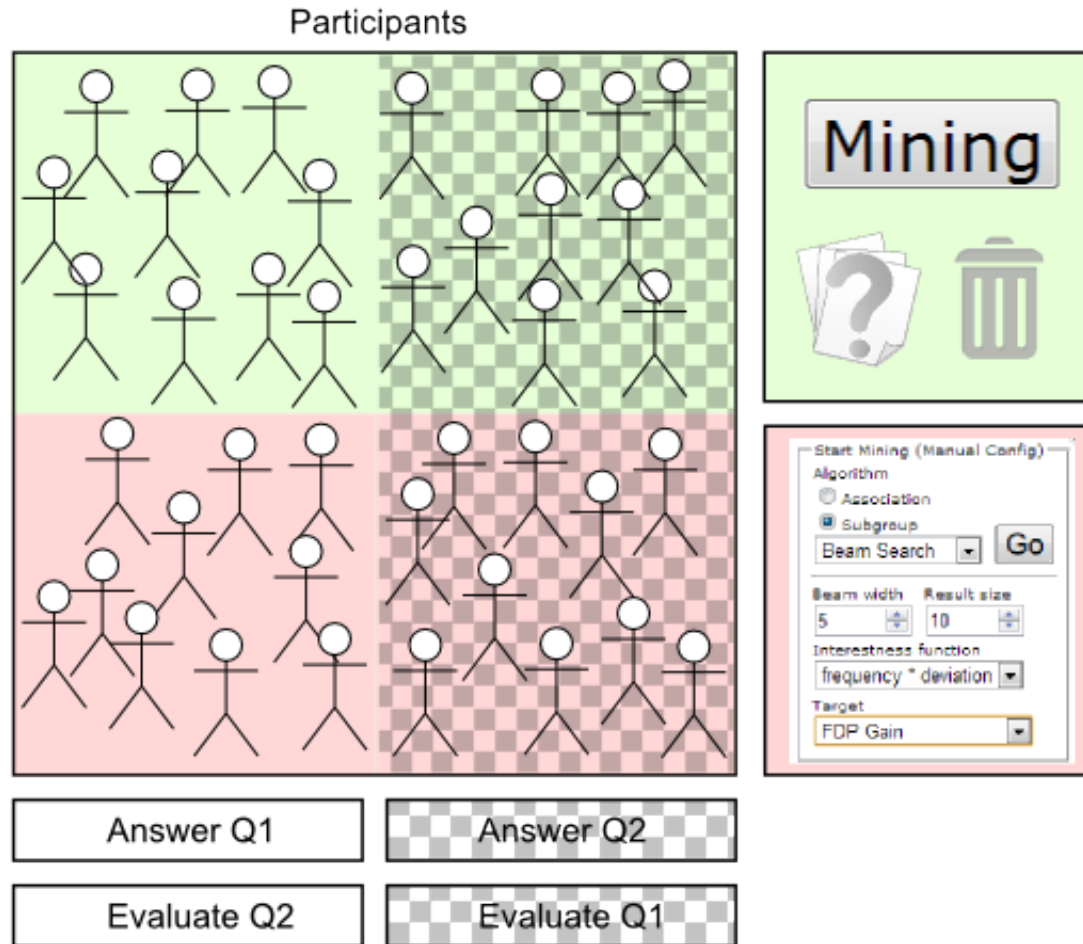
# We are interested in performance of the system compared to *manual variant*



