Learning ORDER: Learning for Operationalizing Data into Energy Management

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E4F Interview Committee-Smart Grids/MIT

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A few words about myself...

Vladimir (**Vlad**) Dvorkin

2015-2021 M.Sc.+Ph.D. in Electrical Engineering from DTU (Danmarks Tekniske Universitet)

2019 (1/2) Visiting scholar at GeorgiaTech (Industrial and Systems Eng.)

March 2021 Ph.D. thesis defense

Present Postdoctoral associate at MIT

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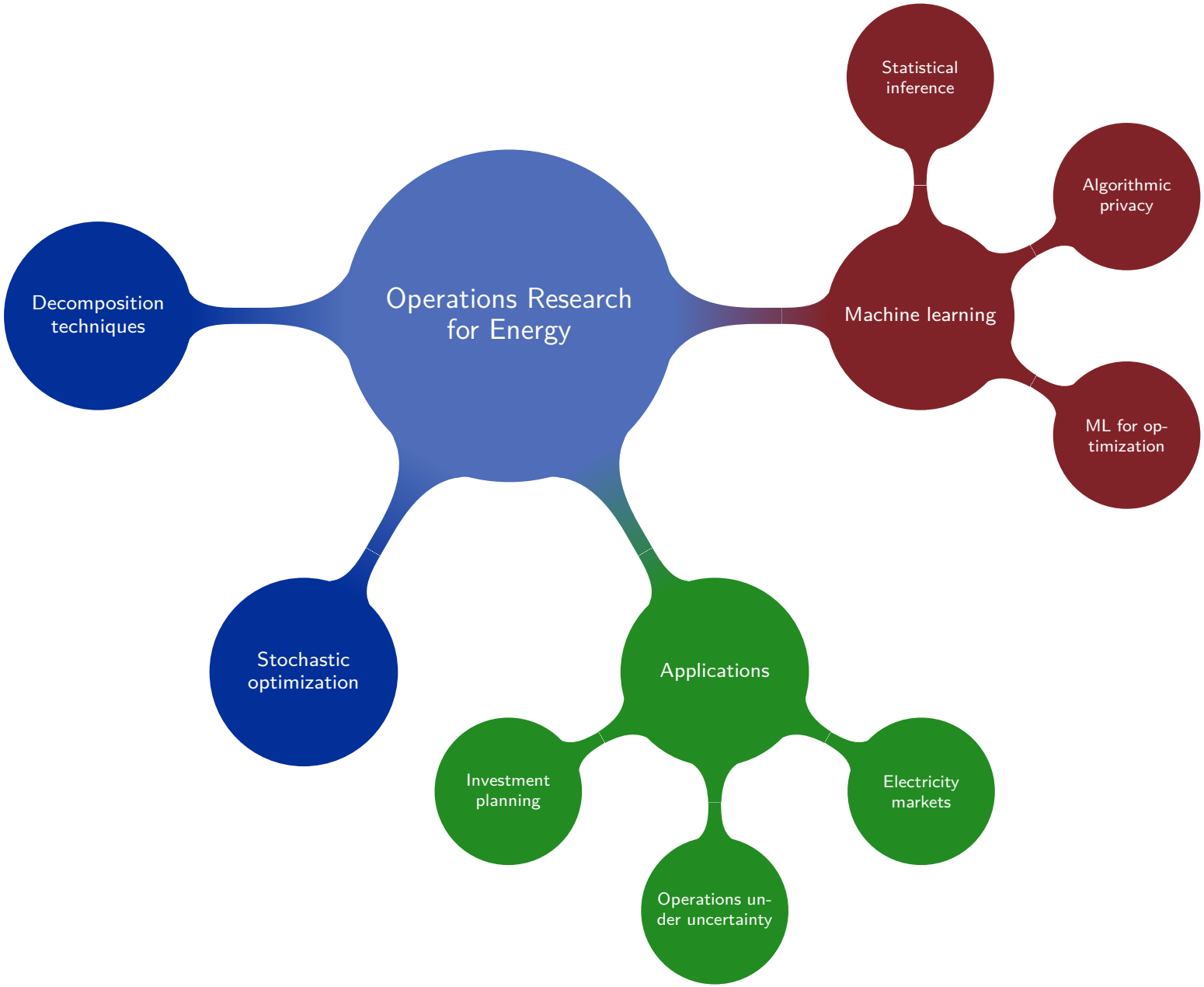
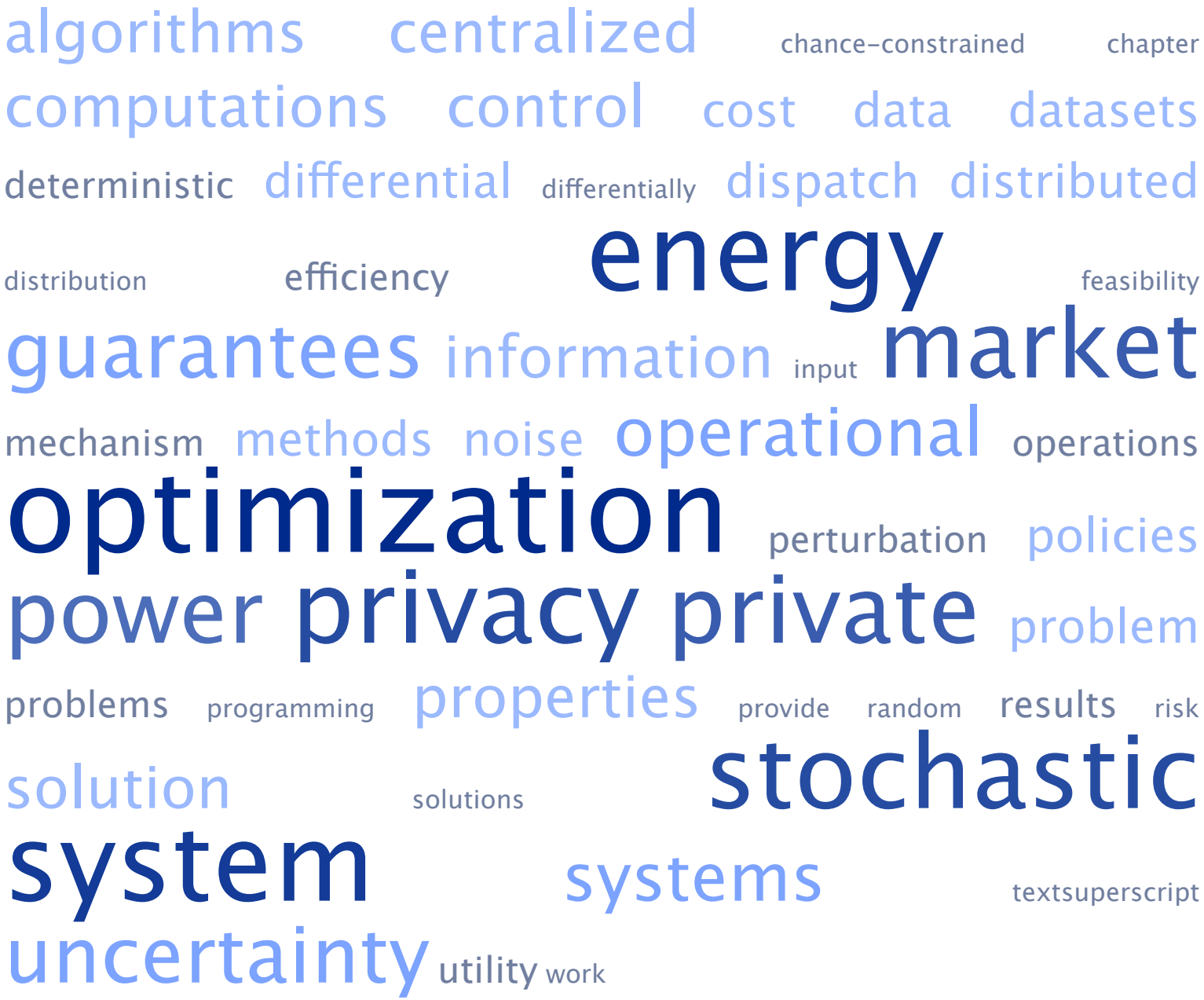
My research (biased picture)

