DIGITALIZATION AND DIGITAL TWINS

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SINTEF Energy Research

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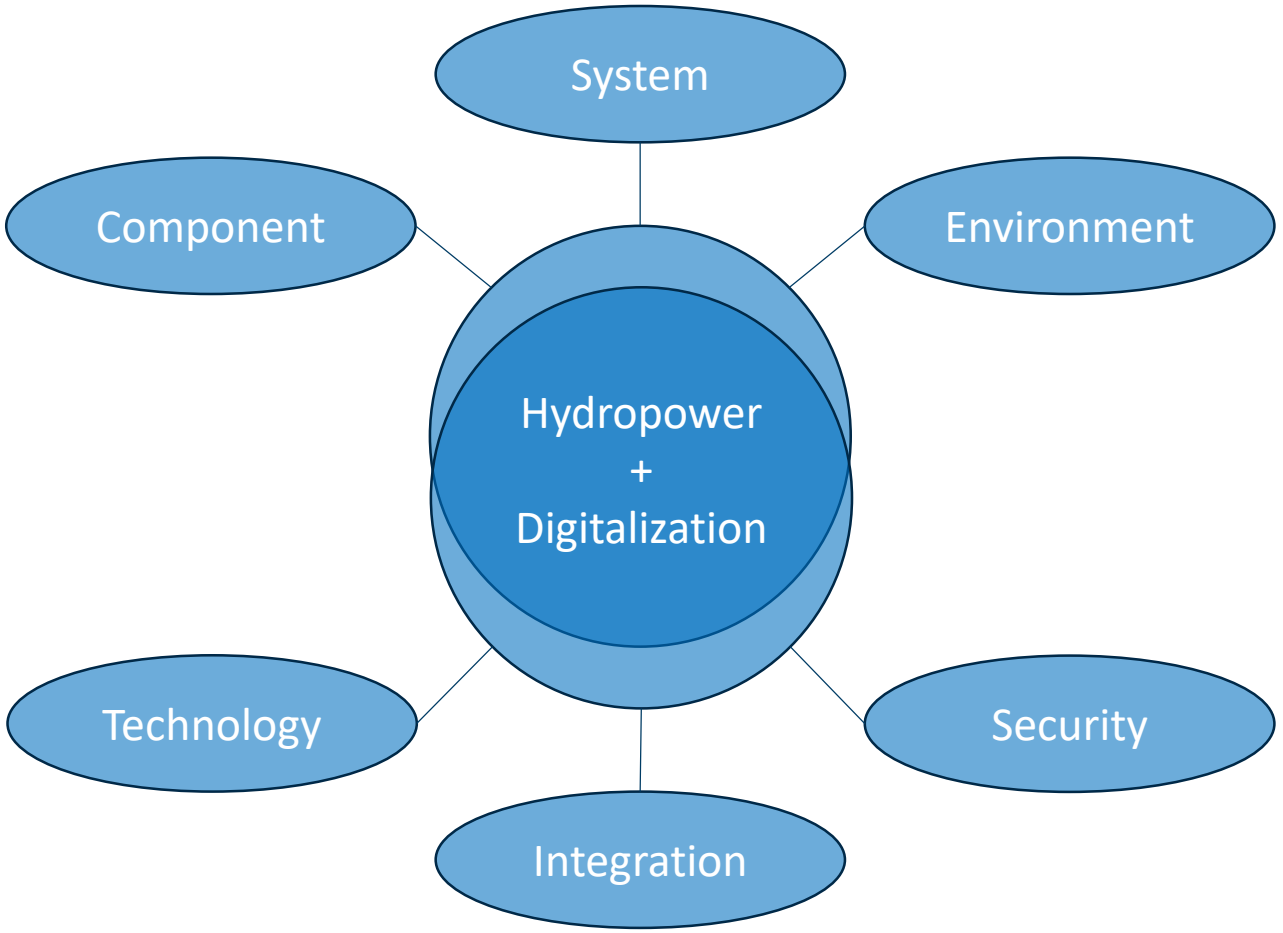
Digitalization of hydropower



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Digitalization of Hydropower

Hydropower			ICT		
Component	System	Environment	Technology	Integration	Security

- Installation and operation of sensor systems
- Streamlined maintenance processes, from interval based to condition based
- Increased flexibility due to better monitoring
- Digital twin of turbine, generator and hydraulic structures

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Digitalization of Hydropower

Hydropower			ICT		
Component	System	Environment	Technology	Integration	Security

- Cost effective unification of operation and maintenance
- System services from virtual powerplants
- New business models from digital platforms
- Interfaces to other digitalization initiatives
- Digital twin from dam to outlet

