

Data-First Visualization Design Studies

Michael Oppermann and Tamara Munzner

 michaeloppermann.com/work/data-first



THE UNIVERSITY
OF BRITISH COLUMBIA

Design Study

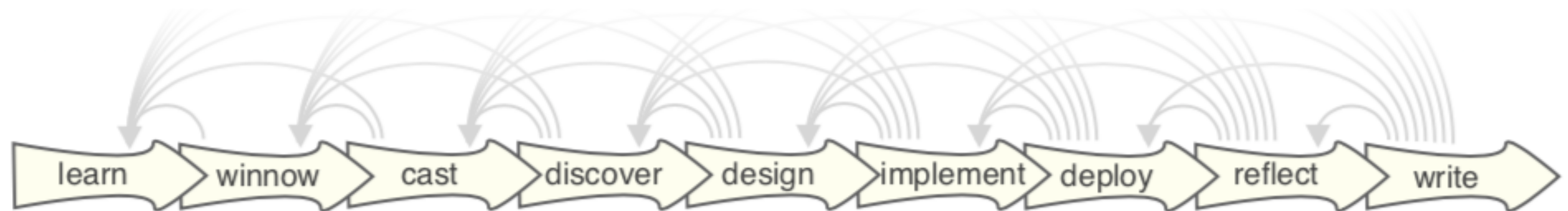
“A design study is a project in which visualization researchers analyze a specific real-world problem faced by domain experts...”

“A design study is a project in which visualization researchers analyze a specific real-world problem faced by domain experts, design a visualization system that supports solving this problem...”

“A design study is a project in which visualization researchers analyze a specific real-world problem faced by domain experts, design a visualization system that supports solving this problem, validate the design, and reflect about lessons learned in order to refine visualization design guidelines.”

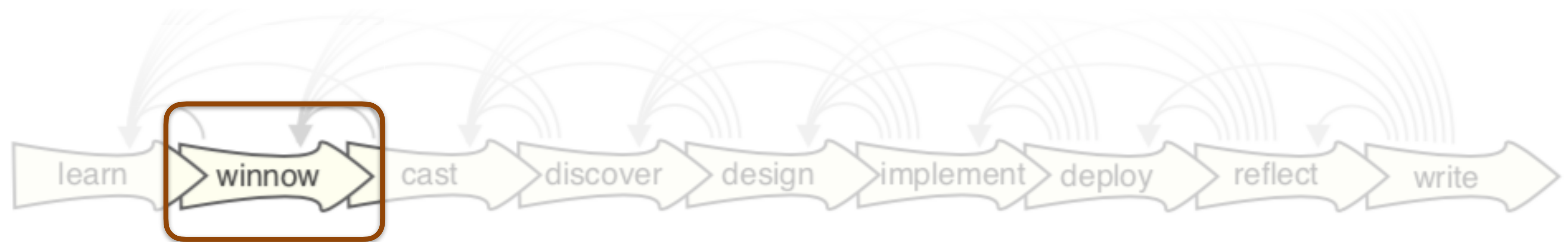
Design Study Methodology (DSM)

- ▶ Provides methodological guidance
- ▶ 9-stage framework



Design Study Methodology (DSM)

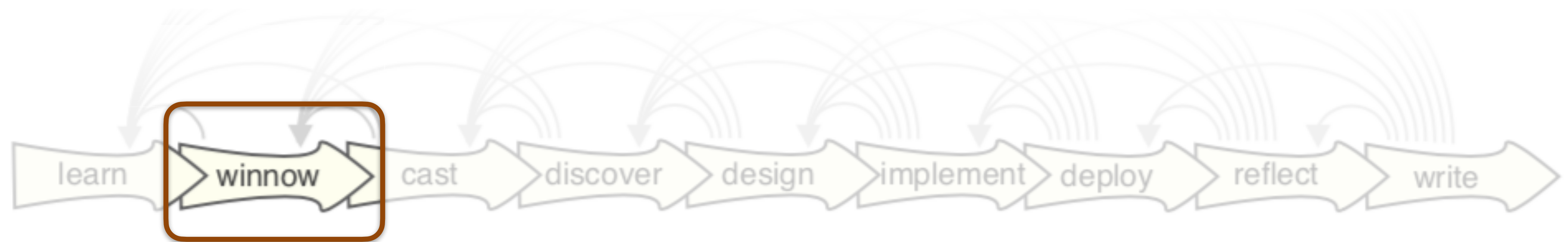
- ▶ Provides methodological guidance
- ▶ 9-stage framework



Connect with domain experts

Design Study Methodology (DSM)

- ▶ Provides methodological guidance
- ▶ 9-stage framework



Connect with domain experts → **stakeholder-first ordering**

Data-First Design Study

Data-First Design Study

Primarily initiated by acquiring an interesting real-world dataset rather than selecting a specific stakeholder.

Data-First Design Study

Primarily initiated by acquiring an interesting real-world dataset rather than selecting a specific stakeholder.

- ▶ **Data:** Constrains appropriate choices for stakeholders
- ▶ **Problem characterization:** Multiple potential stakeholders
- ▶ **Focus stakeholders:** Chosen based on *data–task* match

Not Explicitly Reported, But ...

- ▶ Class projects
- ▶ Visualization design competitions
- ▶ Research contexts
- ▶ ...

Contributions

Refined and extended design study framework

Review of 64
design studies

Opportunities
and Risks

Reflect on
2 case studies

Contributions

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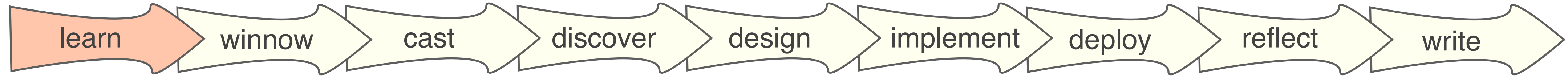
Opportunities
and Risks

Reflect on
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Original DSM framework



Original DSM framework



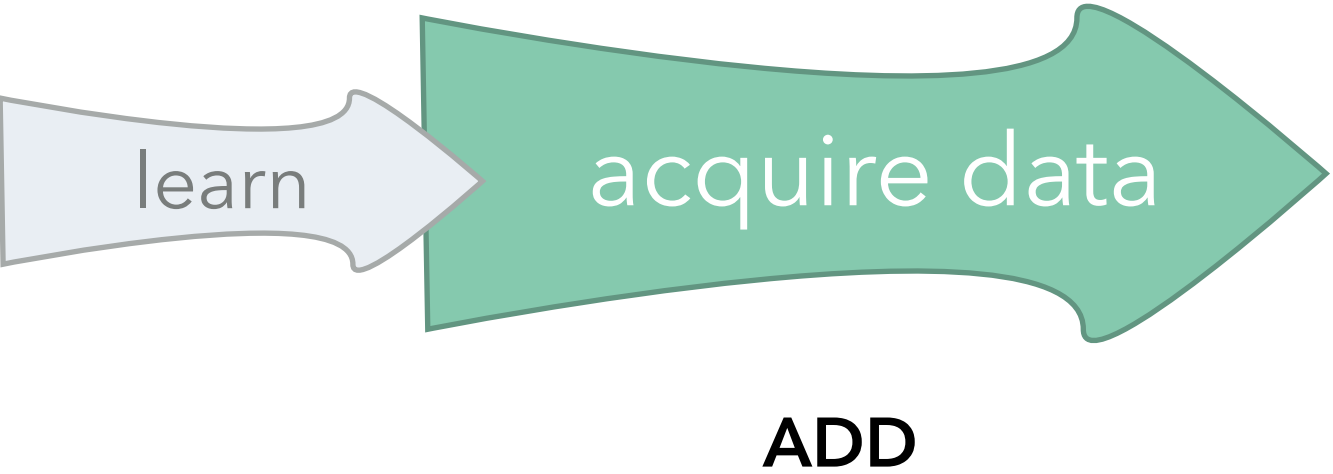
Data-first DSM framework



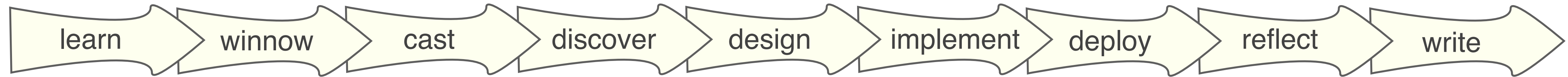
Original DSM framework



Data-first DSM framework



Original DSM framework



Data-first DSM framework



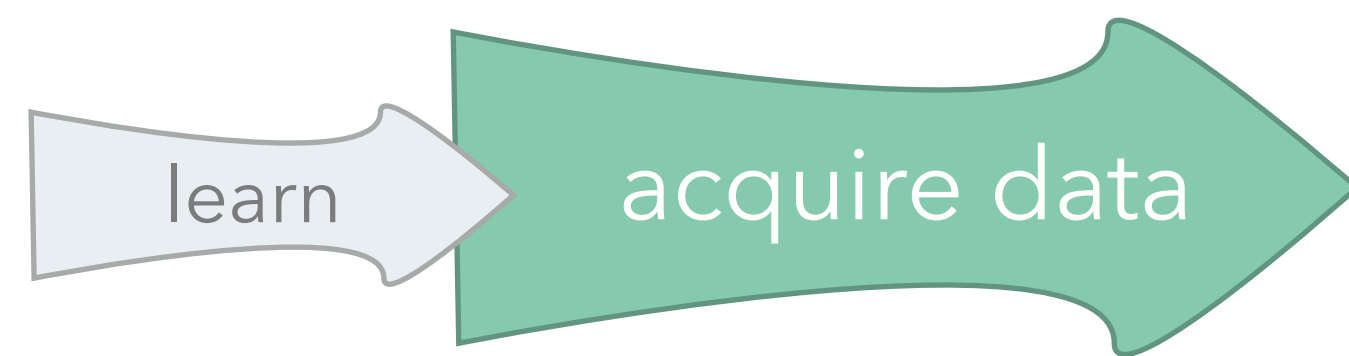
ADD

- ▶ What type of data am I working with?

