Towards an Automated Pattern Selection Procedure in Software Models

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Software (development) is becoming increasingly complex

Three main reasons:

1. Increased complexity of problems to be solved by software
2. Shift towards distributed software
3. Relatively long lifetime of software

Software patterns are used to manage this complexity:

- Selecting patterns is *hard*, *knowledge intensive* and *time-consuming*
- Instantiating patterns is *repetitive* and *error-prone*

We propose an automated approach to selecting software patterns with two contributions:

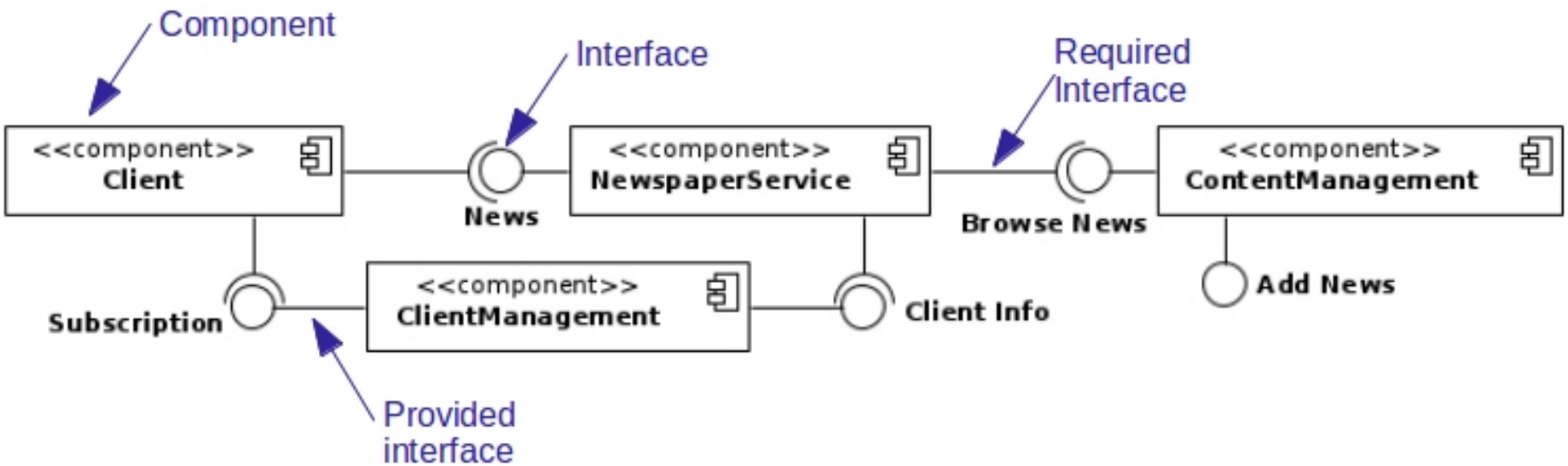
- Formal representation of software models and patterns
- Automatically learn roles for software models

Software development is gathering requirements and ensuring the system meets them

Achieved by defining a number of components which each:

- Satisfy a subset of the gathered requirements
- Offer functionality through one or more interfaces