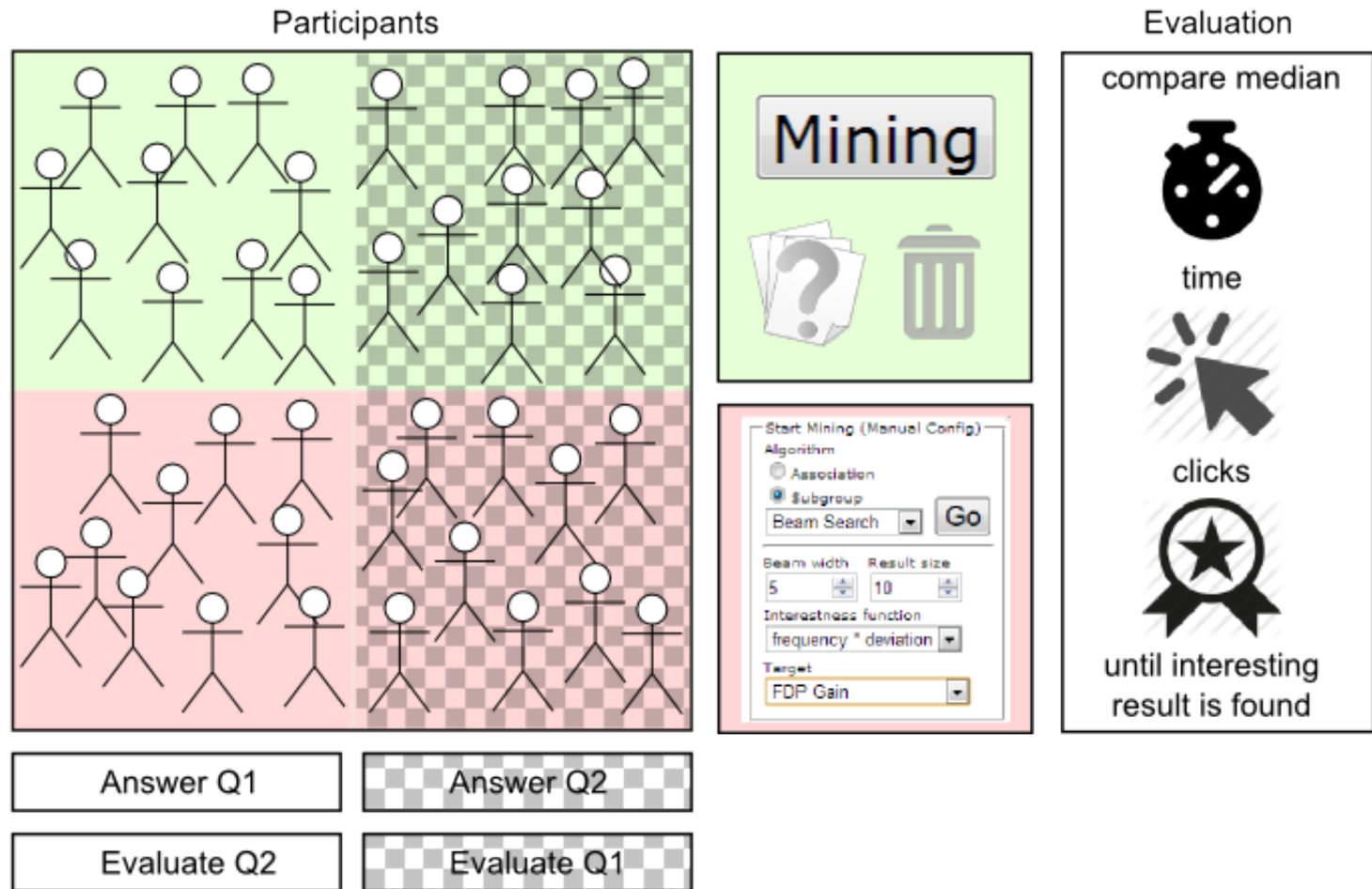
# Users are further split into groups according to different analysis questions they have to tackle



**After producing answers (patterns) to questions; quality of solutions is assessed by members of other group**



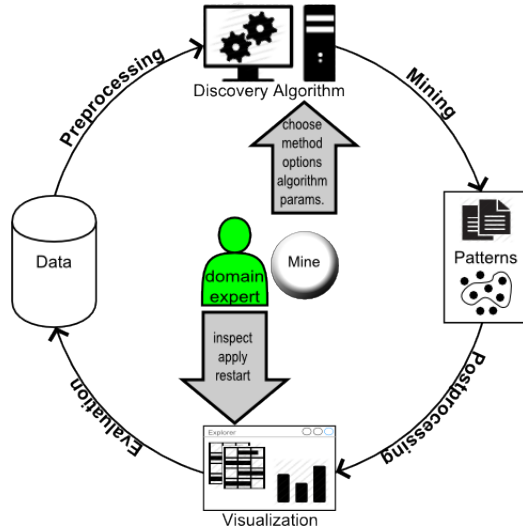
# Setup allows to compute expressive *evaluation metrics*



