



National Research Council of Italy (CNR)
Institute of Science and Technologies of Information
(ISTI)
Domotics Lab



Preventing health emergencies in an unobtrusive way

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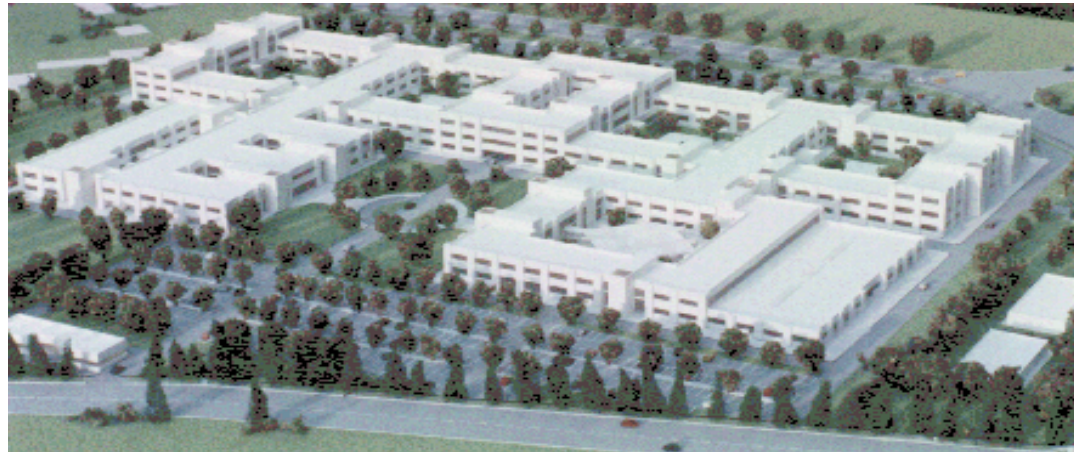


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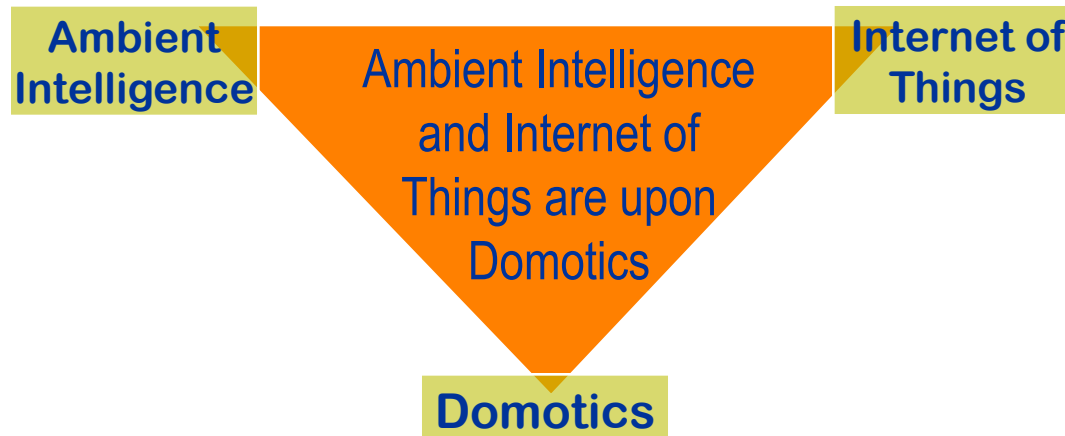


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Research Lab of the “*Institute of Science and Technologies of Information*” (ISTI) of the *National Research Council of Italy* (CNR).

Domotics Lab focuses its activities on the **home** and **smart cities** environments and aims to improve the quality of everyday life contributing to achieve the **Ambient Intelligence** (AmI) and **Internet of Things** (IoT) visions.



