

# A Formal Model for Soft Enforcement: Influencing the Decision-Maker

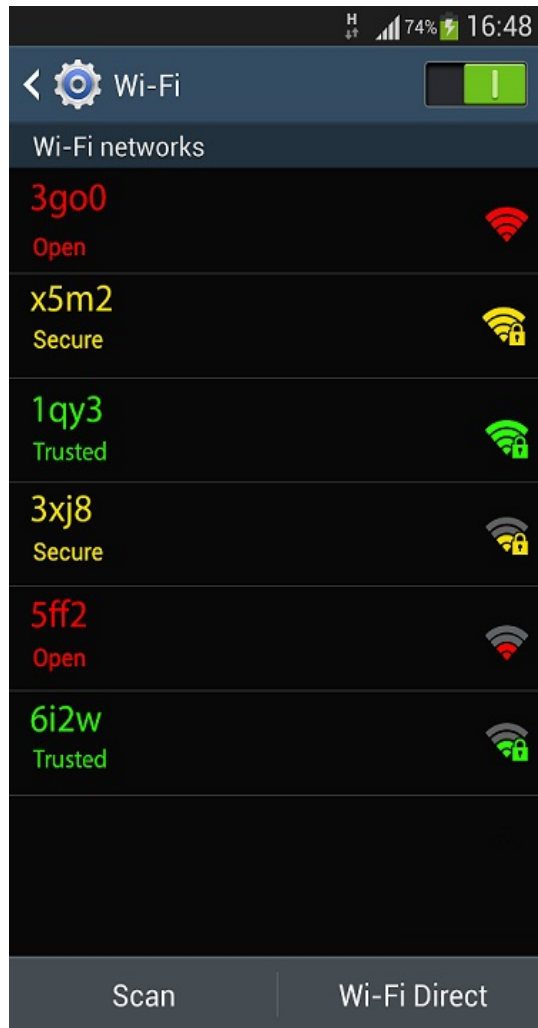
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# Research Institute in the Science of Cyber Security



- EPSRC/GCHQ-sponsored, £3.5M
- Lead: Angela Sasse at UCL, with Imperial College, Royal Holloway and Newcastle U.
- Halfway 3½ year project
- Newcastle part with psychologists from Northumbria (Pam Briggs, Lynne Coventry)
- Newcastle part is about nudging: influencing behaviour while leaving choice with the user
- Nudge: popular in governments, eg. opt-in instead of opt-out of pension schemes