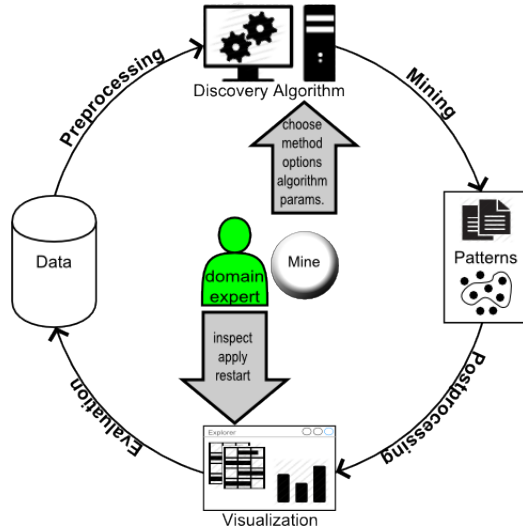
# Current Work

- **Evaluation**
- **Improve user interface**
- **Embedding representation**

# Summary



# Summary



**Bonn Click Mining**  
A One-Click Mining Prototype by KDMI Group, University of Bonn and Fraunhofer IAIS.

You are working on table: Socio-economics of Germany

| Area Code | Area Name                 | Type  | State              | Region | CDU Gain | SPD Gain | FDP Gain | GREEN Gain | LEFT Gain | Elect. Participn. Gain | CDU  | SPD  | FDP  | GREEN | LEFT | Elect. Participn. |
|-----------|---------------------------|-------|--------------------|--------|----------|----------|----------|------------|-----------|------------------------|------|------|------|-------|------|-------------------|
| 9173      | Bad Teolitz-Wolfershausen | Rural | Bavaria            | South  | -9.2     | -5.9     | 5.8      | 2.4        | 2.2       | -6.8                   | 46.7 | 12   | 17.1 | 11.2  | 4.6  | 73.1              |
| 9188      | Starnberg                 | Rural | Bavaria            | South  | -7.7     | -6.2     | 6.3      | 2.2        | 1.6       | -4.3                   | 39.2 | 14.1 | 22.1 | 14.7  | 3.7  | 80                |
| 9175      | Ebersberg                 | Rural | Bavaria            | South  | -7.9     | -7.5     | 5.3      | 2.8        | 1.7       | -5.9                   | 42.4 | 14.9 | 16.9 | 13.1  | 4.2  | 77.7              |
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| 9184      | Munich (district)         | Rural | Bavaria            | South  | -5.5     | -7.4     | 5        | 2.1        | 1.9       | -4.3                   | 39.8 | 16.7 | 19.6 | 12.7  | 4.5  | 79.1              |
| 9176      | Eichstaett                | Rural | Bavaria            | South  | -2.8     | -10.8    | 4.4      | 2.4        | 2.6       | -5.9                   | 51.4 | 15.7 | 11.2 | 7.8   | 5.3  | 75.3              |
| 9182      | Miesbach                  | Rural | Bavaria            | South  | -6.7     | -7       | 4.8      | 2.6        | 1.5       | -6.5                   | 48.1 | 12.2 | 17.6 | 10.2  | 3.9  | 73.8              |
| 9185      | Neuburg-Schrobenhausen    | Rural | Bavaria            | South  | -5.2     | -8.9     | 5.7      | 2.4        | 2.7       | -7.4                   | 52.6 | 13.2 | 13.5 | 7.2   | 5.7  | 70.1              |
| 9186      | Pfaffenhofen a.d. Ilm     | Rural | Bavaria            | South  | -4.8     | -10      | 4.8      | 2.7        | 2.4       | -6.7                   | 48.3 | 13.7 | 14.1 | 9.1   | 5.6  | 71.6              |
| 9189      | Traunstein                | Rural | Bavaria            | South  | -9.2     | -7.4     | 4.5      | 4.7        | 2.3       | -7.9                   | 47.7 | 12.7 | 12.8 | 12.1  | 5.1  | 70.3              |
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| 9773      | Dillingen a.d. Donau      | Rural | Bavaria            | South  | -8       | -8.1     | 6.5      | 2.5        | 3         | -8.7                   | 47.3 | 13.2 | 16.2 | 7.5   | 6    | 68.4              |
| 8315      | Breisgau-Hochschwarzwald  | Rural | Baden-Wuerttemberg | South  | -3.9     | -10.8    | 6.6      | 2.7        | 2.9       | -6.3                   | 34.1 | 19.8 | 17.4 | 16.7  | 6.4  | 74.7              |
| 8311      | Freiburg im Breisgau      | Urban | Baden-Wuerttemberg | South  | -2.2     | -9.6     | 4.4      | -0.8       | 4.5       | -5.2                   | 24.2 | 21.6 | 12.8 | 25.4  | 10   | 74.1              |
| 9779      | Donau-Ries                | Rural | Bavaria            | South  | -7.8     | -8.7     | 6.2      | 2.6        | 3.3       | -7.1                   | 49.1 | 15.1 | 13.5 | 7.8   | 5.8  | 72.2              |
| 9679      | Wuerzburg                 | Rural | Bavaria            | South  | -4.6     | -8.6     | 4.5      | 3.2        | 2.3       | -4.9                   | 41.3 | 18.9 | 13.5 | 12.1  | 6    | 78.7              |