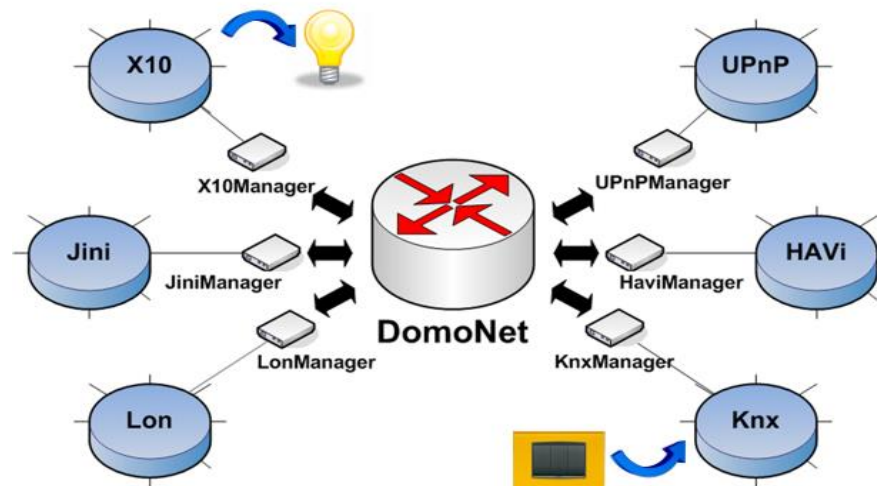
DomoNet: interoperability framework



One of the main obstacles of domotics is the presence of many non-interoperable standards such as *KNX*, *UPnP*, *LonWorks*, *Zigbee*...

DomoNet is an **IoT** framework able to provide integration and interoperability between the different home automation systems permitting them to **share** data, states, and actions, eliminating their technological and protocol differences.

DomoNet is a genuine Internet node that interfaces domotic devices with **IPv6** network permitting them to communicate with other Internet smart objects.



Motivations



Today's **e-health solutions** provide important contributions to the health management of the elderly and chronically ill within their own homes permitting to identify and opportunely signal any hazardous situations requiring intervention.

In most cases, however, by the time the call for help is issued, the emergency is already in progress.

An IoT system able to **anticipate danger** before life-threatening situations arise would certainly lead to faster, more effective intervention could often save lives.

DomoPredict for Health goals



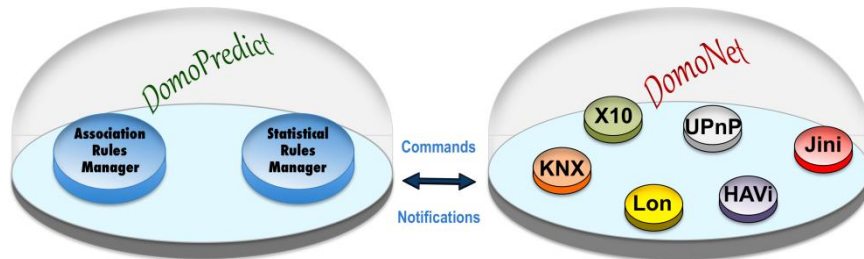
Taking advantage of the *DomoNet* framework, *DomoPredict for Health* aims to infer particular state of illness or discomfort in advance.

To reach its goals, the *DomoPredict for Health* must:

- learns user habits obtained monitoring his actions;
- analyzes data provided by domotic home environment;
- launches alarm and notifies suspected dangerous behaviors.

DomoPredict exploits an hybrid machine-learning approach:

- *Data Mining paradigm: Association Rules* mechanism with *Apriori* algorithm. It finds frequent **correlated actions**. Two or more actions are considered correlated if they are executed within a prefixed time window;
- *Statistical paradigm*: to learn user specific profiles that are not covered by the data mining approach: if they are not related by any other action (like the preferred frequent temperature setting, the music preferences and so on).