# Example

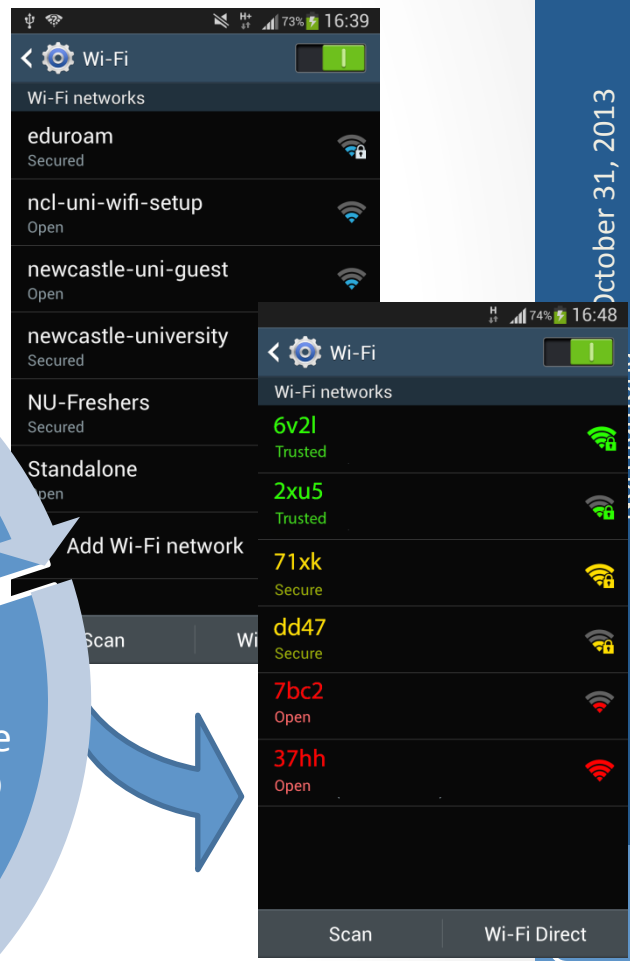
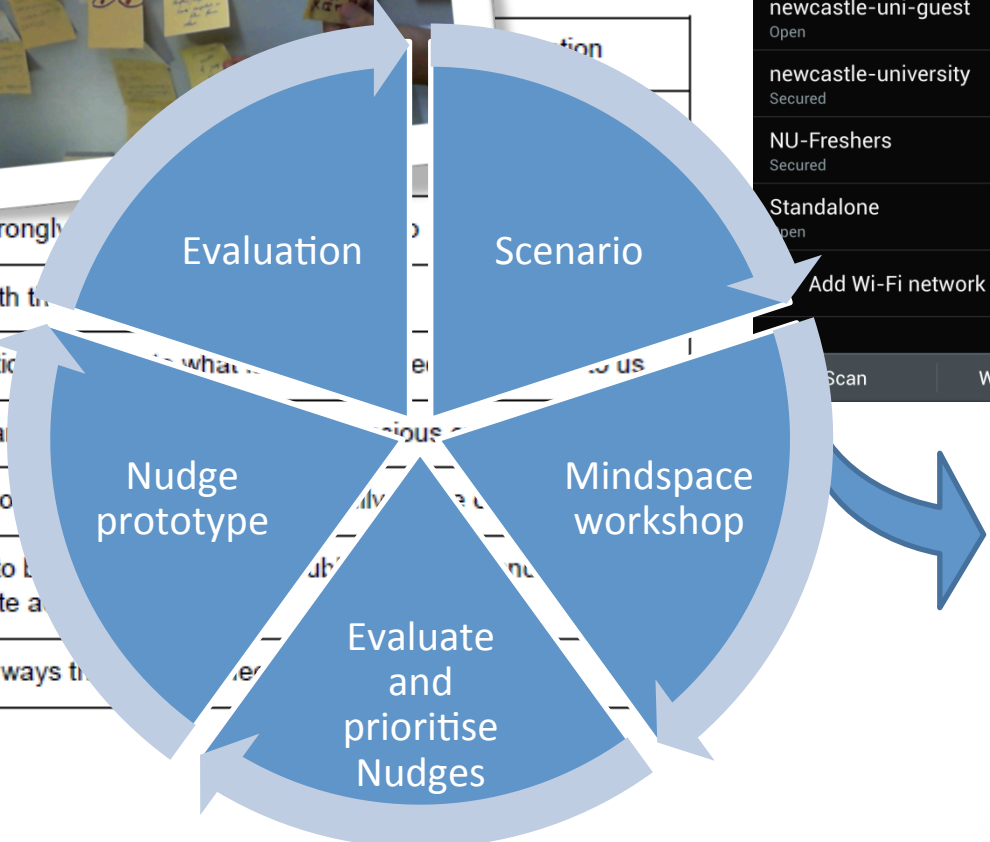


- If you have all necessary passwords, and you are in a public space, which network do you select?
- 25 over 34 participants selected 1qy3