Subgroup: SPD Gain=low, LEFT=high  
Frequency: 0.342233  
Dev. of LEFT Gain: 0.463916

Subgroup: Constr. world=low, Workforce=high  
Frequency: 0.152913  
Dev. of GDP growth 2009=low ...

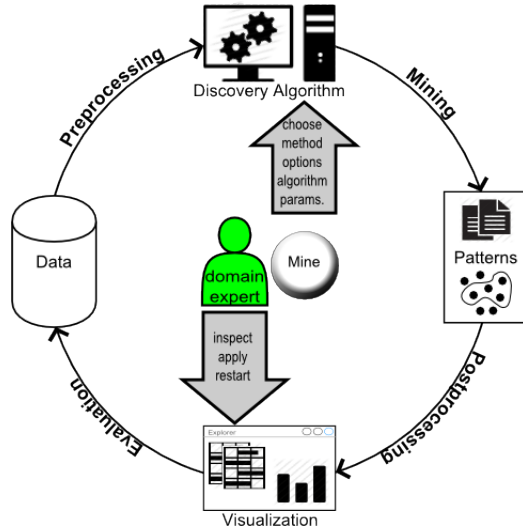
Subgroup: Agricult. world=low, #cars=low  
Frequency: 0.288335  
Dev. of Pop. Density: 0.001365

Subgroup: Elect. Participn.=low, GREEN=low  
Frequency: 0.322816  
Dev. of Elect. Participn. Gain: 0.406395

Subgroup: CDU=low, LEFT Gain=high  
Frequency: 0.310580  
Dev. of SPD Gain: 0.225062

Region=East, Unemploy.=high, Income=low, Children Pop.=low, CDU Gain=high  
Frequency: 0.211165  
Deviation of LEFT: 0.162206  
Pattern Mean: 28.548276  
Global Mean: 12.604369

