

Optimization of Behaviours by IoT for Energy Efficiency in Smart Buildings

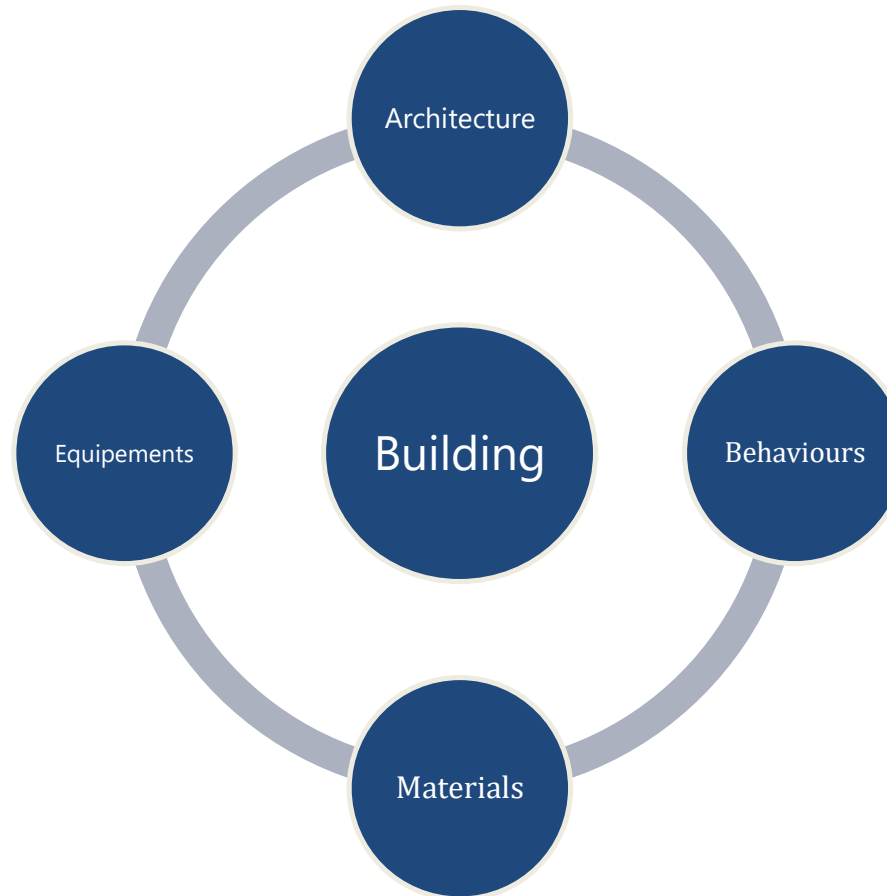
Lucas Desport
Sandrine Selosse,
Gilles Guerassimoff



Context

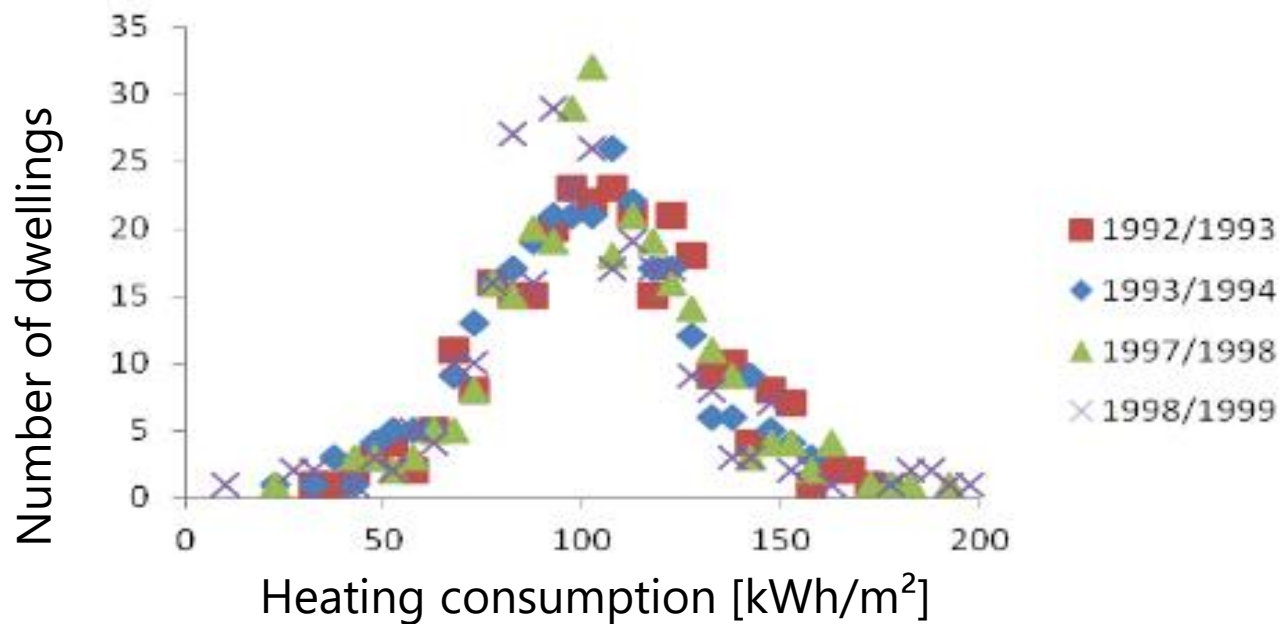
Context

What are the four main conception parameters of a building?