# Nudge design cycle



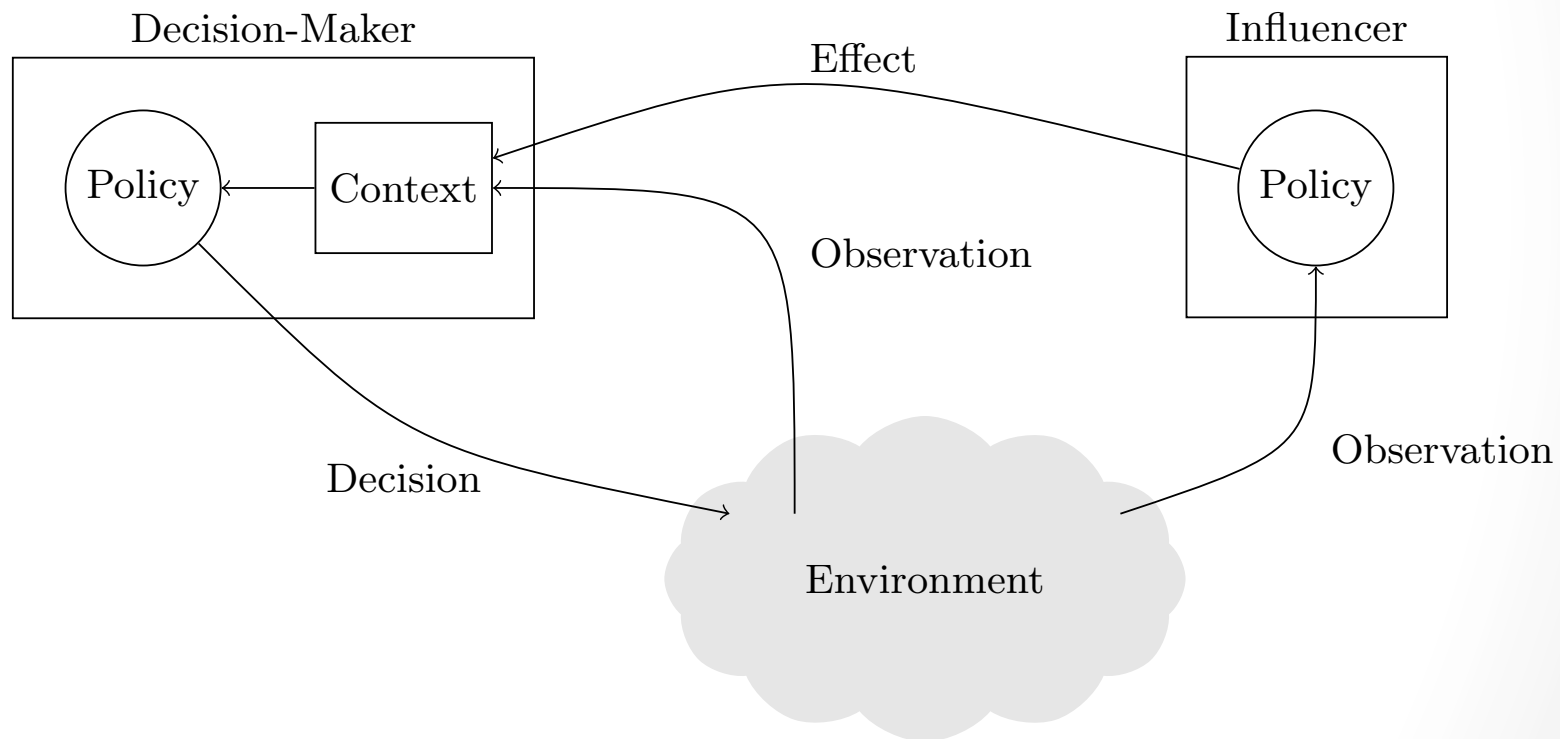
	we are strongly
Defaults	we 'go with the
Saliency	our attention
Priming	our acts are
Affect	our emotions
Commitments	we seek to
Ego	we act in ways



# Modeling

- Conceptually, how to think about nudges:
  - a form of influencing → we used an agent model
  - decision-making → we model ‘intuitive’ decisions within usual frameworks (multi-criteria, utility models)
  - we showed that it’s possible that nudges outperform enforcement
  - a WIFI case study provided us with data to fit a multi-criteria decision model utility function → allows us to determine which people are influenced and how

# Main abstraction: agent model



# Utility model

$$\delta_i(e, c) = \sum_{\theta \in \Theta} p_i(\theta | e) \sum_{d \in \mathcal{D}_i} \pi_i(\theta, c, d) \rho_i(e, d)$$

Impact (points to  $\delta_i(e, c)$ )  
 Context (points to  $c$ )  
 User Policy (points to  $\pi_i(\theta, c, d)$ )  
 Environment (points to  $e$ )  
 Influencer Observation (points to  $\theta$ )  
 Security Policy (points to  $\rho_i(e, d)$ )

$$\Delta_i(c) = \sum_{e \in \mathcal{E}} p(e) \delta_i(e, c)$$

Global Impact (points to  $\Delta_i(c)$ )  
 Local Impact (points to  $\delta_i(e, c)$ )