Original DSM framework



Data-first DSM framework



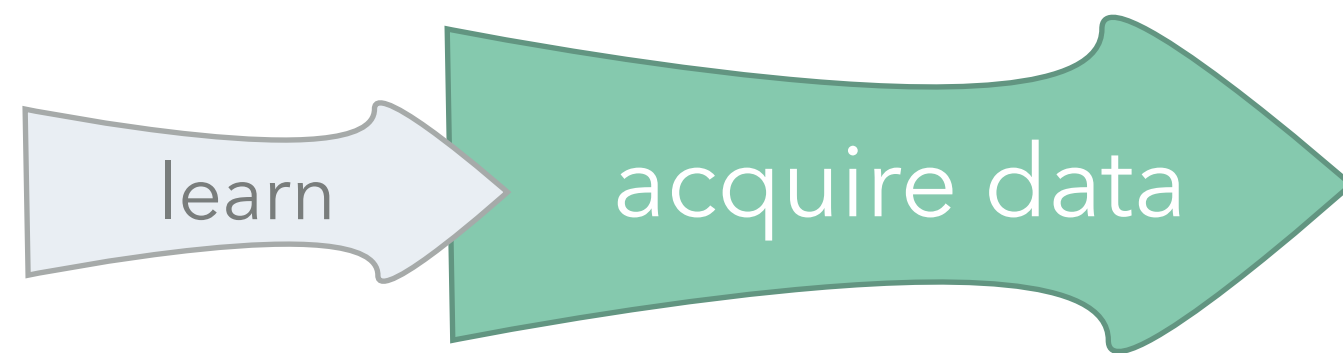
ADD

- ▶ What type of data am I working with?
- ▶ Are there any data quality challenges?

Original DSM framework



Data-first DSM framework



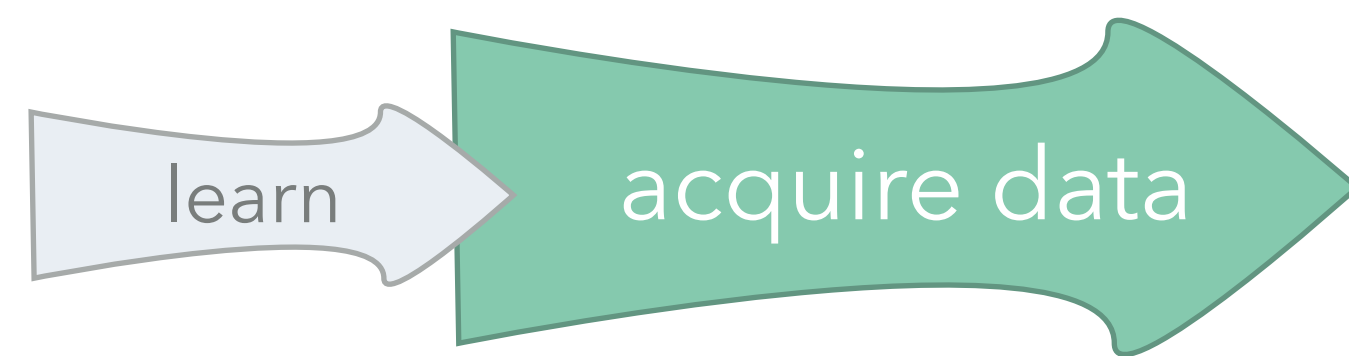
ADD

- ▶ What type of data am I working with?
- ▶ Are there any data quality challenges?
- ▶ What is special about this data?

Original DSM framework



Data-first DSM framework



ADD

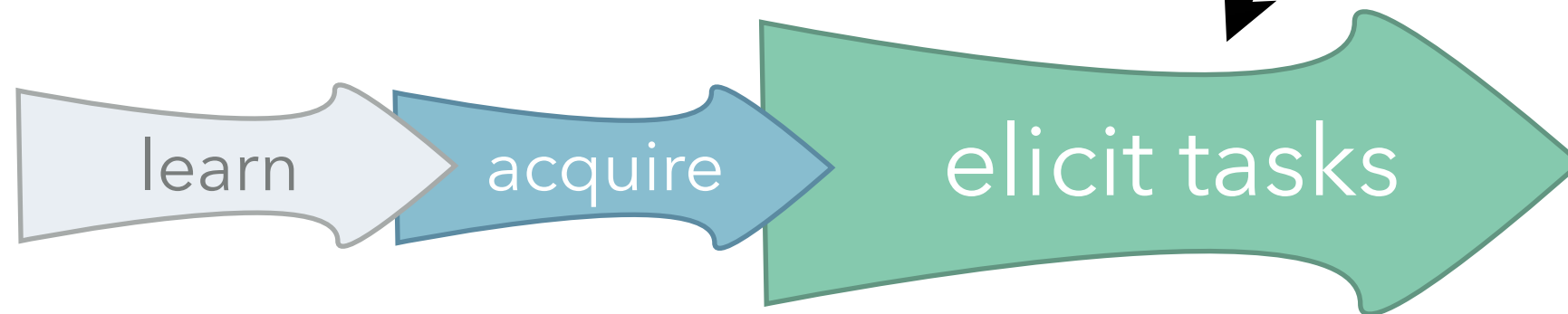
- ▶ What type of data am I working with?
- ▶ Are there any data quality challenges?
- ▶ What is special about this data?
- ▶ Who would benefit from seeing and exploring it?

