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Sustainable Urban Mobility

Co-Developing Responsible AI
With People, For People

Dr Alina Patelli

Senior Lecturer in Applied AI
Aston University



Speaker Background



Dr Alina Patelli, SFHEA

- Senior Lecturer in Applied Artificial Intelligence, Aston University
- Industry & Impact Lead, AI Ethics Champion, ACAIRA
- Comms Work Group Co-Chair, Sustainability Steer Group member, UK Young Academy
- Responsible AI Recommenders for industry, the public sector, and society



Aston Centre for AI Research and Application (ACAIRA)

- Innovative, impactful, Collaborative cross-disciplinary AI research
- Transparent, ethical, sustainable, and trustworthy AI methodologies
- High-quality training for the next generation of AI users and researchers
- AI for Health, Sustainability and Transport, Trust and Ethics, Autonomous Robots and Agents, Evolutionary and Adaptive Intelligence

Outline



A Practical Challenge



Aim

- Urban transport administrators manage urban mobility, i.e., vehicle and pedestrian traffic.
- Successful urban mobility management means a better experience of city life for all people.



Method

- Smart decision-making leads to wise strategies that generate real value for society.
- Real value stems from sound infrastructure investments, clean tech deployment and effective policies.



Scope

- Public administrators, policymakers, industry and the public must coordinate requirements and behaviours.
- Decisions must be informed by human expertise complemented by automated insight from data (historical and live).



Solution

- One-stop-shop intelligent recommender system that is **responsible**
- ... and **developed responsibly**.

Images retrieved from (top to bottom):

- <https://www.linkedin.com/pulse/smart-city-accessibility-all-bridging-urban-divide-technology-bhoda-sbbac/>
- <https://emotivebrand.com/business-decision-making/>
- <https://www.myaifrontdesk.com/blogs/empathy-in-every-interaction-ai-s-consistent-emotional-intelligence>
- <https://www.shaip.com/blog/responsible-ai-vs-ethical-ai/>



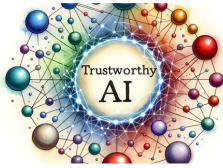
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Responsibility Trifecta



Responsible AI Recommender: Goal



Responsible AI

- Human-centric: accessible, equitable, ethical (data privacy)
- Technically sound: reliable, robust, **explainable**



Responsible development

- Human-in-the-loop: participatory **co-creation** from design to evaluation
- Agile cycles: incremental prototyping, frequent stakeholder evaluation and requirements revision



Responsible decision making

- Operational: application-ready, straightforward integration with existing systems and devices
- Meaningful: recommendations make sense and inform **value-adding** actions

Images retrieved from (top to bottom):

- <https://epil.ai/project/trustworthy-ai/>
- <https://www.agilitypr.com/pr-news/public-relations/content-co-creation-unlocking-the-power-of-collaborative-content-strategies/>
- <https://frostandullivaninstitute.org/8-smart-city-initiatives-around-the-world-contributing-to-better-quality-of-life/>



Responsible AI

- Recommender system blueprint



Responsible development

- Repeatable, coherent, participatory methodology (workshops)



Responsible decision making

- Prelim user-centric evaluation



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The Road to Responsibility



iU&Mi Case Study Overview



$$y = 0.42x_0 + 0.42\text{lag}(x_0) + 0.176\text{lag}_2(x_0) + 0.074\text{lag}_3(x_0) + x_1 + 0.42x_2 + 0.074\text{lag}_3(x_2) + 0.596$$

iU&Mi: intelligent Urban Mobility

- 1.X0 and X2 vehicles are stalled (lags in the model)
- 2.X1 traffic has the greatest influence on outflow (coefficient is 1)
- 3.X4 traffic does not impact the outflow at all

Decision makers draw valuable insight from patterns

- 1.reprogram stop lights, widen lanes or add overflow arms
- 2.consider other topologies where all arms are relevant
- 3.repurpose X4 as a pedestrian or bicycle lane



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Responsible AI Responsible Dev



