

# Design study methodology

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Michael Sedlmair

# Acknowledgements

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- Tamara's vis course slides / Tom's edits from past years
- Design study methodology: Reflections from the trenches and the stacks. Michael Sedlmair, Mariah Meyer, and Tamara Munzner. IEEE Trans. Visualization and Computer Graphics 18(12):2431-2440, 2012.
- Cluster and Calendar based Visualization of Time Series Data. Jarke J. van Wijk and Edward R. van Selow. Proc. InfoVis 1999, p 4-9.

# Nested model for vis design

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**Domain situation**



**Data/task abstraction**



**Visual encoding/interaction idiom**



**Algorithm**

# Nested model for vis design

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**Domain situation**

What are people doing?  
What are their goals?



**Data/task abstraction**



**Visual encoding/interaction idiom**



**Algorithm**

# Nested model for vis design

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**Domain situation**



**Data/task abstraction**

What are data/tasks to accomplish these goals?



**Visual encoding/interaction idiom**



**Algorithm**

# Nested model for vis design

---



**Domain situation**



**Data/task abstraction**



**Visual encoding/interaction idiom**

How do I show/interact  
with the data?



**Algorithm**

# Nested model for vis design

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**Domain situation**



**Data/task abstraction**



**Visual encoding/interaction idiom**



**Algorithm**

How do I make  
this all work?

