

OSYST: Knowledge based engineering system for structural optical design

Maxim Kolchin
(kolchinmax@gmail.com)
Dmitry Mouromtsev
(d.muromtsev@gmail.com)

St. Petersburg National Research
University of ITMO



1 Motivation

The design of optical systems (OS) is a sequential process including stages of the analysis of a technical specification, structural synthesis, parametric optimization etc. Currently there exists a lot of computer-aided design systems (CAD) that can effectively solve the problem of an optical scheme optimization (also known as parametric synthesis), calculating the exact parameters of an optical system. Some examples of such system are "CODE V", "OSLO", "SYNOPTIS" and others. Some of them provide user with decision support using a database of stock lenses from various vendors, what limits them to the number of existing solutions. But for successful calculation of an optical system's parameters of the initial optical scheme, or "starting point" for the whole design process must be specified correctly. Until now this problem is solved by an optical designer relying on his or her experience.

3 Formalization

Optical element (OE) – one reflective or combination of two reflective surfaces, i.e. a mirror or a single lens;

Optical system (OS) – a combination of several optical elements, i.e. telescope, microscope and etc.;

There are 4 types of OE – base "B", correction "C", fast "T", wide-angular "Y" and several types of surfaces - "O", "P", "A" and etc.

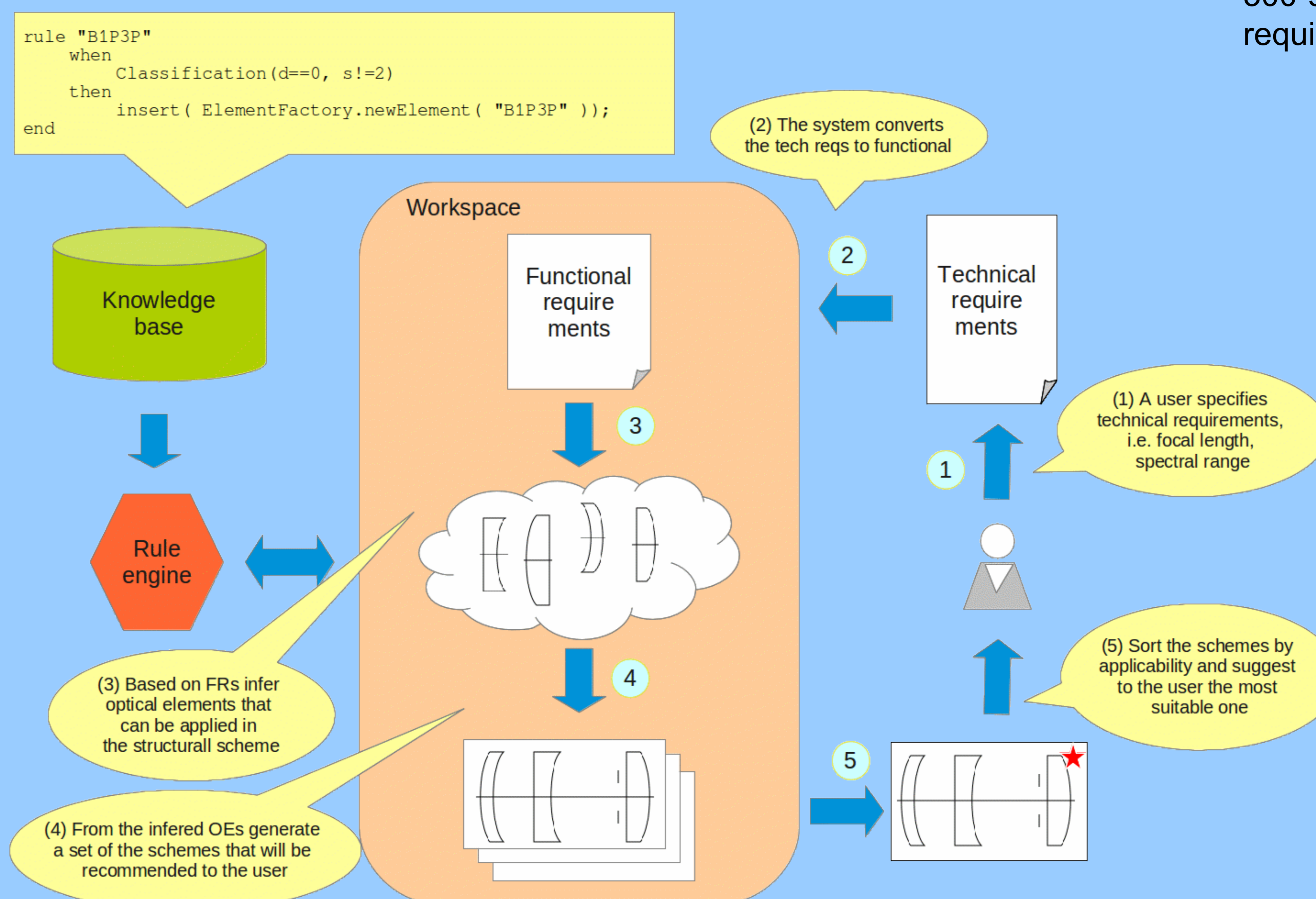
The Backus-Naur form that describes the formal representaiion syntax for structural schemes:

```
OS ::= <Y> + "<B>" + "<T>
<Y> ::= "" | <Y_expr> | <Y_expr><C>
<Y_expr> ::= <numbers_elements>"Y"<surface_list>
<B> ::= <B_expr> | <B_expr><C>
<B_expr> ::= <numbers_elements>"B"<surface_list>
<T> ::= "" | <T_expr> | <T_expr><C>
<T_expr> ::= <numbers_elements>"T"<surface_list>
<C> ::= "" | <C_expr>
<C_expr> ::= <numbers_elements>"C"<surface_list>
<numbers_elements> ::= "" | "2" | "3" | "4" | "5"
<surface_list> ::= <surface><surface>
<surface> ::= <zone><surface_type>
<zone> ::= "1" | "2" | "3"
<surface_type> ::= "0" | "P" | "A" | "F" | "I" | "V"
```