Original DSM framework

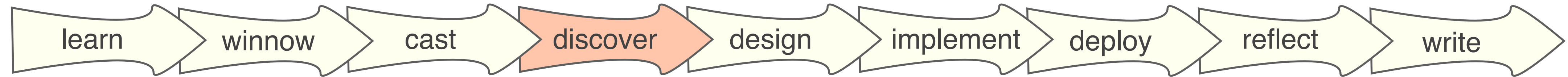


MOVE AND RENAME

Data-first DSM framework

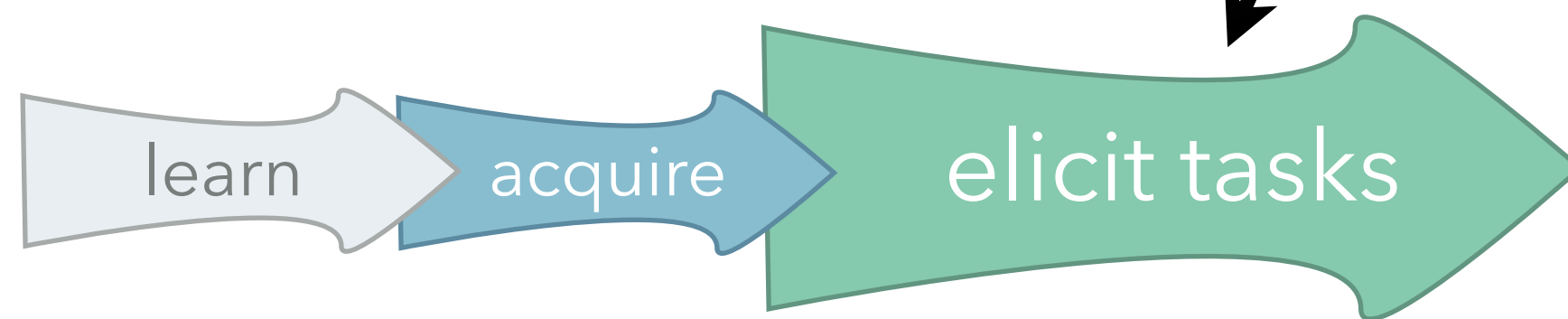


Original DSM framework



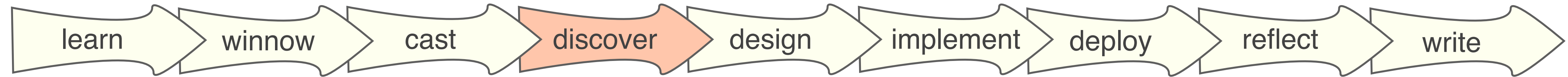
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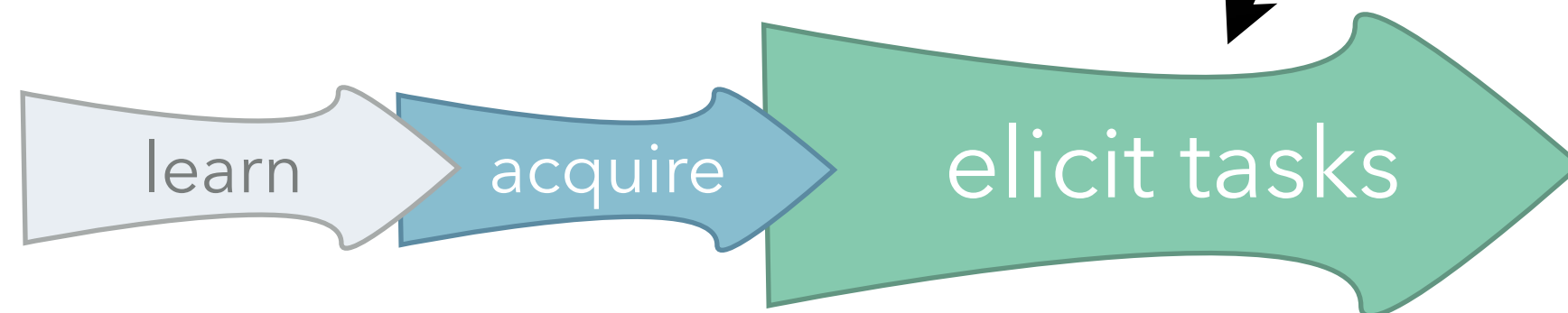
- ▶ Multiple potential stakeholders

Original DSM framework



MOVE AND RENAME

Data-first DSM framework



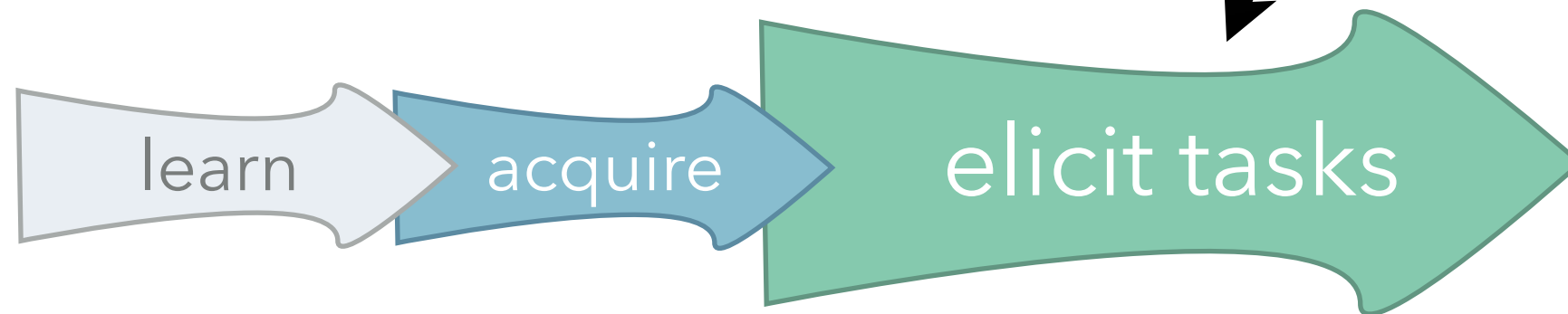
- ▶ Multiple potential stakeholders
- ▶ Explain initial data abstractions

Original DSM framework



MOVE AND RENAME

Data-first DSM framework

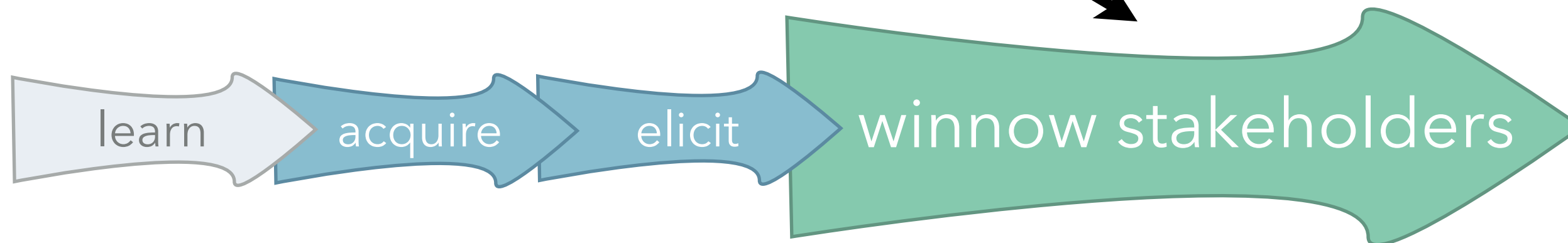


- ▶ Multiple potential stakeholders
- ▶ Explain initial data abstractions
- ▶ Learn about unsolved stakeholder needs

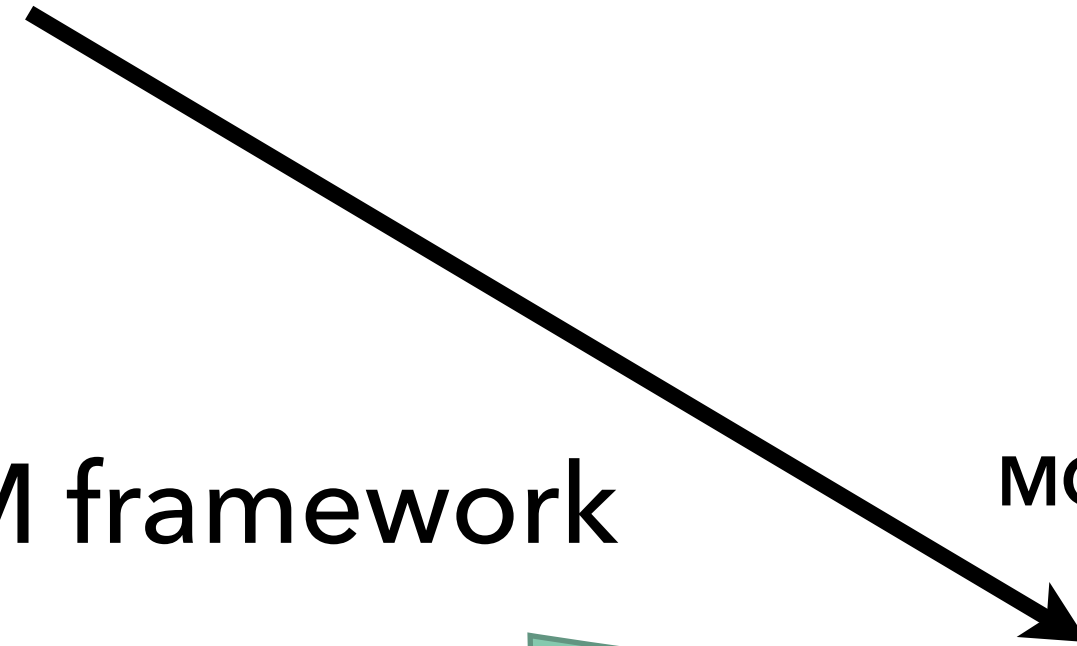
Original DSM framework



Data-first DSM framework



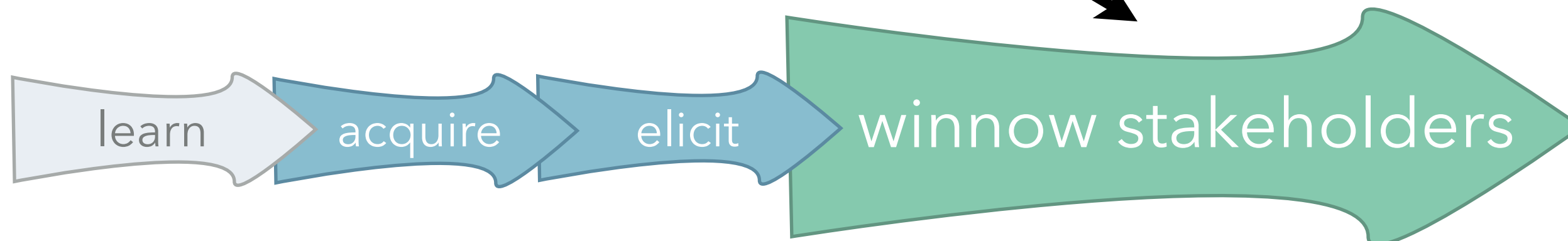
MODIFY



Original DSM framework



Data-first DSM framework

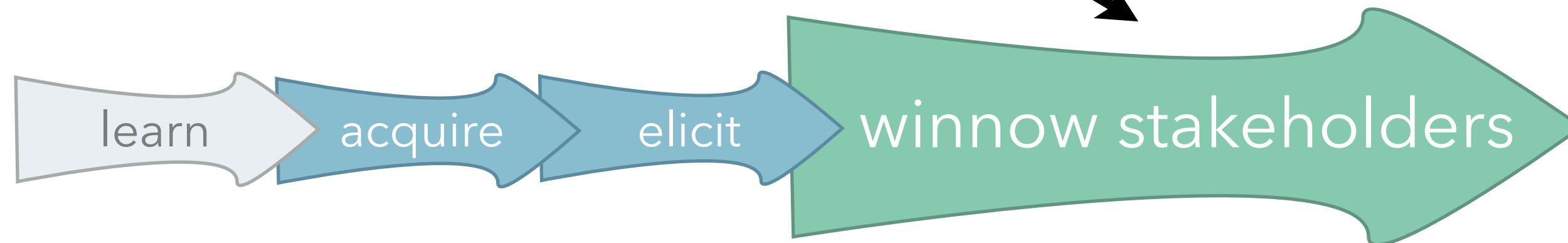


- ▶ How frequent are their data-relevant tasks?