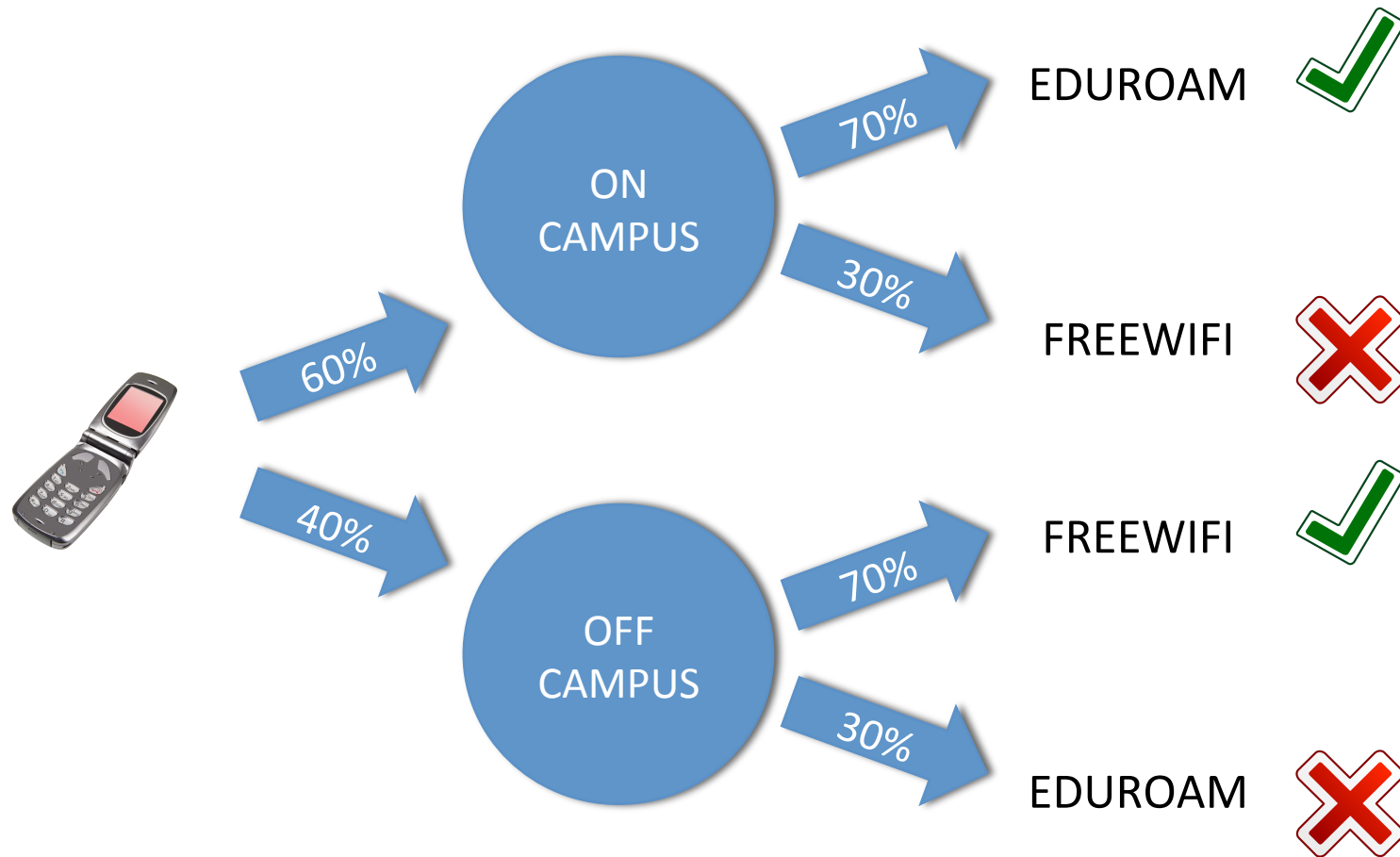
# Modeling: a case for soft enforcement



- In some cases, we can influence decision-makers by increasing the likelihood they make a particular decision → soft enforcement is better than enforcing a choice
- The optimality of the influence depends both on the control over the decision-maker, and the uncertainty of the agent observations.



# Example



# Example

- Do nothing
  - Impact:  $0.6*0.7 + 0.4*0.7 = 0.7$
- Deactivate FreeWifi
  - Impact:  $0.6*1 + 0.4*0 = 0.6$
- Increase by 0.1 chance of selecting eduroam
  - Impact:  $0.6*0.8 + 0.4*0.6 = \underline{0.72}$

# Conclusions

- Nudging for information security
- Design cycle for nudges
- Model for nudging (agent model) and decision-making in utility model
- Soft enforcement can be optimal under uncertainty