PARROT Ontology Technical Report

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ABSTRACT

As the Internet of Things (IoT) technologies are becoming widespread in our lives, privacy issues are significantly raising to the surface. The aim of this research is to develop a personal assistant that is able to answer software engineers questions about privacy practices during the design phase. Thus, there is a demanding need to develop a method that assists software developers to understand and apply the Privacy by Design (PbD) practices into their systems. We used semantic web technologies to model the knowledge of PbD schemes, their intersections with Privacy Patterns, IoT system needs, and the Privacy Patterns that should be applied in these IoT systems. In this paper, we are introducing the PARROT ontology that combines these pieces of knowledge. To assemble the PARROT ontology's requirements, we first associated many real-world IoT use cases with a set of well-known Privacy Patterns that should be applied by the software developers. Then, we gathered Competency Questions (CQs) about these IoT use cases from researchers and software developers throw a series of workshops we conducted, and we curated with 81 CQs to be modeled. We proved the validation of the PARROT ontology and evaluated it with the Common Pitfalls with the help of Protégé & HermiT Reasoner, Ontology Pitfall Scanner (OOPS!), and external experts. We demonstrated the use of the PARROT ontology by user based study and found that the PARROT ontology is able to answer up to 58% of software engineers' questions.

Contents

Keywords First keyword · Second keyword · More

1   Introduction

In this document, we present the technical report for the phases of building the PARROT ontology. We present the six use cases with their descriptions and Data Flow Diagrams (DFDs). Then we set out the Ontology Requirements Specification Document (ORSD) which lists the purpose, scope, non-functional requirements, and functional requirements (i.e., Competency Questions (CQs)) for building the PARROT ontology. Afterwards, we put on view a table of the analysis of the information needs for the PARROT ontology. Next, we disclose the PARROT ontology RDF file. In addition, we display the validation of the PARROT ontology via SPARQL queries. Moreover, we present the show evaluation form that we made to assess the PARROT ontology. Finally, we reveal the content evaluation details that we collected from a user study. The full information about this information will be found in our published paper under the title: Quarriable Privacy by Design Knowledge Towards Augmenting Internet of Things Developer Capabilities and Knowledge.

2   Use Cases

- **Health Care System**
  Diabetes treatment and monitoring is an IoT application that analyses patient health data to issue alerts and notifications. The researcher needs to gather and analyze data from a Continuous Glucose Monitor (CGM) sensor device worn by her patients. The sensor measures glucose levels by taking readings at consistent intervals across several days. The researcher uses an application that can detect any triggers for blood glucose levels. This application analyses the gathered data and produces a notification to both the patient and the nurse. In addition to the researcher, the nurse, and the doctor have access to patient data for follow-up purposes. The figure 1 shows the DFD of the system.

Figure 1: Health Care System DFD

- **Fitness Watch**
  Fitness Watch is a system that keeps records of data subjects' activities. It also sends the data to the cloud and allows the data subject to access them via an online website. The figure 2 shows the DFD of the system.
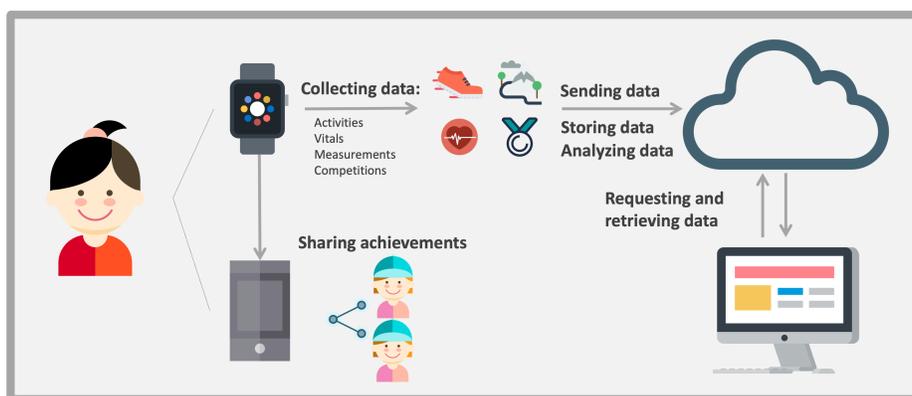

Figure 2: Fitness Watch System DFD

- **Real Tracking Location System (RTLS)**
  Real Tracking Location System (RTLS) aims to help the driver to find where he parked his car. It is considered as a real time tracking solution where it stores and retrieves the parked car location in a centralized system. As the figure illustrates the use case, the location data will be sent by the GPS device embedded in the car via the gateway to be stored in the cloud. When the user wants to get this information, he requests the location data via a provided mobile application. Thus, the application will retrieve the car location and show it to the user. The figure 3 shows the DFD of the system.
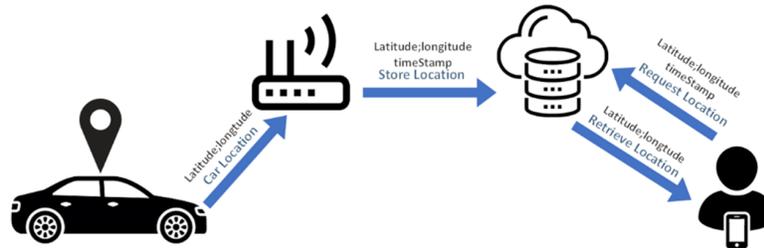
Figure 3: Real Tracking Location System (RTLS) DFD

- **Park Monitoring System**
  Park Monitoring System is designed for a park theme that facilitates many rides for visitors with waiting queue. This system will help to get expected waiting time for each ride. A snapshot for the queue will be taken from a camera device, the photos will be analysed by applying a specific API. Then, the analysed data will be sent from the park edge to the cloud environment via the gate way. The supervising team are able to monitor the status for each ride from the monitoring edge. They can request and retrieve the data from the cloud environment via the gateway. The figure 4 shows the DFD of the system.
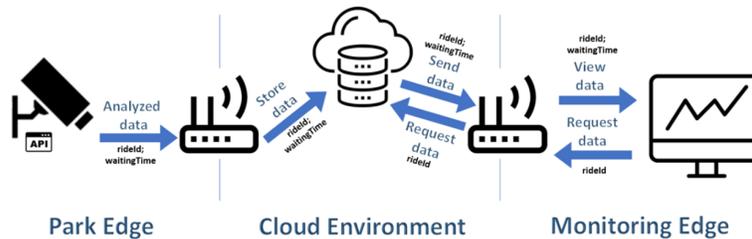
Figure 4: Park Monitoring System DFD

- **Smart Home System**
  Smart home system has many sensors in the house that are connected to the cloud to either observe or control the devices in the home. The figure 5 shows the DFD of the system.
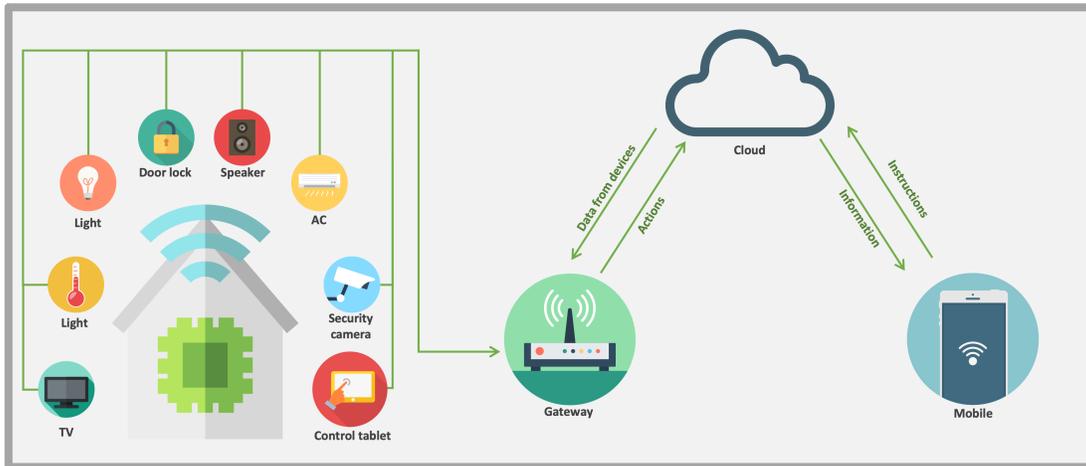
Figure 5: Smart Home System DFD

- **Drone Delivery System**
  Drone delivery is a system that makes shipments to customers' homes. When the shipping company packs the shipment in a box of the drone, they use the GPS and the Camera to guide the drone to the right home. The figure 6 shows the DFD of the system.

Figure 6: Drone Delivery System DFD

3   Ontology Requirements Specification Document (ORSD)

1. **Purpose** The purpose of building the PARROT ontology is to combine the knowledge of privacy-preserving schemes and IoT devices for systematic guidance to software developers when designing IoT systems.

2. **Scope** The ontology will include the 10 Privacy by Design (PbD) schemes cited in the technical report, IoT knowledge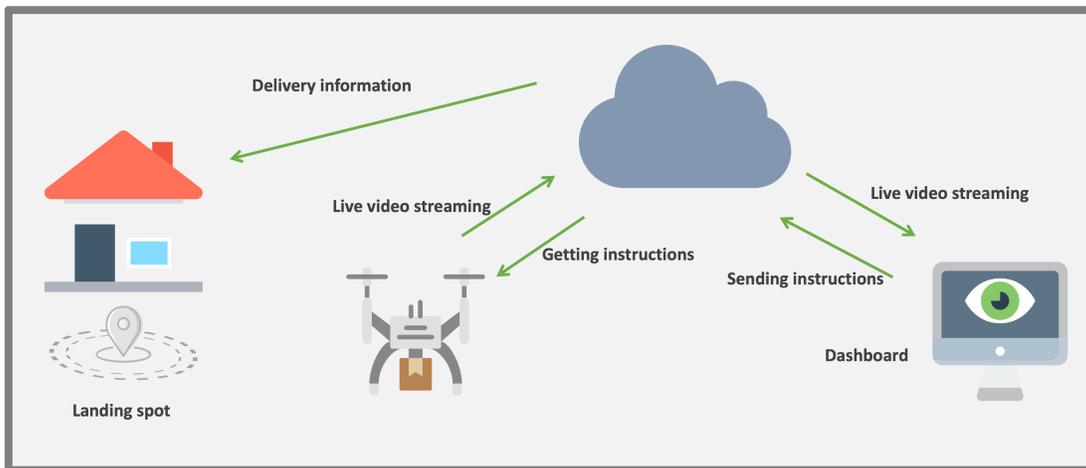. In addition, it encapsulates the associations of IoT and PbD schemes to answer the competency questions stated in this document.

3. **Implementation Language** The ontology must be implemented in the OWL2 language.

4. **Intended End-Users** User1. Software developers who are intending to apply privacy-preserving practices in the design phase of their systems. User2. Researchers who are looking for a modeled knowledge of privacy schemes and IoT sensors for different purposes.

5. **Intended Uses** Use1. For tools that need a semantic knowledge base to get information about applying privacy-preserving practices. Use2. For companies and organizations who intend to apply privacy-preserving practices.

6. **Ontology Requirements**

   (a) Non-Functional Requirements

   NFR1. The ontology must include all Privacy by Design (PbD) schemes stated in the technical report.
   NFR2. The ontology must include the relationship between the different PbD schemes as stated in the technical report.
   NFR3. The ontology must identify similar PbD schemes.
   NFR4. The ontology must include the IoT components.
   NFR5. The ontology must include the IoT components and their associated Privacy Patterns.

   (b) Functional Requirements: Groups of Competency Questions

   CQG1. Health System (11 CQ)

   CQ1. What are PbD patterns I should apply if my system includes a user interface/ mobile application/ screen/ mobile phone?

   CQ2. What are PbD patterns I should apply if my system stores data subject's information in a cloud-based data base?

   CQ3. What are PbD patterns I should apply if my system reports data subject's information to an Administrator/ Controller?

   CQ4. What are PbD patterns I should apply if my system shares data subject's information to a third party/ another organization?

   CQ5. What are PbD patterns I should apply if my system requires collecting Personal Data?

   CQ6. What are PbD patterns I should apply if my system includes a Sensor/ device that collects data?

   CQ7. What are PbD patterns I should apply if my system routes data subject's information among the system components /nodes?

   CQ8. What are the PbD privacy patterns I should apply if my system requires user login?

   CQ9. What are the PbD privacy patterns I should apply to allow data subject to have control on his stored data?

   CQ10. What are the PbD privacy patterns I should apply to allow data subject to choose his collected data?

   CQ11. What are the PbD privacy patterns I should apply if my system collects data subject's location?

   CQG2. Drone Delivery (9 CQ)

   CQ12. What are PbD patterns I should apply if my system provides tracking service?

   CQ13. What are PbD patterns I should apply if my system was attacked?

   CQ14. What are PbD patterns I should apply if my system stores address data that belong to previous customers?

   CQ15. What are PbD patterns I should apply if my system has the possibility of being infiltrated?

   CQ16. What are PbD patterns I should apply if my system allows customers to delete their data at any time?

   CQ17. What are PbD patterns I should apply if my system provides cloud access to customers as well?

CQ18. What are PbD patterns I should apply if my system provides drone access to more than one users (pilots) to provide required services?

CQ19. What are PbD patterns I should apply if my system requires 24 hour monitoring?

CQ20. What are PbD patterns I should apply if my system save historical data for how long?

CQ21. What are PbD patterns I should apply if my system recorded sensitive information about customers?

CQG3. Fitness Watch (30 CQ)

CQ22. What are PbD patterns I should apply to ensure data subject's advantage?

CQ23. What are PbD patterns I should apply to ensure my system does not collect data more than what is stated in the privacy policy?

CQ24. What are the PbD patterns I should apply if the system capabilities such as microphone is always on?

CQ25. What are PbD patterns I should apply if my system shares data subject's information with third party. e.g., insurance companies?

CQ26. What are the PbD patterns I should apply if my system allow trusted parties to access my data?

CQ27. What are the PbD patterns I should apply if the system is collecting/ gathers data subject's information?