Original DSM framework



Data-first DSM framework

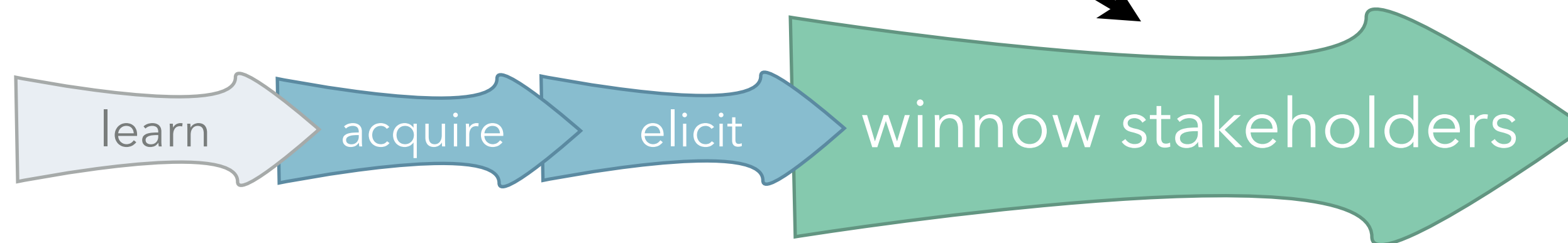


- ▶ How frequent are their data-relevant tasks?
- ▶ How central are these tasks to the stakeholder's primary mission?

Original DSM framework

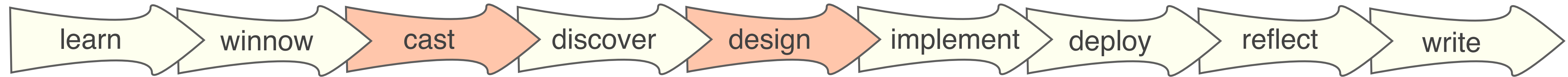


Data-first DSM framework

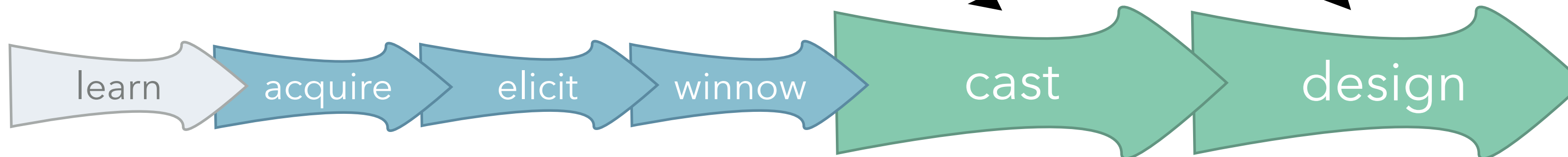


- ▶ How frequent are their data-relevant tasks?
- ▶ How central are these tasks to the stakeholder's primary mission?
- ▶ How many people in the organization deal with these tasks?

