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TERRITORI APERTI

City Reconstruction Planner with Social Perspective

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Outlines

- Motivating Scenario
- Main Challenges
- Research Problems
- Propose Methodology
- Implementation
- Evaluation and Results
- Conclusion and Future work

Motivating Scenario

- ➢Post-disaster Reconstruction Planner
- ➢Post disaster
  - ✓ Relief
  - ✓ Recovery
  - ✓ Development
- ➢Online Service Management
  - ✓ Decision Support System

Motivating Scenario

✓Decision Support system

- Maintinance of buildings
- Maintinance of roads/bridges
- Social benefits of community

Main Challenges

- ➢ Manual maintinace plan is risky and error prone
- ➢ Existing models do not consider key attributes
- ➢ Key concepts we consider in our approach are;
    - ✓ Social benefits
    - ✓ Political Priorities
    - ✓ Physical Dependencies

Research Problems

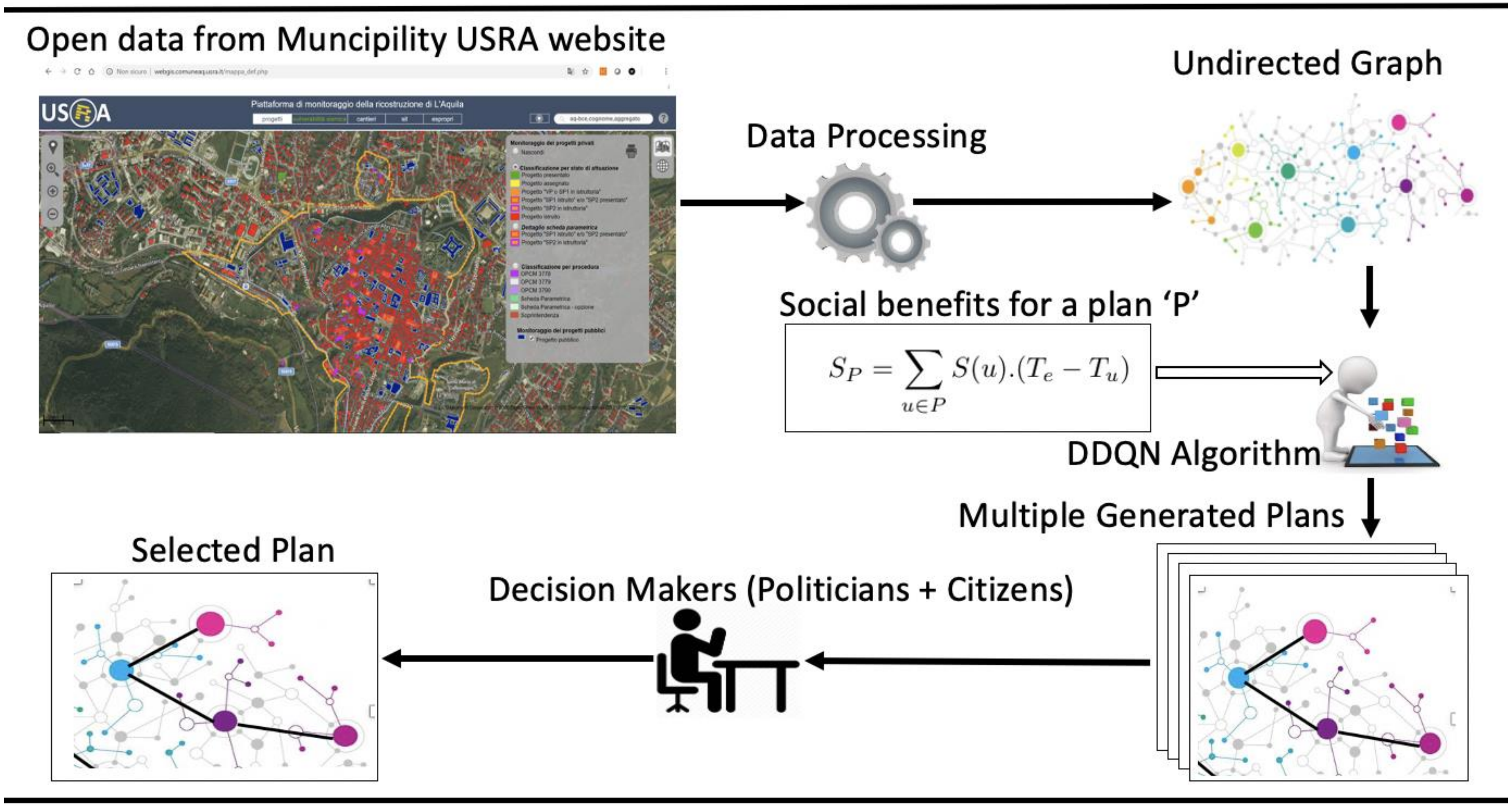
RQ1: Which is the best way to embeds the **political strategies** and **political priority** into the maintenance planning model?