CQ28. What are PbD patterns I should apply to notify the data subject about his data collection?

CQ29. What are PbD patterns I should apply to allow data subject to control his data?

CQ30. What are PbD patterns I should apply if my system detects a criminal behaviour?

CQ31. What are PbD patterns I should apply if my system shares the the collected data between Data subjects?

CQ32. What are PbD patterns I should apply if my system stores data in the cloud?

CQ33. What are PbD patterns I should apply if my system store data in the smart watch?

CQ34. What are PbD patterns I should apply if my system keeps user's real-time location in cloud

CQ35. What are PbD patterns I should apply if my system store the location in the cloud?

CQ36. What are PbD patterns I should apply if my system can store the data in the mobile?

CQ37. What are PbD patterns I should apply if my system keeps the data for a period of time?

CQ38. What are PbD patterns I should apply if my system sell the users info with third parties?

CQ39. What are PbD patterns I should apply if my system collects user's age, gender, marital status and other personal information is required?

CQ40. What are PbD patterns I should apply if my system stores user's food intake information?

CQ41. What are PbD patterns I should apply if my system stores user's gym information?

CQ42. What are PbD patterns I should apply if I do not need the identity of the user? (anonymise)

CQ43. What are PbD patterns I should apply to prevent attackers from identify the identity of the user?

CQ44. What are PbD patterns I should apply if my system requires user's city information?

CQ45. What are PbD patterns I should apply to allow the user to delete his data if he/she wants to do?

CQ46. What are PbD patterns I should apply if my system requires user's address?

CQ47. What are PbD patterns I should apply to give user privacy notification in case he/she wants to share personal data e.g exact location ?

CQ48. What are PbD patterns I should apply if my system scans wireless access points for indoor positioning?

CQ49. What are PbD patterns I should apply if my system have attack/threats?

CQ50. What are PbD patterns I should apply if my system stores user's daily routine?

CQ51. What are PbD patterns I should apply if my system requires user's device's properties?

CQ52. What are PbD patterns I should apply if my system shares user's accident information to emergency services?

CQG4. Park Monitoring (9 CQ)

CQ53. What are PbD patterns I should apply if my system store people faces/ photos (identifiable info)?

CQ54. What are PbD patterns I should apply if my system allows administration staff to view the images?

CQ55. What are PbD patterns I should apply to make sure non authorised people (staff) accessing the images?

CQ56. What are PbD patterns I should apply if my system send raw data ex: people faces?

CQ57. What are PbD patterns I should apply if my system detect age, gender or other properties of customers?

CQ58. What are PbD patterns I should apply to make my system analyse (aggregation) the data in the cloud?

CQ59. What are PbD patterns I should apply to make sure the data subject has the right to delete his data?

CQ60. What are PbD patterns I should apply if my system save the videos for long time?

CQ61. What are PbD patterns I should apply if my system allows real-time monitoring of the images locally?

CQG5. Real-Time Tracking System RTLS (10 CQ)

CQ62. What are PbD patterns I should apply if my system is storing the data in the cloud?

CQ63. What are PbD patterns I should apply if my system is sharing data subject's information with third party?

CQ64. What are PbD patterns I should apply if my system is being used in different countries applying different privacy policies?

CQ65. What are PbD patterns I should apply if my system is notifying the users?

CQ66. What are PbD patterns I should apply if my system is collecting the data continuously?

CQ67. What are PbD patterns I should apply if my system is sending subject's data to the server?

CQ68. What are PbD patterns I should apply if my system is processing subject's data?

CQ69. What are PbD patterns I should apply if GPS tracking the car?

CQ70. What are PbD patterns I should apply if my system requires contacting the data subject e.g., by phone, email, etc.?

CQ71. What are PbD patterns I should apply if my system can be paired with other IoT devices?

CQG6. Smart Home (10 CQ)

CQ72. What are PbD patterns I should apply if the TV preferred shows and episodes be shared and accessed by third parties?

CQ73. What are PbD patterns I should apply if my system allows data subject to choose which data and how much data to be shared across connected devices?

CQ74. What are PbD patterns I should apply if my system connects multiple smart devices and synced data across them?

CQ75. What are PbD patterns I should apply if my system has the possibility of being infiltrated?

CQ76. What are PbD patterns I should apply if my system stores clients' data in a secure manner?

CQ77. What are PbD patterns I should apply if my system records audio when I have a private talk with my home mates?

CQ78. What are PbD patterns I should apply if my system requests a consent from data subject to store his data?

CQ79. How do you deal with outdoor cameras if they record strangers?

CQ80. What are PbD patterns I should apply if my system suspects intruder or privacy invasion?

CQ81. What are PbD patterns I should apply if my system has cameras?

4 Data Set

CQ	Type	Sub-type	Rank	Answer	Minimize	Hide	Separate	Aggregate	Inform	Control	Enforce	Demonstrate
Health System												

#	Question	Category	Subtype	Validity	Patterns	C1	C2	C3	C4	C5	C6	C7	C8	C9
1	What are PbD patterns I should apply if my system includes a user mobile phone?	Device	Mobile Phone	Valid	10. Privacy Policy Display 11. Layered Policy Design 15. Abridged Terms and Conditions 20. Dynamic Privacy Policy Display 21. Privacy Labels 30. Privacy icons 31. Privacy-Aware Network Client 36. Privacy Colour Coding 37. Appropriate Privacy Icons 39. Icons for Privacy Policies 59. Privacy Aware Wording							X		X
2	What are PbD patterns I should apply if my system stores data subject's information in a cloud-based data base?	Storage	Cloud	Duplicated	6. Encryption with User-managed Keys 8. Use of Dummies 22. Data Breach Notification Pattern 27. Personal Data Store 33. Single Point of Contact 58. Lawful Consent 63. Added-noise Obfuscation 65. Attribute Based Credentials	X	X			X	X	X		X
3	What are PbD patterns I should apply if my system reports data subject's information to an Administrator/ Controller?	Process	Share	Valid	9. Who is Listening 12. Discouraging Blanket Strategies 26. Pseudonymous Identity 29. Aggregation Gateway 69. Anonymity Set	X	X	X	X	X	X			
4	What are PbD patterns I should apply if my system shares data subject's information to a third party/ another organization?	Process	Third Party	Duplicated	12. Discouraging Blanket Strategies 18. Outsourcing [with consent] 26. Pseudonymous Identity 29. Aggregation Gateway 50. Obligation Management 58. Lawful Consent 60. Sticky Policies 64. Increasing Aggregation Awareness 69. Anonymity Set	X	X	X	X	X	X	X	X	X
5	What are PbD patterns I should apply if my system requires collecting Personal Data?	Data Collection	Personal Information	Duplicated	1. Protection against Tracking 2. Location Granularity 3. Minimal Information Asymmetry 38. User Data Confinement Pattern 64. Increasing Aggregation Awareness 65. Attribute Based Credentials 66. Trustworthy Privacy Plug-in 69. Anonymity Set	X	X	X	X	X	X			
6	What are PbD patterns I should apply if my system includes a Sensor/ device that collects data?	Device	Reading Sensor	Valid	14. Asynchronous Notice 19. Ambient Notice							X		
7	What are PbD patterns I should apply if my system routes data subject's information among the system components /nodes?	Process	Route	Valid	24. Onion Routing 29. Aggregation Gateway				X	X	X			
8	What are the PbD privacy patterns I should apply if my system requires user login?	Process	Profile	Valid	4. Informed Secure Passwords 71. Unusual Activities							X		
9	What are the PbD privacy patterns I should apply to allow data subject to have control on his stored data?	Regulations	Control	Duplicated	27. Personal Data Store 48. Privacy Dashboard							X	X	X
10	What are the PbD privacy patterns I should apply to allow data subject to choose his collected data?	Regulations	Control	Valid	35. Enable/Disable Function 45. Platform for Privacy Preferences 54. Reasonable Level of Control							X	X	
11	What are the PbD privacy patterns I should apply if my system collects data subject's location?	Data Collection	Location	Valid	2. Location Granularity	X						X		

Drone Delivery

#	Question	Category	Subtype	Validity	Patterns	C1	C2	C3	C4	C5	C6	C7	C8	C9
12	provides tracking service?	Data Collection	Location	Modified Duplicated	9. Who's Listening 14. Asynchronous notice 19. Ambient Notice 35. Enable/Disable Function							X	X	
13	was attacked?	Regulations	Notify	Modified Duplicated	22. Data Breach Notification Pattern 71. Unusual Activities							X		
14	stores address data that belong to previous customers?	Regulations	Agreement	Duplicated	50. Obligation Management							X		X
15	has the possibility of being infiltrated?	Regulations	Notify	Duplicated	71. Unusual Activities							X		
16	Allows customers to delete their data at any time?	Regulations	Control	Modified Duplicated	48. Privacy Dashboard 61. Personal Data Table							X	X	X
17	provides cloud access to customers as well?	Process	Access	Valid	27. Personal Data Store 48. Privacy Dashboard 61. Personal Data Table							X	X	X
18	provides drone access to more than one users (pilots) to provide required services?	Process	Access	Valid	5. Awareness Feed. 9. Who's Listening							X		
19	requires 24 hour monitoring?	Device	Camera	Duplicated	5. Awareness Feed. 9. Who's Listening 14. Asynchronous notice 19. Ambient Notice 35. Enable/Disable Function							X	X	
20	save historical data for how long?	Regulations	Agreement	Modified Duplicated	5. Awareness Feed. 42. Appropriate Privacy Feedback 50. Obligation Management 57. Privacy Awareness Panel							X		X X

#	Question	Category	Sub	Status	PbD Patterns							
21	recorded sensitive information about customers?	Data Collection	Personal Information	Valid	8. Use of dummies 32. Sign an Agreement to Solve Lack of Trust on the Use of Private Data Context 63. Added-noise measurement obfuscation	X	X			X	X	
	Fitness Watch											
22	What are PbD patterns I should apply to ensure data subject's advantage?	Regulations	Advantage	Valid	13. Reciprocity 17. Incentivized Participation					X		
23	What are PbD patterns I should apply to ensure my system does not collect data more than what is stated in the privacy policy?	Regulations	Agreement	Modified	28. Trust Evaluation of Services Slides 32. Sign an Agreement to Solve Lack of Trust on the Use of Private Data Context					X	X	X
24	What are the PbD patterns I should apply if the system capabilities such as microphone is always on?	Device	Microphone	Valid	14. Asynchronous notice 19. Ambient Notice					X		
25	What are PbD patterns I should apply if my system shares data subject's information with third party. e.g., insurance companies?	Proccess	Third Party	Duplicated	18. Outsourcing [with consent] 50. Obligation Management 60. Sticky Policies						X	X
26	What are the PbD patterns I should apply if my system allow trusted parties to access my data?	Proccess	Access	Valid	18. Outsourcing [with consent] 50. Obligation Management 60. Sticky Policies						X	X
27	What are the PbD patterns I should apply if the system is collecting/ gathers data subject's information?	Data Collection	Personal Information	Duplicated	3. Minimal Information Asymmetry 5. Awareness Feed. 29. Aggregation Gateway 38. User Data Confinement Pattern 40. Obtaining Explicit Consent 42. Appropriate Privacy Feedback 43. Impactful Information and Feedback 51. Informed Credential Selection 57. Privacy Awareness Panel 58. Lawful Consent 64. Increasing Awareness of Information Aggregation 65. Attribute Based Credentials	X	X	X	X	X	X	X
28	What are PbD patterns I should apply to notify the data subject about his data collection?	Regulations	Notify	Valid	5. Awareness Feed. 14. Asynchronous notice 19. Ambient Notice					X		
29	What are PbD patterns I should apply to allow data subject to control his data?	Regulations	Control	Duplicated	27. Personal Data Store 35. Enable/Disable Function 45. Platform for Privacy Preferences 48. Privacy Dashboard 54. Reasonable Level of Control					X	X	X
30	What are PbD patterns I should apply if my system detects a criminal behaviour?	Regulations	Notify	Duplicated	22. Data Breach Notification Pattern 71. Unusual Activities					X		
31	What are PbD patterns I should apply if my system shares the the collected data between Data subjects?	Proccess	Share	Valid	12. Discouraging Blanket Strategies 46. Selective Access control 55. Masquerade 56. Buddy List 68. Private Link 70. Active Broadcast of Presence				X		X	
32	What are PbD patterns I should apply if my system stores data in the cloud	Storage	Cloud	Duplicated	8. Use of dummies 26. Pseudonymous Identity 27. Personal Data Store 40. Obtaining Explicit Consent 58. Lawful Consent 63. Added-noise measurement obfuscation 65. Attribute Based Credentials	X	X			X	X	X
33	What are PbD patterns I should apply if my system store data in the smart watch?	Storage	Local	Modified Duplicated	27. Personal Data Store 38. User Data Confinement Pattern			X		X		X
34	What are PbD patterns I should apply if my system keeps user's real-time location in cloud	Data Collection	Location	Valid	5. Awareness Feed. 35. Enable/Disable Function					X	X	
35	What are PbD patterns I should apply if my system store the location in the cloud?	Storage	Cloud	Valid	2. Location Granularity 8. Use of dummies 44. Decoupling [content] and Location Information Visibility 63. Added-noise measurement obfuscation 64. Increasing Awareness of Information Aggregation 74. Dynamic Location Granularity	X	X			X	X	X
36	What are PbD patterns I should apply if my system can store the data in the mobile?	Storage	Local	Modified Duplicated	27. Personal Data Store 38. User Data Confinement Pattern			X		X		X
37	What are PbD patterns I should apply if my system keeps the data for a period of time	Regulations	Agreement	Modified Duplicated	32. Sign an Agreement to Solve Lack of Trust on the Use of Private Data Context 40. Obtaining Explicit Consent 58. Lawful Consent 59. Privacy Aware Wording					X	X	X
38	What are PbD patterns I should apply if my system sell the users info with third parties?	Proccess	Third Party	Valid	18. Outsourcing [with consent] 26. Pseudonymous Identity 40. Obtaining Explicit Consent 50. Obligation Management 54. Reasonable Level of Control 58. Lawful Consent 60. Sticky Policies	X			X	X	X	X