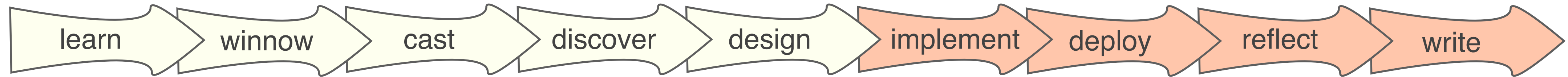
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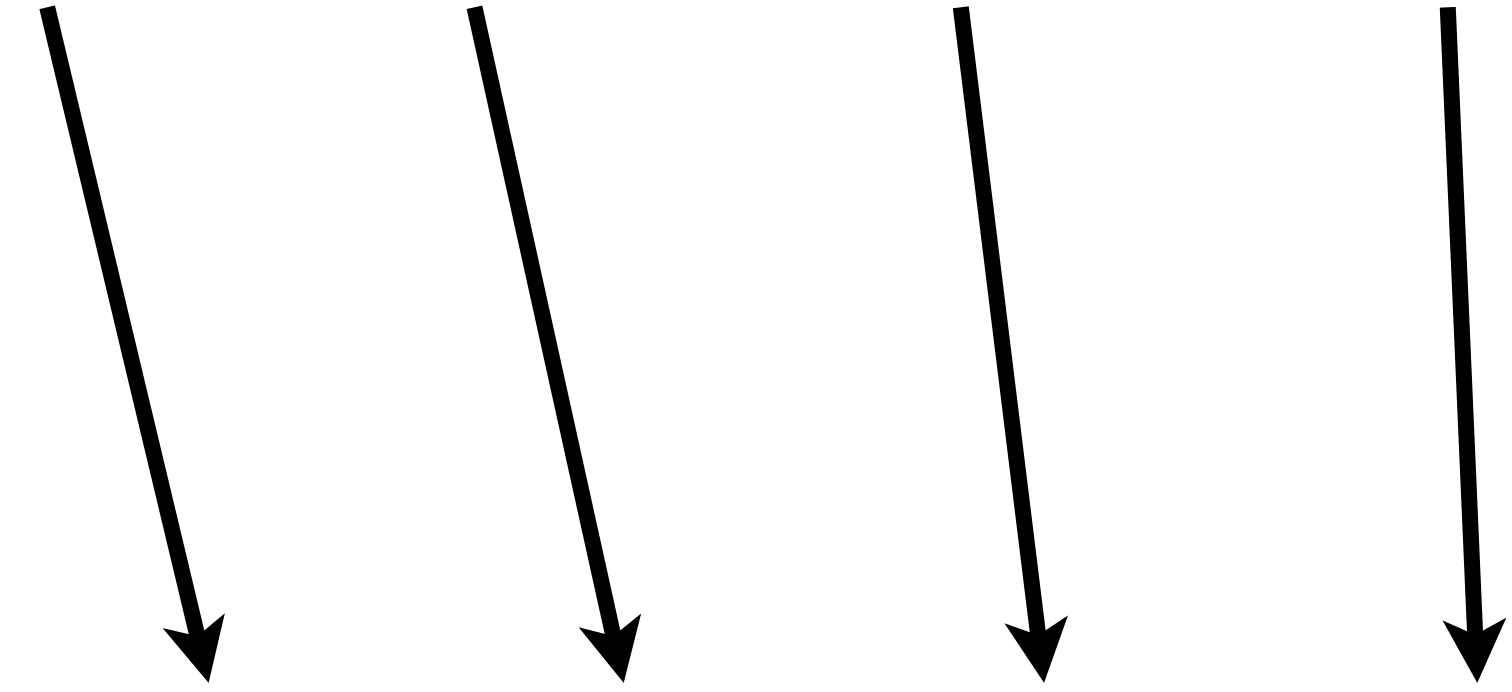
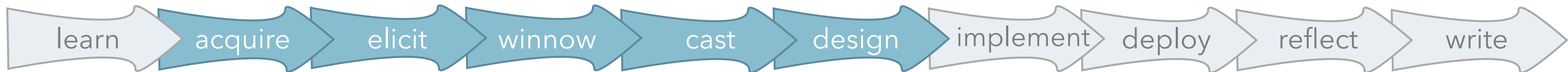
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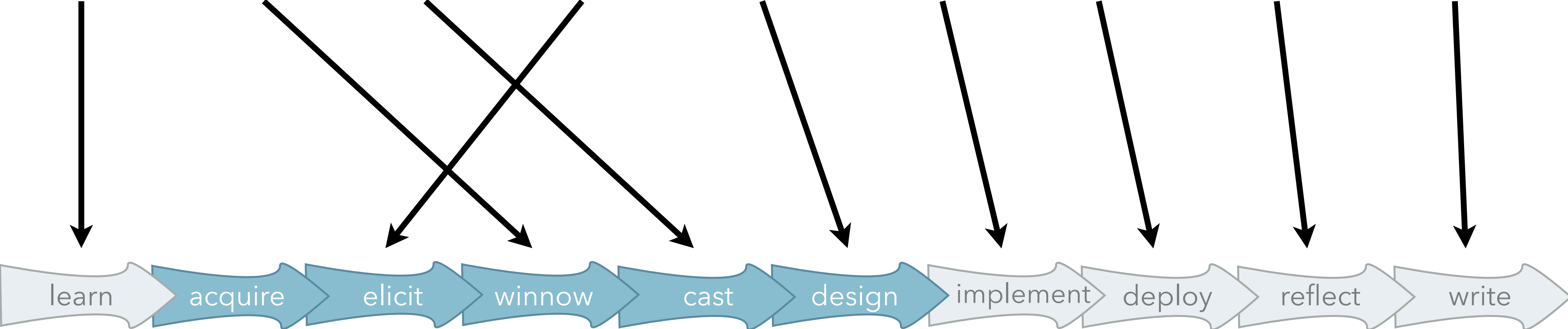
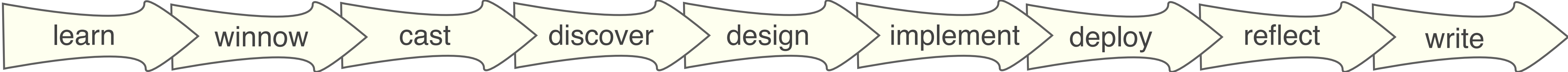
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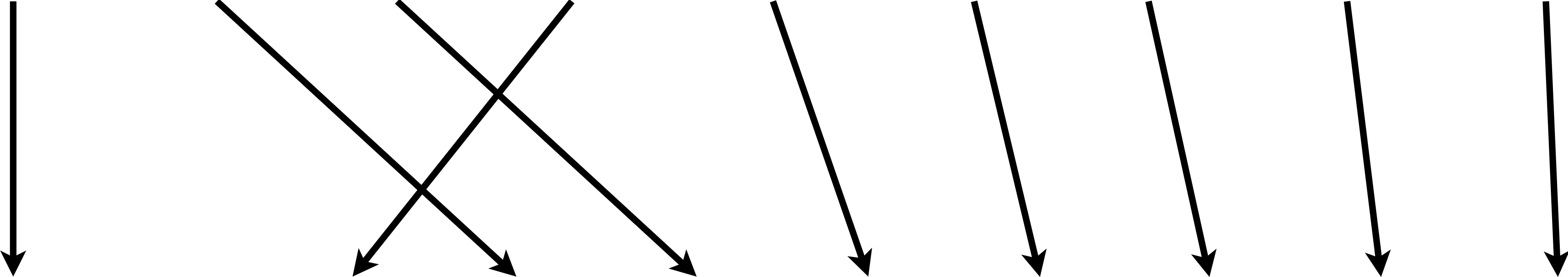
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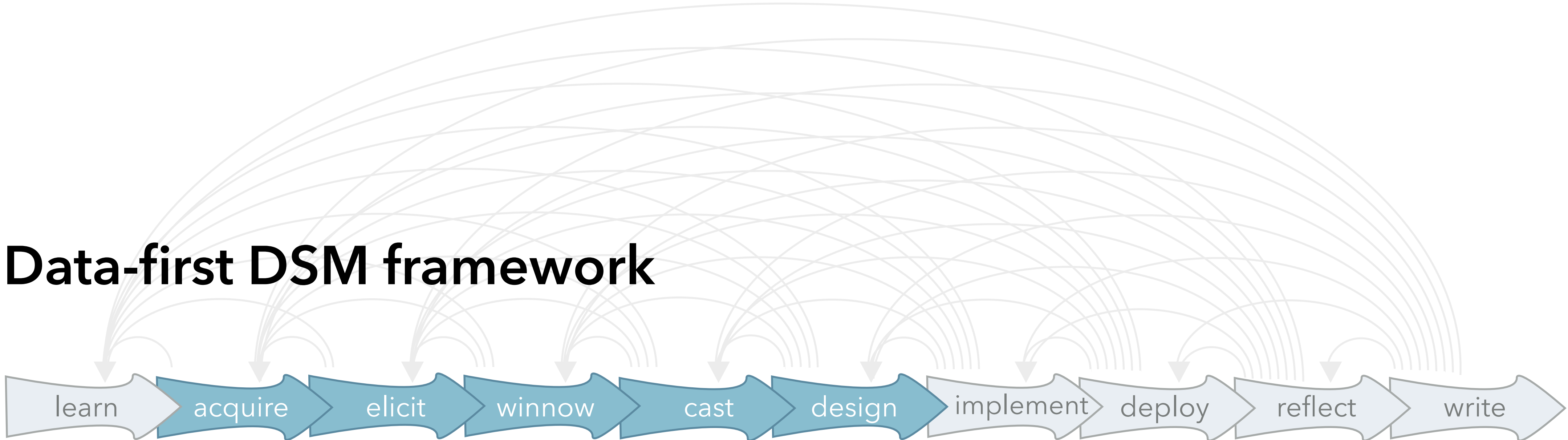
Original DSM framework



Data-first DSM framework



Data-first DSM framework



Contributions

Refined and extended design study framework

Review of 64
design studies

Opportunities
and Risks

Reflect on
2 case studies

Review of Design Studies

64 publications



Review of Design Studies

64 publications

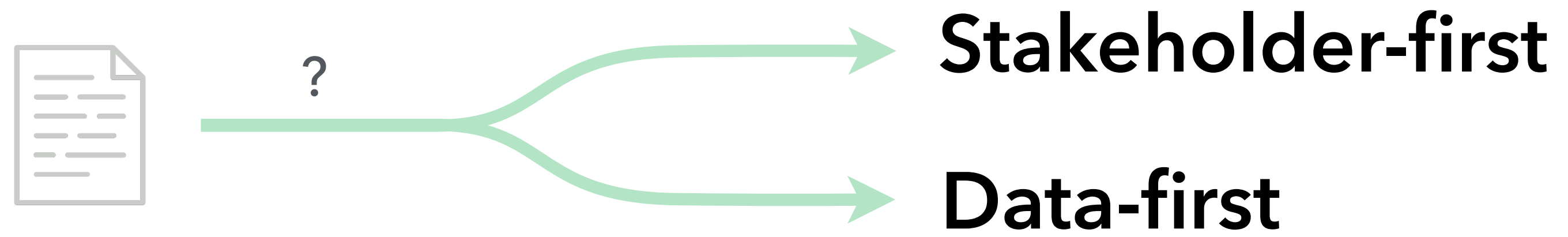
16 potential cases (25%)

indicate characteristics of
a data-first design process



Review of Design Studies

Retrospective analysis



Review of Design Studies

Retrospective analysis



Review of Design Studies

Retrospective analysis



- ▶ Judgement is based on limited information

Review of Design Studies

Retrospective analysis



- ▶ Judgement is based on limited information
- ▶ Difficult to know when stakeholder engagement began

Review of Design Studies

Retrospective analysis



- ▶ Judgement is based on limited information
- ▶ Difficult to know when stakeholder engagement began
- ▶ Difficult to disambiguate: researcher-as-stakeholder vs. data-first process

Review of Design Studies

Retrospective analysis



- ▶ Judgement is based on limited information
- ▶ Difficult to know when stakeholder engagement began
- ▶ Difficult to disambiguate: researcher-as-stakeholder vs. data-first process

→ *16 potential cases of data-first design studies*

Contributions

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design studies

**Opportunities
and Risks**

Reflect on
2 case studies

Opportunities

Opportunities

- ▶ Alternative way to approach research collaborations
 - Possibilities that do not fit traditional DSM process
 - Push ideas from an outside perspective

Opportunities

- ▶ Alternative way to approach research collaborations
- ▶ Early data sketches or technology probes with real-world data

Opportunities

- ▶ Alternative way to approach research collaborations
- ▶ Early data sketches or technology probes with real-world data
- ▶ Gradual expansion of stakeholder set

Risks

Risks

- ▶ Hypothesized tasks

Risks

- ▶ Hypothesized tasks
- ▶ Hammer looking for a nail

Risks

- ▶ Hypothesized tasks
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- ▶ **No actual users**

Risks

- ▶ Hypothesized tasks
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- ▶ **Mismatch between data and stakeholder tasks**

Risks

- ▶ Hypothesized tasks
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- ▶ **Enthusiasm of seeing own data for the first time vs. actual needs**

Risks

- ▶ Hypothesized tasks
- ▶ Hammer looking for a nail
- ▶ No actual users
- ▶ Mismatch between data and stakeholder tasks
- ▶ Enthusiasm of seeing own data for the first time vs. actual needs
- ▶ **Data promises**