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| 9188      | Starnberg                 | Rural | Bavaria            | South  | -7.7     | -6.2     | 6.3      | 2.2        | 1.6       | -4.3             | 39.2 | 14.1 | 22.1 | 14.7  | 3.7  | 80               |
| 9175      | Ebersberg                 | Rural | Bavaria            | South  | -7.9     | -7.5     | 5.3      | 2.8        | 1.7       | -5.9             | 42.4 | 14.9 | 16.9 | 13.1  | 4.2  | 77.7             |
| 9172      | Berchtesgaden Land        | Rural | Bavaria            | South  | -7.9     | -6.9     | 5        | 4          | 2.1       | -8.5             | 50.7 | 12.3 | 13.2 | 10.6  | 4.9  | 68.2             |
| 9177      | Erding                    | Rural | Bavaria            | South  | -9.5     | -7.9     | 5.3      | 4.6        | 1.9       | -6.2             | 45.5 | 12.4 | 14.7 | 12    | 4.8  | 73.3             |
| 9184      | Munich (district)         | Rural | Bavaria            | South  | -5.5     | -7.4     | 5        | 2.1        | 1.9       | -4.3             | 39.8 | 16.7 | 19.6 | 12.7  | 4.5  | 79.1             |
| 9176      | Eichstaett                | Rural | Bavaria            | South  | -2.8     | -10.8    | 4.4      | 2.4        | 2.6       | -5.9             | 51.4 | 15.7 | 11.2 | 7.8   | 5.3  | 75.3             |
| 9182      | Miesbach                  | Rural | Bavaria            | South  | -6.7     | -7       | 4.8      | 2.6        | 1.5       | -6.5             | 48.1 | 12.2 | 17.6 | 10.2  | 3.9  | 73.8             |
| 9185      | Neuburg-Schrobenhausen    | Rural | Bavaria            | South  | -5.2     | -8.9     | 5.7      | 2.4        | 2.7       | -7.4             | 52.6 | 13.2 | 13.5 | 7.2   | 5.7  | 70.1             |
| 9186      | Pfaffenhofen a.d. Ilm     | Rural | Bavaria            | South  | -4.8     | -10      | 4.8      | 2.7        | 2.4       | -6.7             | 48.3 | 13.7 | 14.1 | 9.1   | 5.6  | 71.6             |
| 9189      | Traunstein                | Rural | Bavaria            | South  | -9.2     | -7.4     | 4.5      | 4.7        | 2.3       | -7.9             | 47.7 | 12.7 | 12.8 | 12.1  | 5.1  | 70.3             |
| 9572      | Erlangen-Hochstadt        | Rural | Bavaria            | South  | -5.7     | -9.9     | 5.8      | 2.6        | 3         | -5.3             | 39.1 | 20.5 | 15.1 | 11.5  | 6    | 77.3             |
| 9773      | Dillingen a.d. Donau      | Rural | Bavaria            | South  | -8       | -8.1     | 6.5      | 2.5        | 3         | -8.7             | 47.3 | 13.2 | 16.2 | 7.5   | 6    | 68.4             |
| 8315      | Breisgau-Hochschwarzwald  | Rural | Baden-Wuerttemberg | South  | -3.9     | -10.8    | 6.6      | 2.7        | 2.9       | -6.3             | 34.1 | 19.8 | 17.4 | 16.7  | 6.4  | 74.7             |
| 8311      | Freiburg im Breisgau      | Urban | Baden-Wuerttemberg | South  | -2.2     | -9.6     | 4.4      | -0.8       | 4.5       | -5.2             | 24.2 | 21.6 | 12.8 | 25.4  | 10   | 74.1             |
| 9779      | Donau-Ries                | Rural | Bavaria            | South  | -7.8     | -8.7     | 6.2      | 2.6        | 3.3       | -7.1             | 49.1 | 15.1 | 13.5 | 7.8   | 5.8  | 72.2             |
| 9679      | Wuerzburg                 | Rural | Bavaria            | South  | -4.6     | -8.6     | 4.5      | 3.2        | 2.3       | -4.9             | 41.3 | 18.9 | 13.5 | 12.1  | 6    | 78.7             |