Graphical models capture design decisions more formally



Excerpt of a digital news system's model

Software patterns provide established solutions to recurring design issues

1. **Name**

   Client-Dispatcher-Server

2. **Resolved design issue**

   Clients have to use services regardless the location of the servers

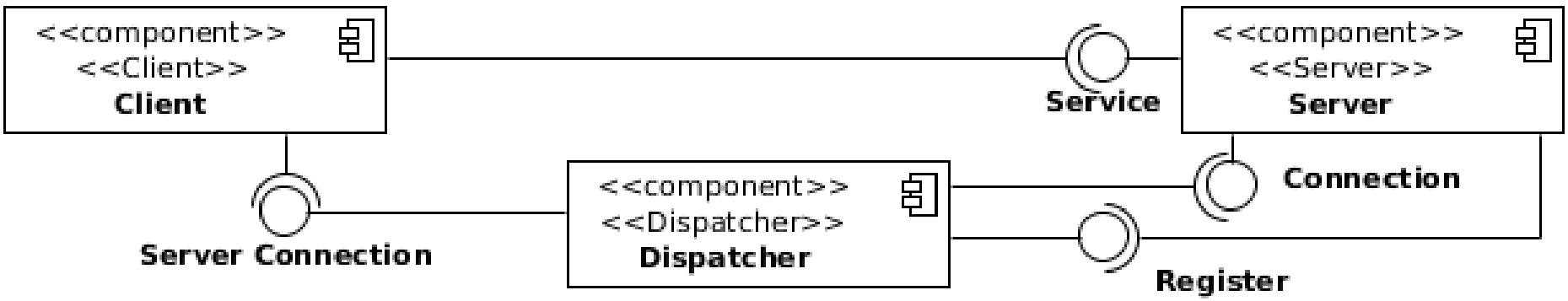
3. **Provided solution**

   Add a dispatcher as an intermediate layer between clients and servers

4. **Consequences**

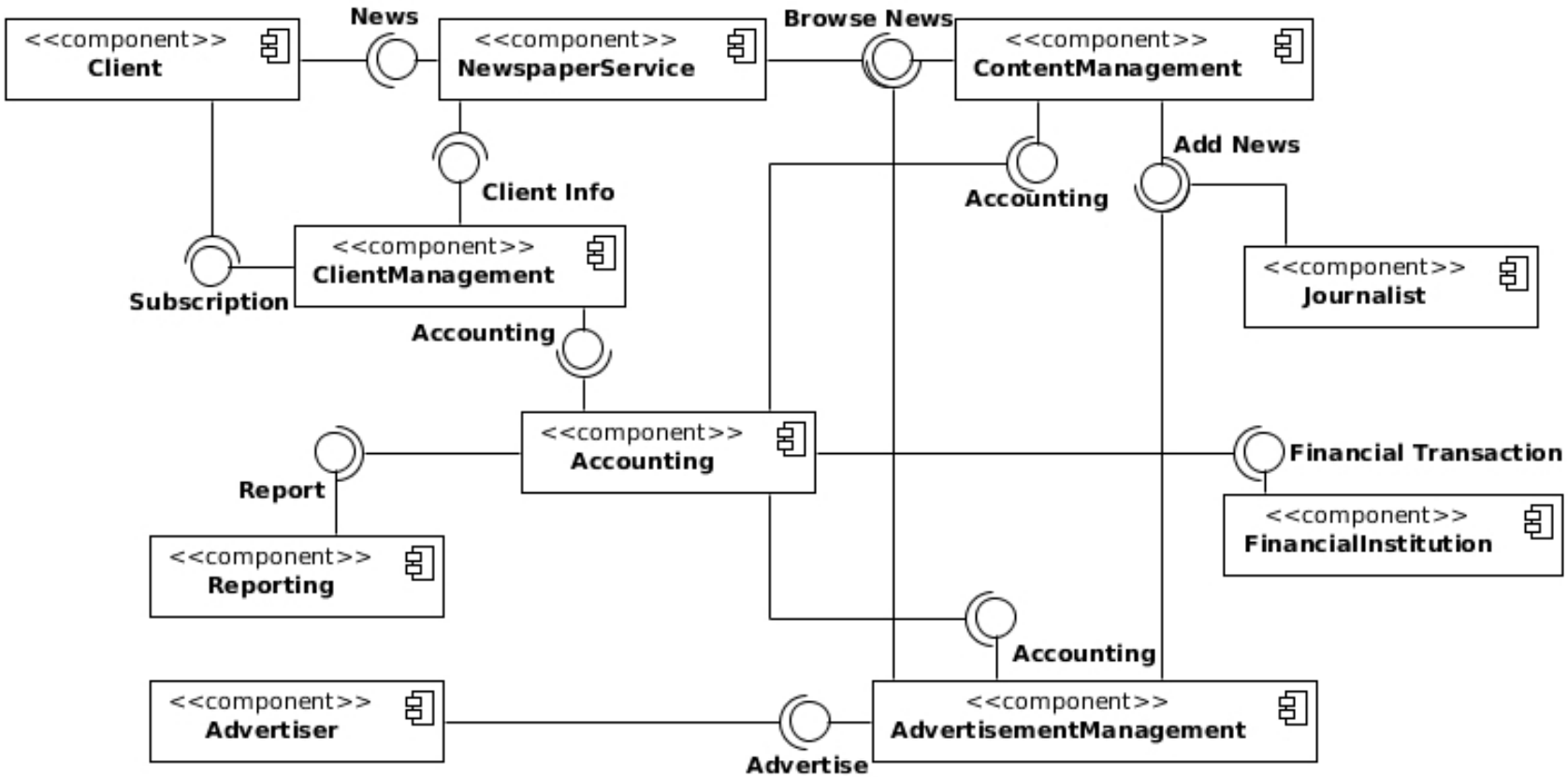
   Decouple clients and servers ✔
   Dispatcher is a possible bottleneck ✗