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Digitalization of Hydropower

Hydropower			ICT		
Component	System	Environment	Technology	Integration	Security

- Improved models from increased availability of data
- Image processing for monitoring of fish populations
- Scanning rivers with drones and satellites
- Digital twin of the entire river

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Digitalization of Hydropower

Hydropower			ICT		
Component	System	Environment	Technology	Integration	Security

- Quality assurance and harmonization of data
- Benchmarking of methods for big data and machine learning
- Visualization techniques

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Digitalization of Hydropower

Hydropower			ICT		
Component	System	Environment	Technology	Integration	Security

- Acceptance of existing and new technology
- Prevent increased complexity for users of more advanced tools
- Manage knowledge from multiple disciplines

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Digitalization of Hydropower

Hydropower			ICT		
Component	System	Environment	Technology	Integration	Security

- End-to-end encryption of data, edge processing
- Hydropower as an enabler for other renewable energy
- Cyber-attacks gains power as a disabler

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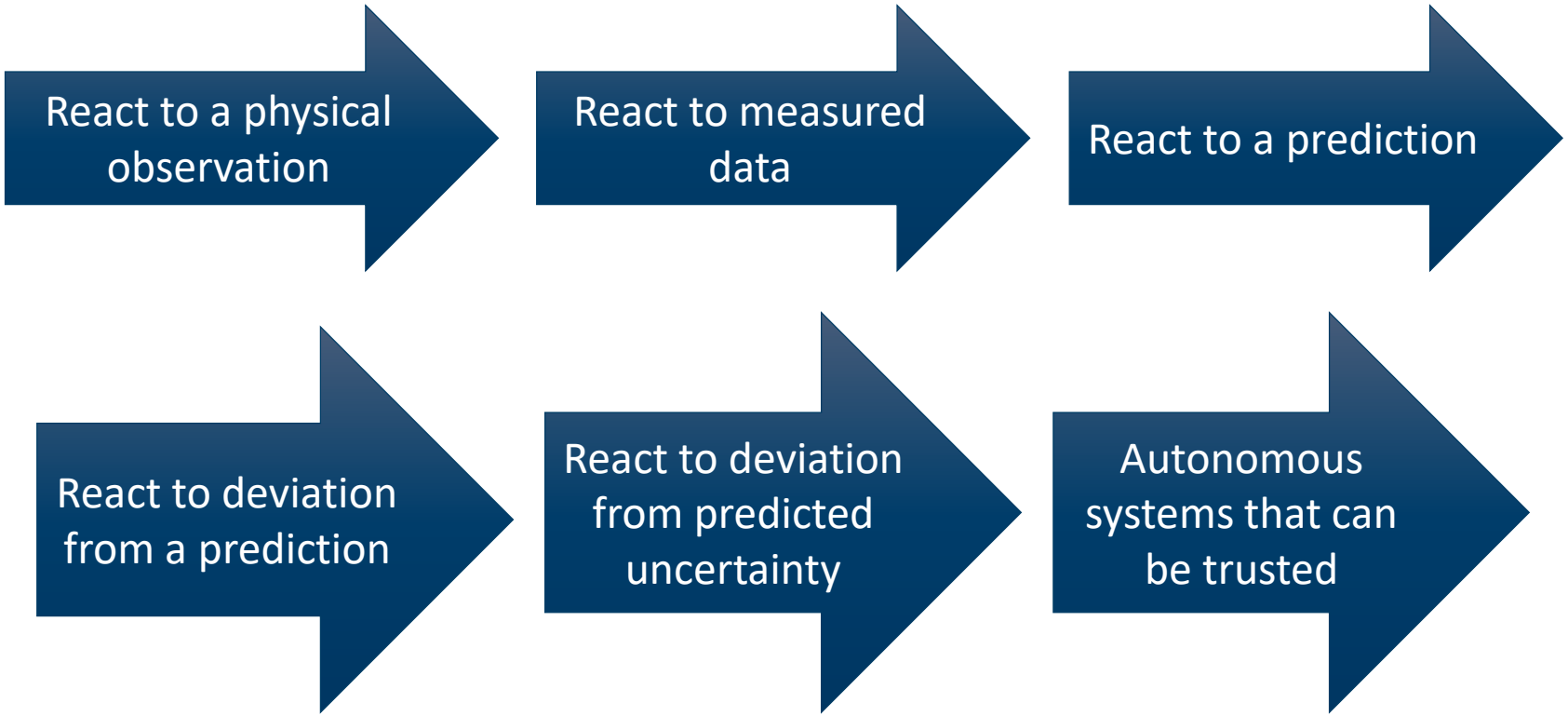
Value creation from more available data