**Subgroup**  
SPD Gain=low  
LEFT=high  
Frequency : 0.342233  
Dev. of LEFT Gain: 0.463916

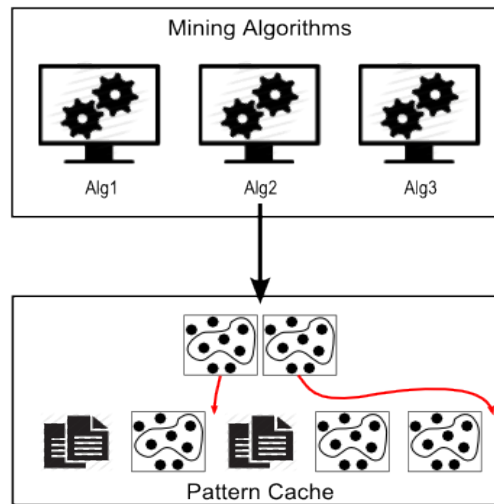
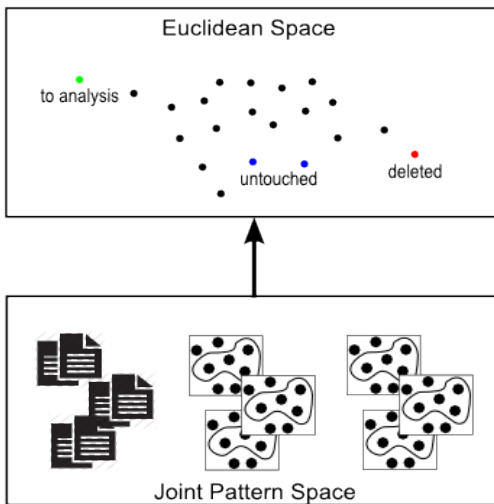
**Subgroup**  
Constr. world=low  
Workforce=high  
GDP growth 2009=low  
Frequency : 0.152913  
Dev. of GDP growth 2009: 0.120925

**Subgroup**  
Agricult. world=low  
cars=low  
Finance world=high  
Frequency : 0.288835  
Dev. of Pop. Density: 0.001365

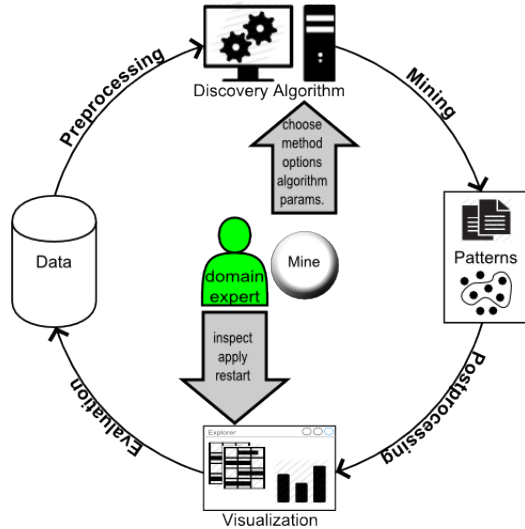
**Subgroup**  
Elect. Particip.=low  
GREEN=low  
Frequency : 0.322816  
Dev. of Elect. Particip. Gain: 0.406395

**Subgroup**  
CDU=low  
LEFT Gain=high  
Frequency : 0.310580  
Dev. of SPD Gain: 0.225062

**Subgroup**  
Region=East  
Unemployment=high  
Income=low  
Children Pop.=low  
CDU Gain=high  
Frequency : 0.211165  
Deviation of LEFT: 0.162206  
Pattern Mean: 28.948276  
Global Mean: 12.604369