Graphical models capture the solution more formally



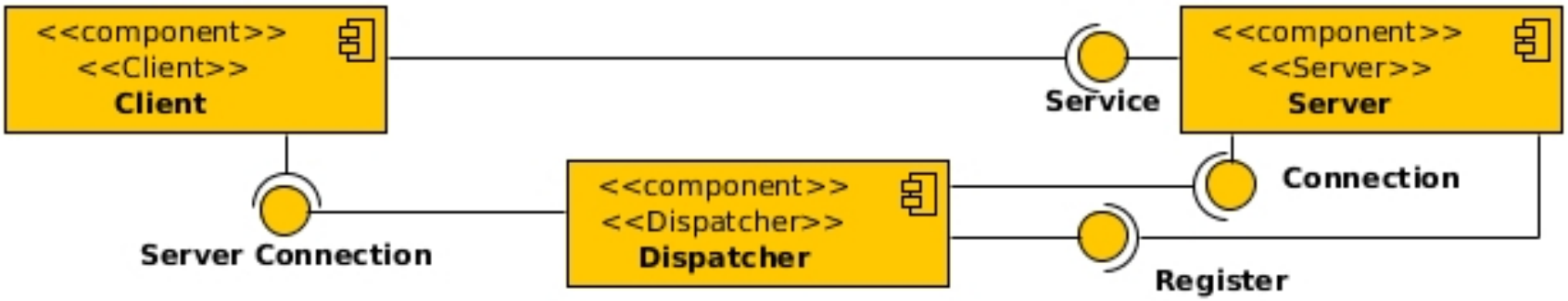
Client-Dispatcher-Server pattern

Given: a software model



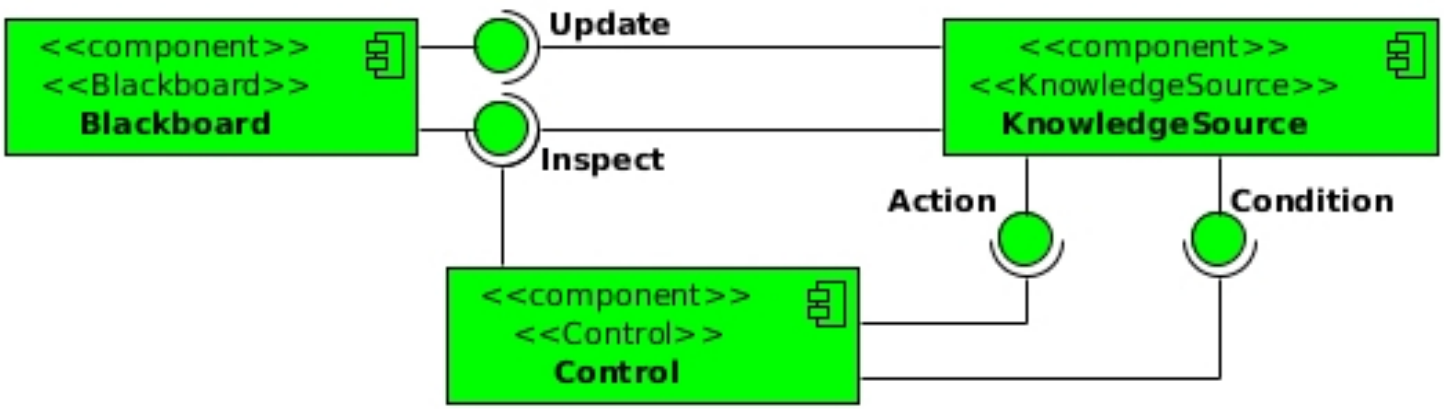
A digital news system

Given: a collection of software patterns



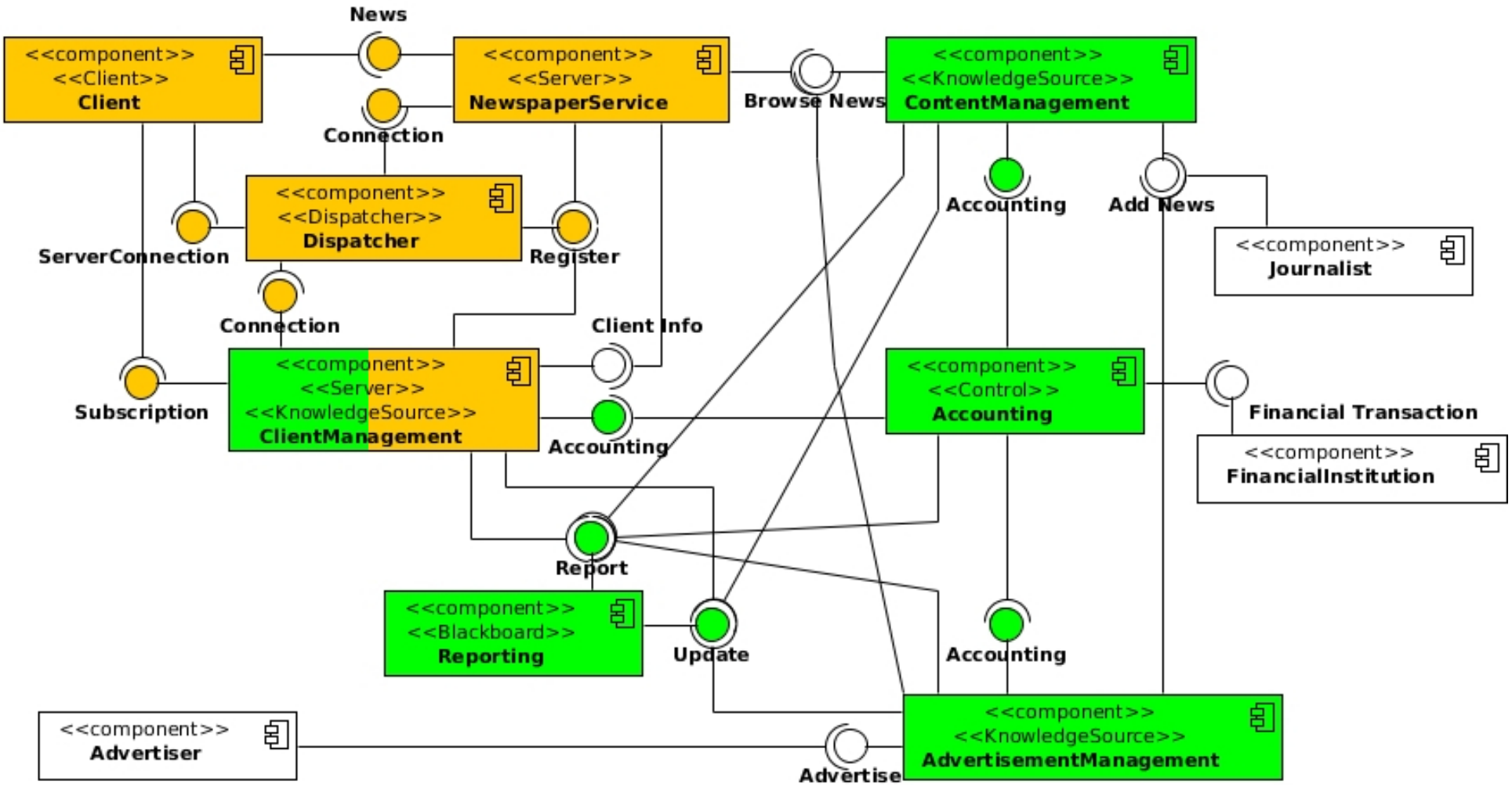
Client-Dispatcher-Server pattern