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#	Question	Category	Sub	Status	Patterns								
39	What are PbD patterns I should apply if my system collects user's age, gender, marital status and other personal information is required?	Data Collection	Personal Information	Modified	3. Minimal Information Asymmetry 26. Pseudonymous Identity 27. Personal Data Store 32. Sign an Agreement to Solve Lack of Trust on the Use of Private Data Context 38. User Data Confinement Pattern 40. Obtaining Explicit Consent 41. Privacy Mirrors 48. Privacy Dashboard 51. Informed Credential Selection 54. Reasonable Level of Control 57. Privacy Awareness Panel 61. Personal Data Table 64. Increasing Awareness of Information Aggregation 65. Attribute Based Credentials	X		X	X	X	X		X
40	What are PbD patterns I should apply if my system stores user's food intake information?	Data Collection	Routine	Valid	5. Awareness Feed. 8. Use of dummies 26. Pseudonymous Identity 27. Personal Data Store 35. Enable/Disable Function 38. User Data Confinement Pattern 43. Impactful Information and Feedback 48. Privacy Dashboard 51. Informed Credential Selection 54. Reasonable Level of Control 57. Privacy Awareness Panel 61. Personal Data Table 63. Added-noise measurement obfuscation 64. Increasing Awareness of Information Aggregation 65. Attribute Based Credentials	X	X	X	X	X	X		X
41	What are PbD patterns I should apply if my system stores user's gym information?	Data Collection	Personal Information	Valid	26. Pseudonymous Identity 27. Personal Data Store 35. Enable/Disable Function 38. User Data Confinement Pattern 43. Impactful Information and Feedback 48. Privacy Dashboard 51. Informed Credential Selection 54. Reasonable Level of Control 57. Privacy Awareness Panel 61. Personal Data Table 64. Increasing Awareness of Information Aggregation 65. Attribute Based Credentials	X		X	X	X	X		X
42	What are PbD patterns I should apply if I do not need the identity of the user? (anonymously)	Data Collection	Personal Information	Modified	26. Pseudonymous Identity	X		X					
43	What are PbD patterns I should apply to prevent attackers from identify the identity of the user?	Regulations	Agreement	Valid	2. Location Granularity 8. Use of dummies 26. Pseudonymous Identity 29. Aggregation Gateway 44. Decoupling [content] and Location Information Visibility 51. Informed Credential Selection 55. Masquerade 63. Added-noise measurement obfuscation 64. Increasing Awareness of Information Aggregation 65. Attribute Based Credentials 67. [Support] Selective Disclosure 73. Identity Federation Do Not Track Pattern	X	X	X	X	X	X		X
44	What are PbD patterns I should apply if my system requires user's city information	Data Collection	Personal Information	Valid	2. Location Granularity 29. Aggregation Gateway 38. User Data Confinement Pattern 41. Privacy Mirrors 48. Privacy Dashboard 61. Personal Data Table 64. Increasing Awareness of Information Aggregation 67. [Support] Selective Disclosure 74. Dynamic Location Granularity	X	X	X	X	X	X		X
45	What are PbD patterns I should apply to allow the user to delete his data if he/she wants to do?	Regulations	Control	Duplicated	48. Privacy Dashboard 61. Personal Data Table						X	X	X
46	What are PbD patterns I should apply if my system requires user's address	Data Collection	Personal Information	Valid	2. Location Granularity 29. Aggregation Gateway 38. User Data Confinement Pattern 41. Privacy Mirrors 48. Privacy Dashboard 61. Personal Data Table 64. Increasing Awareness of Information Aggregation 67. [Support] Selective Disclosure 74. Dynamic Location Granularity	X	X	X	X	X	X		X
47	What are PbD patterns I should apply to give user privacy notification in case he/she wants to share personal data e.g exact location ?	Proccess	Share	Valid	12. Discouraging Blanket Strategies 46. Selective Access control 55. Masquerade 56. Buddy List 67. [Support] Selective Disclosure 68. Private Link						X		X
48	What are PbD patterns I should apply if my system scans wireless access points for indoor positioning	Data Collection	Location	Valid	14. Asynchronous notice 19. Ambient Notice 35. Enable/Disable Function 42. Appropriate Privacy Feedback						X	X	X
49	What are PbD patterns I should apply if my system have attack/threats?	Regulations	Notify	Duplicated	22. Data Breach Notification Pattern 71. Unusual Activities							X	

#	Question				Patterns	C1	C2	C3	C4	C5	C6	C7	C8
50	What are PbD patterns I should apply if my system stores user's daily routine?	Data Collection	Routine	Valid	5. Awareness Feed. 8. Use of dummies 26. Pseudonymous Identity 27. Personal Data Store 35. Enable/Disable Function 38. User Data Confinement Pattern 43. Impactful Information and Feedback 48. Privacy Dashboard 51. Informed Credential Selection 54. Reasonable Level of Control 57. Privacy Awareness Panel 61. Personal Data Table 63. Added-noise measurement obfuscation 64. Increasing Awareness of Information Aggregation 65. Attribute Based Credentials	X	X	X	X	X	X		X
51	What are PbD patterns I should apply if my system requires user's device's properties	Data Collection	Personal Information	Valid	12. Discouraging Blanket Strategies 46. Selective Access control 55. Masquerade			X	X	X			
52	What are PbD patterns I should apply if my system shares user's accident information to emergency services	Process	Third Party	Valid	18. Outsourcing [with consent] 50. Obligation Management 60. Sticky Policies						X	X	
Park Monitoring													
53	What are PbD patterns I should apply if my system store people faces/ photos (identifiable info)	Data Collection	Photos	Valid	14. Asynchronous notice 19. Ambient Notice 40. Obtaining Explicit Consent						X	X	
54	What are PbD patterns I should apply if my system allows administration staff to view the images	Proccess	Access	Valid	40. Obtaining Explicit Consent						X		
55	What are PbD patterns I should apply to make sure non authorised people (staff) accessing the images ?	Regulations	Agreement	Modified	28. Trust Evaluation of Services Slides 32. Sign an Agreement to Solve Lack of Trust on the Use of Private Data Context						X	X	X
56	What are PbD patterns I should apply if my system send raw data ex: people faces?	Data Collection	Personal Information	Valid	38. User Data Confinement Pattern 65. Attribute Based Credentials	X			X	X			
57	What are PbD patterns I should apply if my system detect age, gender or other properties of customers	Data Collection	Personal Information	Valid	3. Minimal Information Asymmetry 40. Obtaining Explicit Consent 59. Privacy Aware Wording 65. Attribute Based Credentials 69. Anonymity Set	X	X		X	X	X		X
58	What are PbD patterns I should apply if my system analyse the data in the cloud? (aggregation)	Proccess	Route	Modified	65. Attribute Based Credentials 69. Anonymity Set	X	X		X				
59	What are PbD patterns I should apply to make sure the data subject has the right to delete his data?	Regulations	Agreement	Duplicated	28. Trust Evaluation of Services Slides 32. Sign an Agreement to Solve Lack of Trust on the Use of Private Data Context						X	X	X
60	What are PbD patterns I should apply if my system save the videos for long time?	Regulations	Agreement	Duplicated	3. Minimal Information Asymmetry 59. Privacy Aware Wording						X		X
61	What are PbD patterns I should apply if my system allows real-time monitoring of the images locally	Device	Camera	Duplicated	3. Minimal Information Asymmetry 14. Asynchronous notice 19. Ambient Notice 40. Obtaining Explicit Consent						X	X	
Real-Time Tracking System RTLS													
62	What are PbD patterns I should apply if my system is storing the data in the cloud?	Storage	Cloud	Duplicated	8. Use of dummies 22. Data Breach Notification Pattern 27. Personal Data Store 41. Privacy Mirrors 50. Obligation Management 63. Added-noise measurement obfuscation	X	X		X			X	X
63	What are PbD patterns I should apply if my system is sharing data subject's information with third party?	Proccess	Third Party	Duplicated	18. Outsourcing [with consent] 50. Obligation Management 60. Sticky Policies						X	X	
64	What are PbD patterns I should apply if my system is being used in different countries applying different privacy policies?	Regulations	Privacy Policy	Valid	16. Policy Matching Display 18. Outsourcing [with consent] 21. Privacy Labels 30. Privacy icons 36. Privacy Color Coding 59. Privacy Aware Wording 60. Sticky Policies						X	X	X	X
65	What are PbD patterns I should apply if my system is notifying the users?	Regulations	Notify	Valid	14. Asynchronous notice 19. Ambient Notice						X		
66	What are PbD patterns I should apply if my system is collecting the data continuously?	Data Collection	Routine	Valid	14. Asynchronous notice 19. Ambient Notice 42. Appropriate Privacy Feedback 70. Active Broadcast of Presence						X	X	X
67	What are PbD patterns I should apply if my system is sending subject's data to the server?	Proccess	Route	Valid	24. Onion Routing 43. Impactful Information and Feedback		X				X		X
68	What are PbD patterns I should apply if my system is processing subject's data?	Proccess	Route	Valid	24. Onion Routing 28. Trust Evaluation of Services Sides 38. User Data Confinement Pattern	X	X				X		X

#	Question	Type	Sub-type	Validity	Answers				
69	What are PbD patterns I should apply if GPS tracking the car?	Data Collection	Location	Duplicated	14. Asynchronous notice 19. Ambient Notice 35. Enable/Disable Function		X	X	
70	What are PbD patterns I should apply if my system requires the data subject information e.g., by phone, email, car etc.?	Data Collection	Personal Information	Modified	3. Minimal Information Asymmetry 32. Sign an Agreement to Solve Lack of Trust on the Use of Private Data Context 40. Obtaining Explicit Consent 41. Privacy Mirrors 48. Privacy Dashboard 51. Informed Credential Selection 54. Reasonable Level of Control 58. Lawful Consent 61. Personal Data Table		X	X	X
71	What are PbD patterns I should apply if my system can be paired with other IoT devices?	Proccess	Route	Duplicated	24. Onion Routing	X			
	Smart Home								
72	my TV preferred shows and episodes be shared and accessed by third parties?	Proccess	Third Party	Modified Duplicated	50. Obligation Management 60. Sticky Policies				X
73	Do I get to choose which data and how much data to be shared across connected devices?	Regulations	Control	Valid	35. Enable/Disable Function 53. Negotiation of Privacy Policy 54. Reasonable Level of Control		X	X	
74	connects multiple smart devices and synced data across them?	Proccess	Route	Modified Duplicated	24. Onion Routing 35. Enable/Disable Function	X		X	
75	has the possibility of being infiltrated?	Regulations	Notify	Duplicated	71. Unusual Activities	X			
76	will my clients' data be stored in a secure manner?	Regulations	Agreement	Modified	4. Informed Secure Passwords 32. Sign an Agreement to Solve Lack of Trust on the Use of Private Data Context		X	X	
77	records audio when I have a private talk with my home mates?	Device	Microphone	Valid	5. Awareness Feed. 14. Asynchronous notice 19. Ambient Notice 35. Enable/Disable Function		X	X	
78	Requests a consent from data subject to store his data?	Regulations	Agreement	Modified	15. Abridged Terms and Condition 34. Informed Implicit Consent 40. Obtaining Explicit Consent 58. Lawful Consent 59. Privacy Aware Wording 62. Informed Consent for Web-based Transactions		X	X	X
79	How do you deal with outdoor cameras if they record strangers?	Device	Camera	Valid	14. Asynchronous notice 19. Ambient Notice		X		
80	suspects intruder or privacy invasion?	Regulations	Notify	Modified	22. Data Breach Notification Pattern 71. Unusual Activities		X		
81	has cameras?	Device	Camera	Valid	14. Asynchronous notice 19. Ambient Notice 35. Enable/Disable Function		X	X	

Table 1: The table shows all data collected and analysed. It shows the CQ, its type and sub-type, the answers and their tags.

5   Validation

	Health Care System
CQ1.	What are PbD patterns I should apply if my system includes a user interface/ mobile application/ screen/ mobile phone?
	SELECT ?Device ?PrivacyPattern WHERE ?Device rdf:type parrot:Device. ?Device parrot:entails ?PrivacyPattern. filter (?Device = parrot:MobilePhone)
CQ2.	What are PbD patterns I should apply if my system stores data subject's information in a cloud-based data base?
	SELECT ?DataActivity ?PrivacyPattern WHERE ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Store_Data)
CQ3.	What are PbD patterns I should apply if my system reports data subject's information to an Administrator/ Controller?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:SystematicMonitoring. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Report_for_Adminstration)

CQ4.	What are PbD patterns I should apply if my system shares data subject's information to a third party/ another organization?
	SELECT ?DataActivity ?PrivacyPattern WHERE ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Share_Personal_Data_with_Third_Party)
CQ5.	What are PbD patterns I should apply if my system requires collecting Personal Data?
	SELECT ?DataActivity ?PrivacyPattern WHERE ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Collection_of_Personal_Data)
CQ6.	What are PbD patterns I should apply if my system includes a Sensor/ device that collects data?
	SELECT ?Sensor ?PrivacyPattern WHERE ?Sensor a parrot:Sensor. ?Sensor parrot:entails ?PrivacyPattern. FILTER (?Sensor = parrot:Glucose_Sensor)
CQ7.	What are PbD patterns I should apply if my system routes data subject's information among the system components /nodes?
	SELECT ?DataActivity ?PrivacyPattern WHERE ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Route_Data)
CQ8.	What are the PbD privacy patterns I should apply if my system requires user login?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:IdentificationOfDataSubject. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Login)
CQ9.	What are the PbD privacy patterns I should apply to allow data subject to have control on his stored data?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:ExerciseRights. ?Activity parrot:entails ?PrivacyPattern FILTER (?Activity = parrot:Data_subject_controls_his_data)
CQ10.	What are the PbD privacy patterns I should apply to allow data subject to choose his collected data?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:ExerciseRights. ?Activity parrot:entails ?PrivacyPattern FILTER (?Activity = parrot:Data_subject_chooses_collected_data)
CQ11.	What are the PbD privacy patterns I should apply if my system collects data subject's location?
	SELECT ?Data ?PrivacyPattern WHERE ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern FILTER (?Data = parrot:Location)
	Drone Delivery System
CQ12.	What are PbD patterns I should apply if my system provides tracking service?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Tracking)
CQ13.	What are PbD patterns I should apply if my system was attacked?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Notification_Activity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Notify_System_Attack)
CQ14.	What are PbD patterns I should apply if my system stores address data that belong to previous customers?

