No Correlations Involved:
Decision Making Under Uncertainty in a Conservative Sparse Information Space

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Problem Statement

- **Decision making under uncertainty** - fundamental problem in robotics and artificial intelligence
- **Objective**: find action that minimizes an information-theoretic objective function (e.g. entropy)

$$\mathcal{H} = -\frac{1}{2}\log\left[(2\pi e)^n |\Lambda^+|\right]$$

a posteriori information matrix,
different for each action

$$\Lambda^+ = \Lambda + A^T A$$

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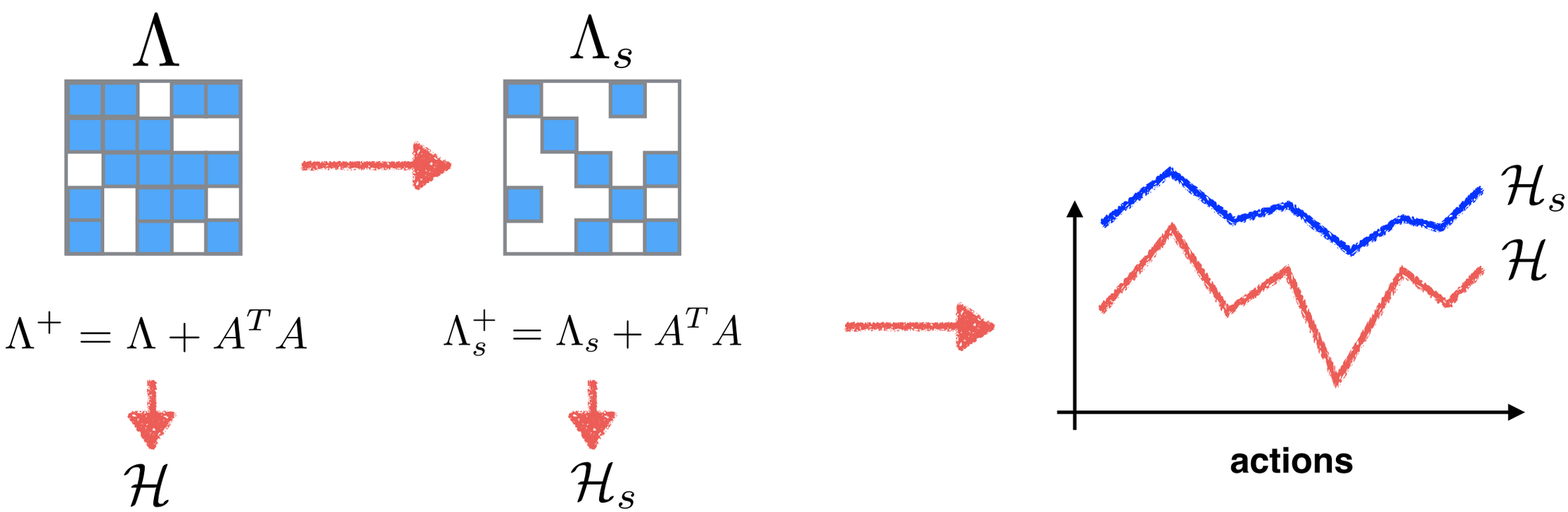
$$\mathcal{H} = -\frac{1}{2}\log\left[(2\pi e)^n|\Lambda^+|\right]$$

- **Expensive** for high dimensional state spaces!
  - Evaluating impact of a candidate action typically involves determinant calculation
  - $O(n^3)$, in the general case

Key Idea

- Find an appropriate **conservatively sparsified** information space
- Perform decision making over that, rather the original, information space



- Do we get the same performance (decisions)??