⋮ (other pattern models) ⋮



Blackboard pattern

Do: instantiate patterns in a software model



Patterns instantiated in the digital news system

Overview of our approach

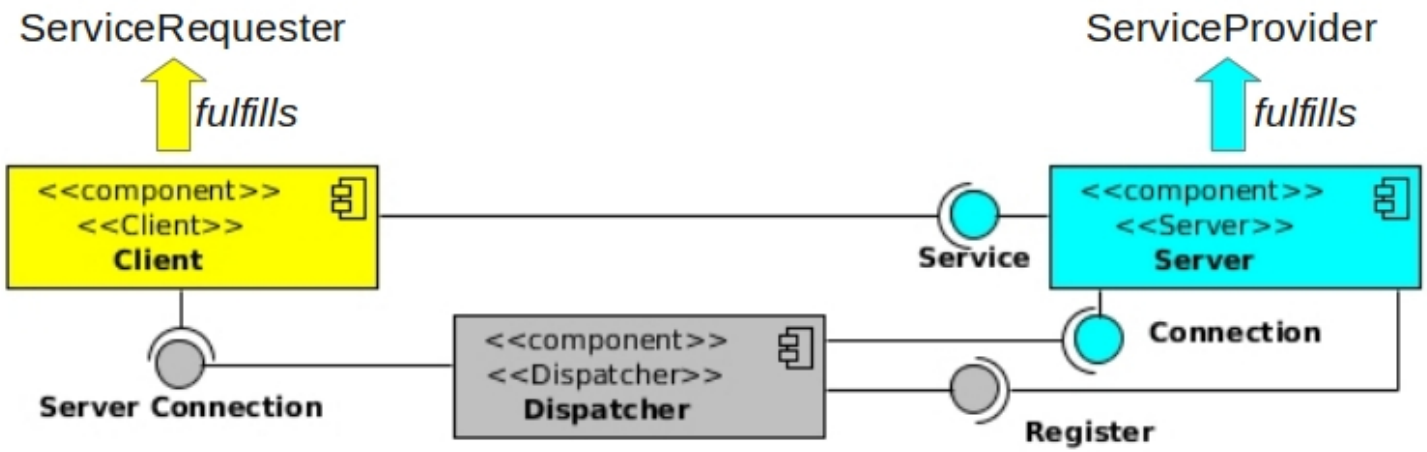
Observation: software models and patterns are highly relational

Our approach consists of three steps:

1. Represent the available patterns formally
2. Assign roles to the components in the software model
3. Select applicable patterns by leveraging the assigned roles

Step 1: Represent patterns formally

A software pattern is represented as a set of **primitives**
A primitive is a precisely defined building block that can **fulfill roles**