- Digitalisering sjekker om en antakelse er riktig
- Målet bør ikke være å reagere på data, men å forutsi data
- Kvalitet på data er lik læringseffekt
- Et laboratorium sjekker alt som virkeligheten ikke kan gi på bestilling
- Integrasjon av laboratorium gir deg muligheten til å sjekke om dine antakelser om omverdenen er riktige

Digital transformation



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Value of laboratories for digitalization

- Direct access to measurements
- Create situations that cannot be easily created in real life
- Integration of laboratories enable validation of boundary conditions

MonitorX - Background

- Measurements/data available already today
→ Potential data sources for different purposes
- Today these data are not much used for maintenance decisions
→ Potentially large benefit when using these data

Decarbonisation

Decentralization

Digitalization ← MonitorX

Predictive maintenance | Smartgrid | Prosumers

Generation → Transmission → Distribution → Wholesale trading → Retail

Smart production planning | Virtual power plants

Operation (O)

Maintenance (M) ← MonitorX

Forskningsrådet

MonitorX 2015-2019 — Optimal utilization of hydropower asset lifetime by monitoring of technical condition and risk (Optimal levetidsutnyttelse av vannkraftanlegg basert på overvåking av teknisk tilstand og risiko)

MonitorX - Aims

internet of things
machine learning
internet of services
big data
cyber-physical systems
industry 4.0
data mining
predictive maintenance

Results

- Model and algorithms for fault detection (and optimal lifetime utilization)
- Demonstrate practical application in selected power plants (cases)

Benefits

- Reduced maintenance costs by … :
  - … avoiding (catastrophic) faults …
  - … avoiding unnecessary component replacements …
  - … prioritizing the most critical components for maintenance …
  - … optimized maintenance …
- … through early warnings of ageing and potential faults.

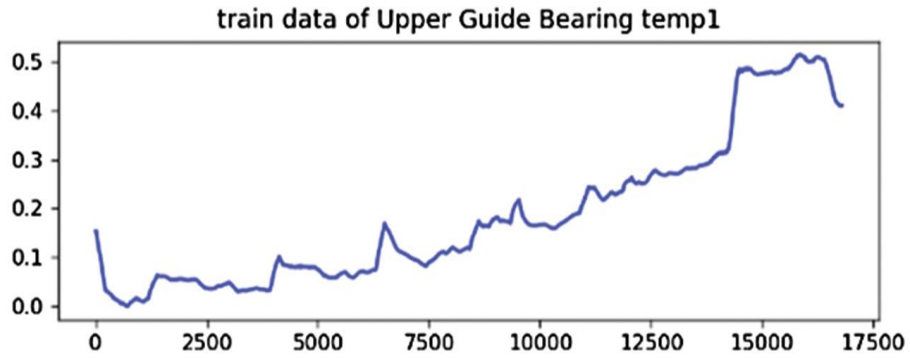
Knowledge gain

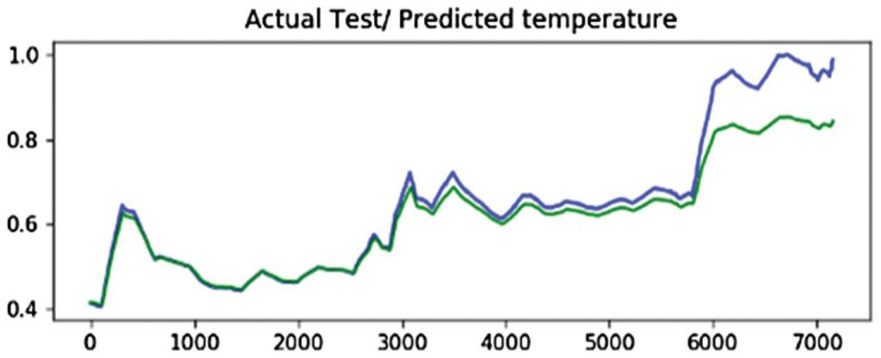
- How can operators utilize the mentioned **concepts and methods** for plant maintenance?
- What are possibilities, challenges & restrictions?
- How can monitoring data be used to carry out maintenance more predictive?

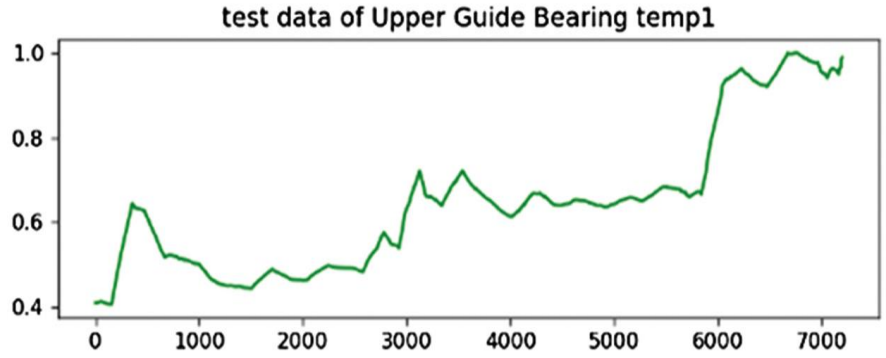
Testing through cases is important part of the project

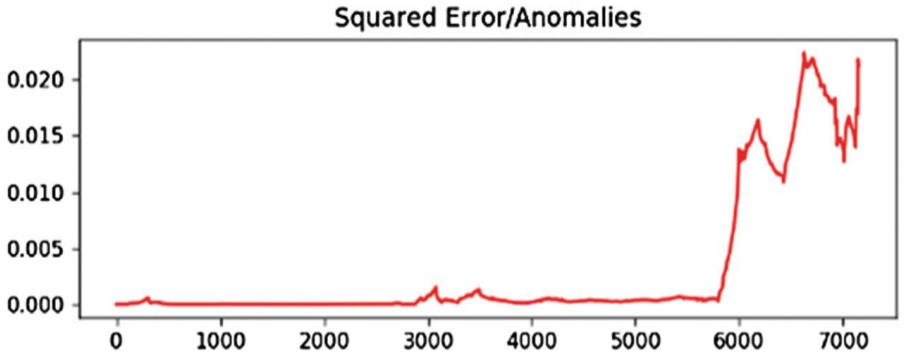
Problem/case identification and description → Modelling & algorithm and prototype development → Testing / demonstration

Example: Generator bearings









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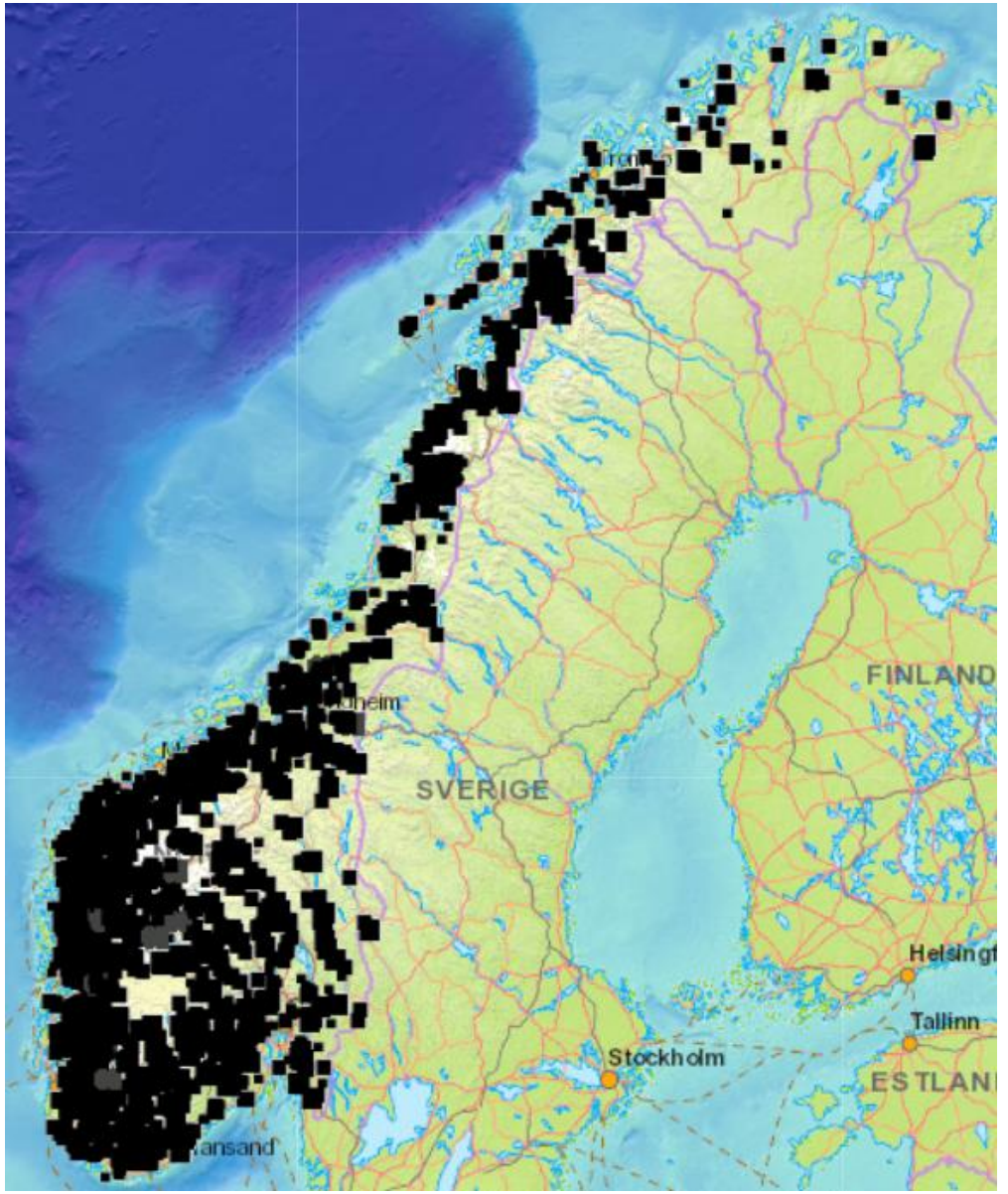
Hydropower in Norway

- 95% of electricity in Norway produced by hydropower
- 1550 hydropower plants and 1000 reservoirs
- Storage capacity for 70% of yearly consumption
- Largest reservoir stores 8.7 TWh
- New cables to Europe are under construction



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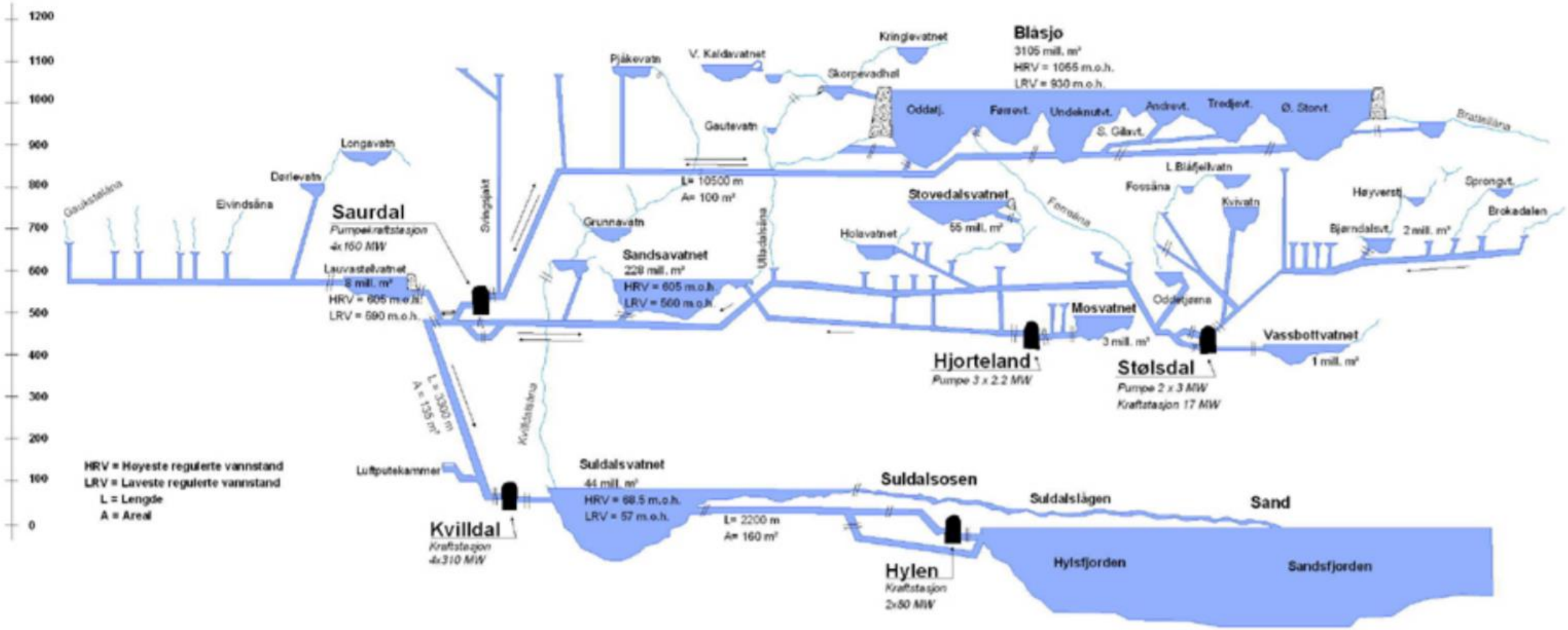
Typical hydro system



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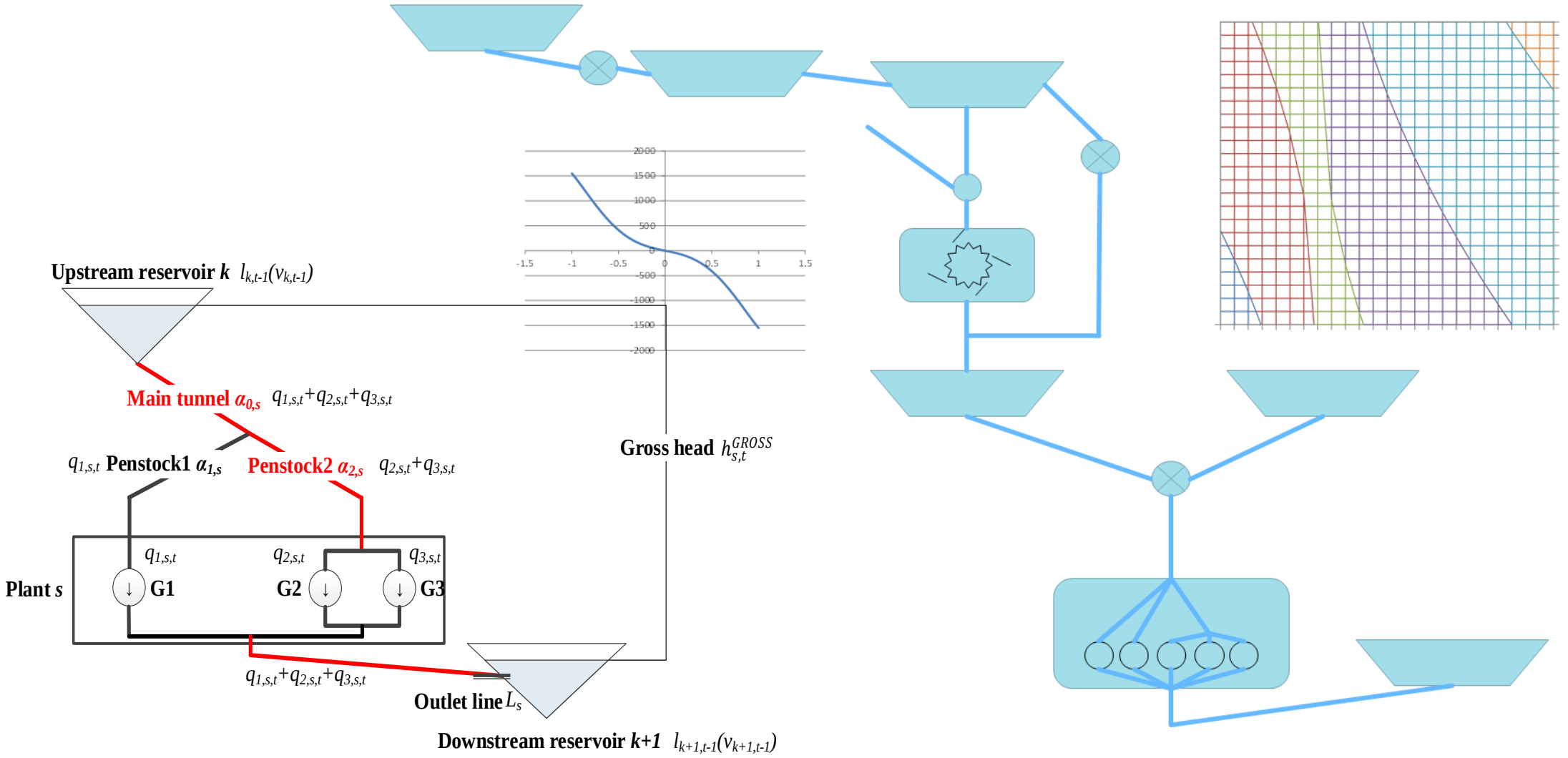
Model of the power system



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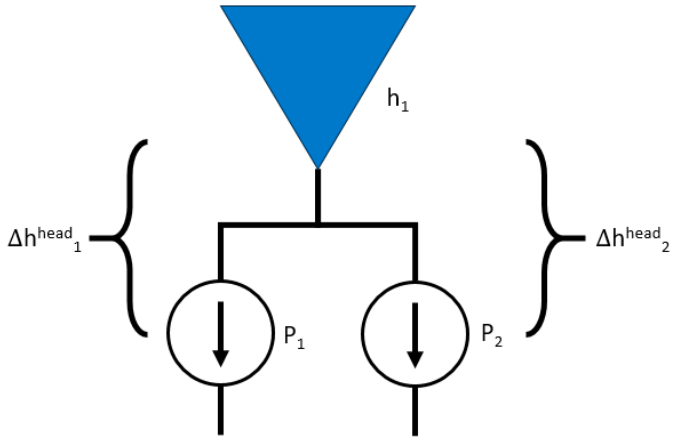
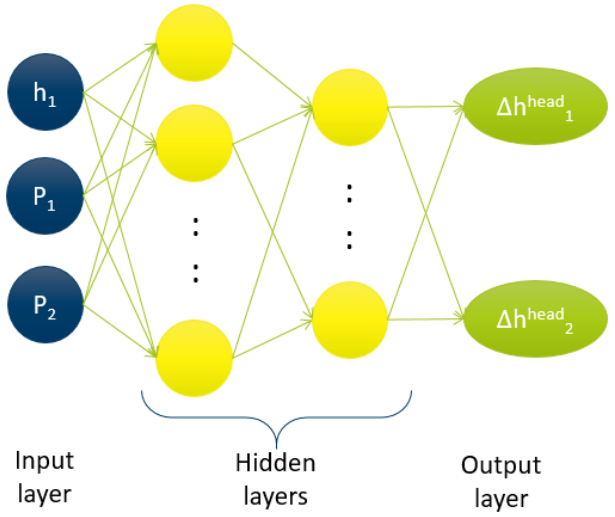
Modeling of hydropower plants





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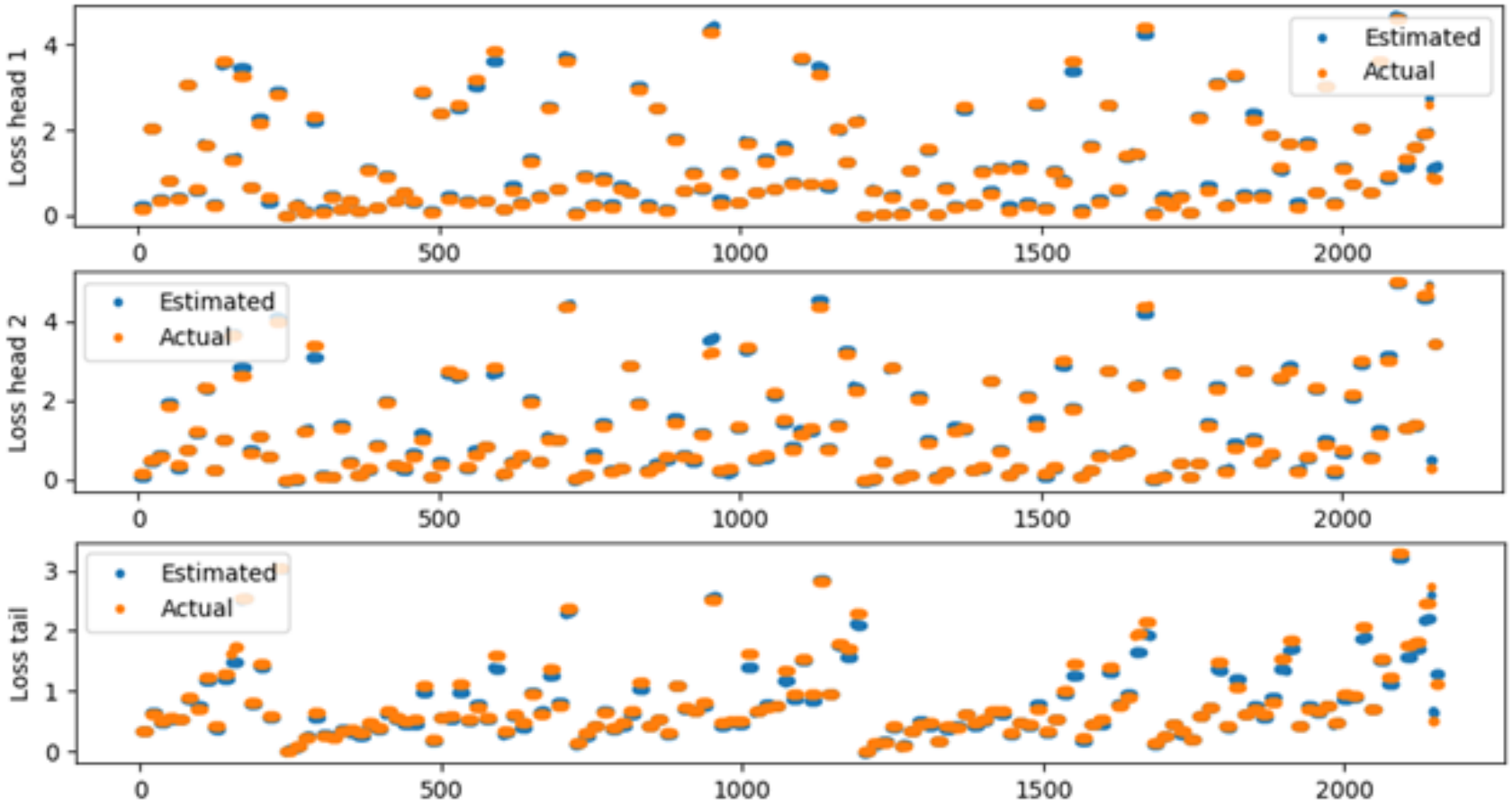
Estimation quality



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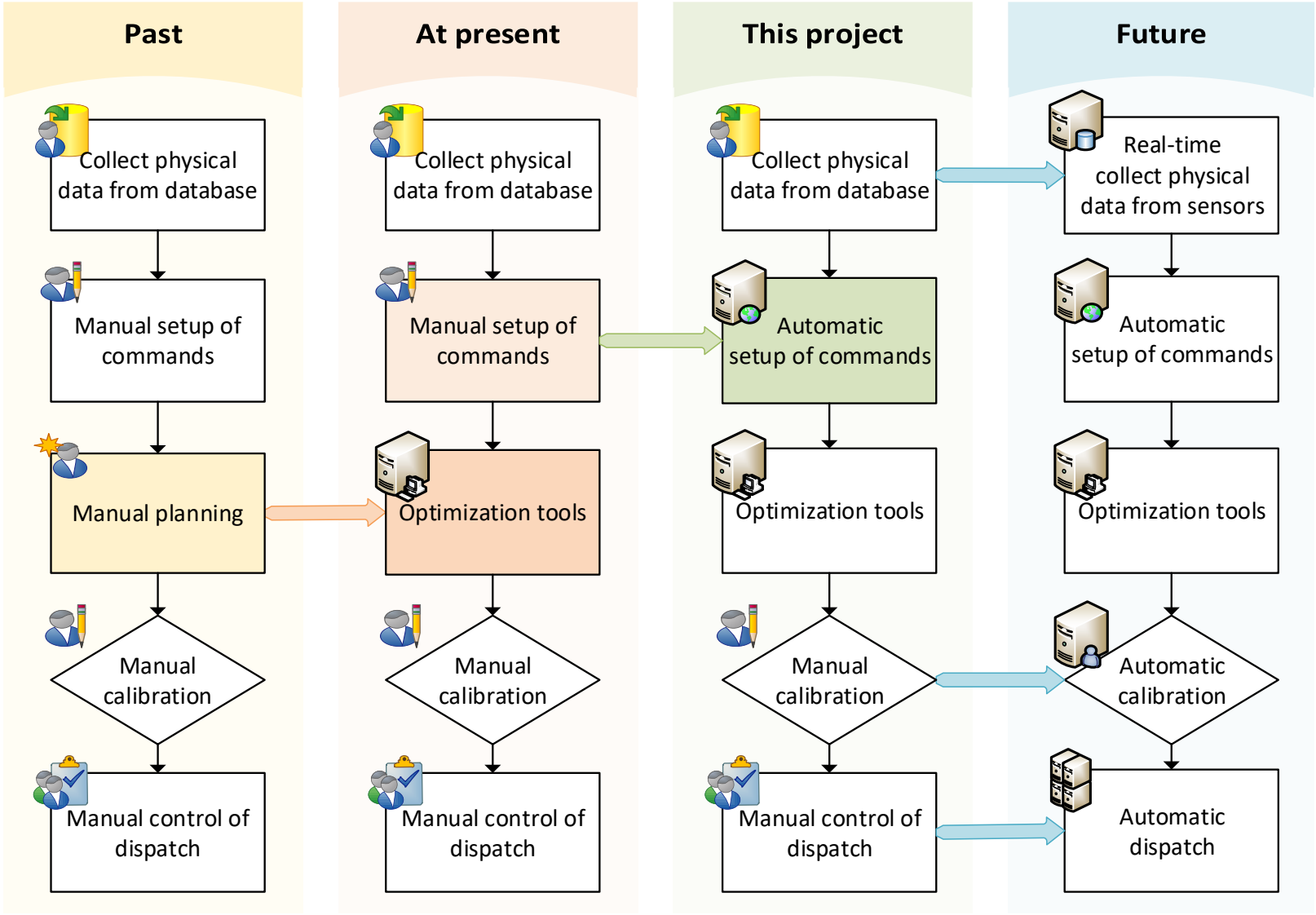
iScheduling – context based optimization



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Teknologi for et bedre samfunn