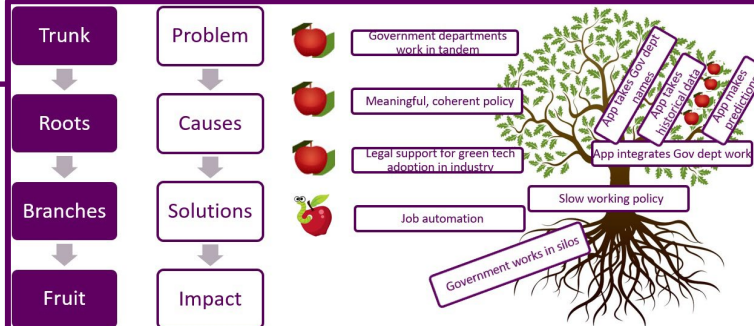
Requirements Elicitation Workshop

Participants

- Industry: infrastructure and sustainable engineering expert
- Policy: West Midlands transport governance, AI in public-Gov engagement
- Public sector: Transport for West Midlands senior leaders
- Motorists, pedestrians, public transport users

Activities

- Ice-breaker
- Demo
- Requirements synthesis: TREQ



O u t p u t r e q s

Requirement [The traffic prediction algorithm]		Definition	
R3	M	<p>Learns, in real-time, from heterogeneous data sources: organisations, sensor feeds, and personal.</p> <p><i>Legitimate organisations: online data repositories maintained by Transport for West Midlands, National Highways, MET Office, etc.</i></p> <p><i>Sensor feeds: induction loops at road junctions, parking occupancy, etc.</i></p> <p><i>Personal: travel habits, health goals (if user allows sync with fitness tracker), etc.</i></p>	<p>Real-time</p> <p>$avg(L) \leq r \leq avg(H)$</p> <p>$L$ = set of the 20% shortest traffic transition intervals [min] available in area</p> <p>r = prediction refresh interval [min]</p> <p>H = set of all traffic transition intervals [min] available in area</p> <p>Heterogeneous data sources</p> <p>As a minimum, periodically monitor data repositories maintained by National Highways, Transport for West Midlands, BBC (incl. MET Office). Periodically crawl the web in search of additional transport data sources (appropriately certified).]</p>
		<p>Is inclusive: caters to the specific requirements of all society groups, including neurodiverse, financially vulnerable, elderly, and technology-averse communities.</p>	<p>Scope of specific groups coverage</p> <p>No of end-users from each category (based on profile data) increases consistently each month</p> <p>Quality of specific groups coverage</p> <p>Survey filled in by representative samples from each group</p>
		<p>Caters to a variety of stakeholders, simultaneously: provides recommendations that support SMEs as well as major haulers with reaching their organisational goals (including green policies), that help individual drivers and pedestrians navigate traffic efficiently, according to their personal definitions of efficiency, and that cultivate environmentally sustainable habit formation supportive of net zero policy.</p>	<p>Sustainable travel behaviours promotion</p> <p>A green travel option is available for at least one leg of the recommended route</p> <p>Stakeholder range</p> <p>No of end-users from each category (based on profile data) increases consistently each month</p> <p>Quality of bespoke support</p> <p>Survey filled in by representative samples from each group</p>
R5	M		
R10	M		