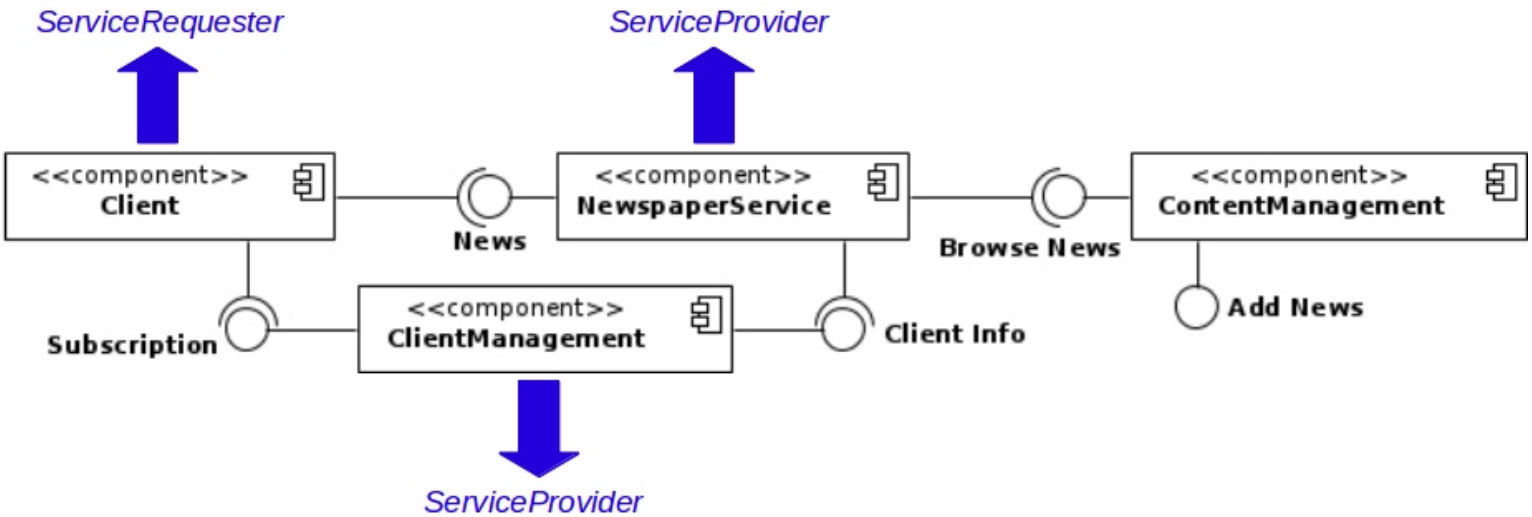


Client-Dispatcher-Pattern with three primitives

Implementation: Prolog knowledge base

```
pattern(clientDispatcherServer).
primitive(client).
primitive(server).
primitive(dispatcher).
role(serviceRequester).
role(serviceProvider).
fulfills(client, serviceRequester).
fulfills(server, serviceProvider).
used_in(client, clientDispatcherServer).
used_in(dispatcher, clientDispatcherServer).
used_in(server, clientDispatcherServer).
```

Step 2: Assign roles to components in the software model



Excerpt of digital news system's model with the assigned roles

Facts derived from assigned roles:

required_role(serviceRequester).

required_role(serviceProvider).

Step 2: Automatically assigning roles

Learning task:

A collective classification task on relational data

Given:

- Software model at hand (optionally with manually assigned roles)
- Software models with previously learned/assigned roles

Learn:

Roles of the components in the software model at hand

Step 2: Any relational learner can solve this learning task

We are working on a **proof-of-concept** using **kLog**

(`http://people.cs.kuleuven.be/~alexander.vandenberghe/arbps.html`)

What is kLog?

- Logical and relational language for kernel-based learning
- Builds upon several simple but powerful concepts
  (i.e., entity-relationship data modeling and graph kernels)

Why kLog?