	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:ArchiveData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Historical_Data)
CQ15.	What are PbD patterns I should apply if my system has the possibility of being infiltrated?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Notification_Activity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Notify_Data_Infiltration)
CQ17.	What are PbD patterns I should apply if my system allows customers to delete their data at any time?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:DataActivity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Delete_Data)
CQ19.	What are PbD patterns I should apply if my system provides drone access to more than one users (pilots) to provide required services?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Access_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_service_provider)
CQ20.	What are PbD patterns I should apply if my system requires 24 hour monitoring?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:24_Hour_Monitoring)
CQ21.	What are PbD patterns I should apply if my system save historical data for how long?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:ArchiveData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Historical_Data)
CQ22.	What are PbD patterns I should apply if my system recorded sensitive information about customers?
	SELECT ?Data ?PrivacyPattern WHERE ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. FILTER (?Data = parrot:Sensitive_personal_information)
Fitness Watch	
CQ23.	What are PbD patterns I should apply to ensure data subject's advantage?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:ExerciseRights. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Ensure_data_subjects_advantage)
CQ24.	What are PbD patterns I should apply to ensure my system does not collect data more than what is stated in the privacy policy?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:ObligationForCollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Specified_in_the_privacy_policy)
CQ25.	What are the PbD patterns I should apply if the system capabilities such as microphone is always on?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Device_Always_On)

CQ25.	What are PbD patterns I should apply if my system shares data subject's information with third party. e.g., insurance companies?
	SELECT ?DataActivity ?PrivacyPattern WHERE ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Share_Personal_Data_with_Third_Party)
CQ26.	What are the PbD patterns I should apply if my system allow trusted parties to access my data?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity rdf:type parrot:Access_Data. ?Activity parrot:entails ?PrivacyPattern. filter (?Activity = parrot:to_trusted_parties)
CQ27.	What are the PbD patterns I should apply if the system is collecting/ gathers data subject's information?
	SELECT ?DataActivity ?PrivacyPattern WHERE ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Collection_of_Personal_Data)
CQ28.	What are PbD patterns I should apply to notify the data subject about his data collection?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Notification_Activity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Notify_Data_Collection)
CQ29	What are PbD patterns I should apply to allow data subject to control his data?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:ExerciseRights. ?Activity parrot:entails ?PrivacyPattern FILTER (?Activity = parrot:Data_subject_controls_his_data)
CQ30.	What are PbD patterns I should apply if my system detects a criminal behaviour?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Notification_Activity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Notify_System_Attack)
CQ31.	What are PbD patterns I should apply if my system shares the the collected data between Data subjects?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_another_user)
CQ32.	What are PbD patterns I should apply if my system stores data in the cloud?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:in_cloud)
CQ33.	What are PbD patterns I should apply if my system store data in the smart watch?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Locally)
CQ34.	What are PbD patterns I should apply if my system keeps user's real-time location in cloud?
	SELECT ?Data ?PrivacyPattern WHERE ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. FILTER (?Data = parrot:Real_Time_Location)
CQ35.	What are PbD patterns I should apply if my system store the location in the cloud?

SELECT ?Activity ?PrivacyPattern
WHERE ?Activity a gdprtext:StoreData.
?Activity parrot:entails ?PrivacyPattern.
FILTER (?Activity = parrot:Store_Location)

CQ36.	What are PbD patterns I should apply if my system can store the data in the mobile?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Locally)
CQ37.	What are PbD patterns I should apply if my system keeps the data for a period of time?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:for_a_period_of_time)
CQ38	What are PbD patterns I should apply if my system sell the users info with third parties?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:sell_data)
CQ39.	What are PbD patterns I should apply if my system collects user's age, gender, marital status and other personal information is required?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Collecting_Personal_Information)
CQ40.	What are PbD patterns I should apply if my system stores user's food intake information?
	SELECT ?Data ?PrivacyPattern WHERE ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. FILTER (?Data = parrot:Food_Data)
CQ41.	What are PbD patterns I should apply if my system stores user's gym information?
	SELECT ?Data ?PrivacyPattern WHERE ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. FILTER (?Data = parrot:Gym_Data)
CQ42.	What are PbD patterns I should apply if I do not need the identity of the user? (anonymously)
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Anonymously)
CQ43.	What are PbD patterns I should apply to prevent attackers from identify the identity of the user?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:ExerciseRights. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Hide_data_subjects_identity_from_attackers)
CQ44.	What are PbD patterns I should apply if my system requires user's city information?
	SELECT ?Data ?PrivacyPattern WHERE ?Personal_Data rdf:type gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. filter (?Data = parrot:City)
CQ45.	What are PbD patterns I should apply to allow the user to delete his data if he/she wants to do?

SELECT ?Activity ?PrivacyPattern
WHERE ?Activity a gdprtext:DataActivity.
?Activity parrot:entails ?PrivacyPattern.
FILTER (?Activity = parrot:Delete_Data)

CQ46.	What are PbD patterns I should apply if my system requires user's address?
	SELECT ?Personal_Data ?PrivacyPattern WHERE ?Personal_Data rdf:type gdprtext:PersonalData. ?Personal_Data parrot:entails ?PrivacyPattern. filter (?Personal_Data = parrot:Address)
CQ47.	What are PbD patterns I should apply to give user privacy notification in case he/she wants to share personal data egexact location?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:user_to_user)
CQ48.	What are PbD patterns I should apply if my system scans wireless access points for indoor positioning?
	SELECT ?Data ?PrivacyPattern WHERE ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. FILTER (?Data = parrot:Indoor_positioning)
CQ49.	What are PbD patterns I should apply if my system have attack/threats?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Notification_Activity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Notify_System_Attack)
CQ50.	What are PbD patterns I should apply if my system stores user's daily routine?
	SELECT ?Data ?PrivacyPattern WHERE ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. FILTER (?Data = parrot:Daily_Routine)
CQ51.	What are PbD patterns I should apply if my system requires user's device's properties?
	SELECT ?Data ?PrivacyPattern WHERE ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. FILTER (?Data = parrot:Data_subjects_device_properties)
CQ52.	What are PbD patterns I should apply if my system shares user's accident information to emergency services?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_emergency_services)
Park Monitoring System	
CQ53.	What are PbD patterns I should apply if my system store people faces/ photos (identifiable info)?
	SELECT ?Data ?PrivacyPattern WHERE ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. FILTER (?Data = parrot:Face_photo)
CQ54.	What are PbD patterns I should apply if my system allows administration staff to view the images?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity rdf:type parrot:Access_Data. ?Activity parrot:entails ?PrivacyPattern. filter (?Activity = parrot:to_administrator)
CQ55.	What are PbD patterns I should apply to make sure non authorised people (staff) accessing the images?

SELECT ?Activity ?PrivacyPattern
WHERE ?Activity a gdprtext:Compliance.
?Activity parrot:entails ?PrivacyPattern.
FILTER (?Activity = parrot:Non-authorized_people_access)

CQ56.	What are PbD patterns I should apply if my system send raw data ex: people faces?
	SELECT ?Data ?PrivacyPattern WHERE ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. FILTER (?Data = parrot:Raw_Data)
CQ57.	What are PbD patterns I should apply if my system detect age, gender or other properties of customers
	SELECT ?Personal_Data ?PrivacyPattern WHERE ?Personal_Data rdf:type gdprtext:PersonalData. ?Personal_Data parrot:entails ?PrivacyPattern. filter (?Personal_Data = parrot:Age) _ SELECT ?Personal_Data ?PrivacyPattern WHERE ?Personal_Data rdf:type gdprtext:PersonalData. ?Personal_Data parrot:entails ?PrivacyPattern. filter (?Personal_Data = parrot:Gender)
CQ58.	What are PbD patterns I should apply to make my system analyse the data in the cloud? (aggregation)
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Route_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_cloud)
CQ59.	What are PbD patterns I should apply to make sure the data subject has the right to delete his data?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:ExerciseRights. ?Activity parrot:entails ?PrivacyPattern FILTER (?Activity = parrot:Data_subject_deletes_his_data)
CQ60.	What are PbD patterns I should apply if my system save the videos for long time?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:for_a_period_of_time)
CQ61.	What are PbD patterns I should apply if my system allows real-time monitoring of the images locally?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Live_Video_Monitoring)
	Real-Time Tracking System RTLS
CQ62.	What are PbD patterns I should apply if my system is storing the data in the cloud?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:in_cloud)
CQ63.	What are PbD patterns I should apply if my system is sharing data subject's information with third party?
	SELECT ?DataActivity ?PrivacyPattern WHERE ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Share_Personal_Data_with_Third_Party)
CQ64.	What are PbD patterns I should apply if my system is being used in different countries applying different privacy policies?

SELECT ?Activity ?PrivacyPattern
WHERE ?Activity a gdprtext:CrossBorderTransfer.
?Activity parrot:entails ?PrivacyPattern.
FILTER (?Activity = parrot:Used_in_Different_Countries)

CQ65.	What are PbD patterns I should apply if my system is notifying the users?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Notification_Activity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Notify_Users)
CQ66.	What are PbD patterns I should apply if my system is collecting the data continuously?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Continuous_Data_Collection)
CQ67.	What are PbD patterns I should apply if my system is sending subject's data to the server?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Route_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_server)
CQ68.	What are PbD patterns I should apply if my system is processing subject's data?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:DataActivity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Processing_Data)
CQ69.	What are PbD patterns I should apply if GPS tracking the car?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Tracking)
CQ70.	What are PbD patterns I should apply if my system requires contacting the data subject e.g., by phone, email, etc.?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:PersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Email || ?Activity = parrot:Phone)
CQ71.	What are PbD patterns I should apply if my system can be paired with other IoT devices?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a parrot:Route_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Between_Devices)
	Smart Home System
CQ72.	What are PbD patterns I should apply if the TV preferred shows and episodes be shared and accessed by third parties?
	SELECT ?DataActivity ?PrivacyPattern WHERE ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Share_Personal_Data_with_Third_Party)
CQ73.	What are PbD patterns I should apply if my system allows data subject to choose which data and how much data to be shared across connected devices?
	SELECT ?Activity ?PrivacyPattern WHERE ?Activity a gdprtext:DataActivity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Choose_Data)
CQ74.	What are PbD patterns I should apply if my system connects multiple smart devices and synced data across them?

SELECT ?Activity ?PrivacyPattern
WHERE ?Activity a parrot:Route_Data.
?Activity parrot:entails ?PrivacyPattern.
FILTER (?Activity = parrot:Between_Devices)

CQ75.	What are PbD patterns I should apply if my system has the possibility of being infiltrated?

SELECT ?Activity ?PrivacyPattern
WHERE ?Activity a parrot:Notification_Activity.
?Activity parrot:entails ?PrivacyPattern.
FILTER (?Activity = parrot:Notify_Data_Infiltration)

CQ76.	What are PbD patterns I should apply if my system stores clients' data in a secure manner?

SELECT ?Activity ?PrivacyPattern
WHERE ?Activity a gdprtext:ExerciseRights.
?Activity parrot:entails ?PrivacyPattern.
FILTER (?Activity = parrot:Data_stored_securely)

CQ77.	What are PbD patterns I should apply if my system records audio when I have a private talk with my home mates?

SELECT ?Device ?PrivacyPattern
WHERE ?Device a parrot:Device.
?Device parrot:entails ?PrivacyPattern.
FILTER (?Device = parrot:Microphone)

CQ78.	What are PbD patterns I should apply if my system requests a consent from data subject to store his data?

SELECT ?Activity ?PrivacyPattern
WHERE ?Activity a gdprtext:ObtainingConsent.
?Activity parrot:entails ?PrivacyPattern
FILTER (?Activity = parrot:Request_consent_from_data_subject)

CQ79.	How do you deal with outdoor cameras if they record strangers?

SELECT ?Device ?PrivacyPattern
WHERE ?Device a parrot:Device.
?Device parrot:entails ?PrivacyPattern.
FILTER (?Device = parrot:Outdoor_Camera)

CQ80.	What are PbD patterns I should apply if my system suspects intruder or privacy invasion?

SELECT ?Activity ?PrivacyPattern
WHERE ?Activity a parrot:Notification_Activity.
?Activity parrot:entails ?PrivacyPattern.
FILTER (?Activity = parrot:Notify_Intruder)

CQ81.	What are PbD patterns I should apply if my system has cameras?

SELECT ?Device ?PrivacyPattern
WHERE ?Device a parrot:Device.
?Device parrot:entails ?PrivacyPattern.
FILTER (?Device = parrot:Camera)

Table 2: The PARROT ontology validation via SPARQL queries. The table shows
the CQs grouped regarding the use cases and thier SPARQL queries.

6 Evaluating the Common Pitfalls

6.1 Structural Dimension

Pitfall		Element	Fix
P07. Merging different concepts in the same class.	3	:Principles_of_ Wright_and_Raab :Pricniples_of_ Cavoukian_and _Jonas :Goals_of_ Rost_and_Bock	The scanner considers these classes to have more than one concept because of the word "and", however, these names refer to the same PbD scheme.
P13. Inverse relationships are not explicitly declared.	3	:partially_inspired _by :fully_inspired_by :entails	In the PARROT ontology, we did not create an inverse relationship.
P19. Defining multiple domains or ranges in properties.	3	:partially_inspired _by :fully_inspired_by :entails	We addressed this problem by typing the domains and ranges in the "Class expression editor" as a union of/ an intersection of multiple classes as a single domain/ range.

Table 3: Structural Dimension Table. The table shows the pitfalls occurred in the OOPS! scanner and how they were assisted.