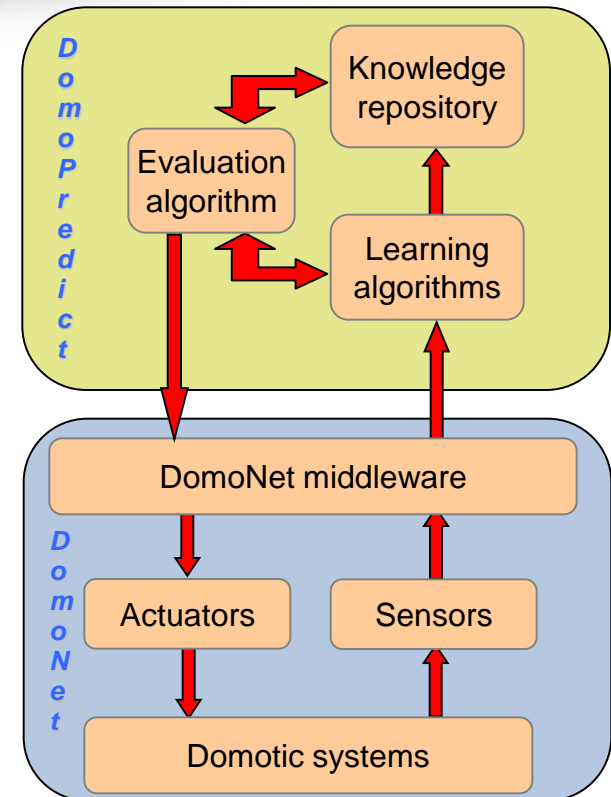


DomoPredict for Health lifecycle 1 / 4



The lifecycle of *DomoPredict for Health* can be divided in 4 steps:

1. when user perform an action, the corresponding sensor notices the event and *DomoNet* send it to *DomoPredict*;
2. *learning algorithms module of DomoPredict*, with the support of the *Knowledge repository* (where learned data are stored), verifies the corresponding action or group of actions.



DomoPredict for Health lifecycle 2 / 4



If the actions inside *the correlation window*:

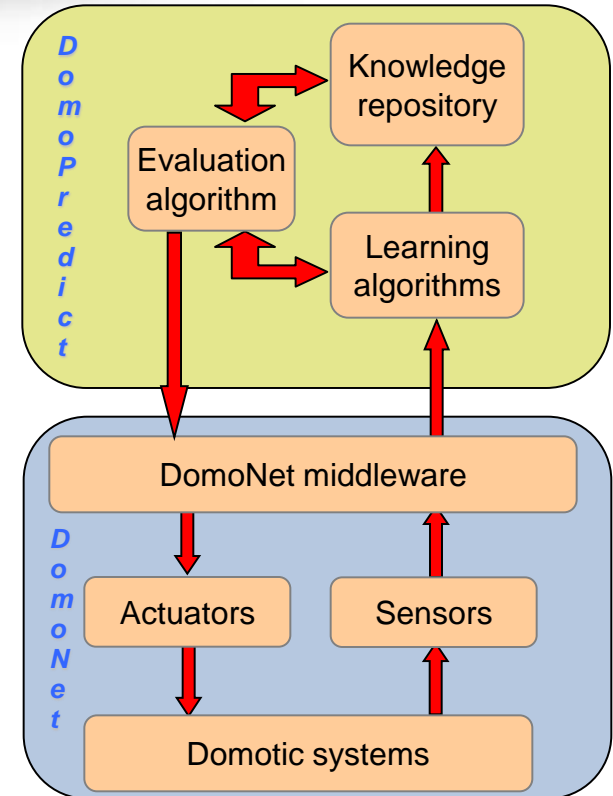
- are repeated with a **not sufficient frequency** to learn them, than nothing is done;
- are repeated with **sufficient frequency**, are created:
 - a new learned rule
 - a new data structure containing frequencies and duration of every action

Knowledge repository

Rules

Durations / frequencies

...					
climb stairs → rest	climb	1' 00"	1' 10"	1' 30"	...
...	rest	3' 00"	2' 05"	5' 10"	...
...					
...					
...					
...					



A new entry is inserted in the data structure every time the learned rule is recognized

DomoPredict for Health lifecycle 3 / 4



3. periodically, the *Evaluation algorithm* verifies if there are the conditions to find in advance signals of possible health problems and throw an alarm.