Risks

- ▶ Hypothesized tasks
- ▶ Hammer looking for a nail
- ▶ No actual users
- ▶ Mismatch between data and stakeholder tasks
- ▶ Enthusiasm of seeing own data for the first time vs. actual needs
- ▶ Data promises
- ▶ Premature finalization of data and task abstractions

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design studies

Opportunities
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**Reflect on
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Case Studies



Ocupado

Visual Analysis of
Building Occupancy



Bike Sharing Atlas

Visual Analysis of
Bike Sharing Networks

Case Studies



Ocupado

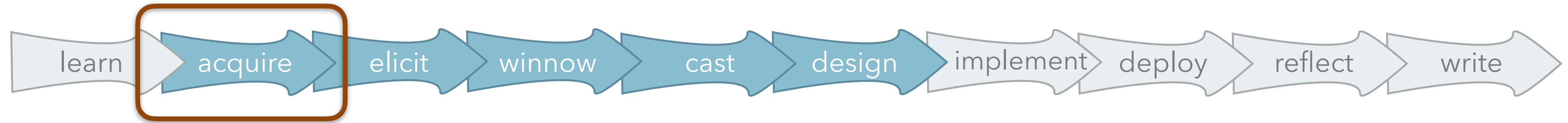
Visual Analysis of
Building Occupancy



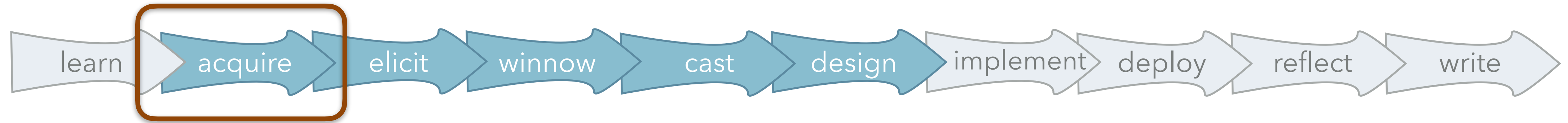
Bike Sharing Atlas

Visual Analysis of
Bike Sharing Networks

Ocupado: Visual Analysis of Building Occupancy

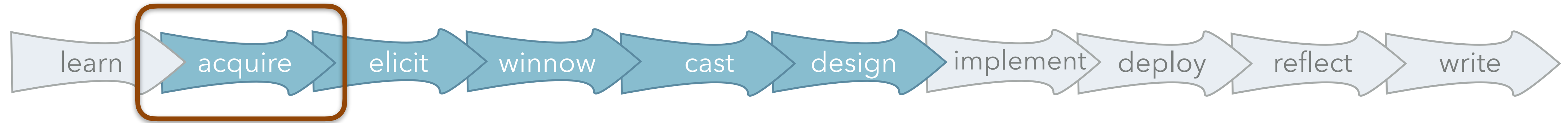


Ocupado: Visual Analysis of Building Occupancy



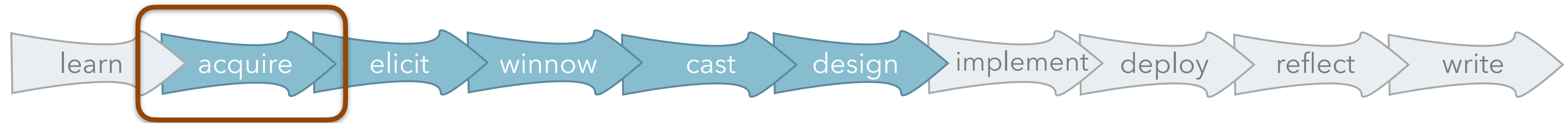
- ▶ **Industry collaborator is data provider**

Ocupado: Visual Analysis of Building Occupancy



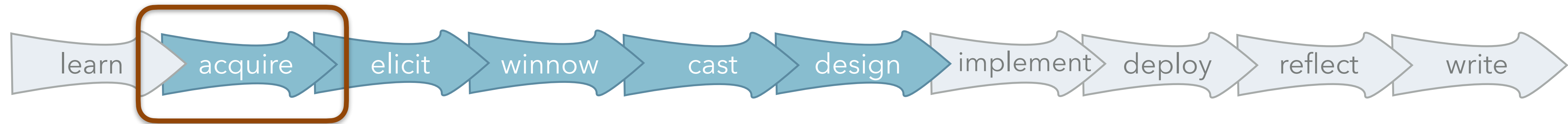
- ▶ **Industry collaborator** is data provider
- ▶ **Data:** WiFi device signals as a proxy for human occupancy

Ocupado: Visual Analysis of Building Occupancy



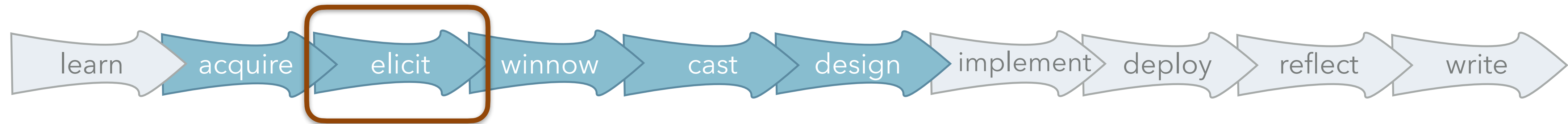
- ▶ **Industry collaborator** is data provider
- ▶ **Data:** WiFi device signals as a proxy for human occupancy
- ▶ **Previous use case:** Automated HVAC control

Ocupado: Visual Analysis of Building Occupancy



- ▶ **Industry collaborator** is data provider
- ▶ **Data:** WiFi device signals as a proxy for human occupancy
- ▶ **Previous use case:** Automated HVAC control
- ▶ **Data abstraction:** Location-based counts
 - # devices per zone, every 5 minutes
 - No movements or device identifiers

Ocupado: Visual Analysis of Building Occupancy



► Interviews in 9 potential stakeholder domains

Energy management

Transportation authority

Custodial services

Physical security

Space planning

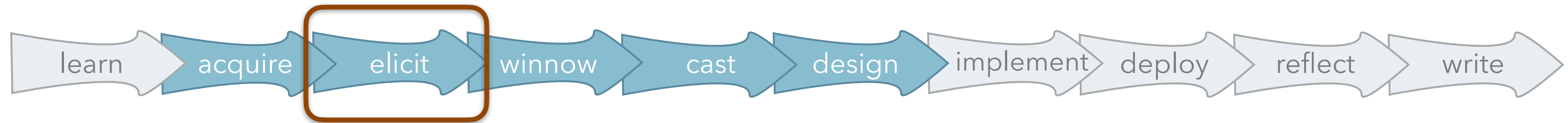
Risk management

Building management

Data quality control

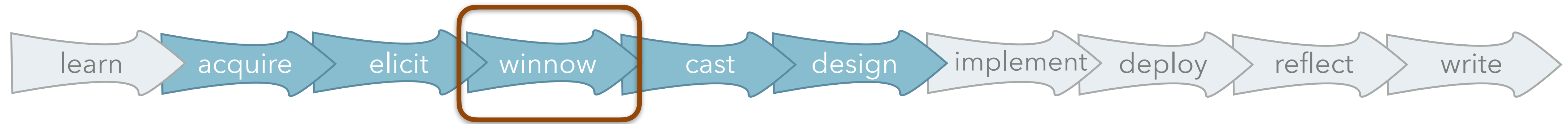
Classroom management

Ocupado: Visual Analysis of Building Occupancy

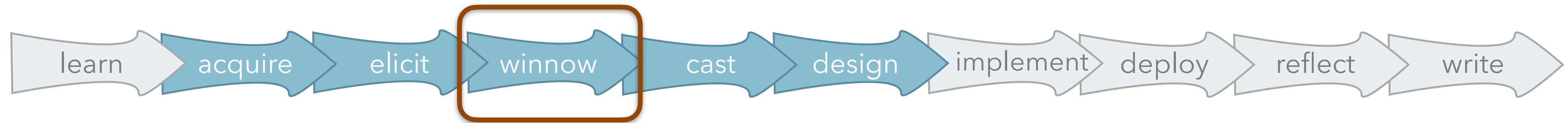


- ▶ Interviews in 9 potential stakeholder domains
- ▶ Full task abstraction for all domains

Ocupado: Visual Analysis of Building Occupancy

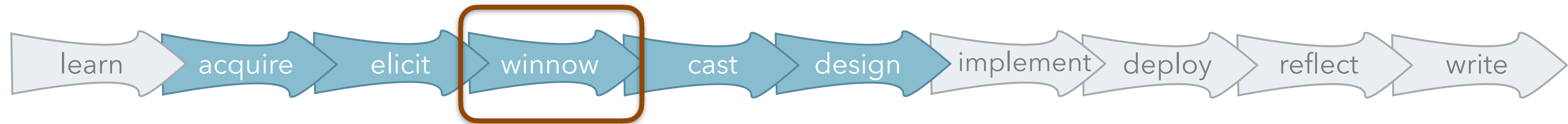


Ocupado: Visual Analysis of Building Occupancy



- ▶ **Assess and prioritize the set of potential stakeholders**

Ocupado: Visual Analysis of Building Occupancy



- ▶ Assess and prioritize the set of potential stakeholders

- ▶ 5 focus domains:

Custodial services

Space planning

Building management

Classroom management

Data quality control

- ▶ Leave out:

Energy management

Physical security

Risk management

Transportation authority

Tasks

Tasks



Confirm assumptions or previous observations.