# Nested model for vis design

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## **Domain situation**

You misunderstood their needs

## **Data/task abstraction**

You're showing them the wrong thing

## **Visual encoding/interaction idiom**

The way you show it doesn't work



## **Algorithm**

Your code is too slow



# Nested model for vis design

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## **Domain situation**

Observe target users using existing tools

## **Data/task abstraction**

## **Visual encoding/interaction idiom** Justify design with respect to alternatives

## **Algorithm** Measure system time/memory Analyze computational complexity

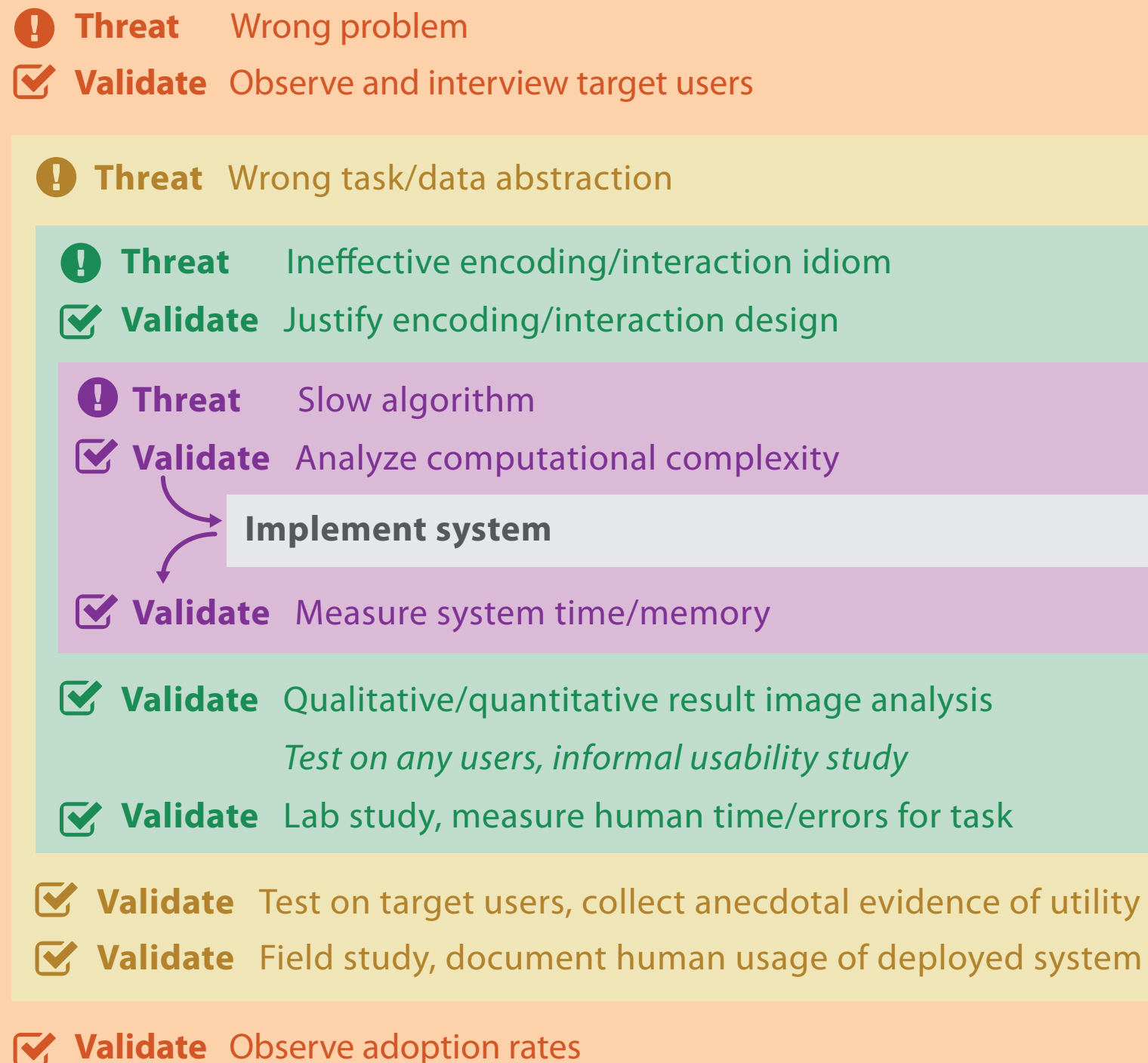
Analyze results qualitatively

Measure human time with lab experiment (*lab study*)

Observe target users after deployment (*field study*)

Measure adoption

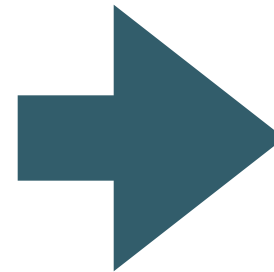
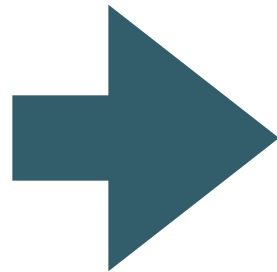
# Nested model for vis design