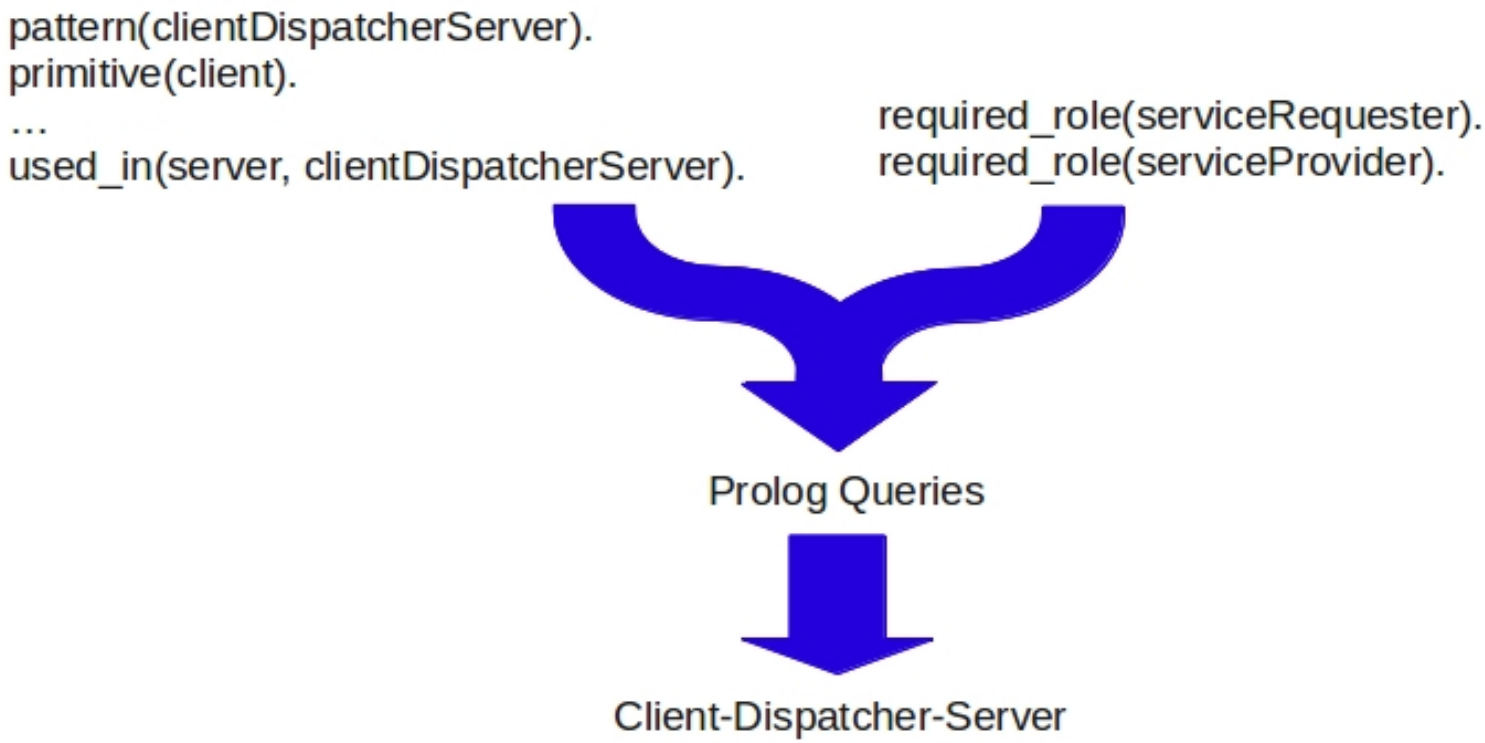
- *Graphicalization* process transforming the logical representation into an entity-relationship diagram
- Intuitively close to the representation of software models and patterns

Step 3: Select applicable patterns leveraging roles

Method:

- A pattern is applicable if it contains a fulfilling primitive for each assigned role
- Select patterns by combining the knowledge from the two previous steps

Implementation:



Conclusion

We proposed a *novel automated approach to selecting patterns* based on the observation that both *software models* and *patterns* are *relational*

Advantages

- ✔ Intuitive representation of both software models and patterns
- ✔ Significant amount of time saved during software development
- ✔ Provide hints on how to instantiate selected software patterns

Future work

Learning roles is difficult and requires further research

Even a semi-automatic role assignment saves a lot of time

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