# Summary



**Bonn Click Mining**  
A One-Click Mining Prototype by KDMI Group, University of Bonn and Fraunhofer IAIS.

You are working on table: Socio-economics of Germany

| Area Code | Area Name                 | Type  | State              | Region | CDU Gain | SPD Gain | FDP Gain | GREEN Gain | LEFT Gain | Elect. Participn. Gain | CDU  | SPD  | FDP  | GREEN | LEFT | Elect. Participn. |
|-----------|---------------------------|-------|--------------------|--------|----------|----------|----------|------------|-----------|------------------------|------|------|------|-------|------|-------------------|
| 9173      | Bad Teolitz-Wolfershausen | Rural | Bavaria            | South  | -9.2     | -5.9     | 5.8      | 2.4        | 2.2       | -6.8                   | 46.7 | 12   | 17.1 | 11.2  | 4.6  | 73.1              |
| 9188      | Starnberg                 | Rural | Bavaria            | South  | -7.7     | -6.2     | 6.3      | 2.2        | 1.6       | -4.3                   | 39.2 | 14.1 | 22.1 | 14.7  | 3.7  | 80                |
| 9175      | Ebersberg                 | Rural | Bavaria            | South  | -7.9     | -7.5     | 5.3      | 2.8        | 1.7       | -5.9                   | 42.4 | 14.9 | 16.9 | 13.1  | 4.2  | 77.7              |
| 9172      | Berchtesgader Land        | Rural | Bavaria            | South  | -7.9     | -6.9     | 5        | 4          | 2.1       | -8.5                   | 50.7 | 12.3 | 13.2 | 10.6  | 4.9  | 68.2              |
| 9177      | Erding                    | Rural | Bavaria            | South  | -9.5     | -7.9     | 5.3      | 4.6        | 1.9       | -6.2                   | 45.5 | 12.4 | 14.7 | 12    | 4.8  | 73.3              |
| 9184      | Munich (district)         | Rural | Bavaria            | South  | -5.5     | -7.4     | 5        | 2.1        | 1.9       | -4.3                   | 39.8 | 16.7 | 19.6 | 12.7  | 4.5  | 79.1              |
| 9176      | Eichstaett                | Rural | Bavaria            | South  | -2.8     | -10.8    | 4.4      | 2.4        | 2.6       | -5.9                   | 51.4 | 15.7 | 11.2 | 7.8   | 5.3  | 75.3              |
| 9182      | Miesbach                  | Rural | Bavaria            | South  | -6.7     | -7       | 4.8      | 2.6        | 1.5       | -6.5                   | 48.1 | 12.2 | 17.6 | 10.2  | 3.9  | 73.8              |
| 9185      | Neuburg-Schrobenhausen    | Rural | Bavaria            | South  | -5.2     | -8.9     | 5.7      | 2.4        | 2.7       | -7.4                   | 52.6 | 13.2 | 13.5 | 7.2   | 5.7  | 70.1              |
| 9186      | Pfaffenhofen a.d. Ilm     | Rural | Bavaria            | South  | -4.8     | -10      | 4.8      | 2.7        | 2.4       | -6.7                   | 48.3 | 13.7 | 14.1 | 9.1   | 5.6  | 71.6              |
| 9189      | Traunstein                | Rural | Bavaria            | South  | -9.2     | -7.4     | 4.5      | 4.7        | 2.3       | -7.9                   | 47.7 | 12.7 | 12.8 | 12.1  | 5.1  | 70.3              |
| 9572      | Erlangen-Hoechststadt     | Rural | Bavaria            | South  | -5.7     | -9.9     | 5.8      | 2.6        | 3         | -5.3                   | 39.1 | 20.5 | 15.1 | 11.5  | 6    | 77.3              |
| 9773      | Dillingen a.d. Donau      | Rural | Bavaria            | South  | -8       | -8.1     | 6.5      | 2.5        | 3         | -8.7                   | 47.3 | 13.2 | 16.2 | 7.5   | 6    | 68.4              |
| 8315      | Breisgau-Hochschwarzwald  | Rural | Baden-Wuerttemberg | South  | -3.9     | -10.8    | 6.6      | 2.7        | 2.9       | -6.3                   | 34.1 | 19.8 | 17.4 | 16.7  | 6.4  | 74.7              |
| 8311      | Freiburg im Breisgau      | Urban | Baden-Wuerttemberg | South  | -2.2     | -9.6     | 4.4      | -0.8       | 4.5       | -5.2                   | 24.2 | 21.6 | 12.8 | 25.4  | 10   | 74.1              |
| 9779      | Donau-Ries                | Rural | Bavaria            | South  | -7.8     | -8.7     | 6.2      | 2.6        | 3.3       | -7.1                   | 49.1 | 15.1 | 13.5 | 7.8   | 5.8  | 72.2              |
| 9679      | Wuerzburg                 | Rural | Bavaria            | South  | -4.6     | -8.6     | 4.5      | 3.2        | 2.3       | -4.9                   | 41.3 | 18.9 | 13.5 | 12.1  | 6    | 78.7              |