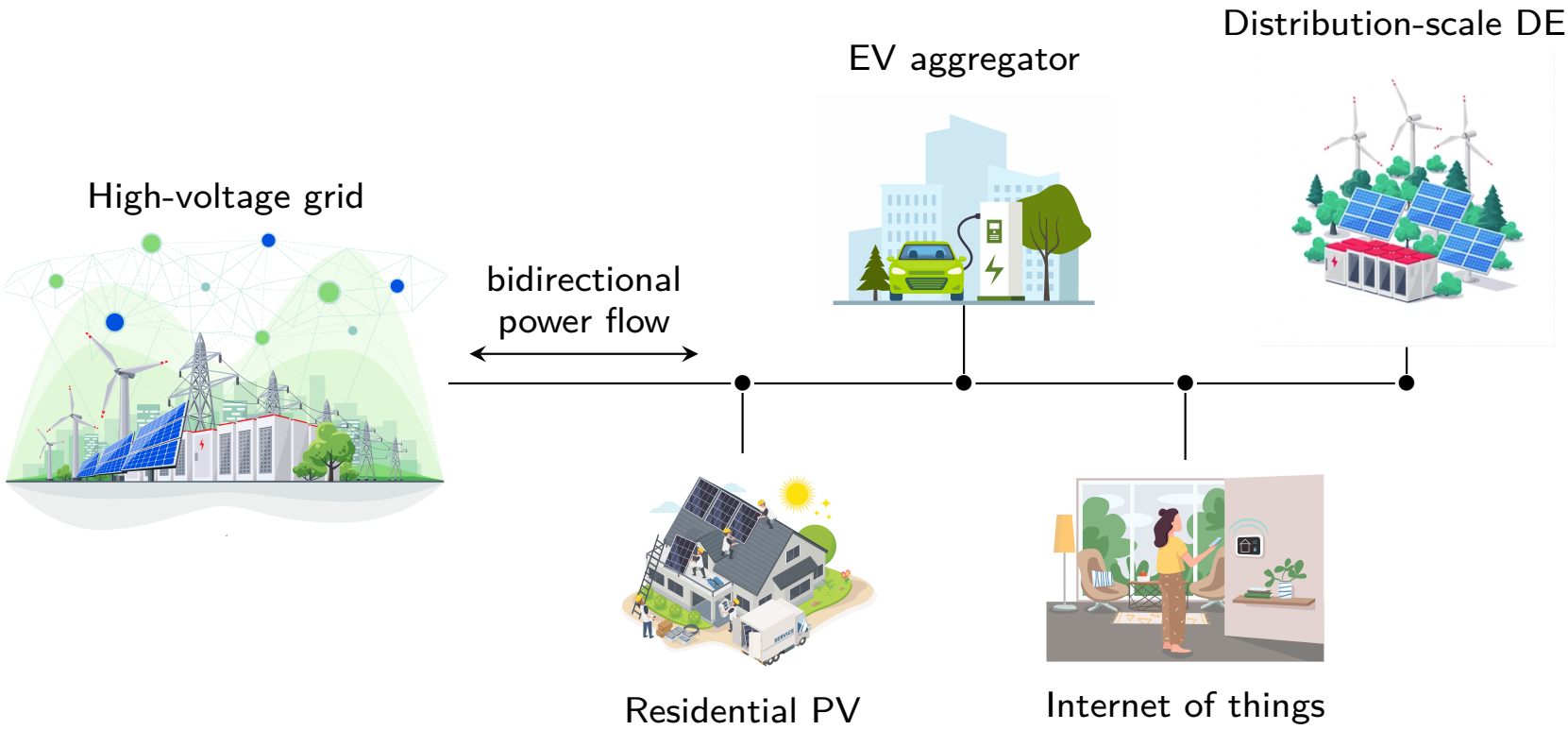


My research (unbiased picture ... compiled from my thesis)



A modern view on distribution grid operations - Part I

- More control opportunities thanks to many inverter-interfaced DERs
- More distributed grid data as more agents/devices engage with the grid
- More operational flexibility to balance distribution grids in real-time
- DSO tasks: real-time grid control, demand response, transmission-distribution coordination
- Cost and "beyond cost" objectives (e.g., local energy supply, emission-aware dispatch)