Context

What potential is hiding behind our behaviours?



R. Andersen, « The influence of occupants' behaviour on energy consumption investigated in 290 identical dwellings and in 35 apartments », p. 3.

The *nudge* theory

- Cass Sunstein and Richard Thaler



*« We have no interest in telling people what we need.
We want to help them to achieve their goals. »*

The *nudge* theory



Context

Nudges

BPS of
behaviours

obFMU

Conclusion

The *nudge* theory

Exploiting the herding behaviour for emulation



Quizz

Eco-gestures



Challenges

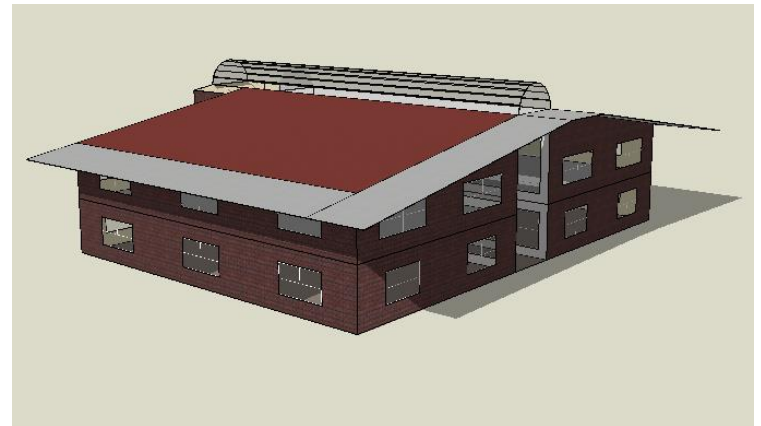
Dashboard

Building Performance Simulations of behaviours



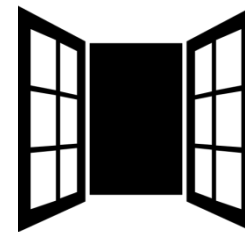
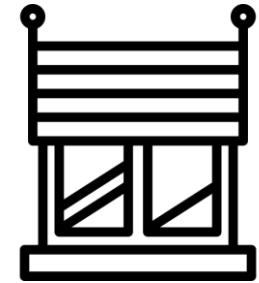
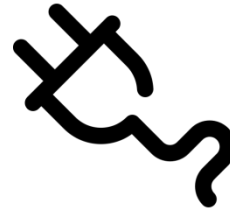
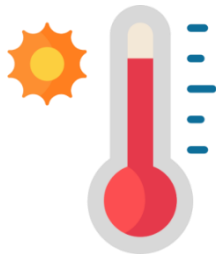
Building Performance Simulations of behaviours

- Evaluate *Energic* solution on
 1. Potentials of the challenges launched
 2. Sensibilisation generated progressively
 3. Considering probabilities
- For different buildings
 - Dwelling
 - Residential building
 - Small office building



Building Performance Simulations of behaviours

Evaluate the potential of the Energetic solution

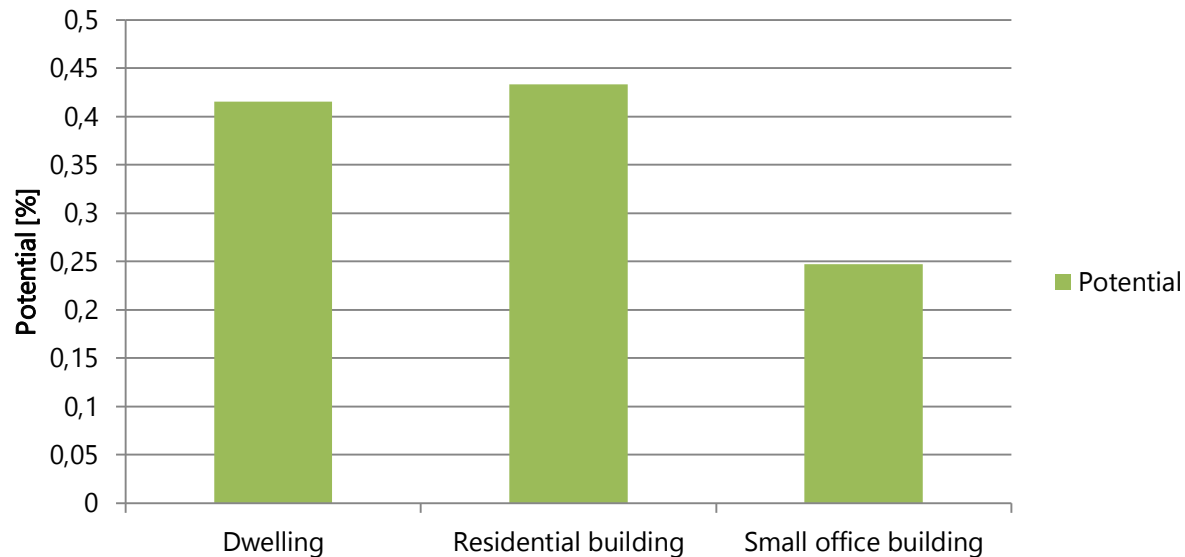


Building Performance Simulations of behaviours

Evaluate the potential of the Energetic solution

- Identical occupation scenarios from UK NCM
- Extreme scenarios taken from ADEME