Architecture Design Workshop

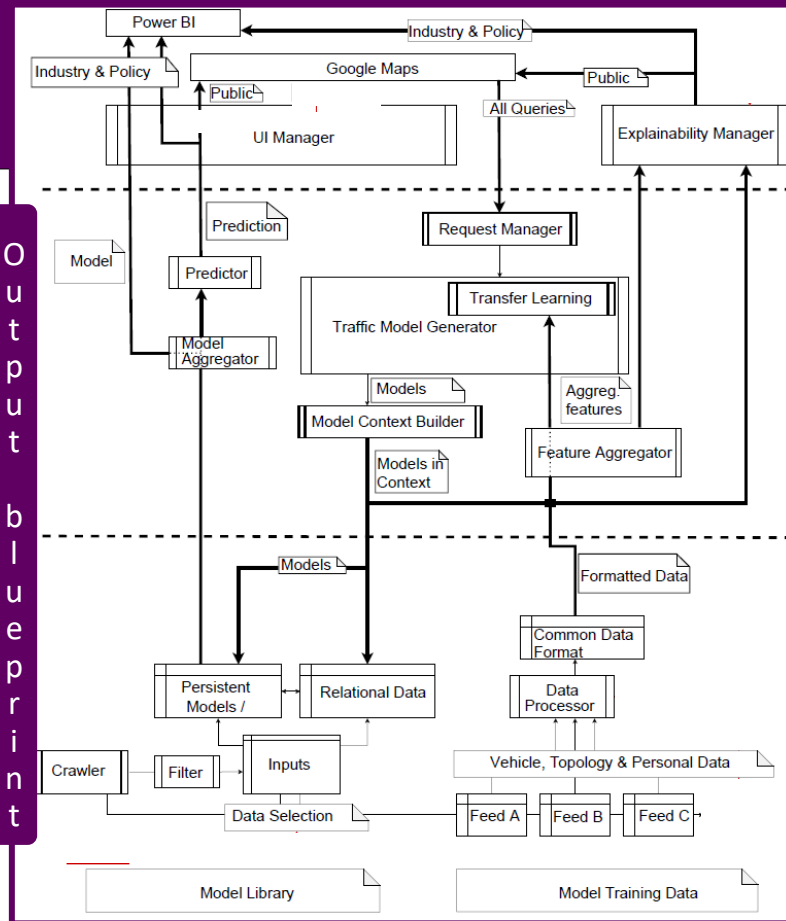
Participants

- AI experts: evolutionary, deep learning, agent-based modelling and optimisation, and self-adapting, self-organising socio-technical systems, trustworthy tech
- Human-computer interaction specialists
- Computing experts: data science and software engineering

Activities

- Introduction
- Requirements fine-tuning
- Architecture design: frontend; core functionality; data backend
- Preliminary evaluation

Output blueprint



Evaluation Workshop

Participants: continuity and fresh perspectives

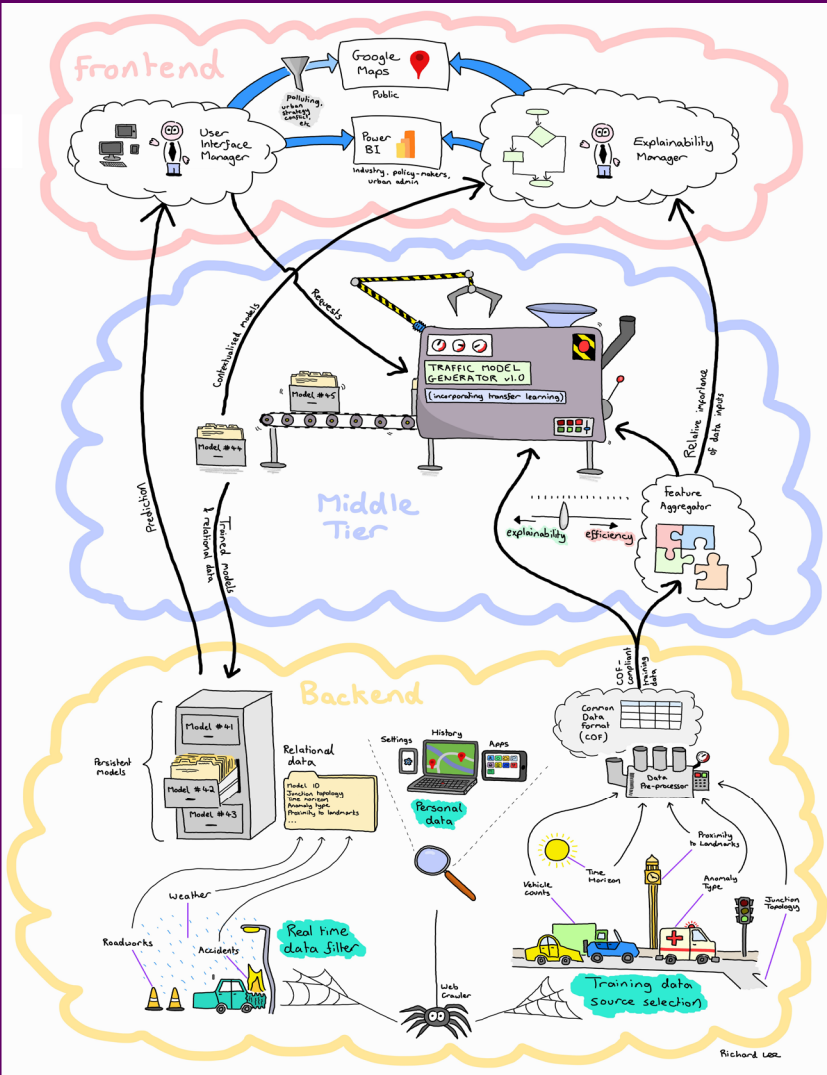
- Industry: transport consultancies, community-centric immersive arts organisation
- Public admin: senior strategy consultant for Midlands Connect
- Policy: research governance expert with Innovate UK