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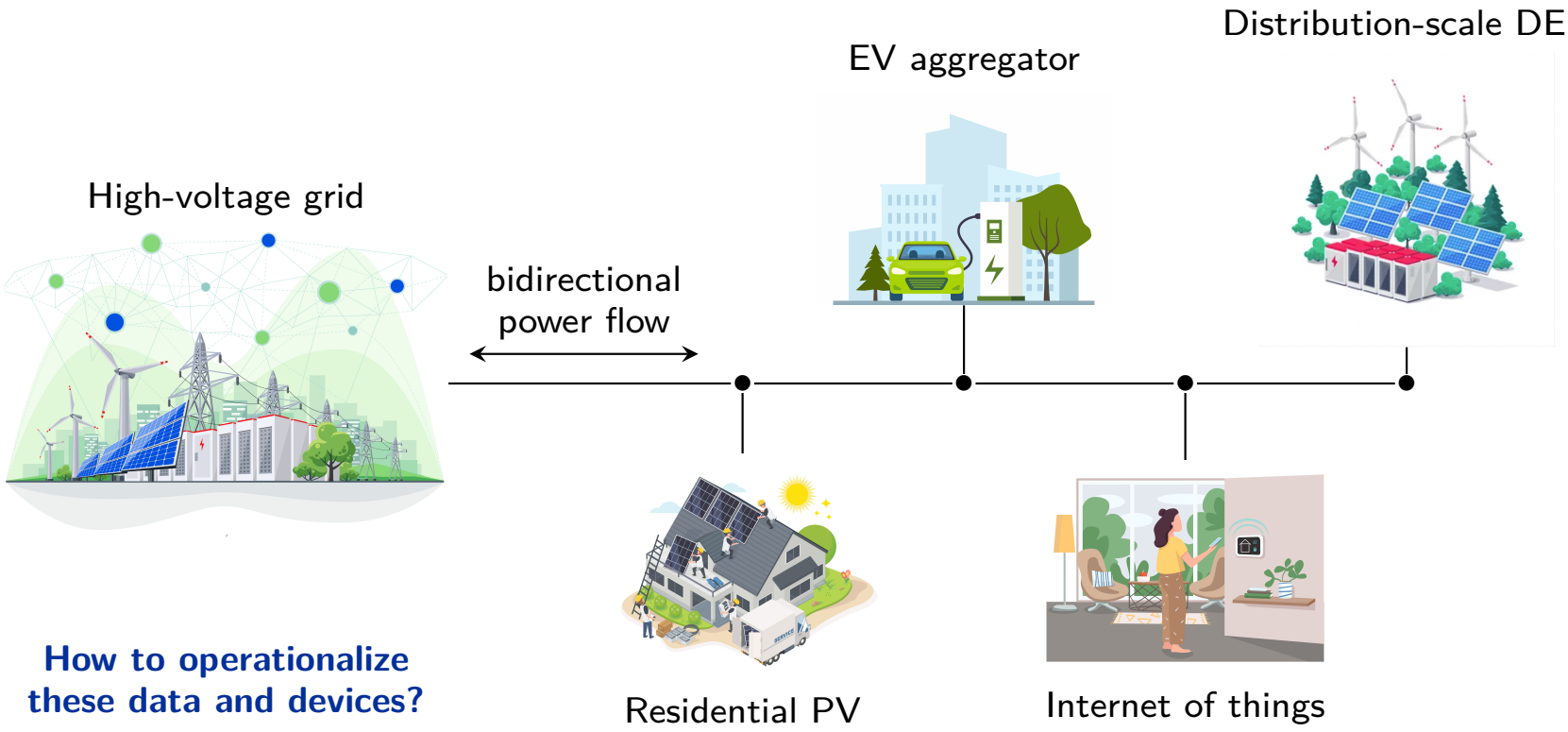
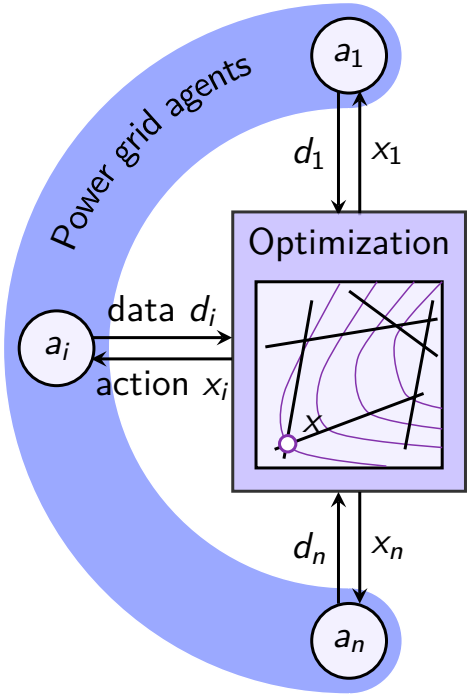


A modern view on distribution grid operations - Part II



- Agents submit data $d_1, \ldots, d_n$
- Operational task is optimized centrally
- Agents receive and implement control actions $x_1, \ldots, x_n$