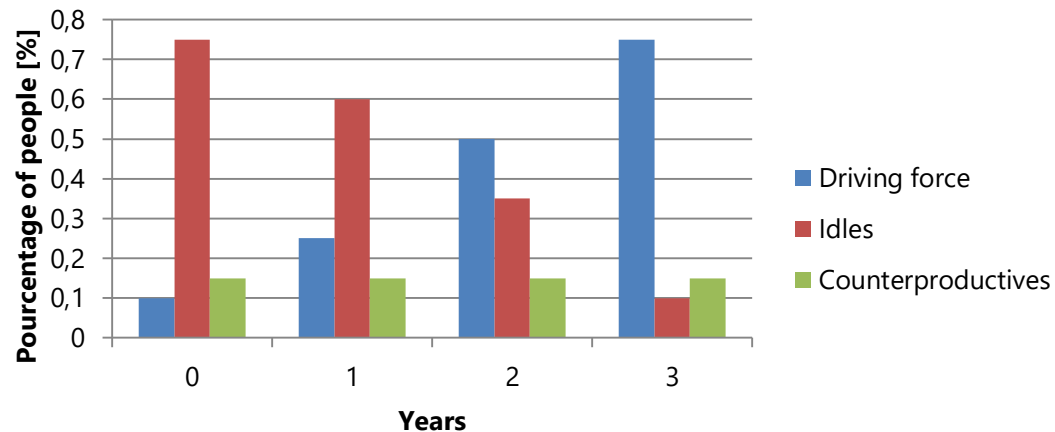
Extreme potentials of power reduction



Building Performance Simulations of behaviours

How to simulate the sensibilisation broadcasted by the application?

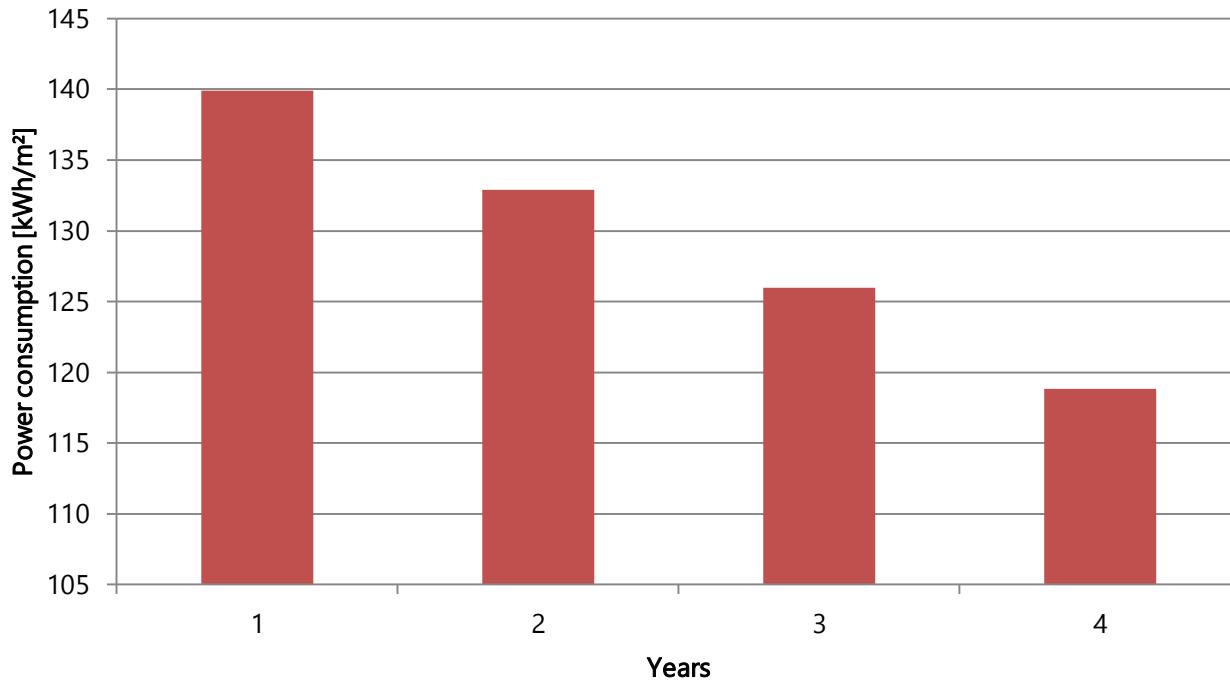
Year	Driving forces	Idles	Counterproductives
0	10%	75%	15%
1	25%	60%	15%
2	50%	35%	15%
3	75%	10%	15%