RQ2: How can we model local **community needs (namely, social benefits)** and embed them into maintenance planning model?

RQ3: How can we model the **physical dependencies** and embed them into maintenance planning model?

RQ4: How do we validate the proposed **maintenance planning** approach?

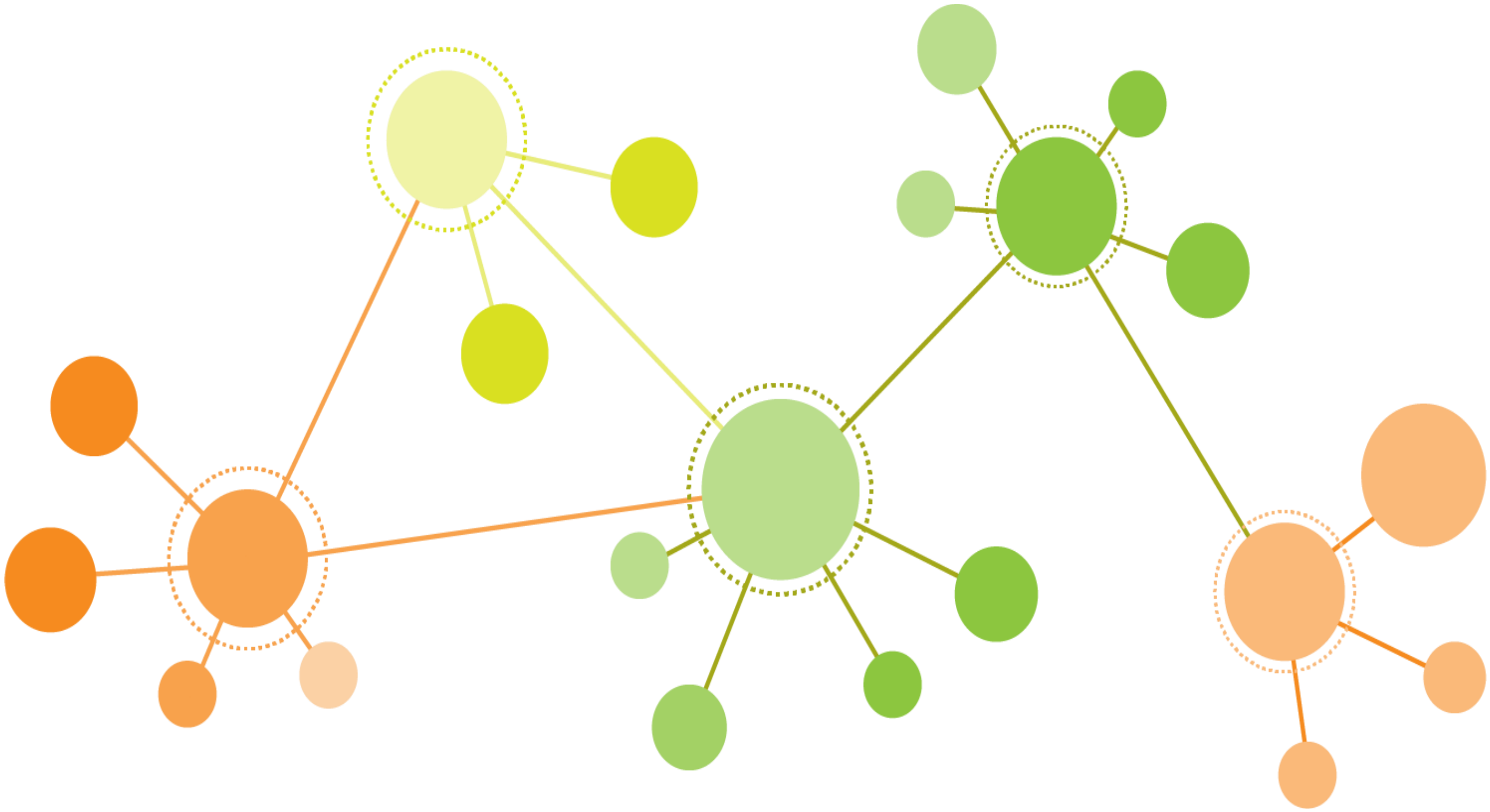
Methodology



How we will achieve this goal?