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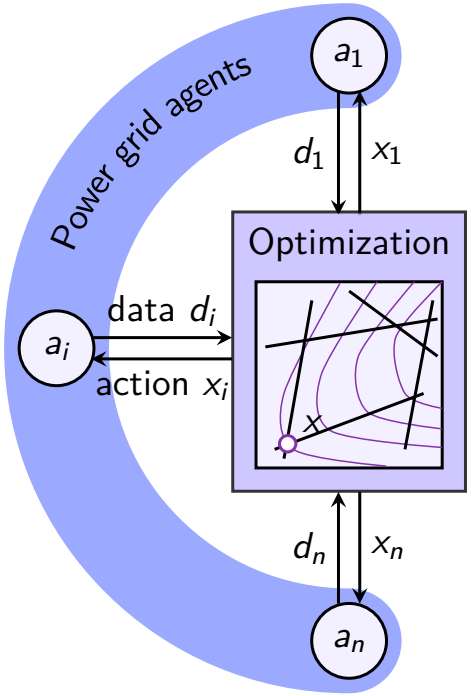

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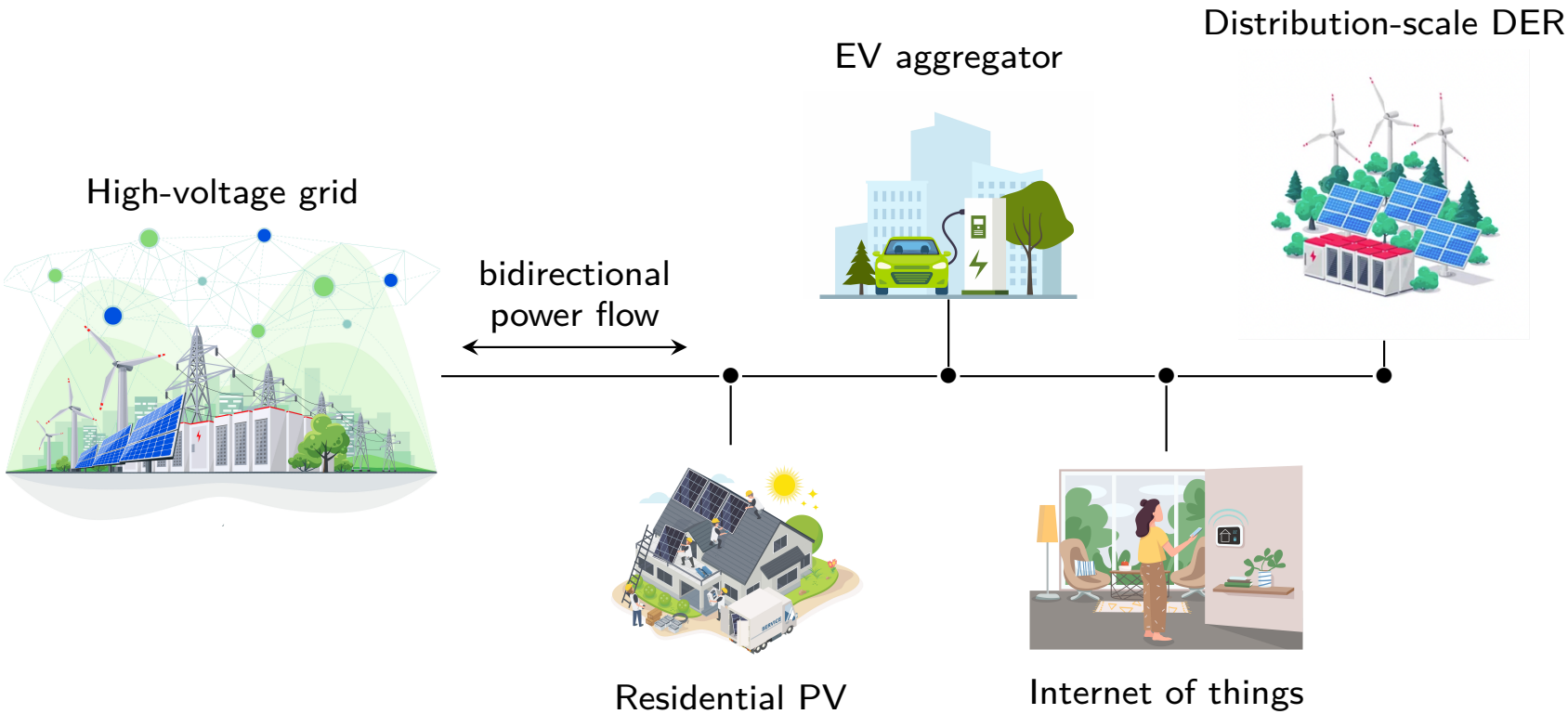
Optimization-based operations face many **challenges**:

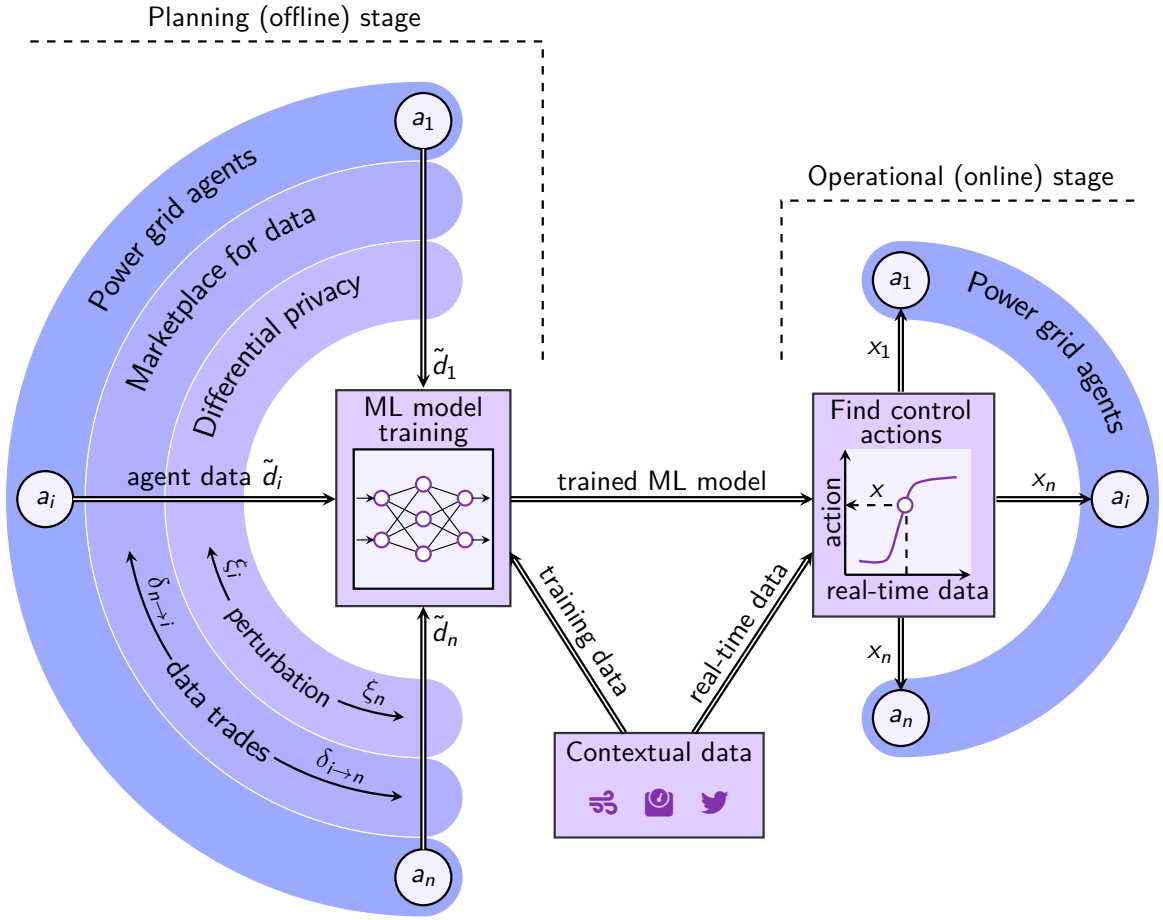
- Missing incentives for data sharing: privacy risks, compensations, etc.
- Transmitting thousands of data streams in real-time is expensive
- Centralized computation is slow to optimize thousands of devices
- Barriers for contextual data (e.g., weather information, social media information)

A postmodern (?) view on distribution grid operations - Part I

- From **optimization-based** to **learning-based** grid management
- Each controllable device is given a policy which guides its operations
- The goal is learn the optimal policy for autonomous distribution grid operations



A postmodern (?) view on distribution grid operations - Part II



- **Planning stage:** collects grid data and learns the optimal control policies offline
- **Operational stage:** deploys control policies using real-time contextual data (weather, ...)