Building Performance Simulations of behaviours

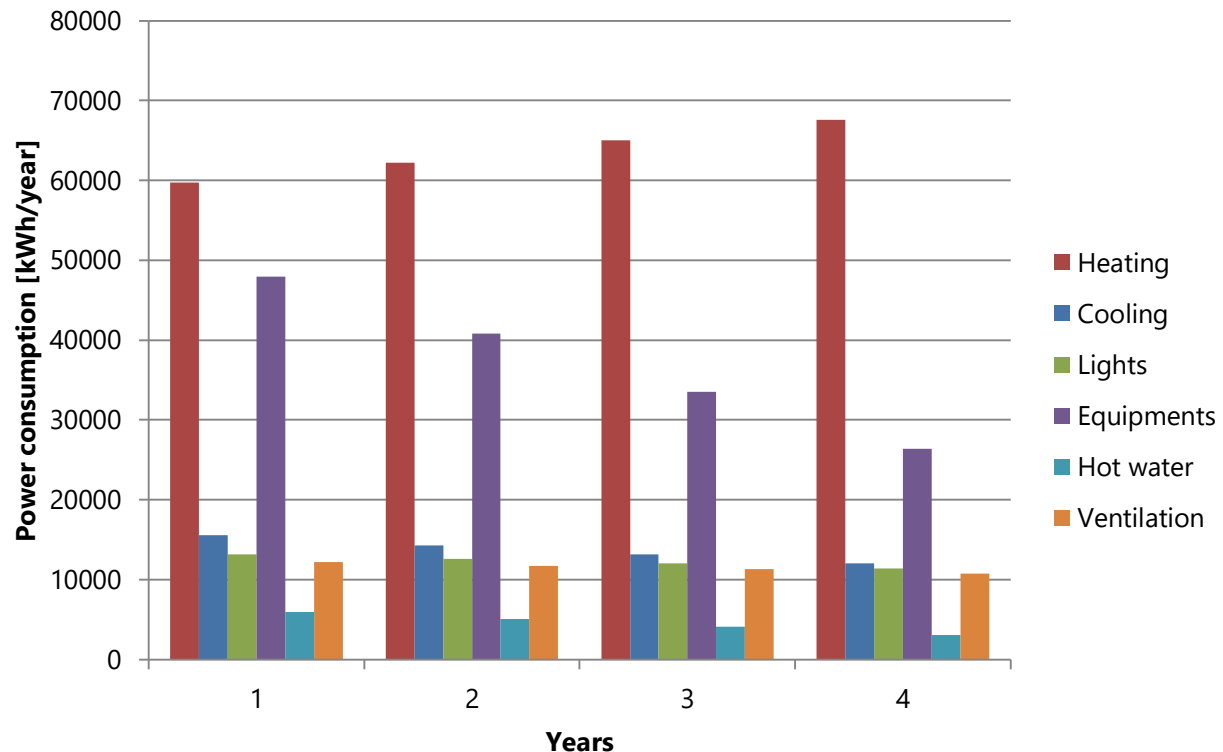
How to simulate the sensibilisation generated by the application?

Power consumption



Building Performance Simulations of behaviours

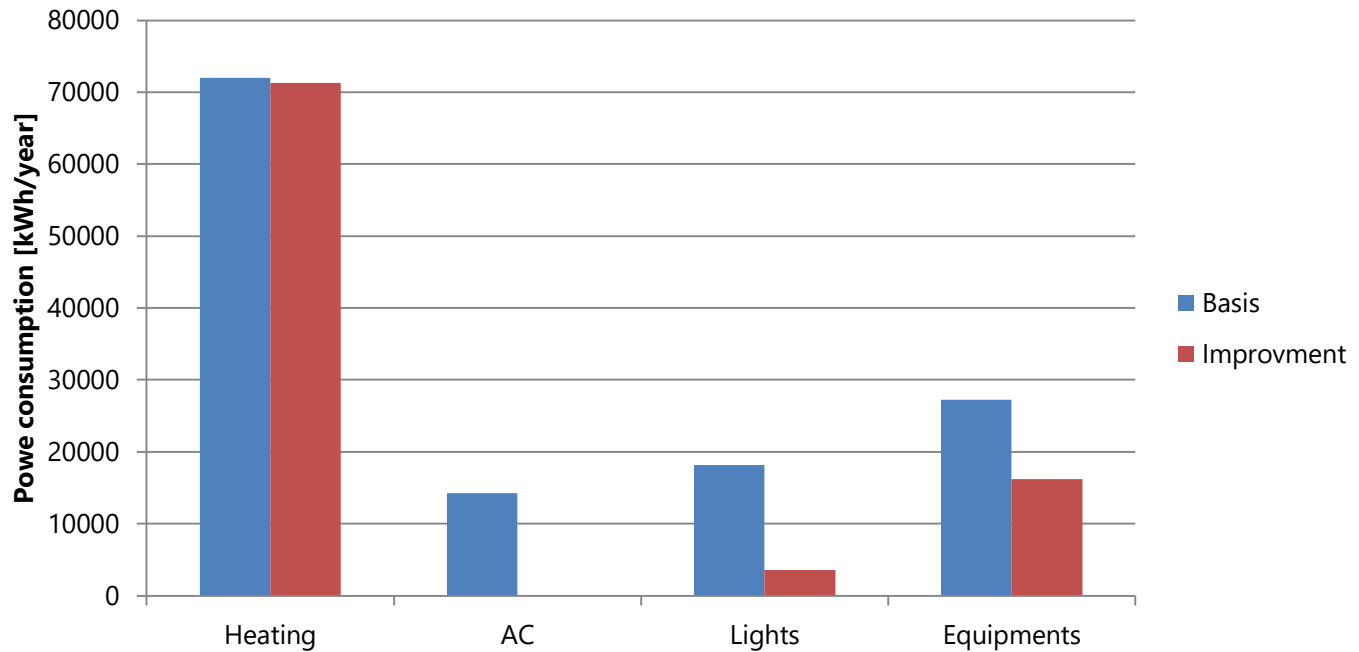
How to simulate the sensibilisation generated by the application?



