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Poster: Optimising Electric Vehicle Charging Infrastructure in Dublin using GEECharge

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Optimising Electric Vehicle Charging Infrastructure in Dublin using GEECharge

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Abstract

Range anxiety poses a hurdle to the adoption of Electric Vehicles (EVs), as drivers worry about running out of charge without timely access to a Charging Point (CP). We present novel methods for optimising the distribution of CPs, namely, EV portacharge and GEECharge. Our findings show that;

- The optimal number of Charging Points for a $1\,\mathrm{km}^2$ area in Dublin is **121 CPs**.
- Success occurs when an EV reaches a CP which is $500\,\mathrm{m}$ or less from its current location.
- The GEECharge method, exhibits a **2.2%** higher efficiency compared to the EV Portacharge method.

The Current EV Charging Network in Dublin

The number of EVs in Dublin increased by 8490 between January and July 2023. We currently have 130 Charging Stations which is a very low number.

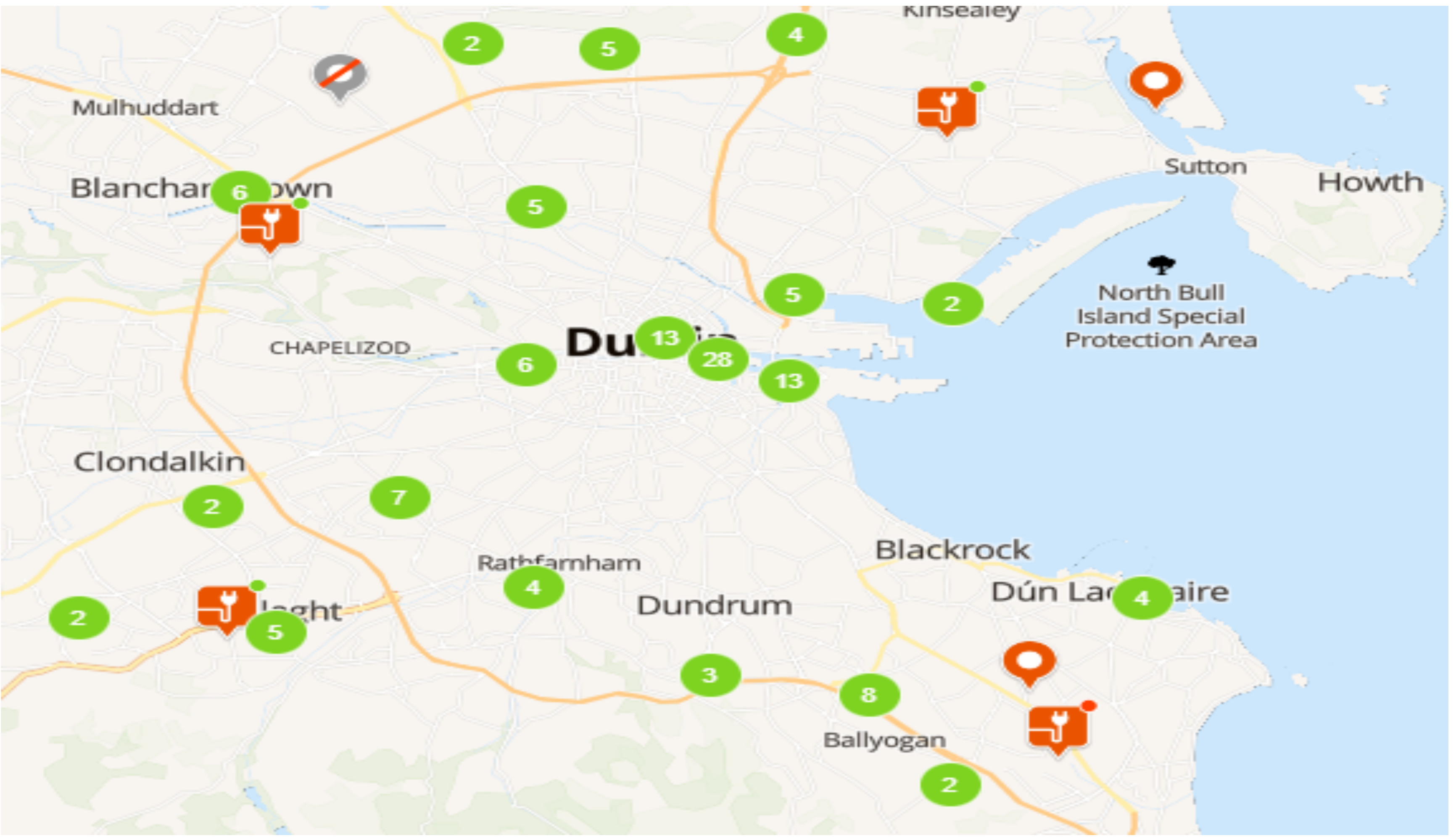

Figure 1. The Current Charging Stations Distribution in Dublin

GEECharge and EV Portacharge Methods Design

The EV Portacharge assigns scores based on Population Density and Points Of Interest (POIs). The GEECharge method adds the most used roads in each cell.

- Population Density Score d: $1 \leq d \leq 6$. The lowest Population Density corresponds to 1 and the highest corresponds to 6.
- POIs Scores p: $0 \leq p \leq 20$. POIs are places such as university campuses, supermarkets, hospitals, cinemas and tourist places.