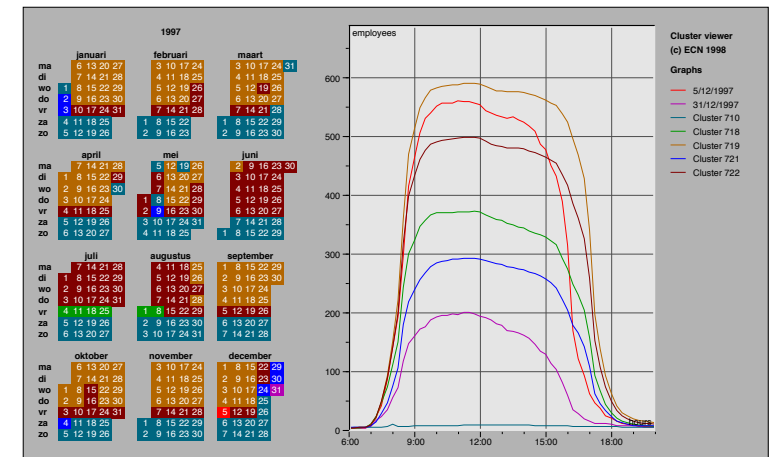
# Workflow for designing a tool

# Making the right tool

Questions  
Data  
Tasks



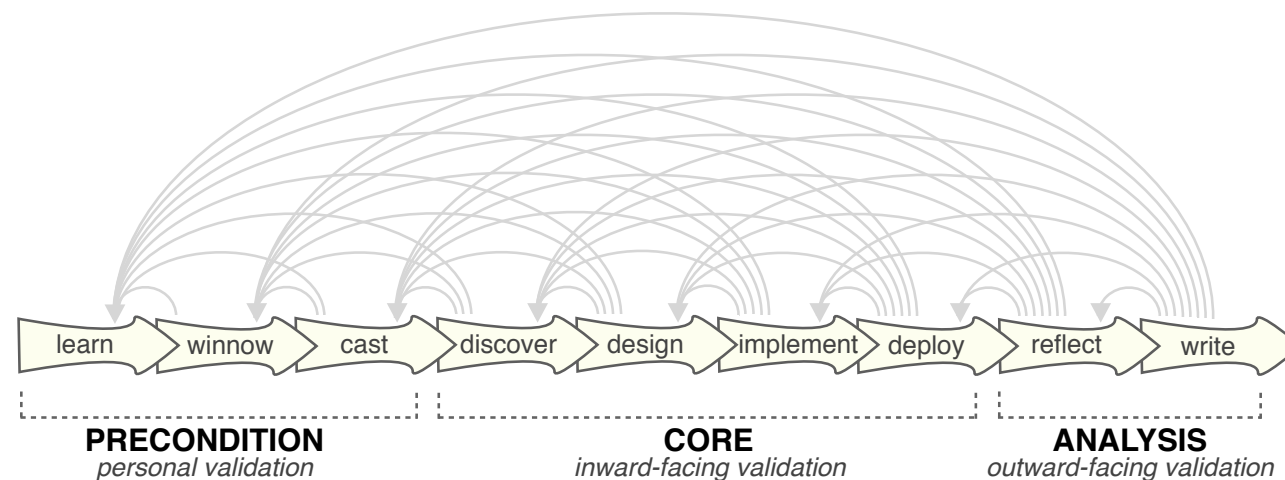
Vis researcher



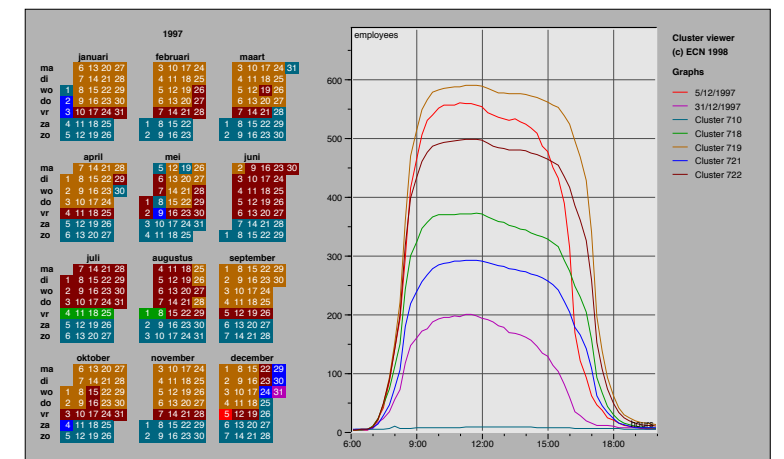
van Wijk:1999

# Making the right tool

Questions  
Data  
Tasks



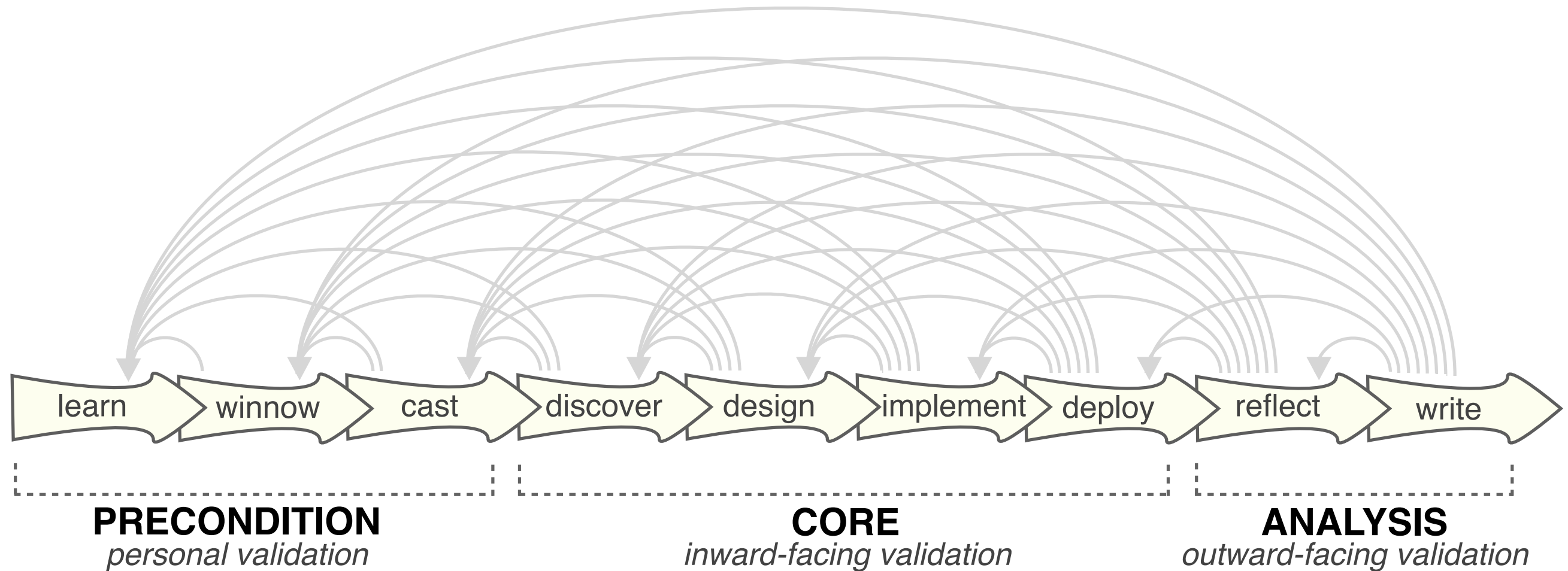
Design study methodology



van Wijk:1999

# Design study methodology

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Sedlmair:2012

# Design study definition

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Design study papers explore the choices made when applying infovis techniques in an application area, for example relating the visual encodings and interaction techniques to the requirements of the target