Building Performance Simulations of behaviours

A way more complex subject

Power consumption



Simulating energy-related occupant behaviour

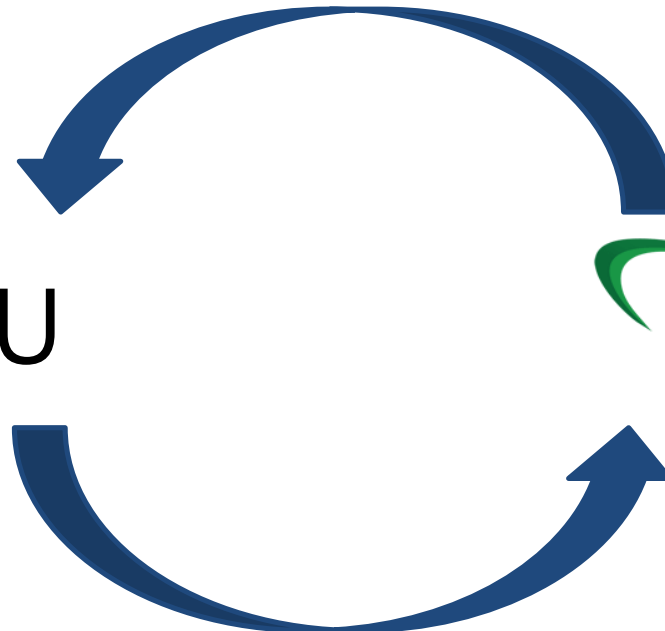


Simulating energy-related occupant behaviour

How to simulate the stochastic nature of behaviours?