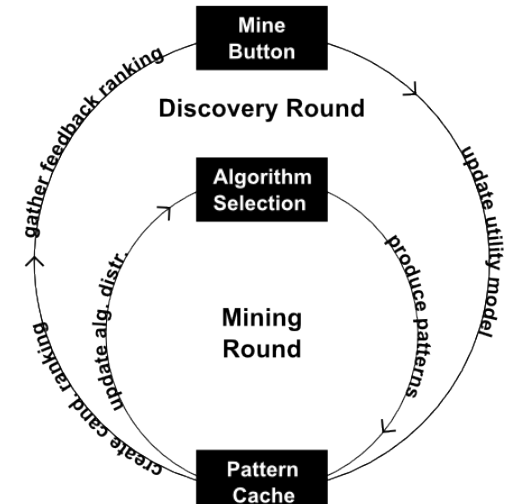
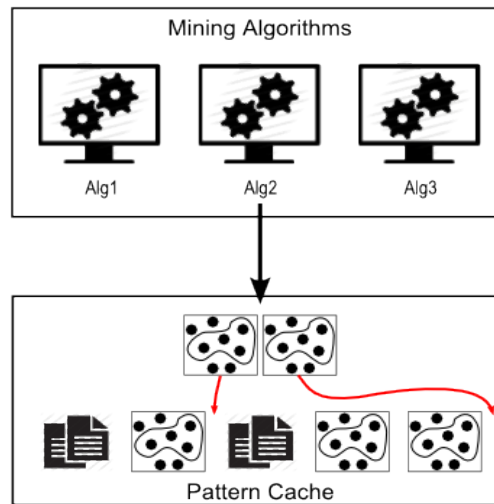
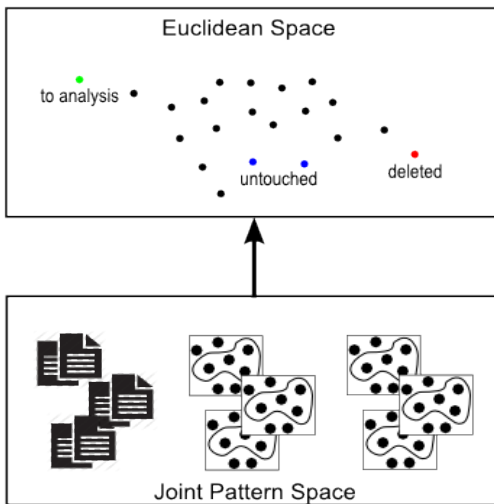
Subgroup: SPD Gain=low, LEFT=high  
Frequency: 0.342233  
Dev. of LEFT Gain: 0.463916

Subgroup: Constr. world=low, Workforce=high, GDP growth 2009=low  
Frequency: 0.152913  
Dev. of GDP growth 2008: 0.120925

Subgroup: Agricul. world=low, #cars=low, Finance world=high  
Frequency: 0.288835  
Dev. of Pop. Density: 0.001365

Subgroup: Elect. Participn.=low, GREEN=low  
Frequency: 0.322816  
Dev. of Elect. Participn. Gain: 0.406395

Subgroup: CDU=low, LEFT Gain=high  
Frequency: 0.310580  
Dev. of SPD Gain: 0.225062



# We are hiring...



Post-doc position for 1y+ at mining and learning group of U. of Bonn, FhG

Working on one click mining; e.g., bringing in your analysis technique

Get in touch with me ([mario.boleyn@iais.fraunhofer.de](mailto:mario.boleyn@iais.fraunhofer.de))