6.2 Functional Dimension

Pitfall		Element	Fix
P10. Missing disjointness	3	This pitfall applies to the ontology in general instead of specific elements.	We declared some subclasses of *GDPRtEXT:Principle* and the subclasses of *parrot:Guidline* as disjoint classes.

Table 4: Functional Dimension Table. The table shows the pitfalls occurred in the OOPS! scanner and how they were assisted.

6.3 Functional Dimension

Pitfall		Element	Fix
P07. Merging different concepts in the same class.	3	:Principles_of_ Wright_and_Raab :Pricniples_of_ Cavoukian_and _Jonas :Goals_of_ Rost_and_Bock	This pitfall was solved in the first dimension 3
P08. Missing annotations.	6	PARROT:Sensor PARROT:Goal PARROT:Guideline PARROT:Device PARROT:Strategy PARROT:entails	We added annotations to the ontology elements. 6
P13. Inverse relationships not explicitly declared.	3	:partially_inspired _by :fully_inspired_by :entails	This pitfall was addressed in the first dimension.
P22. Using different naming conventions in the ontology.	This pitfall applies to the ontology in general instead of specific elements.		Because we reused many ontologies, the naming conventions will vary. In the PARROT ontology we use an underscore between the words and capitalize the main words (for example: "$parrot$: $Principles\_of\_Cavoukian$").
P41. No license declared.		The ontology metadata omits information about the license that applies to the ontology.	

Table 5: Usability-Profiling Dimension Table. The table shows the pitfalls occurred in the OOPS! scanner and how they were assisted.

	Elements in PARROT	Annotation
1	*PARROT:Sensor*	An equivalent class to sosa:Sensor
2	*PARROT:Privacy_by_ Design_Schemes*	
3	*PARROT:Goal*	A set of Privacy by Design goals created by different parties.
4	*PARROT:Guideline*	A set of Privacy by Design guidelines created by different parties.
5	*PARROT:Device*	The devices used in the system.
6	*PARROT:Strategy*	A set of Privacy by Design strategies created by different parties.
7	*PARROT:entails*	The relationship between system components or activities with the privacy patterns.
8	*PARROT:fully_inspired_by*	Is the relationship between the PbD schemes that indicates the connection between a privacy pattern and the other schemes (Principle, Guideline, and Strategy). This connection indicates a full inspiration for the privacy pattern from the privacy scheme.
9	*PARROT:partially_ inspired_by*	Is the relationship between the PbD schemes that indicates the connection between a privacy pattern and the other schemes (Principle, Guideline, and Strategy). This connection indicates a partial inspiration for the privacy pattern from the privacy scheme.
10	*PARROT:Privacy_Pattern*	A set of Privacy by Design privacy patterns created by different parties. This level of Privacy by Design Schemes is linked to all the elements in other Privacy by Design Schemes. It is also linked to systems' components and activities.
11	*GDPRtEXT:Principle*	A set of Privacy by Design principles created by different parties.
12	*PARROT:Notification_ Activity*	The activity of notifying the data subject about any activity.
13	*PARROT:Access_Data*	The activity of providing access to the data for an individual or an organization. Ex: administrator.
14	*PARROT:Share_Data*	The activity of sharing some data subject's information to an individual, a friend or an organization.
15	*PARROT:Route_Data*	The activity of routing data among different nodes of the system.

Table 6: The table shows PARROT elements and the annotation added to them

7 Expert Evaluation Form

Parrot Ontology Expert Evaluation

Contents

General Description

The aim of the PARROT ontology (Privacy by Design for the Internet of Things) is to support a tool that will help software developers find the relevant Privacy by Design (PbD) Practices for their IoT systems. It models the different knowledge of PbD practices (we call them schemes) and their relationships. It also models IoT systems' information and the PbD schemes required to be applied.
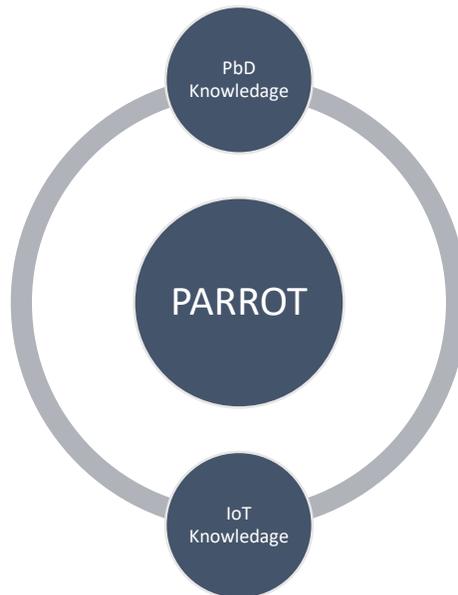

Figure 1 PARROT ontology contained knowledge

Evaluation Purpose

This evaluation aims at verifying whether the PARROT ontology in terms of its concepts and relationships suffers from several common pitfalls in ontologies. The list of the pitfalls we consider in this evaluation can be found in the next section, followed by the PARROT ontology structure.

Privacy and Confidentiality Statement

All responses, including any personal information, will be kept strictly confidential. Your data will only be used and accessed by the researchers working on this project.

For any problem do not hesitate to contact: Lamya Alkhariji (alkharijiLa@cardiff.ac.uk)

You are kindly requested to carefully assess the PARROT ontology in terms of its concepts and relationships against several common pitfalls in ontologies. The pitfalls we consider in this evaluation are listed below, and the PARROT ontology can be found in the next section.

The pitfalls definitions in this document are retrieved from the online pitfalls catalog (https://oops.linkeddata.es/catalogue.jsp).

P01. Creating polysemous elements: An ontology element (class, object property, or datatype property) whose identifier has different senses is included in the ontology to represent more than one conceptual idea or property.

P02. Creating synonyms as classes: Several classes whose identifiers are synonyms are created and defined as equivalent (owl:equivalentClass) in the same namespace.

P07. Merging different concepts in the same class: A class whose name refers to two or more different concepts is created.

P09. Missing domain information: Part of the information needed for modeling the intended domain is not included in the ontology. This pitfall may be related to (a) the requirements included in the Ontology Requirement Specification Document (ORSD) that are not covered by the ontology, or (b) to the lack of knowledge that can be added to the ontology to make it more complete. *In this project, we created our ORSD file which is available in a separate file (ORSD.pdf)*

P17. Overspecializing a hierarchy: The hierarchy in the ontology is specialized in such a way that the final leaves are defined as classes and these classes will not have instances.

P21. Using a miscellaneous class: This pitfall refers to the creation of a class with the only goal of classifying the instances that do not belong to any of its sibling classes (classes with which the miscellaneous problematic class shares a common direct ancestor).

The PARROT Ontology

In this section, we will describe the reused ontology to model the information needed in the PARROT ontology. Furthermore, we will detail the hierarchy of the PARROT ontology. Please find the PARROT ontology file in the sent documents (PARROT.owl).

Reused Ontologies

1. IoT Ontologies

PARROT aims to help apply privacy patterns to IoT systems, thus, we needed to include IoT knowledge (i.e., devices and specifications) in our ontology. We used Semantic Sensor Network (SSN) ontology and its lightweight ontology SOSA (Sensor, Observation, Sample, and Actuator). They both describe sensors, actuators, samplers as well as their observations, actuation, and sampling activities [1]

From SSN we used the class ssn:System and its subclasses such as sosa:Sensor to model the instances of IoT devices in our data set such as the instance 'Glucose Sensor'.

2. PbD Ontologies

For PbD knowledge we found GDPRtEXT ontology that describes the concepts defined, mentioned and required by the General Data Protection Regulation (GDPR). GDPRtEXT uses the Simple Knowledge Organization System (SKOS) upper ontology which provides a model for expressing the basic structure and content of concept schemes. [2] [3]

We used the class GDPRtEXT:Principle to include all PbD principles such as parrot:Principles_of_ISO_29100. We likewise used the class GDPRtEXT:PrivacybyDesign to include all PbD schemes classes such as parrot:Strategies_of_Hoepman and parrot:Privacy_Pattern. We also used other classes such as GDPRtEXT:Activity, GDPRtEXT:DataActivity. From SKOS ontology we used the class skos:Concept and many of its subclasses to model the knowledge of PbD. All used classes are detailed in PARROT elements section.

Classes:

- skos:Concept
  - GDPRtEXT:Activity
    - GDPRtEXT:DataActivity
      - GDPRtEXT:ConsentActivity
        - GDPRtEXT:ObtainingConsent
      - PARROT:Access_Data
      - GDPRtEXT:ArchiveData
      - GDPRtEXT:CollectionOfPersonalData
      - GDPRtEXT:CrossBorderTransfer
      - PARROT:Route_Data
      - PARROT:Share_Data
      - GDPRtEXT:SharePersonalDataWithThirdParty
      - GDPRtEXT:StoreData
    - GDPRtEXT:ExerciseRights
    - GDPRtEXT:IdentificationOfDataSubject
    - PARROT:Notification_Activity
  - GDPRtEXT:Compliance
  - GDPRtEXT:Data
    - GDPRtEXT:PersonalData
  - PARROT:Privacy_by_Design_Schemes
    - GDPRtEXT:Principle
      - Parrot:Principles_of_Cavoukian
      - Parrot:Principles_of_FIPPs
      - Parrot:Principles_of_Fisk_et_al.
      - Parrot:Principles_of_ISO_29100
      - Parrot:Principles_of_Wright_and_Raab
      - Parrot:Princples_of_Cavoukian_and_Jonas
    - Parrot:Strategy
      - Parrot:Strategies_of_Hoepman
    - Parrot:Goal
      - Parrot:Goals_of_Rost_and_Bock
    - Parrot:Guideline
      - Parrot:Guidelines_of_OECD
      - Parrot:Guidelines_of_Perera_et_al.
    - Parrot:Privacy_Pattern
- ssn:System
  - PARROT:Device
    - sosa:Sensor

Properties:

- parrot:fully_inspired_by
- parrot:partially_inspired_by
- parrot:entails

Figure 2 Class hierarchy of the PARROT ontology

Element	Definition
Classes	
skos:Concept	An idea or notion; a unit of thought.
GDPRtEXT:Activity	An Activity signifies some process(es) or step(s) towards specific deed(s), action(s), function(s), or sphere(s) of action.
GDPRtEXT:DataActivity	An activity involving personal data of data subject(s).
GDPRtEXT:ConsentActivity	An activity involving data subject's consent.
GDPRtEXT:ObtainingConsent	The act of getting a data subject's consent.
PARROT:Access_Data	The activity of providing access to the data for an individual or an organization. Ex: administrator.
GDPRtEXT:ArchiveData	An activity where personal data is archived.
GDPRtEXT:CollectionOfPersonalData	Collection of Personal Data is an Activity that deals with acquiring data subject's personal data through some model of interaction.
GDPRtEXT:CrossBorderTransfer	Cross-border data transfer refers to data transfer crossing the boundaries of EU (legislative) region.
PARROT:Route_Data	The activity of routing data among different nodes of the system.
PARROT:Share_Data	The activity of sharing some data subject's information to an individual, a friend or an organization.
GDPRtEXT:SharePersonalDataWithThirdParty	This activity represents the sharing of data subject's personal data with a third party.
GDPRtEXT:StoreData	An activity where personal data is being stored.
GDPRtEXT:ExerciseRights	The activity represents exercising of rights provided by GDPR by the data subject.
GDPRtEXT:IdentificationOfDataSubject	Activity where the data subject is explicitly identified through direct or indirect means.
PARROT:Notification_Activity	The activity of notifying the data subject about any activity.
GDPRtEXT:Compliance	Represents the act of complying with the obligations and actions specified by the GDPR.
GDPRtEXT:Data	A generic term to refer to Data.
GDPRtEXT:PersonalData	Personal data means any information relating to an identified or identifiable natural person ('data subject'); an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person.
PARROT:Privacy_by_Design_Schemes	Privacy by design schemes are several guidance practices for software developers published by many organizations and researchers at different levels of abstractness.
GDPRtEXT:Principle	A set of Privacy by Design principles created by different parties.
PARROT:Strategy	A set of Privacy by Design strategies created by different parties.

PARROT:Goal	A set of Privacy by Design goals created by different parties.
PARROT:Guideline	A set of Privacy by Design guidelines created by different parties.
PARROT:Privacy_Pattern	A set of Privacy by Design privacy patterns created by different parties. This level of Privacy by Design Schemes is linked to all the elements in other Privacy by Design Schemes. It is also linked to systems' components and activities.
ssn:System	System is a unit of abstraction for pieces of infrastructure that implement Procedures. A System may have components, its subsystems, which are other systems.
PARROT:Device	The devices used in the system.
sosa:Sensor	Device, agent (including humans), or software (simulation) involved in, or implementing, a Procedure. Sensors respond to a stimulus, e.g., a change in the environment, or input data composed from the results of prior Observations, and generate a Result. Sensors can be hosted by Platforms.
Properties	
PARROT:entails	The relationship between system components or activities with the privacy patterns.
PARROT:fully_inspired_by	Is the relationship between the PbD schemes that indicates the connection between a privacy pattern and the other schemes (Principle, Guideline, and Strategy). This connection indicates a full inspiration for the privacy pattern from the privacy scheme.
PARROT:partially_inspired_by	Is the relationship between the PbD schemes that indicates the connection between a privacy pattern and the other schemes (Principle, Guideline, and Strategy). This connection indicates a partial inspiration for the privacy pattern from the privacy scheme.

Expert's Comments

Pitfall	Element	Description

References

[1]   W3C Recommendation, "Semantic Sensor Network Ontology." Dec. 2017. Accessed: May 30, 2018. [Online]. Available: https://www.w3.org/TR/vocab-ssn/

[2]   "SKOS Simple Knowledge Organization System Primer." https://www.w3.org/TR/skos-primer/

[3]   P. Harshvardhan, "GDPRtEXT." https://openscience.adaptcentre.ie/ontologies/GDPRtEXT/deliverables/docs/ontology (accessed Apr. 04, 2021).