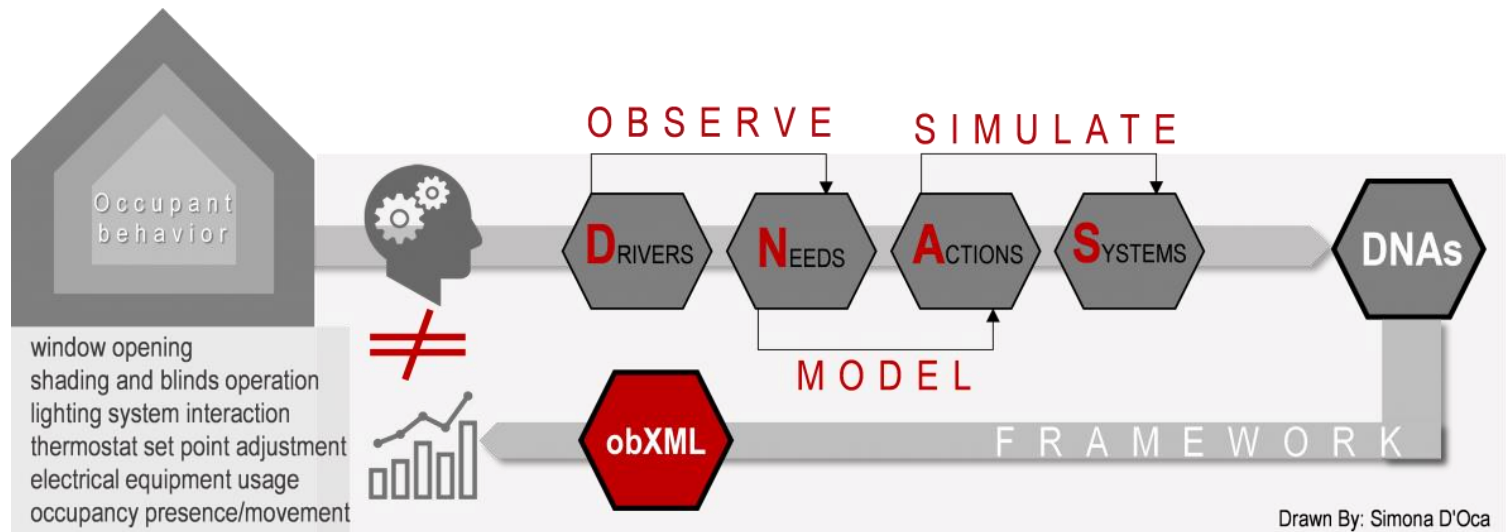


obFMU



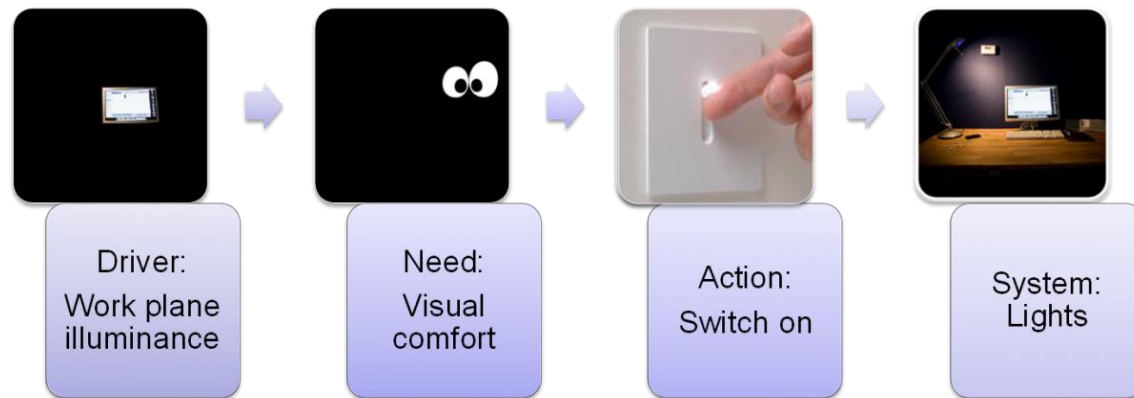
Simulating energy-related occupant behaviour

How to simulate the stochastic nature of behaviours?



Simulating energy-related occupant behaviour

How to simulate the stochastic nature of behaviours?

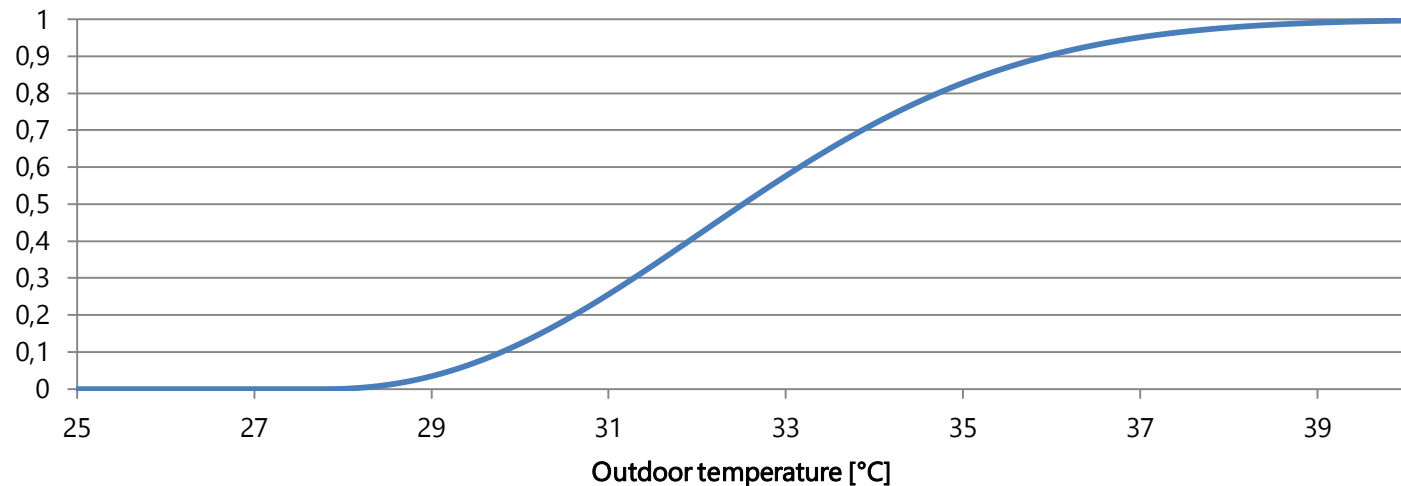


Simulating energy-related occupant behaviour

How to simulate the stochastic nature of behaviours?

$$P = 1 - e^{-\Delta t \left(\frac{T-U}{L}\right)^k}$$

Probability function of air-conditioning usage



X. Ren, D. Yan, et C. Wang, « Air-conditioning usage conditional probability model for residential buildings », *Building and Environment*, vol. 81, p. 172-182, nov. 2014.