Do students occupy room x in evenings or on weekends?

Tasks

Confirm assumptions or previous observations.

Monitor the current/recent utilization rate.

Which rooms are empty/busy?

Tasks

- Confirm assumptions or previous observations.**
- Monitor the current/recent utilization rate.**
- Communicate space usage and justify decisions.**
Did space usage improve after renovation?

Tasks



Confirm assumptions or previous observations.



Monitor the current/recent utilization rate.



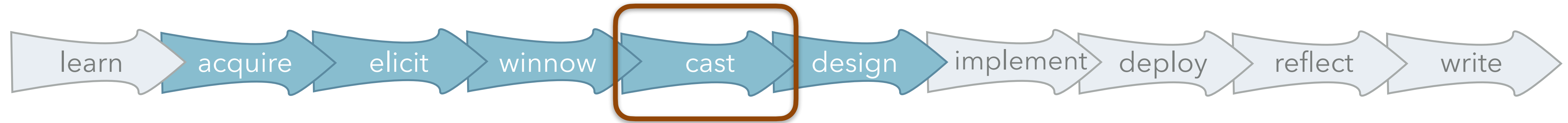
Communicate space usage and justify decisions.



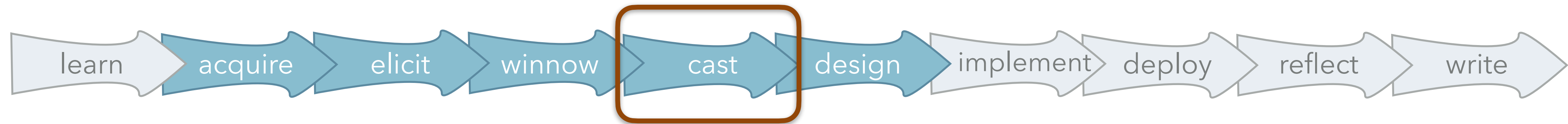
Validate the data (quality control).

What is the minimum room size that could be reliably captured?

Ocupado: Visual Analysis of Building Occupancy

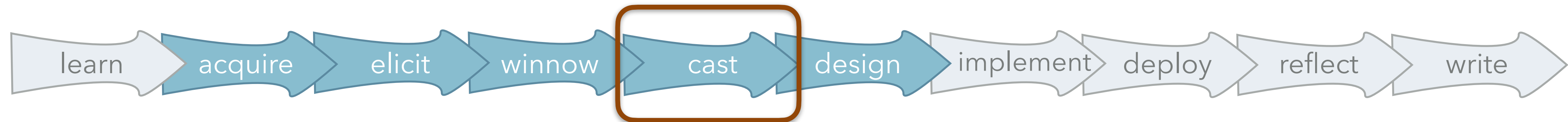


Ocupado: Visual Analysis of Building Occupancy



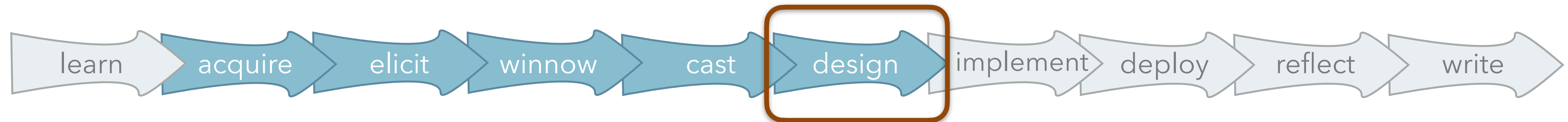
- ▶ Similar to the original DSM
- ▶ The goal is to identify roles

Ocupado: Visual Analysis of Building Occupancy



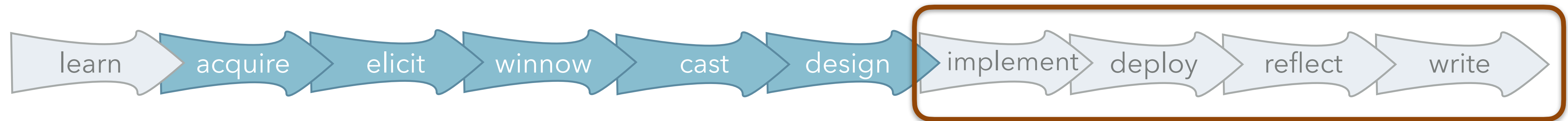
- ▶ Similar to the original DSM
- ▶ The goal is to identify roles
- ▶ **Promoter** role is essential with *data-first*
 - ▶ Present data and visualization opportunities to potential stakeholders
- ▶ **Data producer** and **data consumer** roles are held by different people