An example: Y2V2P + B3A3P + T3F3P + C3V3O

2 Aim

Automate the starting point selection during structural synthesis of an optical system, based on formal rule-based method of structural synthesis proposed by Prof. M.Russinov and developed by Dr. I.Livshits.



4 Current work

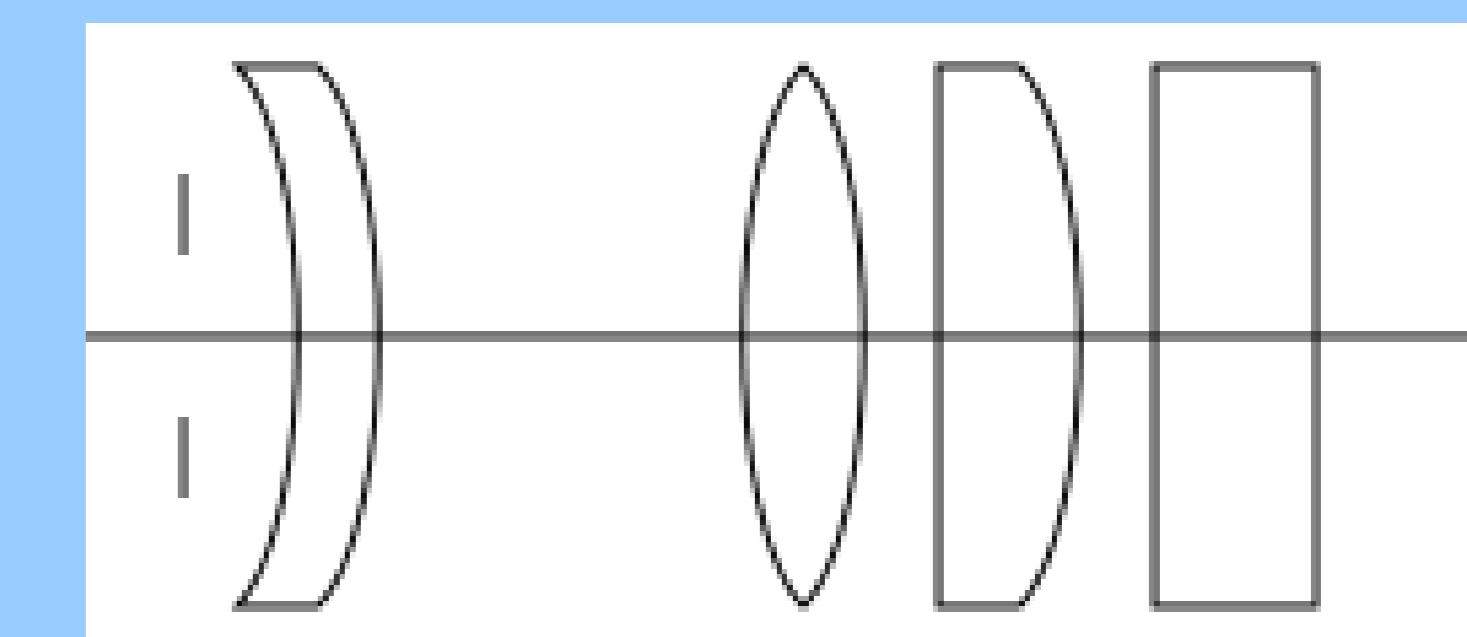
At this stage of the work we are interested in improving the generation of structural schemes based on inferred optical elements. The generation based on different restrictions:

- Each scheme must have an OE with type "B" and only one;
- An OE with type "Y" must be located before an OE with type "B", but the "T" after;
- Only OE with type "B" can be located in all three zones;
- ...