Activities

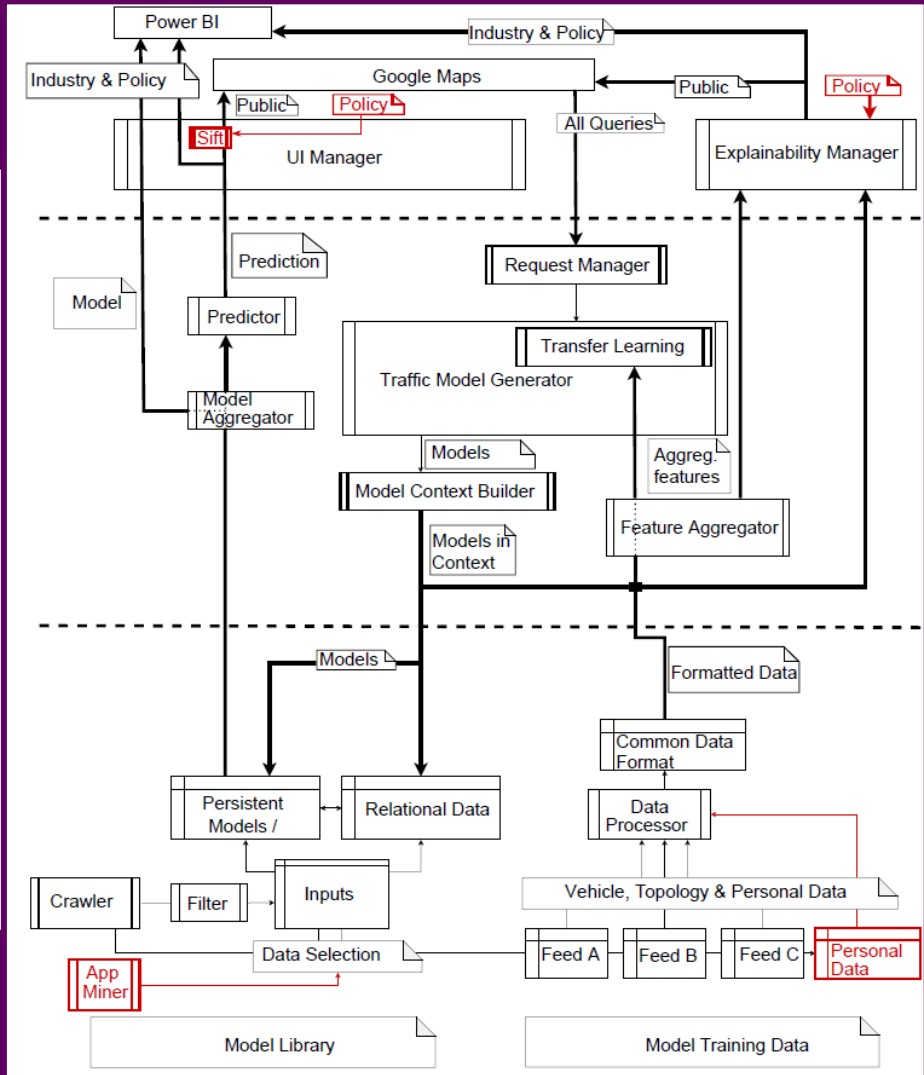
- Introduction
- Architecture discussion
- Architecture evaluation

Output: requirements document with calculated metrics

Requirement [The traffic prediction algorithm]		Metric		
		Definition	Calculation	
R3	M	<p>Learns, in real-time, from heterogeneous data sources: organisations, sensor feeds, and personal.</p> <p><i>Legitimate organisations: online data repositories maintained by Transport for West Midlands, National Highways, MET Office, etc.</i></p> <p><i>Sensor feeds: induction loops at road junctions, parking occupancy, etc.</i></p> <p><i>Personal: travel habits, health goals (if user allows sync with fitness tracker), etc.</i></p>	<p>Real-time</p> <p>$avg(L) \leq r \leq avg(H)$</p> <p>$L$ = set of the 20% shortest traffic transition intervals [min] available in area</p> <p>r = prediction refresh interval [min]</p> <p>H = set of all traffic transition intervals [min] available in area</p> <p>Heterogeneous data sources</p> <p>As a minimum, periodically monitor data repositories maintained by National Highways, Transport for West Midlands, BBC (incl. MET Office).</p> <p>Periodically crawl the web in search of additional transport data sources (appropriately certified).</p>	<p>Medium to high likelihood of meeting R3</p> <p><i>Conditional upon adding an additional block to the backend layer that draws from personal data: past travel behaviours and travel preferences (speed, scenery, safety, sustainability, etc. and their relative importance). This is akin to the way a fitness app tracks exercise, diet, and health goals. The personal data processing block should feature additional privacy safeguards.</i></p>
		<p>Scope of specific groups coverage</p> <p>No of end-users from each category (based on profile data) increases consistently each month</p> <p>Quality of specific groups coverage</p> <p>Survey filled in by representative samples from each group</p>	<p>Low likelihood of meeting R5</p> <p><i>Unlikely to be meaningfully addressed within the traffic prediction algorithm. The frontend 'skins' (i.e., Google Maps, Power BI, etc.) selected by the user interface manager are better suited to cater to inclusivity requirements.</i></p>	
R10	M	<p>Caters to a variety of stakeholders, simultaneously; provides recommendations that support SMEs as well as major haulers with reaching their organisational goals (including green policies), that help individual drivers and pedestrians navigate traffic efficiently, according to their personal definitions of efficiency, and that cultivate environmentally sustainable habit formation supportive of net zero policy.</p>	<p>Sustainable travel behaviours promotion</p> <p>A green travel option is available for at least one leg of the recommended route</p> <p>Stakeholder range</p> <p>No of end-users from each category (based on profile data) increases consistently each month</p> <p>Quality of bespoke support</p> <p>Survey filled in by representative samples from each group</p>	<p>Low to medium likelihood of meeting R10</p>



Output blueprint 2





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Responsible Decisions



Participant selection

- Diverse group of stakeholders ([testimonials](#)), reflecting the target audience's wide range of opinions
- Work groups small enough to enable all to contribute yet sufficiently large to yield meaningful outputs
- Previous participants and newcomers: 'legacies' (continuity) and 'joiners' (fresh perspectives)

Collaborative tools

- Established tools and frameworks (MoSCoW, PESTLE, SMART, three-tier software architecture model): familiarity, confidence
- ...and innovative frameworks (GROWe, TREQ): agile, creativity-prone
- Finetuning needed: reduce task ambiguities.

Lesson 1

Activity design

- Simple relatable examples to ground participatory activities in reality without overly constricting innovation
- Work station switches and summative presentations: engagement and efficiency-creativity trade-off
- UML architecture diagram accompanied by visually engaging equivalent: eliminate technical comms barriers
- New collaborative work techniques to consider: role playing, story boarding, etc.

Lesson 2

Continuous evaluation

- Co-define robust evaluation framework with concrete metrics to assess blueprint ability to meet stakeholder requirements
- Involve participants early-on and periodically seek their input throughout implementation, evaluation and deployment
- Nominal quality metrics: coarse evaluation; consider a more finely-grained grading system (numerical)

Lesson 3

- Novel, systematic and responsible approach to the co-design and co-evaluation of intelligent recommender systems that answers seven key challenges
- Method integrates ethical principles and software engineering best practice throughout system development, enhancing the finished product's potential for social good.
- iU&Mi urban mobility case study combines, adjusts and innovatively improves established development methodologies (SMART, PESTLE, MoSCoW) and participatory research best practice (GROW, TREQ) to create and conduct engaging, collaborative participatory activities.
- Workshops gathered representatives of iU&Mi's target audience and experts who followed our principled process to co-design the recommender system's architecture and co-evaluate it.
- Contributions: (1) a system blueprint that creatively combines complementary components from across the AI tech spectrum and (2) a rigorous evaluation framework with calculated metrics assessing the blueprint's quality.
- Future work: build on current results to develop of a fully articulated responsible AI development methodology for social good.

Discussion