8 Content Evaluation

ID	Question	Rank	Type	Sub-type	Use Case	SPARQL
1	Will the data subject, doctor , and researcher see the same information?	Discarded	Process	Access	Health Care System	
1	What information will be taken from the data subject?	Discarded	Data Collection	Personal Information	Health Care System	
1	How can I deal with the data subject's information?	Discarded	Process		Health Care System	
1	Will all data subject's information will be sent to the cloud?	Discarded			Health Care System	
1	If the system will send data subject's information to the cloud, what can I do?	Valid	Process	Route	Health Care System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Route_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_cloud) }
1	What protocols I can use to keep the data subject's information safe during its routing to the cloud?	Valid	Process	Route	Health Care System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Route_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_server || ?Activity = parrot:to_cloud) }
1	Will the information be encrypted while being routed?	Duplicated	Process	Route	Health Care System	
1	How can I keep the information safe while being routed?	Duplicated	Process	Route	Health Care System	
1	For how long I can keep the information in the cloud?	Valid	Regulation	Agreement	Health Care System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:ArchiveData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Historical_Data) }
1	Can the data subject approve if all or some of his information will be shared?	Valid	Regulations	Control	Health Care System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:DataActivity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Choose_Data) }
1	Will the data subject know exactly who can see his information?	Duplicated			Health Care System	
1	Do I need to inform the data subject about the people who will see his information?	Missing	Regulations	Privacy Policy	Health Care System	
1	Will I save the data subject's information in the cloud?	Duplicated	Storage	Cloud	Health Care System	
1	for how long I can keep the data subject's information?	Duplicated	Regulations	Agreement	Health Care System	
1	Will the doctor and the researcher have the data subject's information associated with his personal information (i.e. name)? Or the information will be shared anonymosly?	Valid	Process	Share	Health Care System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Anonymously) }
1	Will the researcher and doctor have the same privilege? Will they have the same information?	Valid	Process	Share	Health Care System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Report_for_Adminstration) } SELECT ?DataActivity ?PrivacyPattern WHERE { ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Share_Personal_Data_with_Third_Party) }
1	What can we do to make the communication secure, from the sensor to the cloud and to the web application?	Valid	Process	Route	Health Care System	SELECT ?DataActivity ?PrivacyPattern WHERE { ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Route_Data) }
1	Can we share a third party with the infrmation as the researcher is?	Duplicated	Process	Third-Party	Health Care System	
1	How can we guarantee the privacy of the information by the researcher?	Duplicated	Process	Third-Party	Health Care System	
1	Do we need all the information that we asked from the data subject?	Duplicated	Data Collection	Personal Information	Health Care System	
1	How do I store the information in the clould? (ex: some methodology or protocole) to keep them safe?	Valid	Storage	Cloud	Health Care System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:in_cloud) }
1	If we have an external copy or backup for the information, how can I keep them private?	Not available	Storage	Cloud	Health Care System	
1	I need to send a report of the data subject to the doctor, how can I keep the data subjec't privacy?	Valid	Process	Share	Health Care System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Report_for_Adminstration) }
1	How can I keep the data subject's information private inside the cloud?	Duplicated	Storage	Cloud	Health Care System	
1	What can I do if I send the information to the cloud (i.e. GPS data) continuously?	Valid	Data Collection	Routine	Real Tracking Location System (RTLS)	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Continuous_Data_Collection) }

	Question	Status	Category	Sub	System	Query
1	Should the data subject turn it the functionality on and off?	Valid	Regulations	Control	Real Tracking Location System (RTLS)	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:DataActivity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Choose_Data) }
1	How can I make sure the data are sent to the cloud securely? (the communication)	Valid	Process	Route	Real Tracking Location System (RTLS)	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Route_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_server) }
1	For how long I can keep the information in the cloud?	Valid	Regulations	Agreement	Real Tracking Location System (RTLS)	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:ArchiveData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Historical_Data) }
1	Can have the identity of the data subject and have other information?	Valid	Data Collection	Personal Information	Real Tracking Location System (RTLS)	SELECT ?Personal_Data ?PrivacyPattern WHERE { ?Personal_Data rdf:type gdprtext:PersonalData. ?Personal_Data parrot:entails ?PrivacyPattern. filter (?Personal_Data = parrot:Address || ?Personal_Data = parrot:City || ?Personal_Data = parrot:Age || ?Personal_Data = parrot:Email || ?Personal_Data = parrot:Gender || ?Personal_Data = parrot:Location || ?Personal_Data = parrot:Phone || ?Personal_Data = parrot:Face_photo) }
1	If there was a third party, how can we deal with it?	Valid	Process	Third-Party	Real Tracking Location System (RTLS)	SELECT ?DataActivity ?PrivacyPattern WHERE { ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Share_Personal_Data_with_Third_Party) }
1	Do the data subject have an idea about how this information will be stored or processed?	Missing	Regulation	Privacy Policy	Real Tracking Location System (RTLS)	
1	If the system got attacked and accessed the information what can we do?	Valid	Regulations	Notify	Real Tracking Location System (RTLS)	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Notification_Activity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Notify_System_Attack) }
1	Can we keep history of his information? Or shall they be deleted immediately?	Duplicated	Regulation	Agreemen	Real Tracking Location System (RTLS)	
1	Do someone else have access to this information other than the user?	Missing	Process	Access	Real Tracking Location System (RTLS)	
1	Can we share the information with the authorities (ex: police) in case of a crime or emergency?	Valid	Process	Third-Party	Real Tracking Location System (RTLS)	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_emergency_services) }
1	Can we have non essential information (ex: car number, personal photo)?	Duplicated	Data Collection	Personal Information	Real Tracking Location System (RTLS)	
2	What information the nurses and doctors will get if the glucose sensor got abnormal readings?	Valid	Process	Share	Health Care System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Report_for_Adminstration) }
2	What kind of data the mobile app requires other than the name and age of the patient?	Discarded	Data Collection	Personal Information	Health Care System	
2	How to protect the data of data subject that are stored in the cloud?	Duplicated	Storage	Cloud	Health Care System	
2	How to protect the data subject's privacy if more than one person is using the system?	Not available	Regulations	Agreement	Health Care System	
2	What are the research information the researcher have that will not violate the data subjec'ts privacy?	Valid	Process	Share	Health Care System	SELECT ?DataActivity ?PrivacyPattern WHERE { ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Share_Personal_Data_with_Third_Party) }
2	Should the sensor be used by one person only or for more than one user (ex: husband and wife) ?	Discarded			Health Care System	
2	Who should have access to the CCTV cameras?	Missing	Process	Access	Smart Home System	
2	Who should have access to the control tablets of the smart home ?	Missing	Process	Access	Smart Home System	
2	If something wrong happened (ex: thief in the house) people of the house should be informed.	Discarded	Regulation	Notify	Smart Home System	
2	If the parents of the kids don't want them to watch TV ?	Discarded			Smart Home System	
2	If the data subject plays some media other people should not know about it.	Missing	Process	Access	Smart Home System	
2	Laptops and phones should be accessable only by their owners.	Discarded	Process	Access	Smart Home System	
2	How to keep the privacy of the Wifi from the neighbours?	Discarded			Smart Home System	
3	Does the researcher need to know the name and the address of the data subject?	Duplicated	Process	Third-Party	Health Care System	
3	Do the doctor and nurse and the researchers need the same information?	Duplicated	Process	Share	Health Care System	
3	Where we should store the information of the data subject?	Duplicated	Storage	Cloud	Health Care System	
3	How can we store the information in a safe way?	Valid	Storage	Cloud	Health Care System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern.}
3	Do we need to encrypt the information?	Duplicated	Storage	Cloud		

3	Is it possible ways the glucose sensor could invade the privacy of the data subject? How to avoid it?	Valid	Device	Reading Sensor	Health Care System	SELECT ?Sensor ?PrivacyPattern WHERE { ?Sensor a parrot:Sensor. ?Sensor parrot:entails ?PrivacyPattern. FILTER (?Sensor = parrot:Glucose_Sensor) }
3	What information could be included in the report without invading the data subject's privacy?	Duplicated	Process	Share	Health Care System	
3	What information should be shared to the doctores and nurses?	Duplicated	Process	Share	Health Care System	
3	What information should be shared to the researchers?	Discarded	Process	Third-Party	Health Care System	
3	What can we do regarding the data routing?	Valid	Process	Route	Health Care System	SELECT ?DataActivity ?PrivacyPattern WHERE { ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Route_Data) }
3	What privacy measures should be implemented about storing the information in the cloud's database?	Duplicated	Storage	Cloud	Health Care System	
3	How can I collect the data subject's information without invading his privacy?	Valid	Data Collection	Personal Information	Health Care System	SELECT ?DataActivity ?PrivacyPattern WHERE { ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Collection_of_Personal_Data) }
3	How can we protect the privacy of the adult house members from each other?	Not available	Regulations	Agreement	Smart Home System	
3	Are there standard measures for each sensor to protect the data subject's privacy? (ex: camera)?	Valid	Device	Camera	Smart Home System	SELECT ?Device ?PrivacyPattern WHERE { ?Device a parrot:Device. ?Device parrot:entails ?PrivacyPattern. FILTER (?Device = parrot:Camera) }
3	Depending on the used sensors, what are the privacy standard measurments?	Valid	Device	Reading Sensor	Smart Home System	SELECT ?Device ?PrivacyPattern WHERE { ?Device a parrot:Device. ?Device parrot:entails ?PrivacyPattern. FILTER (?Device = parrot:Camera || ?Device = parrot:Outdoor_Camera || ?Device = parrot:MobilePhone || ?Device = parrot:Microphone) }
3	Where to store the information?	Duplicated	Storage	Cloud	Smart Home System	
3	Is there a way for the data subject to control the data collection frequency or the amount of information collected? Can he turn some features on and off?	Valid	Regulations	Control	Smart Home System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:DataActivity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Choose_Data) } SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:ExerciseRights. ?Activity parrot:entails ?PrivacyPattern FILTER (?Activity = parrot:Data_subject_chooses_collected_data) }
3	Do I need to have access control on the screen tablets?	Not available	Process	Access	Smart Home System	
3	How can I deal with the privacy of the visitors? How can we collect information without his consent?	Not available	Regulations	Agreement	Smart Home System	
3	Are there special sensors that are more sensitive to be used in the bed rooms?	Not available	Device	Reading Sensor	Smart Home System	
3	Are there special ways to install the sensors to make them more privacy protecting? (ex: location of the camera)	Not available	Device	Reading Sensor	Smart Home System	
3	Is the microphones will be always open?	Valid	Device	Microphone	Smart Home System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Device_Always_On) }
3	Will the camera will be always open?	Valid	Device	Camera	Smart Home System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:24_Hour_Monitoring) }
3	Is there a way to protect the privacy by the design of the hardware? (ex: the laptop's camera with a cover)	Not available	Device	Reading Sensor	Smart Home System	
3	What are the privacy-preserving measurements to protect the privacy of people who did not provide consent (ex: pedestrians, visitors)	Not available	Regulations	Agreement	Smart Home System	
3	Whom to provide access to the live camera?	Not available	Process	Access	Smart Home System	
4	Can the information be saved in the cloud?	Duplicated	Storage	Cloud	Real Tracking Location System (RTLS)	
4	Will the collected data be saved in the cloud?	Discarded	Storage	Cloud	Real Tracking Location System (RTLS)	
4	Should the information be encrypted?	Not available	Storage	Cloud	Real Tracking Location System (RTLS)	
4	What can be done to make sure no one else has access to data subject's information?	Valid	Regulations	Agreement	Real Tracking Location System (RTLS)	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:Compliance. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Non-authorized_people_access) }
4	Will the taken photos will be encrypted?	Duplicated	Storage	Cloud	Park Monitoring System	

#	Question	Status			System	SPARQL
4	For how long can we keep the photo?	Duplicated	Regulation	Agreement	Park Monitoring System	
4	Where the photos should be stored?	Duplicated	Storage	Cloud	Park Monitoring System	
4	Does the system use face detection tools?	Discarded			Park Monitoring System	
4	Who has access to the monitoring screen?	Valid	Process	Access	Park Monitoring System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:Compliance. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Non-authorized_people_access) }
4	Does everybody has access to the API?	Valid	Process	Access	Park Monitoring System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:Compliance. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Non-authorized_people_access) }
4	Do park visitors know that their photos will be taken?	valid	Regulations	Agreement	Park Monitoring System	
4	How to apply the GDPR rules?	Discarded			Park Monitoring System	
4	Who has access to the database that keeps the photos?	Valid	Process	Access	Park Monitoring System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:Compliance. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Non-authorized_people_access) }
4	Is the cloud local or used from a third-party?	Discarded			Park Monitoring System	
4	Will a report be provided to the park visitors?	Missing	Regulations	Agreement	Park Monitoring System	
4	Is the data subject the only one who has access to his own information?	Missing	Process	Access	Health Care System	
4	Who has access to see data subject's information?	Discarded			Health Care System	
4	Is the data subject's information encrypted?	Duplicated	Storage	Cloud	Health Care System	
4	Who are the researchers that have a copy of the information?	Discarded			Health Care System	
4	Is the cloud local in the hospital or used from a third-party?	Discarded			Health Care System	
4	Is the glucose sensor vulnerable to get information from?	Discarded			Health Care System	
4	For how long the information will be stored?	Duplicated	Regulation	Agreement	Health Care System	
5	How to protect the information that is stored in the cloud?	Duplicated	Storage	Cloud	Fitness Watch	
5	If more than one person is using the watch, how to protect their privacy?	Not available	Regulation	Agreement	Fitness Watch	
5	How to protect the information if the phone was stolen?	Not available	Regulations	Agreement	Fitness Watch	
5	Can the phone inform the data subject if the phone was stolen?	Valid	Regulation	Notify	Fitness Watch	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Notification_Activity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Notify_Intruder) }
5	What to do if the drone got hacked on its way?	Valid	Regulations	Notify	Drone Delivery System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Notification_Activity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Notify_Intruder) }
5	How can we deal with the video streaming? Maybe other sensors than the camera?	Valid	Data Collection	Routine	Drone Delivery System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Live_Video_Monitoring) }
5	How to protect the package from getting damaged or stolen?	Discarded			Drone Delivery System	
5	How to improve the shape of the drone?	Discarded			Drone Delivery System	
5	What if the data subject did not want to use the drone delivery system with a video streaming? Maybe some lights or tag instead of the video?	Discarded			Drone Delivery System	
5	What if the controller stores the video?	Valid	Storage	Cloud	Drone Delivery System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:for_a_period_of_time || ?Activity = parrot:in_cloud) }
6	Do information need to be encrypted?	Duplicated	Storage	Cloud	Real Tracking Location System (RTLS)	
6	For how long the information will be stored?	Duplicated	Regulation	Agreement	Real Tracking Location System (RTLS)	
6	What information I need from the data subject?	Discarded	Data Collection	Personal Information	Real Tracking Location System (RTLS)	
6	Can I get the date of birth of the driver to check if he has a license?	Missing	Data Collection	Personal Information	Real Tracking Location System (RTLS)	
6	For how long I'll save the parking locations?	Duplicated	Regulations	Agreement	Real Tracking Location System (RTLS)	
6	How to choose the friends?	Valid	Process	Profile	Fitness Watch	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_another_user || ?Activity = parrot:user_to_user) }
6	Can we get friends from the contacts list?	Not available	Process	Access	Fitness Watch	