Currently the generation of the schemes implemented by rules. **Can the rules be replaced by ontology and reasoning?**

5 Results

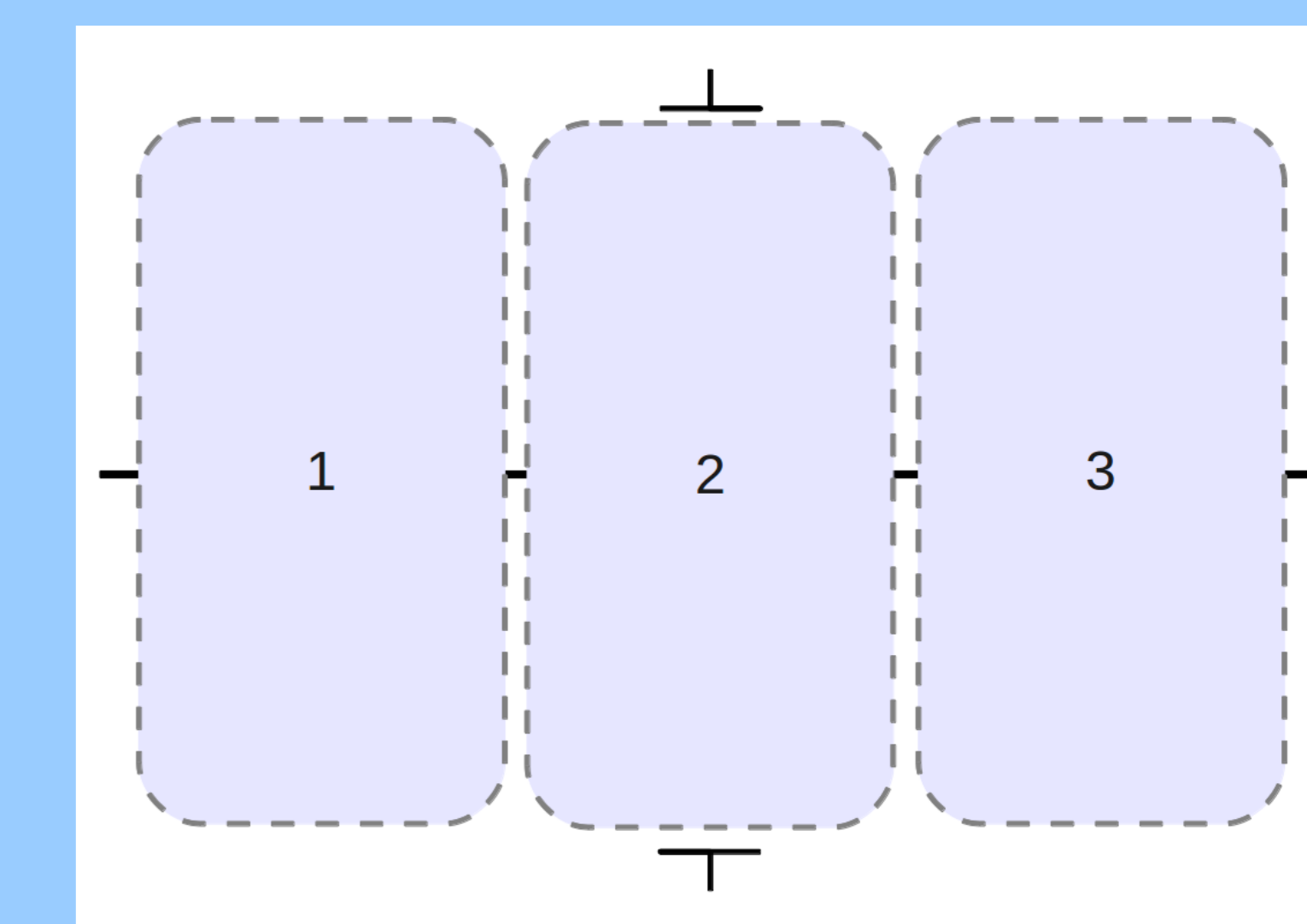
- A prototype of the system was implemented and is being used in the alpha testing;
- The system is able to generate more than 300 structural schemes for different technical requirements;



An example of an optical structural scheme

6 Future work

- Implement testing framework for the knowledge base;
- Implement the algorithm for sorting the structural schemes by the index of applicability;
- Continue expanding the knowledge base;
- Investigate a possibility to use ontologies in the system;



Surface locations (zones)