task. Although a limited amount of application domain background information can be useful to provide a framing context in which to discuss the specifics of the target task, the primary focus of the case study must be the infovis content. Describing new techniques and algorithms developed to solve the target problem will strengthen a design study paper, but the requirements for novelty are less stringent than in a Technique paper.

[InfoVis03 CFP, [infovis.org/infovis2003/CFP](http://infovis.org/infovis2003/CFP)]

Munzner

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# Design study definition

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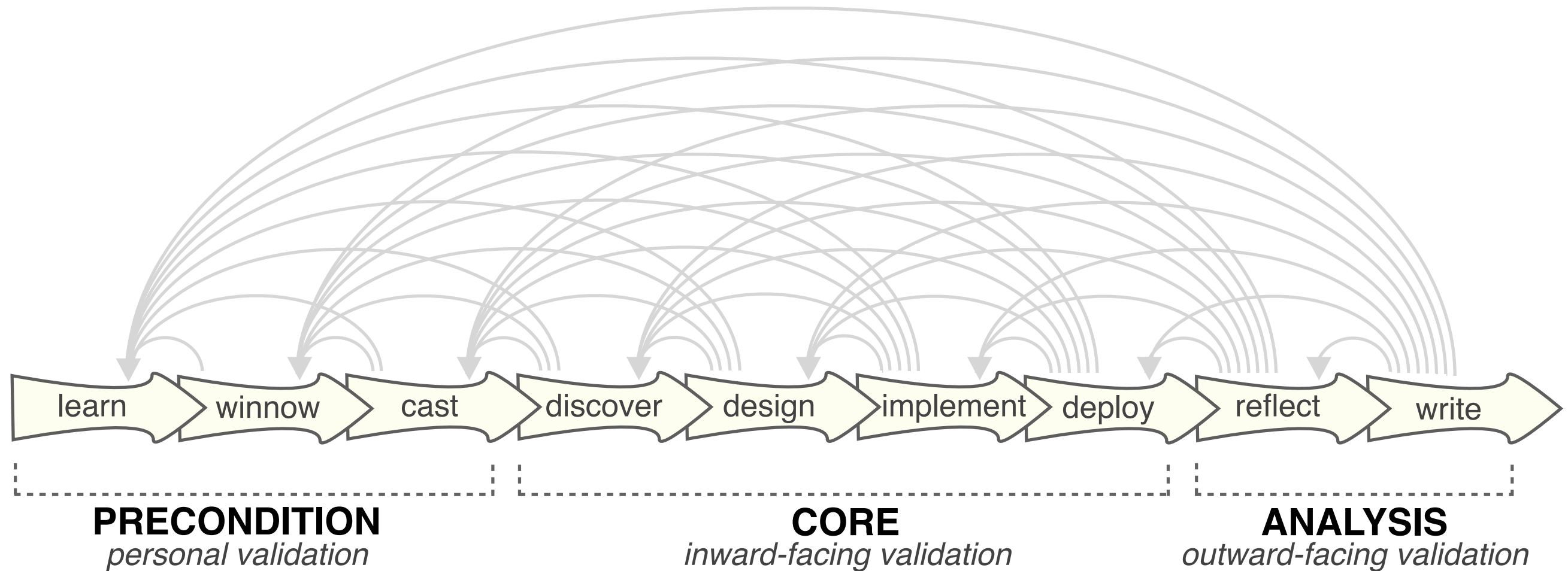
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Munzner