- Road usage score $u(t)$: $0 \leq u \leq 4$. We choose roads with the maximum traffic.

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Population Density and Points Of Interest in Dublin

Figure 2. The heatmap gradient goes from blue and red, showing the intensity in the intersections in Dublin City.

Figure 3. This graph shows the most roads for June 2021 using the blue lines.

EV Portacharge and GEECharge

EV Portacharge

$$s_1(r,c) = \frac{d(r,c)w_d + p(r,c)w_p}{\sum_{r=1}^{6}\sum_{c=1}^{10}(d(r,c)w_d + p(r,c)w_p)} \times 100$$

GEECharge

$$s_2(r,c) = \frac{d(r,c)w_d + t(r,c)w_t + p(r,c)w_p}{\sum_{r=1}^{6}\sum_{c=1}^{10}(d(r,c)w_d + t(r,c)w_t + p(r,c)w_p)} \times 100$$

EV Portacharge Versus GEECharge Simulation Results.

- Before stopping, an EV can drive $1\,\mathrm{km}$ at low speed to reach a CP.
- The simulation assumed around 100 cars passed through an intersection hourly, and most EVs had a range of approximately $400\,\mathrm{km}$.

Runs	Run 1	Run 2	Run 3	Run 4
Parameters	100 CP	50 CP	100 CP	50 CP
Success Rate	71.7	45	69.5	42
Mean distance to the nearest CP (m)	415	455	456	669

Table 1. GEECharge and EV Portacharge Simulation results.

GEECharge: 121 Charging Points

Numerical Evaluation

- We find that 121 Charging Points is the suitable number for a $1\,\mathrm{km}^2$ area on average assuming all EVs have a range of $400\,\mathrm{km}$.
- GEECharge is 2.2% more efficient than EV Portacharge

GEECharge Discussion

In the GEECharge solution, 119 EV routes were simulated, and 90 EVs were successful in being within $500\,\mathrm{m}$ of a CP at the end of the simulation.

GEECharge Simulation

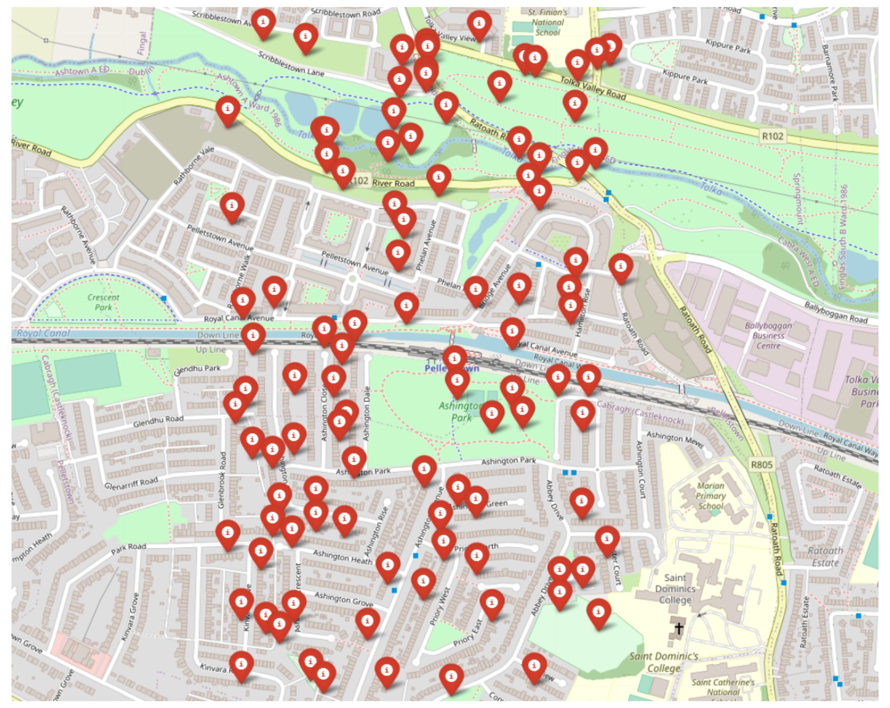

Figure 4. Charging points distribution of one selected cell

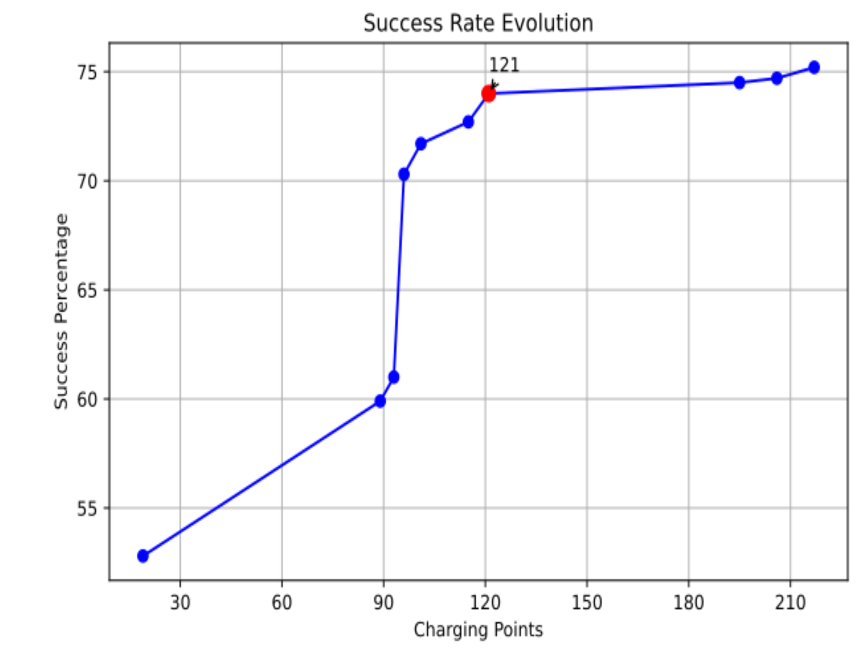

Figure 5. Success rate percentage against the number of charging stations

Conclusion

- GEECharge will be help in determining the distribution of Charging Points.
- The research targets city drivers.
- Discrete Event Simulation is reproducible in other cities.

Acknowledgement

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Key References

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