- **Key features:**
  - Incentives for safe data sharing
  - Small data and communication requirements in real-time operations
  - No barriers for contextual data

Three core research thrusts

Thrust 1: Marketplace for electric power grid data

Goal	Methods	Broader impact
▪ Incentives for data sharing	▪ Game theory ▪ Sampling theory	▪ From passive to active role of data ▪ New forms of customer engagement

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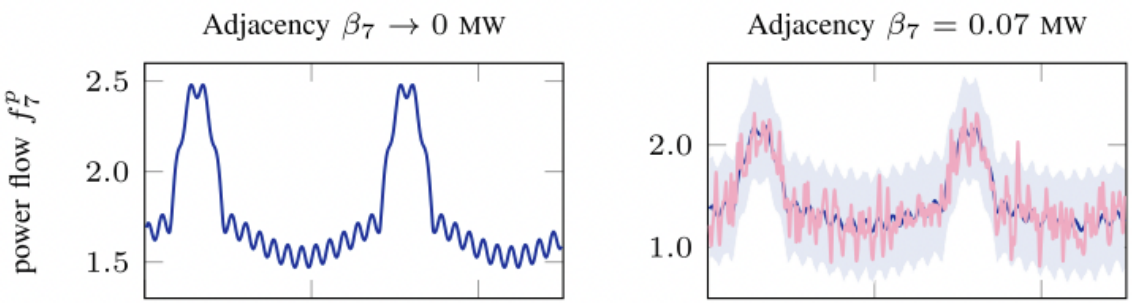

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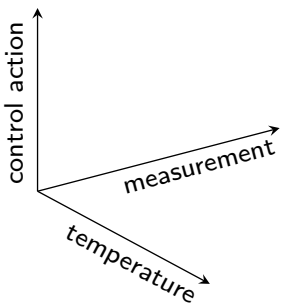
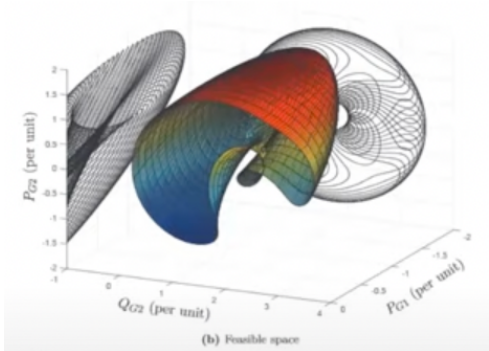
Goal	Methods	Broader impact
▪ Learning-based grid control ▪ Performance certificates	▪ Machine learning ▪ Optimization	▪ New operational paradigm/industry ▪ Trust in machine learning models





(b) Feasible space

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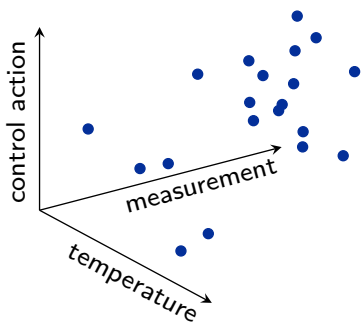