Key Idea

- Same decisions if the impact of **any** two candidate actions **a** and **b** has the **same trend** in both cases

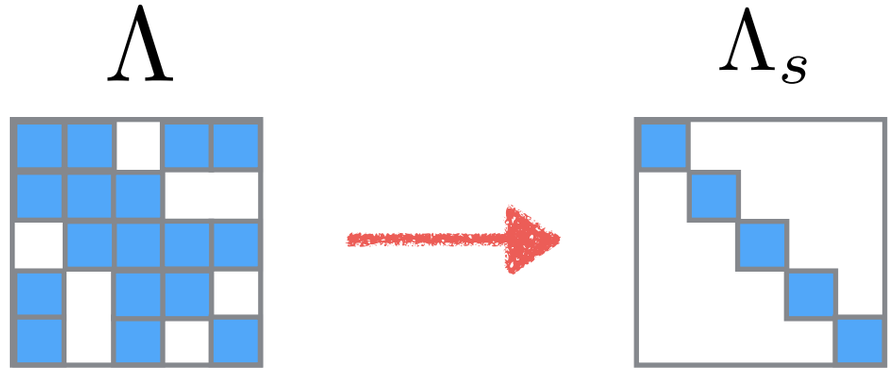
$$|\Lambda^{a+}| \leq |\Lambda^{b+}| \quad \text{iff} \quad |\Lambda_s^{a+}| \leq |\Lambda_s^{b+}|$$

- Decision making can be done considering a sparsified information space (**exact, cheaper**)

- Feasible?

This Work

- Go to the extreme - appropriately drop **all** off-diagonal terms
- Interpretation via covariance intersection (Julier & Uhlmann [ACC 1997])

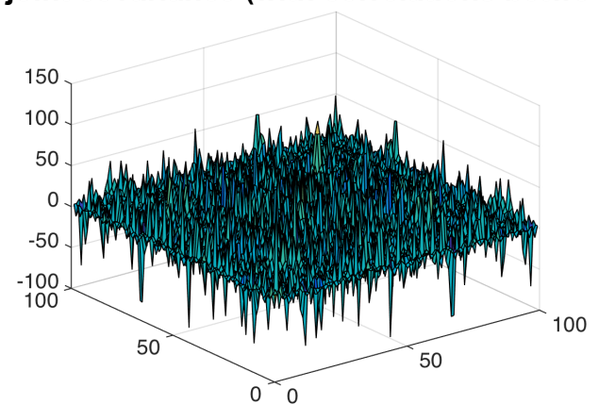


- **Same decisions** for **unary** observation models, i.e. each time measuring one (arbitrary) state element

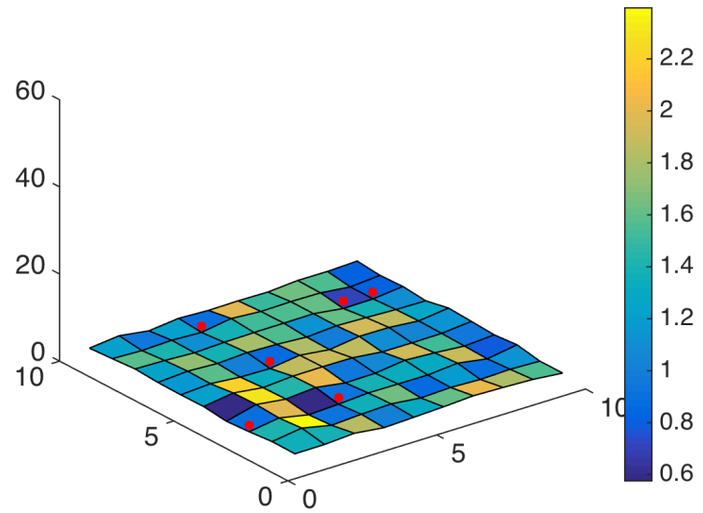
Application to Sensor Deployment Problems

- **Objective**: deploy k sensors in an $N \times N$ area

A priori joint covariance (with correlations between cells)



deploy sensors



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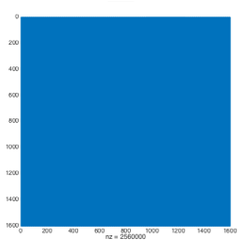


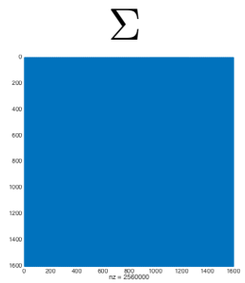
Application to Sensor Deployment Problems

- **Objective**: deploy k sensors in an $N \times N$ area

Same trend (decisions), reduced running time

original

Σ



sparsified

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