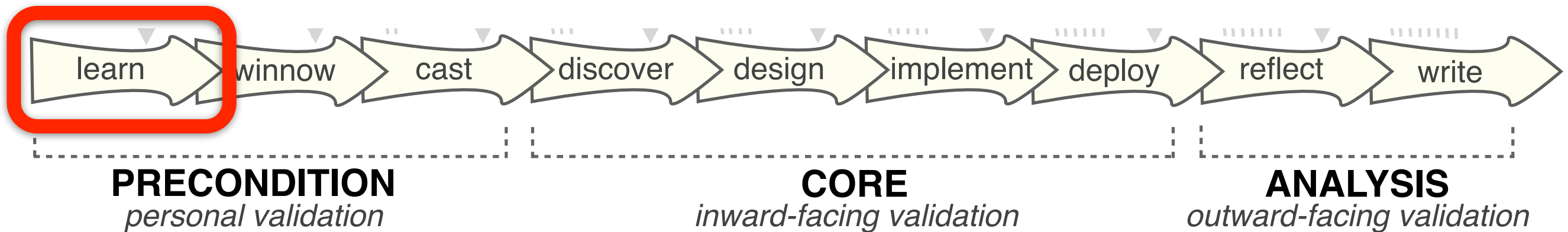
# Design study methodology

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Sedlmair:2012

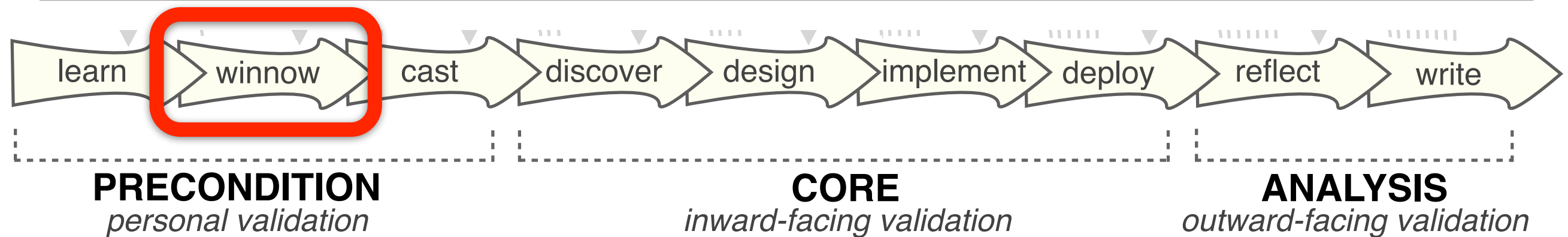
# Design study methodology



What tools/techniques are available?

- Read vis papers
- Read vis books
- Talk to vis practitioners
- This course!