- Data Extraction of selected area to build a graph model
- Design Mathematical model
- Solved the problem by using DDQN
- Validate model

Visualization of City which needs maintenance

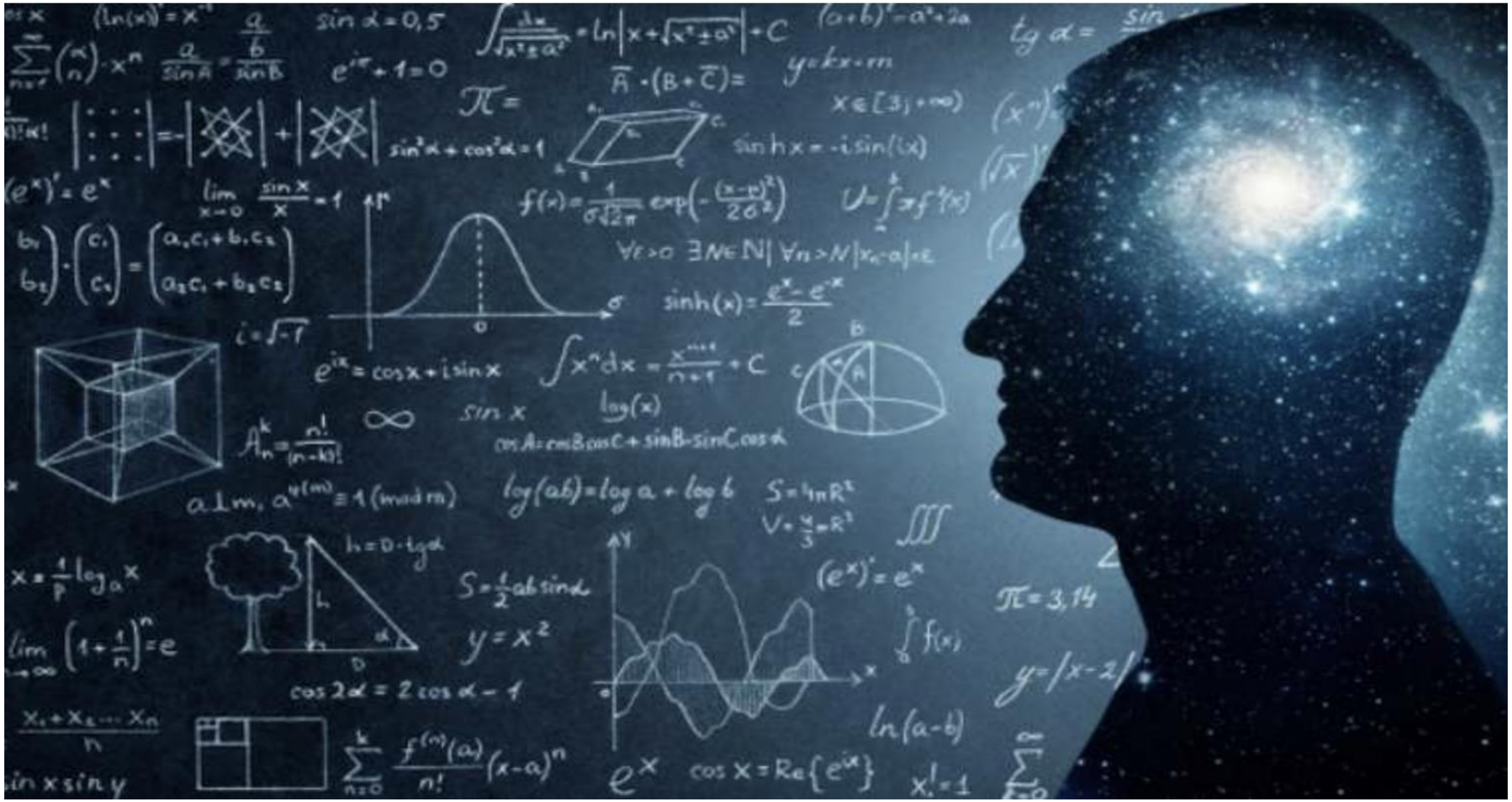


Modeling the city/area

Labelled undirected graph G(V,E) where

- ✓ V= Set of vertices ‘v’ that represents single unit
- ✓ E= Set of edges ‘e’ that represents adjacency between two units
- ✓ d (v1, v2) = label on the edges representing a function that specify the distance between two maintinance units

Mathematical Model



Main Ingredients in the Model (1/3)

Time : concerns the time required to construct any damage unit/building.

$$max_{v \in P} T_v \leq T_e$$

Cost: concerns the cost required to construct any damage unit/building.