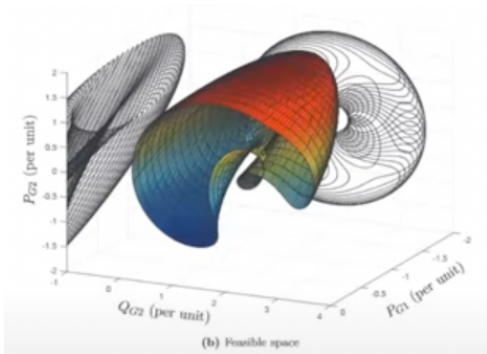

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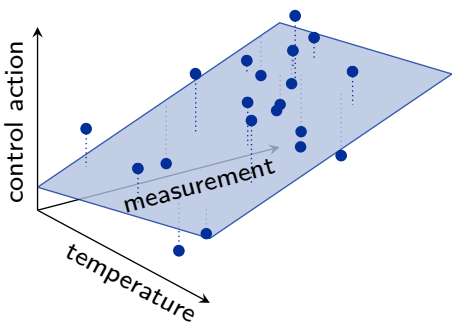
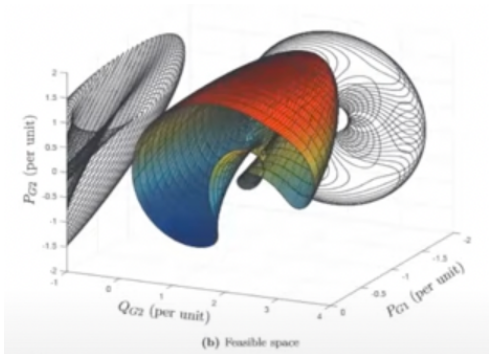
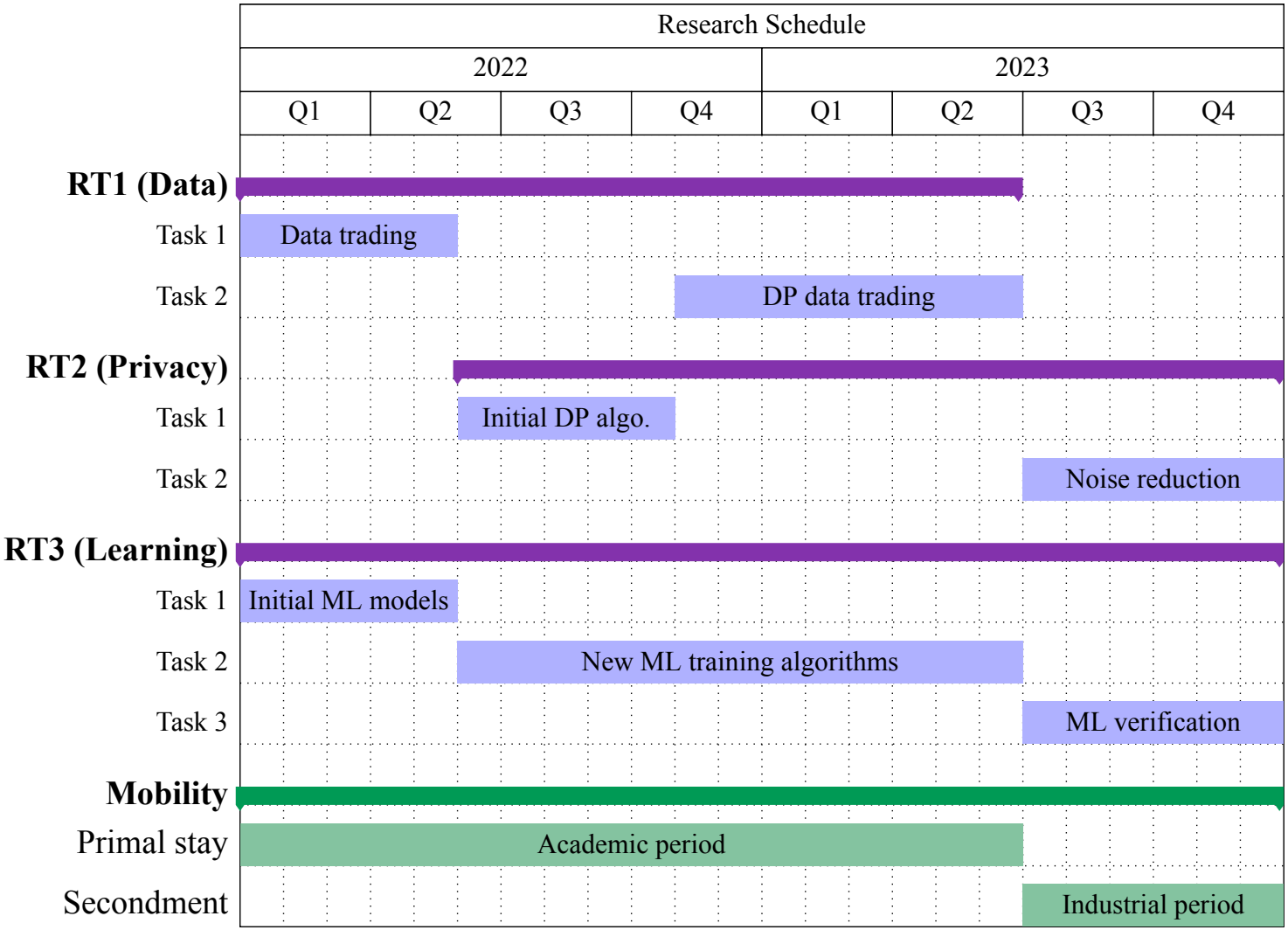




Research schedule (at most two tasks at a time)



That you for your attention!