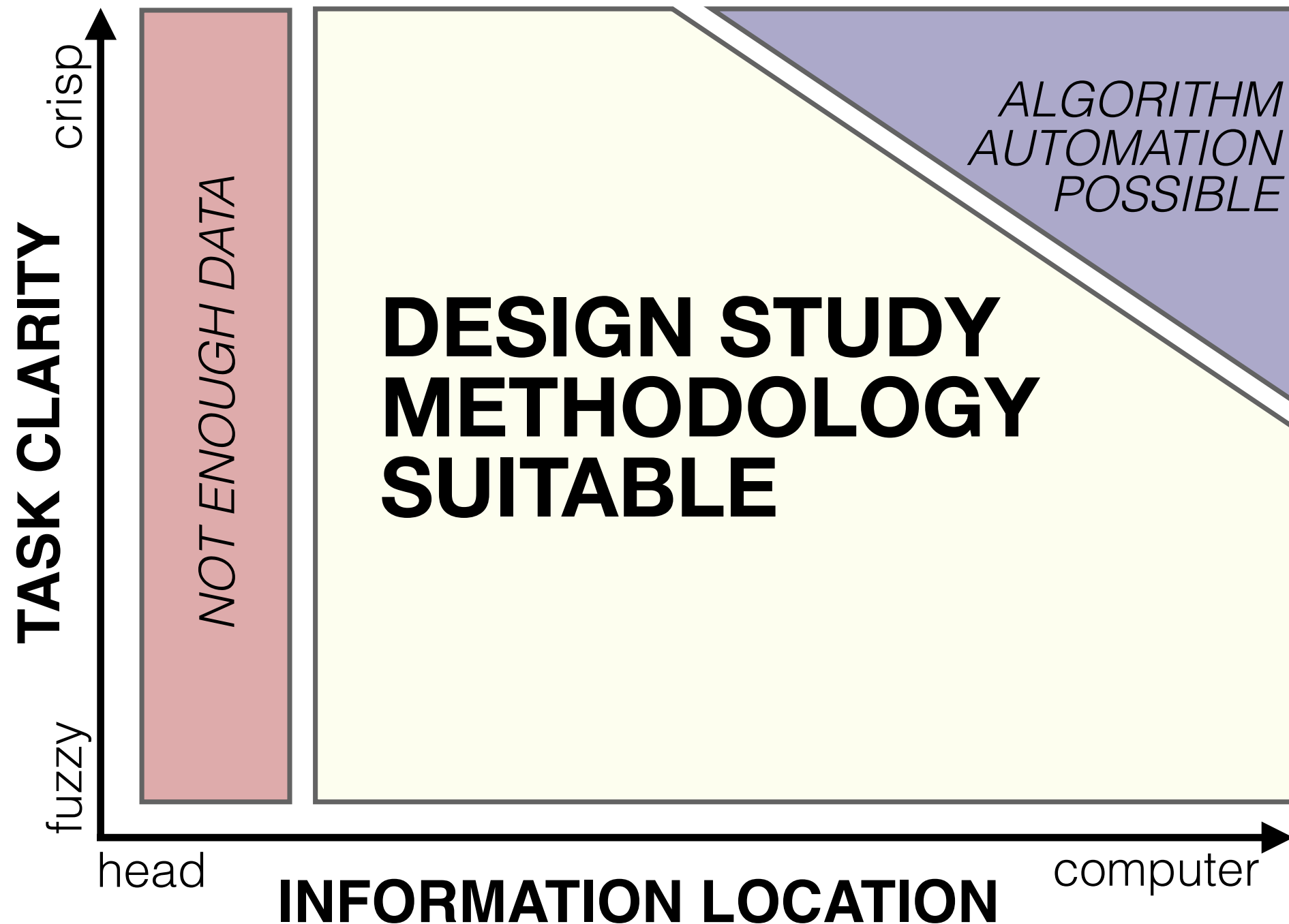
# Design study methodology



Are these good collaborators?