$$\sum_{v \in P} C_v \leq Budget$$

Political Priority : imposes a threshold on the plan in order to guarantee that the building plan respects the set political strategies

$$\text{Political Constraints} : \frac{\sum_{v \in P} P_v}{|P|} \geq 80$$

Main Ingredients in the Model (2/3)

Social benefits : concerns the number of people who will use any unit/building, describe how much the plan is beneficial for the local community

$$P = \{(v_0), (v_1)(v_2)(v_3)....\}$$

$$max \sum_{p \in P} S(v_p).(T_e)$$

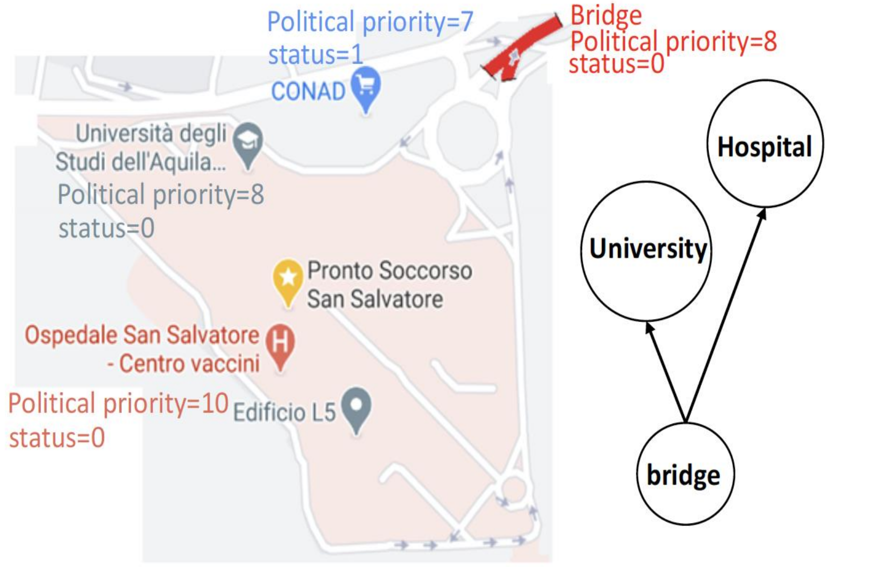
Main Ingredients in the Model (3/3)

Physical dependencies: among units which need maintenance (like bridge/flyover) that impose ordering in the building maintenance

$$\exists\ v \in P\ that\ is$$

$$e = (v, \overline{v})$$

$$\overline{v} \notin p \text{ and } s_v = 1$$



a. Enriched City Map b. Physical Dependencies Graph

Model- *Optimization Function*

$$S_P = \sum_{v \in P} S(v).(T_e - T_v)$$

pdRPP- Model Implementation

Double Deep Q-Learning Netwrok

- Markov Decision Process

- Bellman Equation

$$Q(s,a;\theta) = S_r(v) + \gamma \max_{a' \in A_v} Q'(s',a';\theta_i^-)$$

- Neural Networks

$$L_i(\theta_i) = E[(\overbrace{S_r(v) + \gamma \max_{a' \in A_v} Q'(s',a';\theta_i^-)}^{\text{Q-target}} - \overbrace{Q(s,a;\theta_i)}^{\text{Q-network}})]^2$$

Implementation: Fixed Parameters

Fixed Parameters	**Value**
Optimizer	Adam optimizer, learning rate = 0.001
Loss function	Mean squared error, Eq. 8
Q-Learning function	Q(s,a;θ) $= S_r(v)+\gamma \max_{a' \in A_v} Q'(s',a';\theta_i^-)$
Batch size	32
Steps before training	15000
Maximum memory size	2000
Political Priority	Minimum=0 , Maximum =10
Exploration strategy	Epsilon greedy policy (Epsilon $\in 10^{-7}, 1$ and self.epsilon_ decay=0.0003.)
Reward discount factor	self.discount_factor = 0.95
Input Parameters	‘Budget’ and ‘Time’ (T_e)

Why I choose Double Deep Q-Learning?

- Action Space issue
- Complexity increase
- Not recommended for million of states

Results Summary

- The proposed model will be an efficient mechanism to define maintenance plans on behalf of social benefits.
- Proposed framework provides a set of alternative plans which contain different order of maintenance units.
- Every plan satisfies time, budget and political priority constraints.
- The proposed approach has the ability to identify and consider physical dependencies among reconstruction units.

Conclusion and Future Work

- pd-RPP is comprehensive and multi-attributes decision support system for post- disaster reconstruction planning.
- Used Dual Deep Q-Network (DDQN) for implementation
- The proposed model minimizes human errors in reconstruction planning.
- **In future** work we will make comparison of maintenance model with conventional/traditional and scientific approaches.

THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS?