Colossal Trajectory Mining
Semantic Co-movement Pattern Mining

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Spatio-temporal mobility patterns are at the core of urban planning applications

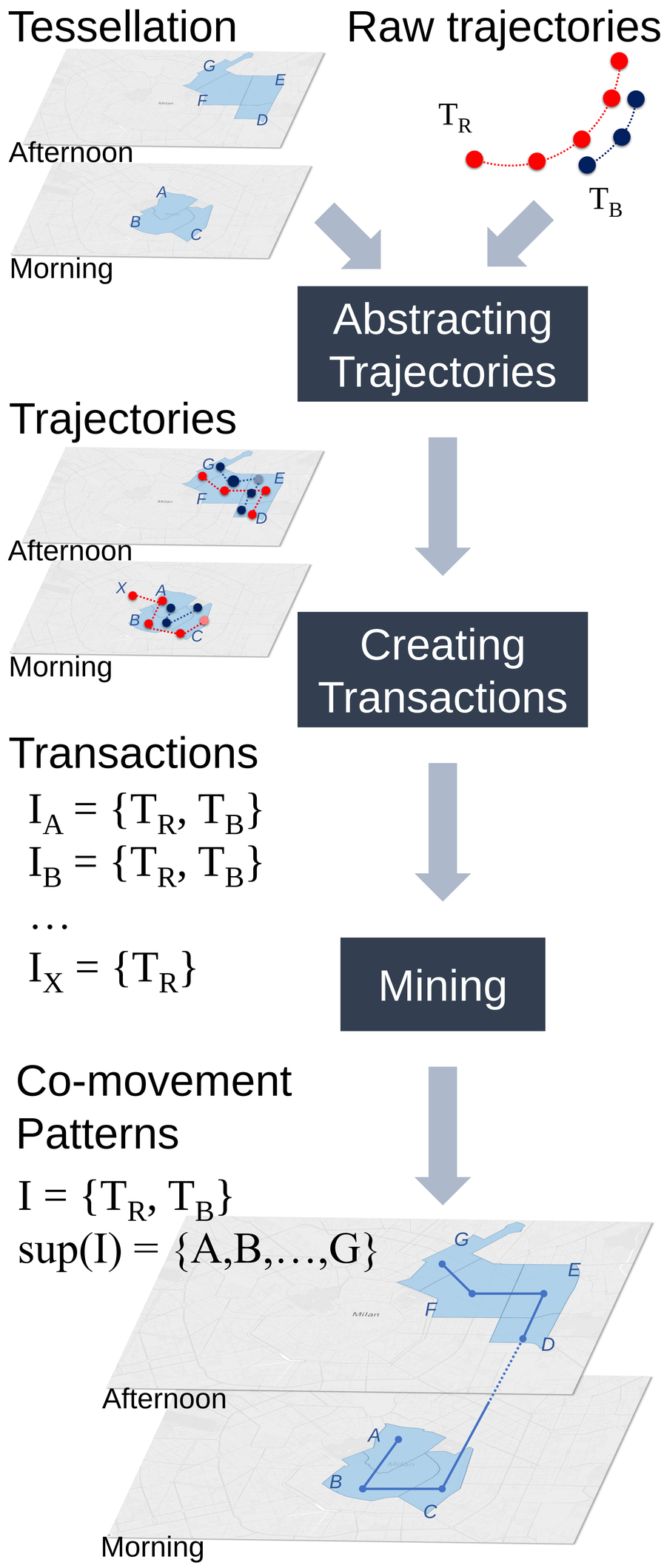
- Mobility patterns can be defined depending on spatiotemporal constraints (co-location, flow, swarm, convoy)
- Existing approaches extract **small** groups of objects sharing **fine-grained** paths
  - Many approaches for single patterns
  - One approach (SPARE) manages the four types of co-movement patterns

Milan has 88 districts (NIL) with over $3 \cdot 10^6$ inhabitants (i.e., potential MOs)

- **Coarse-grained**: finding groups of 100 people in a NIL with 16K residents could require to enumerate $\binom{16000}{100}$ groups!
- **Semantic features**: how do people move within the districts at different times of the day?

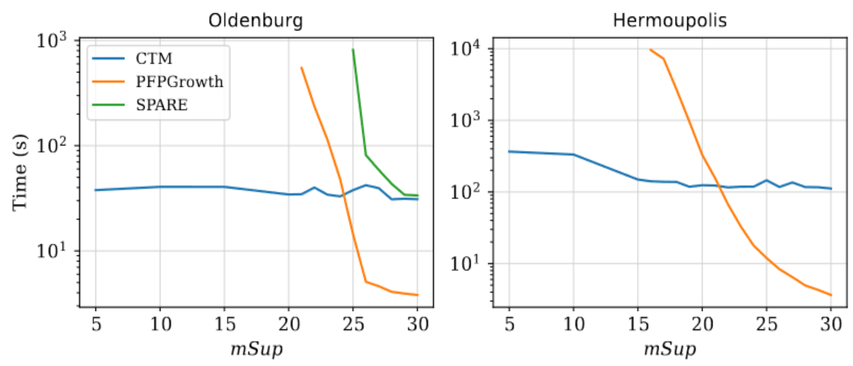
Rather than enumerating groups of MOs and computing the similarity of their trajectories...

- **Map** trajectories into a multidimensional tessellation
  - Tessellation defines the granularity of the analysis
  - We can **consider semantic dimensions** (e.g., means of transport, activity, times of the day)
- **Create a transactional dataset** (1 transaction=1 tile)
- **Mine the co-movement patterns**
  - Bread-first row-enumeration approach: high parallelism plus early pruning through constraints
  - **Colossal**: by combining the tessellation's tiles (and not the MOs), CTM is highly efficient when #transactions (tiles) << items (#MOs)
  - Mine different pattern types depending on spatio-temporal constraints



Milan ($mCrd = 100$, $mSup = 12$)

Type	$\lvert S\rvert$	Patterns	Enum.	Time (s)	Shape check	Card. check	Red. check
Flow	88	$9.7 \cdot 10^4$	$2.1 \cdot 10^7$	31	53%	82%	30%
Co-loc.	88	$2.3 \cdot 10^5$	$2.6 \cdot 10^7$	44	31%	82%	31%
Convoy[4]	528	0	$5.5 \cdot 10^8$	180	1%	99%	90%
Swarm	528	124	$3.0 \cdot 10^8$	127	8.2%	98%	70%



References

- Francia Matteo et al. “Colossal Trajectory Mining: A unifying approach to mine behavioral mobility patterns.” **Expert Systems with Applications** 238 (2024): 122055.

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