Ocupado: Visual Analysis of Building Occupancy



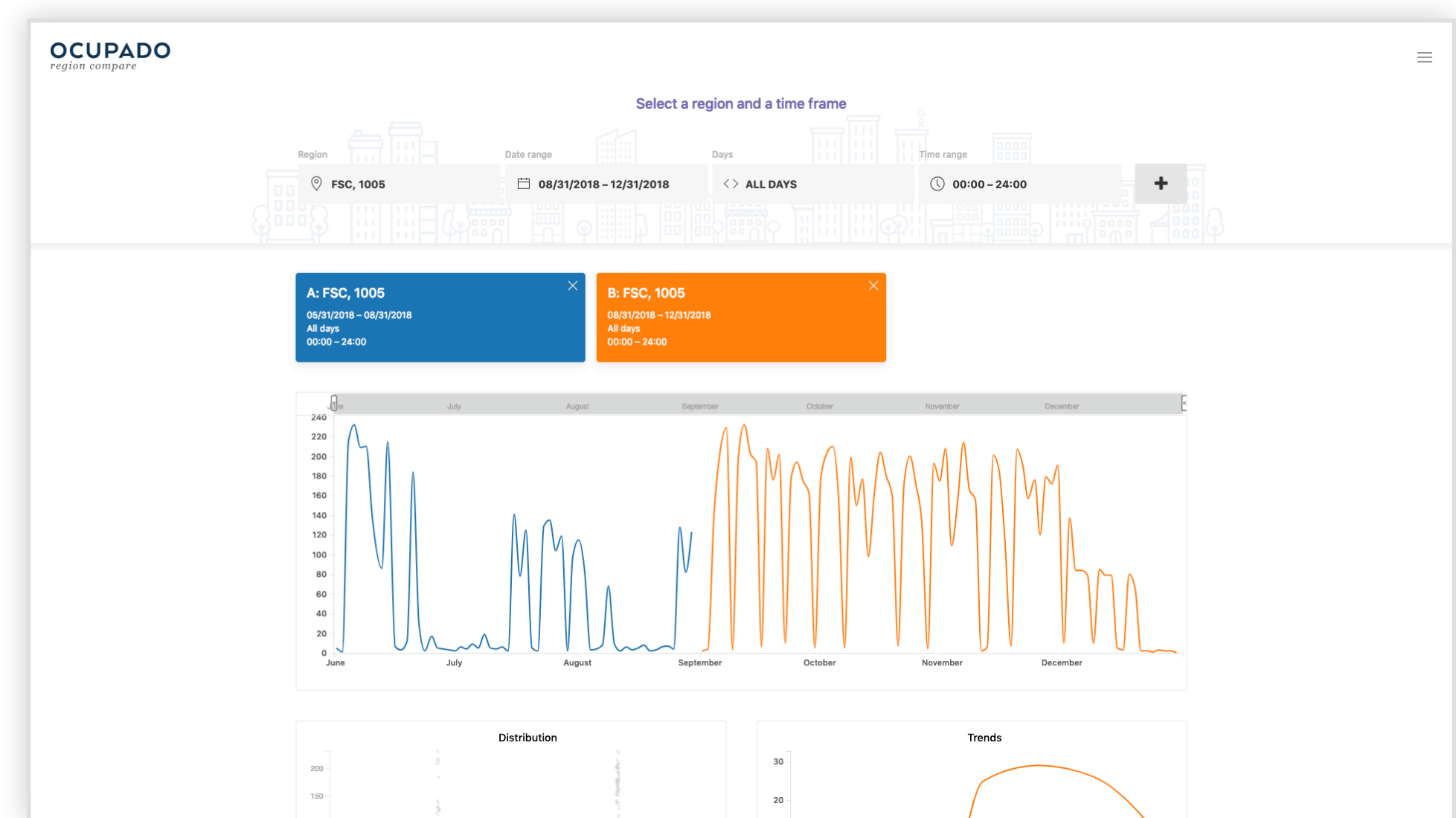
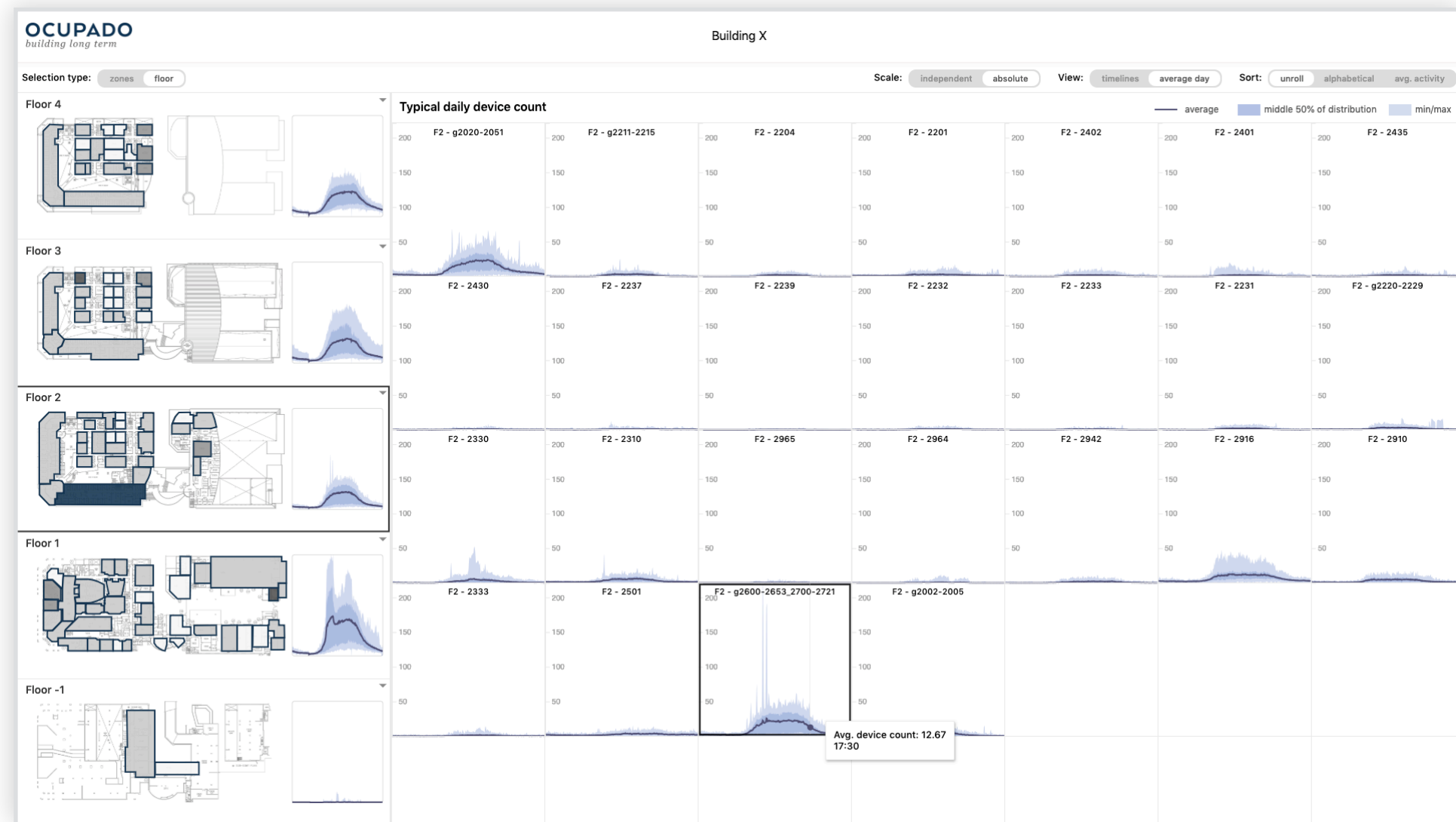
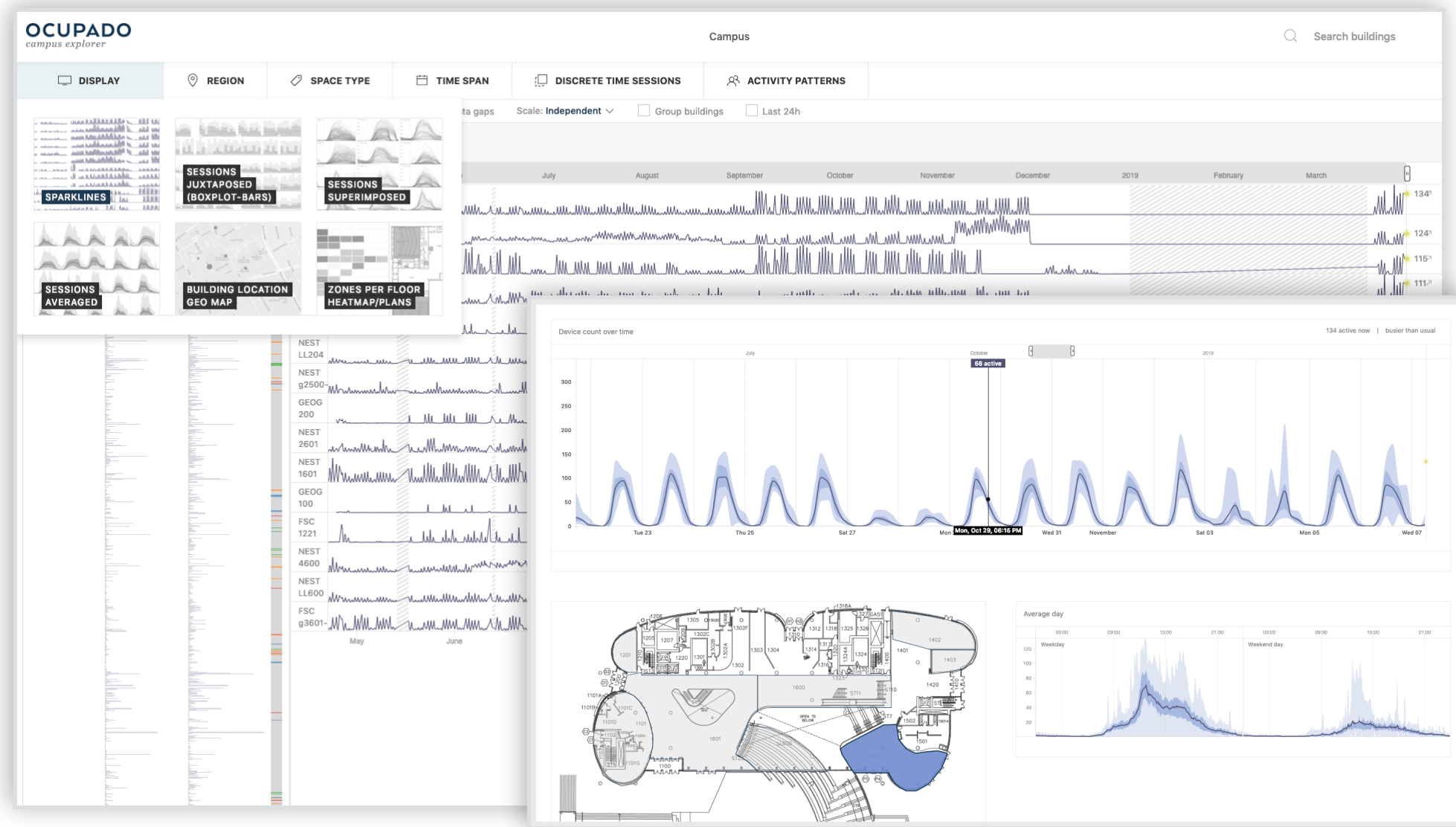
- ▶ **Designed interfaces targeted to specific space-time slices**
 - ▶ Rather than one interface per stakeholder domain
- ▶ **No data abstraction at this stage**
 - ▶ Happened earlier in *acquire*

Ocupado: Visual Analysis of Building Occupancy



- ▶ Mostly aligned with original DSM framework
- ▶ Implemented and deployed multiple interfaces

Ocupado Interfaces



Oppermann & Munzner: "Ocupado: Visual Analysis of Building Occupancy". *Computer Graphics Forum*, 2020

Data-First Visualization Design Studies

Contributions

- ▶ First characterization of a data-first design study
- ▶ Preliminary review of published design studies
- ▶ Refined and extended design study framework
- ▶ Discussion of opportunities and risks

Michael Oppermann (@oppermann_m) and Tamara Munzner (@tamaramunzner)

Paper page: michaeloppermann.com/work/data-first

- Includes supplemental material, slides, and talk recording
- Archival open access version: arxiv.org/abs/2009.01785