	Question	Status	Category	Subcategory	System	Query
6	Can the data subject choose the exact data he will share?	Valid	Process	Share	Fitness Watch	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:to_another_user || ?Activity = parrot:user_to_user) }
6	Can the data subject choose for which friend he can share his data instead of all of them?	Duplicated	Process	Share	Fitness Watch	
6	Do we need to encrypt the information?	Duplicated	Storage	Cloud	Fitness Watch	
6	For how long the information will be stored?	Duplicated	Regulations	Agreement	Fitness Watch	
6	Who has access to see the data subject's information?	Duplicated	Process	Access	Fitness Watch	
6	Do we need to have a life stream of the whole journey?	Discarded			Drone Delivery System	
6	If the Drone got lost, how to protect the data subject's information?	Not available	Regulations	Agreement	Drone Delivery System	
6	How to hide the content of the package from the seen?	Not available	Regulations	Agreement	Drone Delivery System	
6	Do the communication needs to be encrypted?	Duplicated	Process	Route	Drone Delivery System	
6	What exact information do we need?	Discarded	Data Collection	Personal Information	Drone Delivery System	
6	Will the information be deleted? And the orders?	Duplicated	Regulations	Agreement	Drone Delivery System	
6	Can we collect the information anonymously?	Valid	Data Collection	Personal Information	Drone Delivery System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:CollectionOfPersonalData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Anonymously) }
7	If I got the cloud that I use from a third party, will they have access to the data I have?	Duplicated	Process	Third-Party	Real Tracking Location System (RTLS)	
7	What to do in case of the router got attacked?	Valid	Regulations	Notify	Real Tracking Location System (RTLS)	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Notification_Activity. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Notify_Intruder) }
7	What data that could be shared with a friend?	Duplicated	Regulations	Control	Fitness Watch	
7	Can the third party who provides the cloud server access the data that I have?	Duplicated	Process	Third-Party	Fitness Watch	
7	For how long can we store the data?	Duplicated	Regulations	Agreement	Fitness Watch	
7	How can I guarantee that the data are permanently deleted in the cloud server and there is no other copy?	Duplicated	Regulations	Agreement	Fitness Watch	
7	What information we need from the data subject to sign up?	Valid	Process	Profile	Fitness Watch	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:IdentificationOfDataSubject. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Login) }
7	What restrictions should be on sharing the data subject's achievements with friends?	Duplicated	Process	Share	Fitness Watch	
7	Is there a third party that collects and analyzes the data?	Discarded	Process	Third-Party	Fitness Watch	
7	How to guarantee that the company provides the devices don't have access to the data?	Not available	Regulations	Agreement	Fitness Watch	
7	Are the data encrypted?	Duplicated	Storage	Cloud	Fitness Watch	
7	After the delivery, will the information (package and personal data) be saved?	Duplicated	Storage	Cloud	Drone Delivery System	
7	Will the third party (the cloud provider) have access to the data and analyse it?	Discarded			Drone Delivery System	
7	What data does the service provider (delivery company) need to deliver the packages?	Discarded			Drone Delivery System	
7	How to deal with the live streaming which violates the privacy of the data subject and the people in the way?	Not available	Regulations	Agreement	Drone Delivery System	
7	Will the live streaming be saved?	Discarded			Drone Delivery System	
8	Does the system requires pattern recognition (face recognition, finger prints) to be secure?	Discarded			Real Tracking Location System (RTLS)	
8	Will the history information be deleted immediately?	Duplicated	Regulations	Agreement	Real Tracking Location System (RTLS)	
8	Can we remove the history function in the system? Is the system going go be valuable?	Discarded			Real Tracking Location System (RTLS)	
8	We can send a sign for someone or the emergency services if the user feels unsafe.	Duplicated	Process	Third-Party	Fitness Watch	
8	We can add a pattern recognition layer before accessing the information or achievements.	Discarded			Fitness Watch	
8	How to control the information that will be shared to a friend?	Duplicated	Regulations	Control	Fitness Watch	

8	How to secure the personal information from the controller (in: bank account etc.)	Missing	Regulation	Agreement	Drone Delivery System	
8	A consent should be taken from all the neighborhood.	Duplicated	Regulations	Agreement	Drone Delivery System	
8	How to protect the neighbors privacy from the controller?	Not available	Regulation	Agreement	Drone Delivery System	
8	Is the information of the live streaming going to be saved?	Discarded			Drone Delivery System	
8	Will the live streaming be deleted if it got saved?	Duplicated	Regulation	Agreement	Drone Delivery System	
9	How to ensure the system will not reveal the existence of the user in the house by the sensors?	Duplicated	Regulations	Agreement	Smart Home System	
9	Do we need any encryption techniques for the communication between the devices?	Duplicated	Process	Route	Smart Home System	
9	How much of data are we going to store in the cloud?	Duplicated	Storage	Cloud	Smart Home System	
9	Is the TV information going to be recorded? Ex: watching history and favourite TV shows? How to ensure the privacy here?	Valid	Process	Profile	Smart Home System	SELECT ?DataActivity ?PrivacyPattern WHERE { ?DataActivity a gdprtext:DataActivity. ?DataActivity parrot:entails ?PrivacyPattern. FILTER (?DataActivity = parrot:Share_Personal_Data_with_Third_Party) } SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern.} SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:ArchiveData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Historical_Data) }
9	The communication between mobile phone and system devices if the mobile phone got attacked?	Duplicated	Process	Route	Smart Home System	
9	How many privacy measurements should be applied for the communication with these three: the devices, the gateway, and the mobile?	Duplicated	Process	Route	Smart Home System	
9	Is the communication between the gateway and the cloud encrypted?	Duplicated	Process	Route	Smart Home System	
9	What can we do for the door lock if it is using the voice or finger print?	Not available	Process	Profile	Smart Home System	
9	Who can control the tablet?	Duplicated	Regulations	Control	Smart Home System	
9	Who has access to the information in the tablet?	Duplicated	Process	Access	Smart Home System	
9	How much information can we store in the gate way and in the cloud?	Valid	Storage	Cloud	Smart Home System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a gdprtext:StoreData. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity= parrot:Locally || ?Activity= parrot:in_cloud) }
9	Where the data are going to be processed? In the gateway or the cloud?	Missing	Process	Route	Smart Home System	
9	How much sensetive information is sent between the devices and the control tablet? Are there any protocols to be applied here?	Duplicated	Process	Route	Smart Home System	
9	Can we control the data to be collected by the camera? For example density of the faces of people?	Valid			Park Monitoring System	SELECT ?Data ?PrivacyPattern WHERE { ?Data a gdprtext:PersonalData. ?Data parrot:entails ?PrivacyPattern. FILTER (?Data = parrot:Raw_Data) }
9	Does the camera has a storage? Will the pictures be stored in the camera or deleted in the same time?	Duplicated	Storage	Local	Park Monitoring System	
9	What kind of information are going to be sent from the camera to the cloud?	Missing	Process	Route	Park Monitoring System	
9	Do we have a consent from the visitor?	Missing	Regulations	Privacy Policy	Park Monitoring System	
9	What information are going to be stored in the cloud that will provide the right functionality but without having unnecessary information?	Duplicated	Storage	Cloud	Park Monitoring System	
9	What information is going to be displayed to the monitoring edge? Is it faces or numbers?	Valid	Process	Access	Park Monitoring System	SELECT ?Activity ?PrivacyPattern WHERE { ?Activity a parrot:Share_Data. ?Activity parrot:entails ?PrivacyPattern. FILTER (?Activity = parrot:Report_for_Adminstration) }
9	Are we going to store the information in the monitoring edge?	Duplicated	Storage	Cloud	Park Monitoring System	
9	For how long the information will be stored?	Duplicated	Regulations	Agreement	Park Monitoring System	
9	Who can access the monitoring edge?	Duplicated	Process	Access	Park Monitoring System	
9	Will the pictures be used for other purposes? Ex: security or in case of a prime?	Duplicated	Process	Third-Party	Park Monitoring System	
9	Can we get the same functionality (predict waiting time) by having less information?	Discarded			Park Monitoring System	

9	What measures should be applied in the case of attack?	Duplicated	Regulations	Notify	Park Monitoring System
10	Does the camera open the door for the people live in the home?	Discarded			Smart Home System
10	Does the tablet show personal information? Ex: the usage of the light.	Discarded			Smart Home System
10	Can anyone use the control tablet and access the information?	Discarded			Smart Home System
10	What about privacy in the TV?	Duplicated	Device	Reading Sensor	Smart Home System
10	If there is a subscription in the TV like amazon extension?	Discarded			Smart Home System
10	Is there any privacy procedure that can protect the information on the TV?	Duplicated	Device	Reading Sensor	Smart Home System
10	How will the company verify my identity for sending me the bill information?	Discarded			Smart Home System
10	How can I know if my information is protected from a third party?	Duplicated	Process	Third-Party	Smart Home System
10	How can I know who is going to see these pictures?	Duplicated	Process	Access	Park Monitoring System
10	Will a third party have access to the pictures?	Discarded			Park Monitoring System
10	Will pictrues be attached with the time?	Missing	Data Collection	Routine	Park Monitoring System
10	Are the pictures going to be stored with the time?	Duplicated	Storage	Cloud	Park Monitoring System
10	What privacy procedures to protect the stored information in the cloud?	Duplicated	Storage	Cloud	Park Monitoring System
10	Is there any privacy procedures for requesting and sending the pictures?	Duplicated	Process	Route	Park Monitoring System