Simulating energy-related occupant behaviour

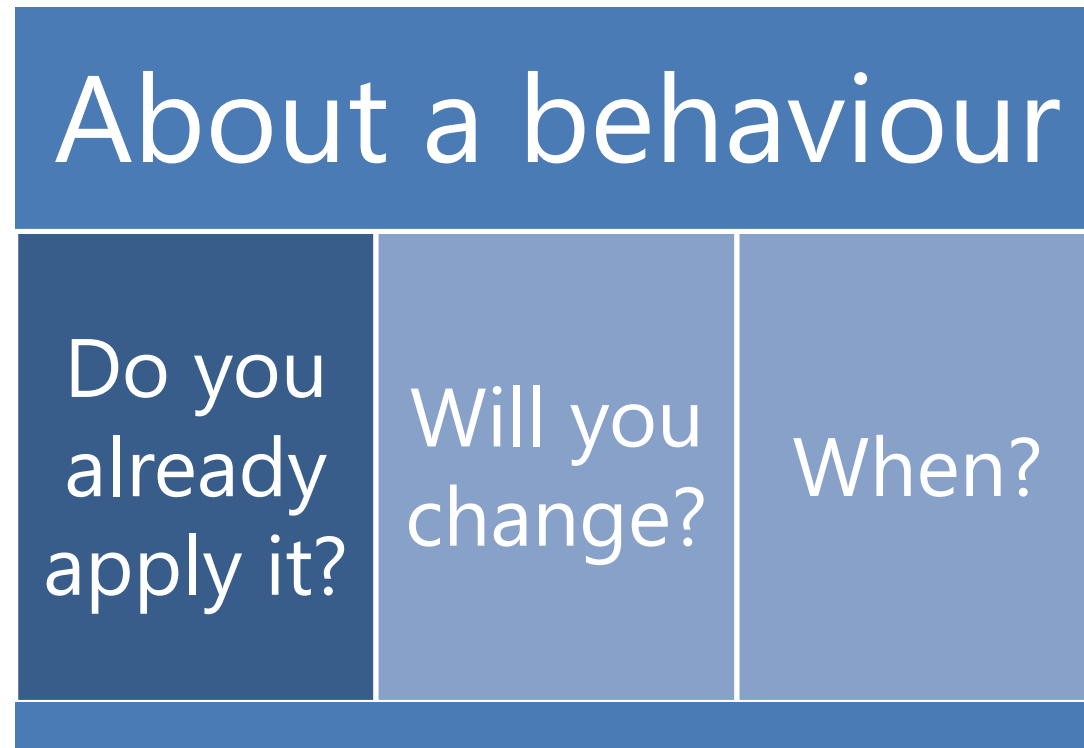
How to simulate the stochastic nature of behaviours?