The algorithm execute the following steps:

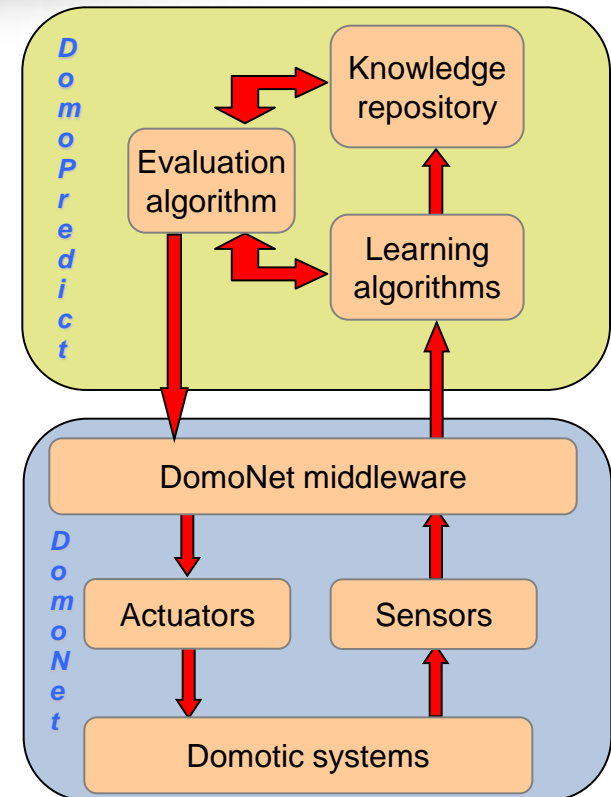
- check of any changes in the duration or frequency of each action belonging the learned rule;
- check of the measured values with the medical recommendations considered to be potentially dangerous
(e. g. more needed time to climb the stairs and more time of rest after the same effort, combined with the number of coughing during night, could be an alarm);

Knowledge repository											
Rules	Durations / frequencies										
...											
climb stairs → rest	<table border="1"> <tr> <td>climb</td> <td>1' 00"</td> <td>1' 10"</td> <td>1' 30"</td> <td>...</td> </tr> <tr> <td>rest</td> <td>3' 00"</td> <td>2' 05"</td> <td>5' 10"</td> <td>...</td> </tr> </table>	climb	1' 00"	1' 10"	1' 30"	...	rest	3' 00"	2' 05"	5' 10"	...
climb	1' 00"	1' 10"	1' 30"	...							
rest	3' 00"	2' 05"	5' 10"	...							
...											
switch TV → rest											
...											
coughing during night	<table border="1"> <tr> <td>coughing</td> <td>3</td> <td>5</td> <td>20</td> <td>...</td> </tr> </table>	coughing	3	5	20	...					
coughing	3	5	20	...							
...											

(e. g. monitoring rest user activity, could be interesting to observe the durations after an effort and not after having switched on the TV);

4. Exploiting *DomoNet* capabilities the *Evaluation algorithm* throw the alarms informing automatically the possibility that there could be a worsening of the disease and that could be useful a medical check.

Knowledge repository					
Rules	Durations / frequencies				
...					
climb stairs → rest	climb	1' 00"	1' 10"	1' 30"	...
...	rest	3' 00"	2' 05"	5' 10"	...
...					
coughing during night	coughing	3	5	20	...
...					



Conclusions

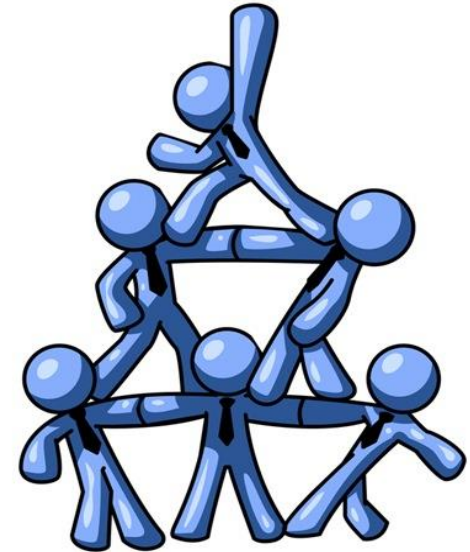


DomoPredict framework learns from the experience monitoring and assisting inhabitants, patients and chronically ill, launching alarms **in advance** when there is the suspect that the health of the user could be in danger.

Its potential is the hybrid approach that **combines data mining** and **statistical approaches** to be able to capture as much as possible the information about the end user and his habits.

DomoPredict is able to interact with heterogeneous domotic systems in order to acquire data without taking into account their native incompatibility, using *DomoNet* framework features.

As future work, we are going to introduce semantics in *DomoNet* to improve *DomoPredict* inference algorithms.





Thanks for the attention

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