9   Figures
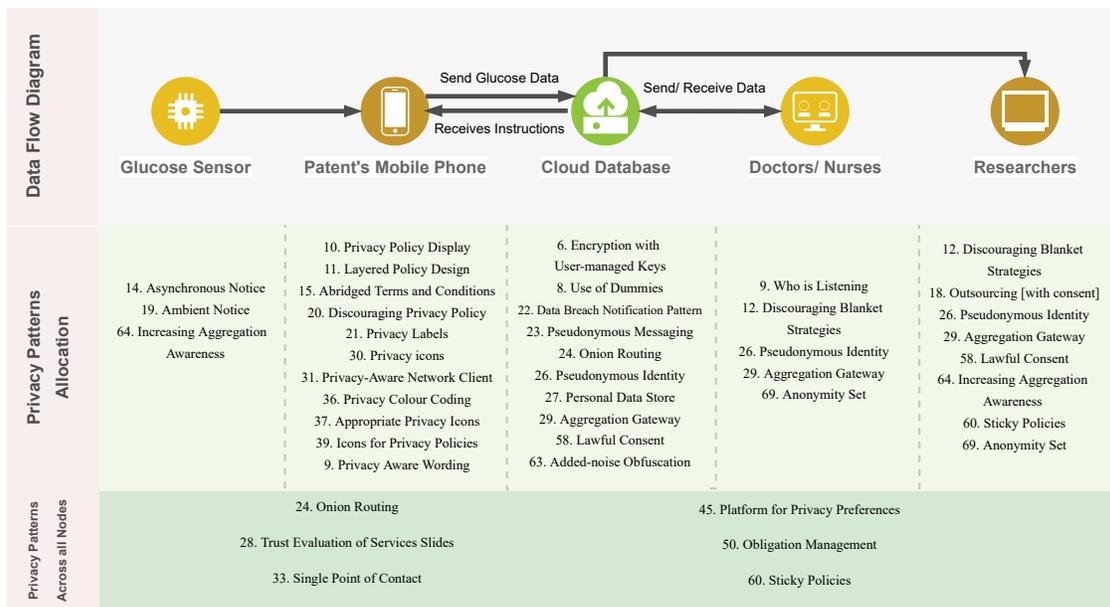
9.1   Paper Figures

Figure 7: Privacy Patterns allocation of Health Care System. It shows a list of Privacy Patterns for each node in the DFD. It also shows the Privacy Patterns that should be applied across all DFD nodes.
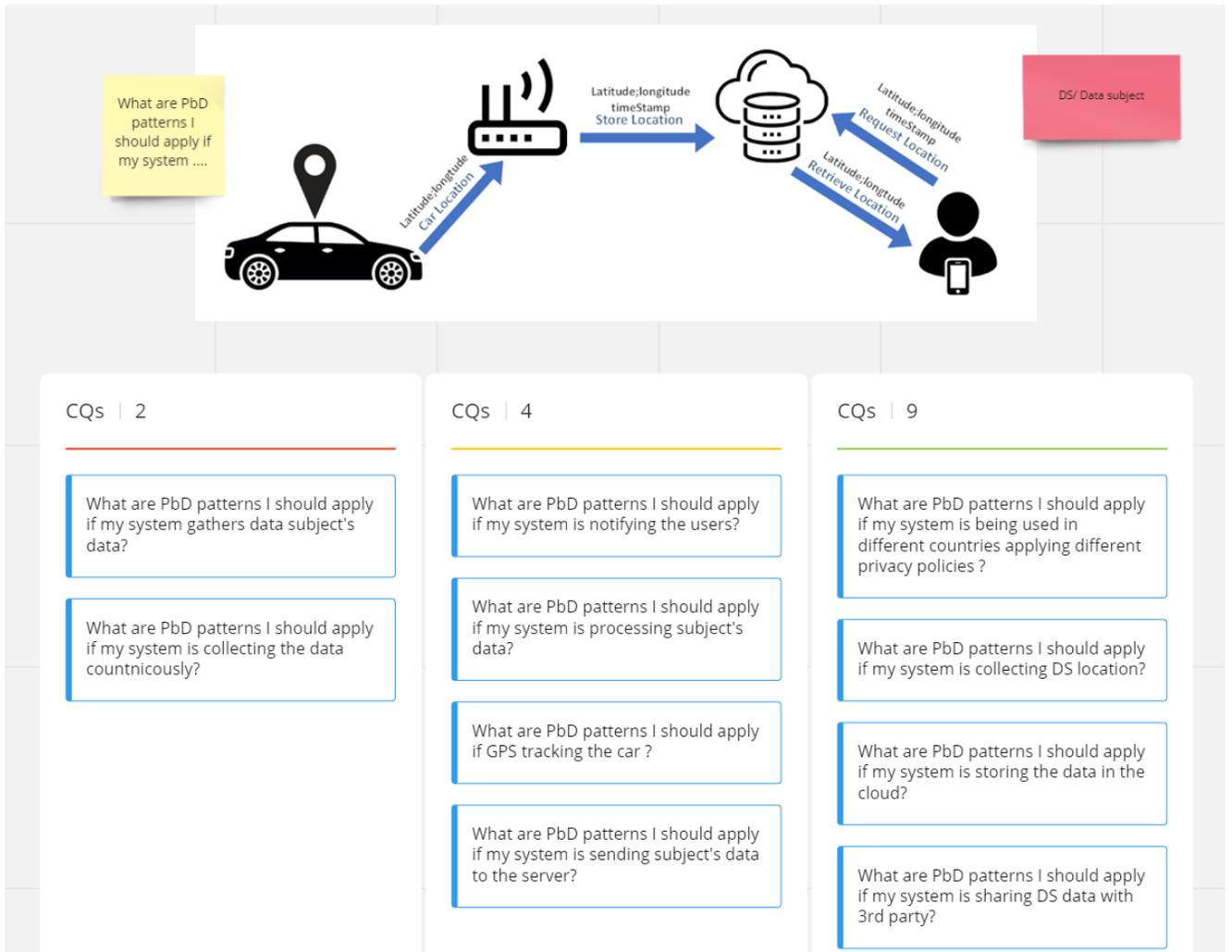
Figure 8: Screenshot of the conducted online workshops to gather CQs that are related to a given use case DFD. The screen shots shows two use cases and the CQs found by participants.
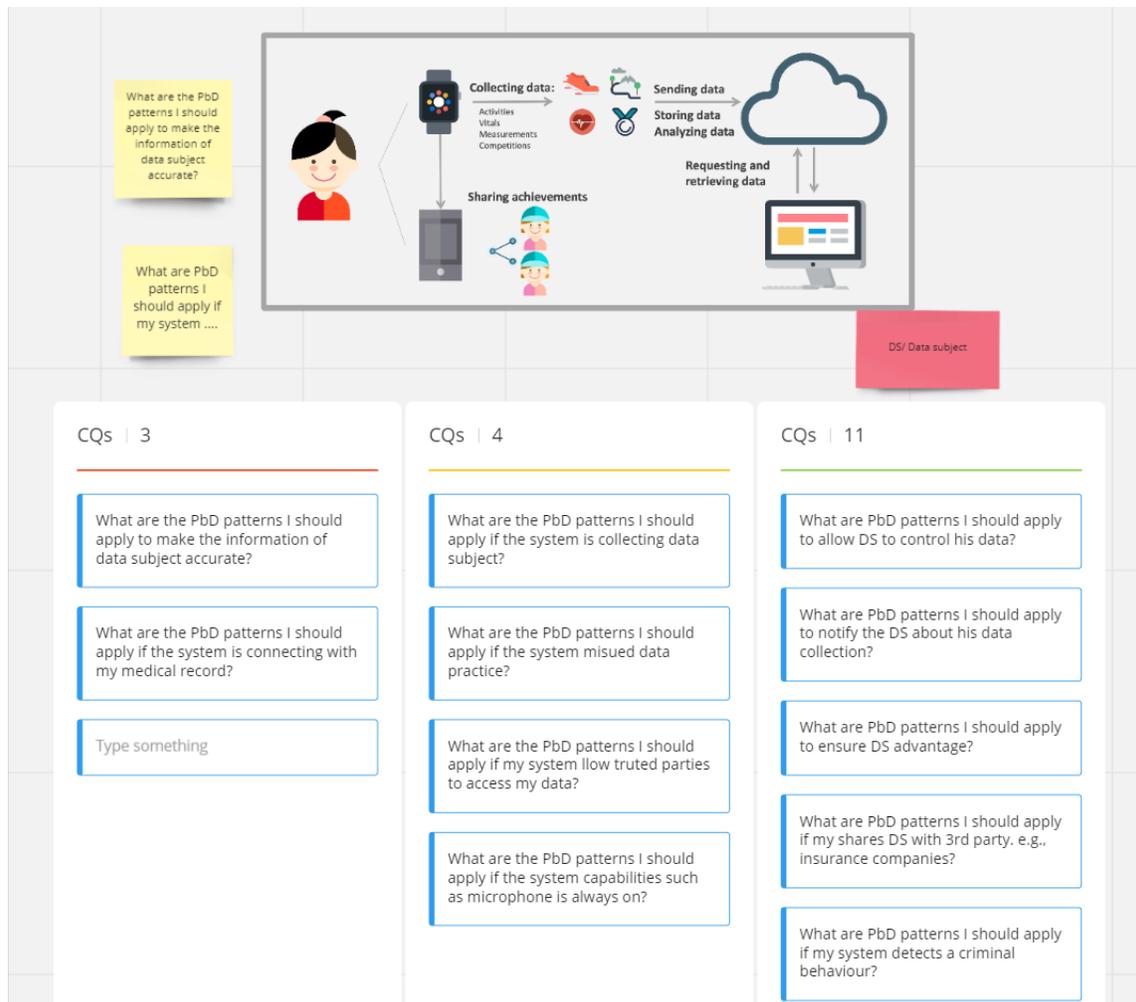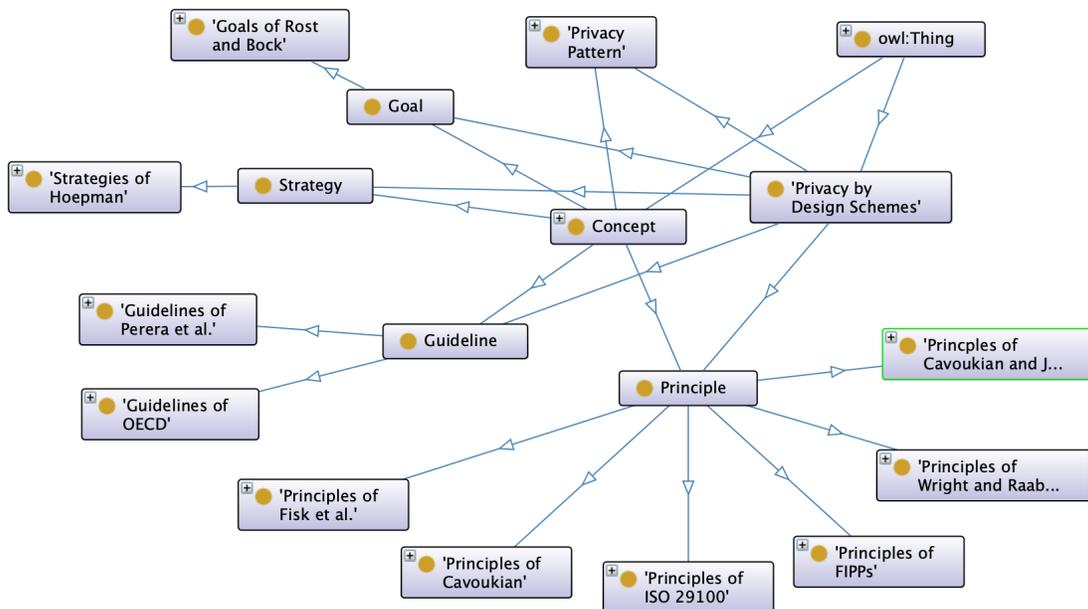
Figure 9: Screenshot of the conducted online workshops to gather CQs that are related to a given use case DFD. The screen shots shows two use cases and the CQs found by participants.

9.2   PARROT Ontology Screenshots

Figure 10: The figure shows all the PbD schemes relationships contained in the PARROT ontology. The owl:Thing class has two sub-classes, Concept and Privacy by Design Schemes. The Privacy by Design Schemes class has five sub-classes, Principle, Guideline, Strategy, Goal, and Privacy Pattern. These five classes are also sub-classes of Concept class. Principle class has six sub-classes. The Guideline class has two sub-classes. The strategy class has one sub-class. The Goal class has one subclass.
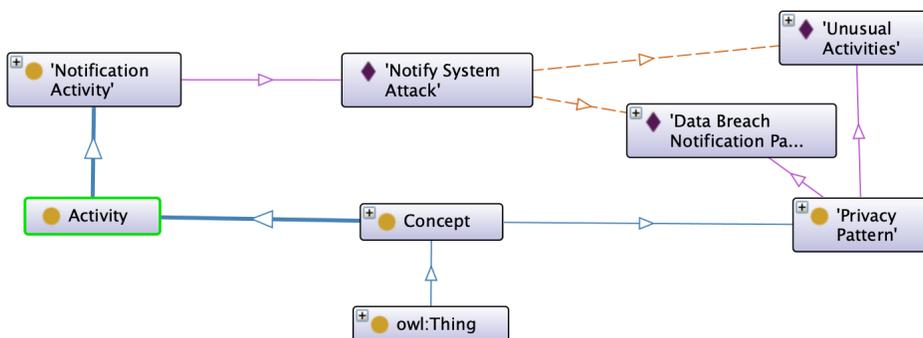
Figure 11: The figure shows an example of an activity and the privacy patterns it entails. Thing class has Concept class which has Activity class. Activity class has Notification Activity sub-class. Notification Activity has an individual 'Notify System Attack'. This individual (activity) entails two privacy patterns, Unusual Activities and Data Breach Notification Pattern, which are individuals of Privacy Pattern class.
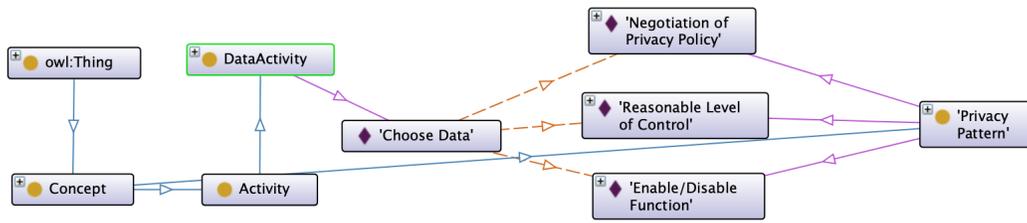
Figure 12: The figure shows an example of an activity and the privacy patterns it entails. Thing class has Concept class which has Activity class. Activity class has Data Activity sub-class. Data Activity class has an individual 'Choose Data'. This individual (activity) entails three privacy patterns, Negotiation of Privacy Policy, Reasonable Level of Control and Enable/Disable Function, which are individuals of Privacy Pattern class.
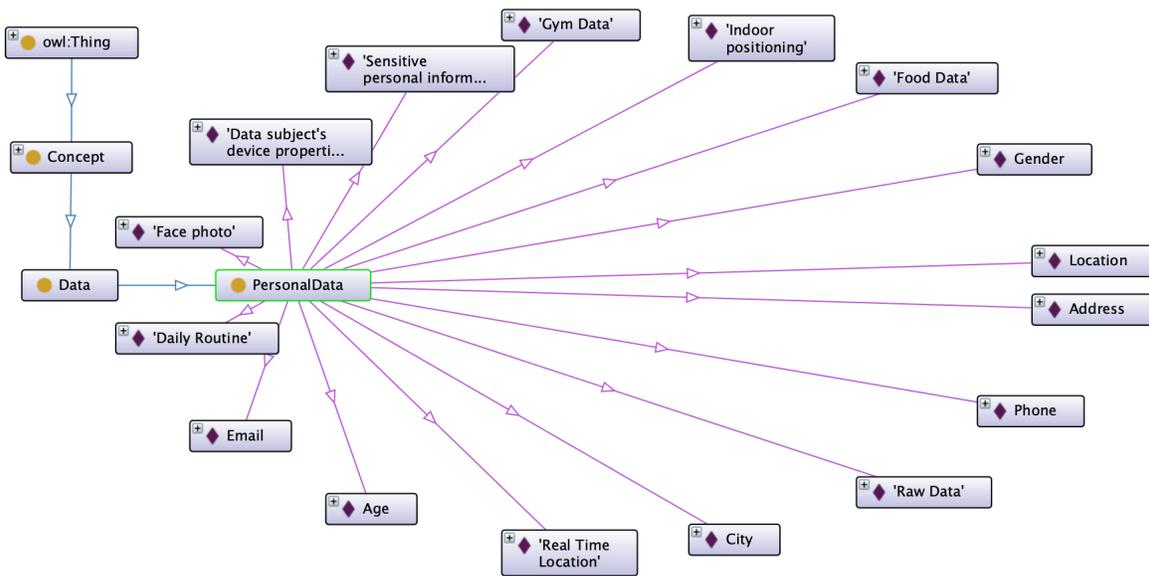

Figure 13: The figure shows the individuals of Personal Data class. Personal Data class is a subclass of Data.