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  <Description>Turn on AC when feeling hot</Description>
  <Drivers>
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        <Type>RoomAirTemperature</Type>
      </Parameter>
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  </Environment>
  <Time>
    <DayofWeek>Weekdays</DayofWeek>
    <SeasonType>Summer</SeasonType>
    <SeasonType>Fall</SeasonType>
    <SeasonType>Spring</SeasonType>
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  </Time>
  </Drivers>
  <Needs>
    <Physical>
      <Thermal>
        <OtherComfortEnvelope>
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          </ParameterRange>
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    </Physical>
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      <Type>TurnOn</Type>
      <Formula>
        <WeibullID>
          <Description>S Shaped Curve Probability Function</Description>
          <CoefficientA>24</CoefficientA> <!-- 27.72 -->
          <CoefficientB>5</CoefficientB> <!-- 15.87 -->
          <CoefficientC>2</CoefficientC> <!-- 2.22 -->
          <ParameterID>RenIndoorTemp_1</ParameterID>
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      </Formula>
    </Interaction>
  </Actions>
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    <HVAC>
      <HVACType>ZoneOnOff</HVACType>
    </HVAC>
  </Systems>
</Behavior>
```

Simulating energy-related occupant behaviour

How to simulate the stochastic nature of behaviours?

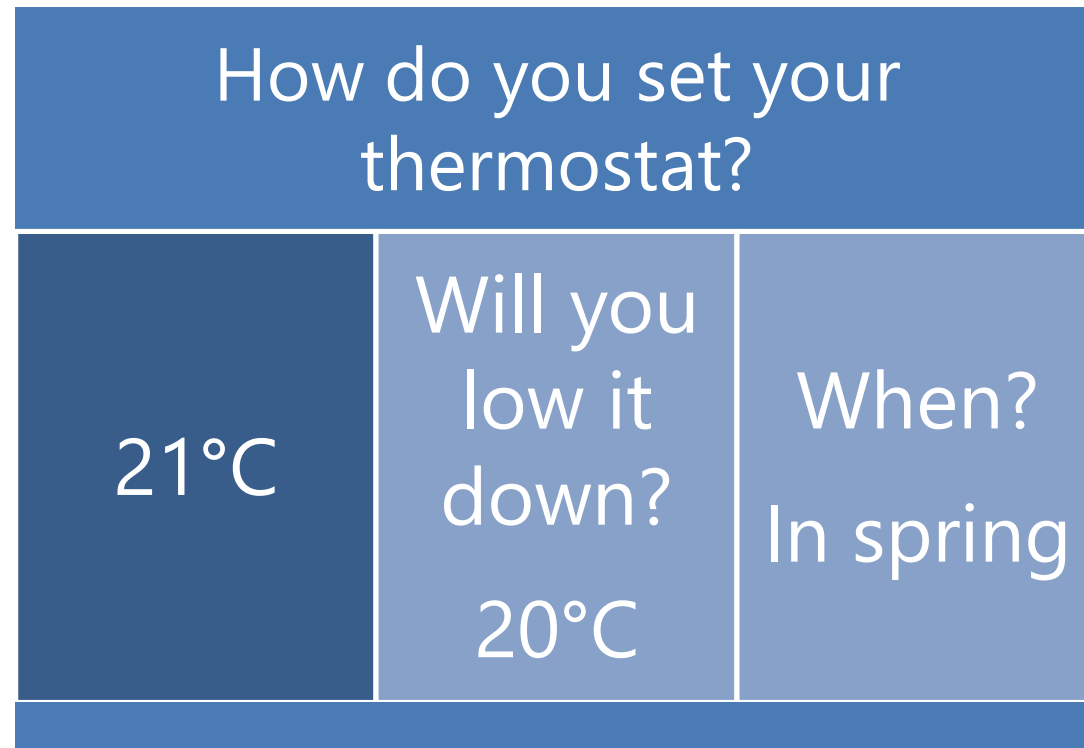
- Exploiting a bias: suggestion



Simulating energy-related occupant behaviour

How to simulate the stochastic nature of behaviours?

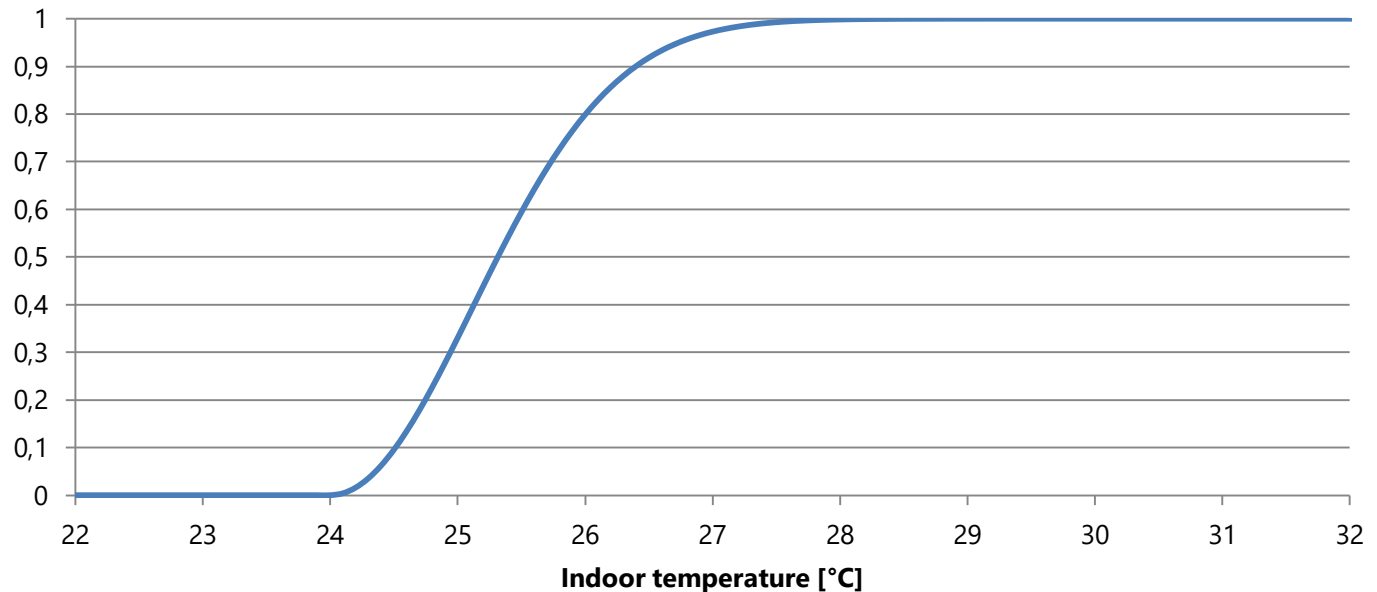
- Exploiting a bias: suggestion



Simulating energy-related occupant behaviour

Find back our own probability curves

Probability function for HVAC activation



Conclusion



Conclusion

1. Multi-disciplined approach
2. Crossing difficulties
3. Data bank for neuron network
4. Exploit more mature data
5. Optimize power consumption of buildings according behaviours, considering occupant comfort

Thank you for your attention!

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