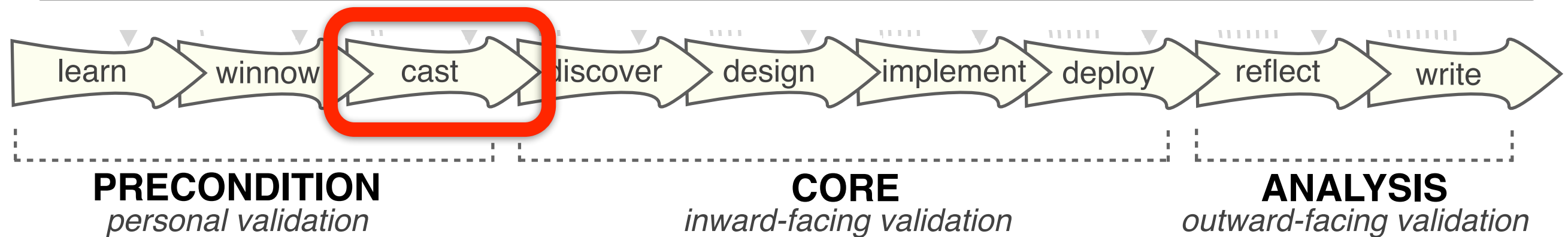
- Do they have interesting problems?
- Do they need novel solutions?
- Is there data?
- Can I work with these people?

# When can you do a design study?



Sedlmair:2012

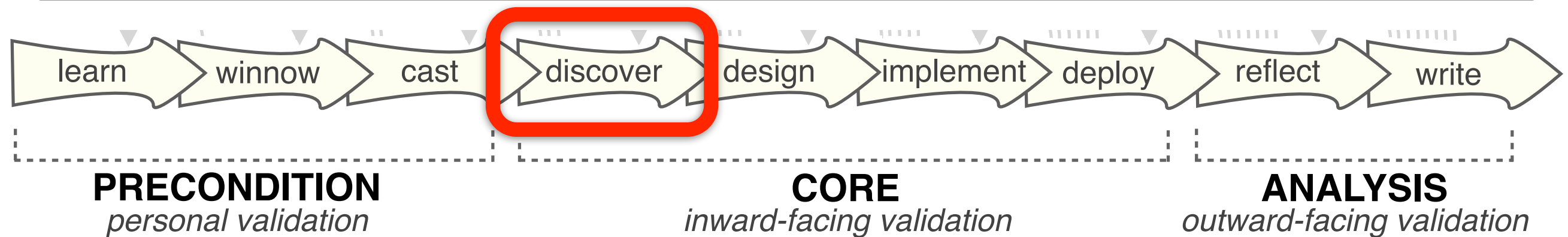
# Design study methodology



## Who's who?

- Do people have time for a new project?
- “Front-line analyst” is the domain expert
- Are there false “front-line analysts”?
- Do you need a “translator”?

# Design study methodology

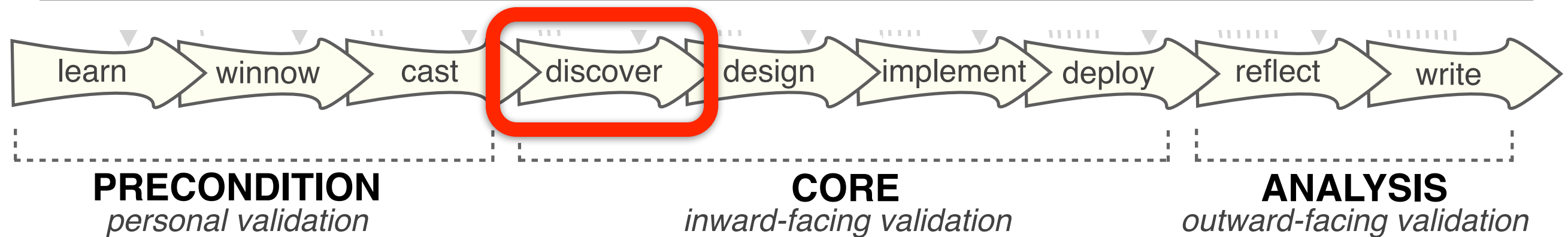


## Problem characterization and abstraction

- Requirements analysis
- Critical reflection on requirements!
- Abstraction is important for transferability
- Need some domain-expert knowledge



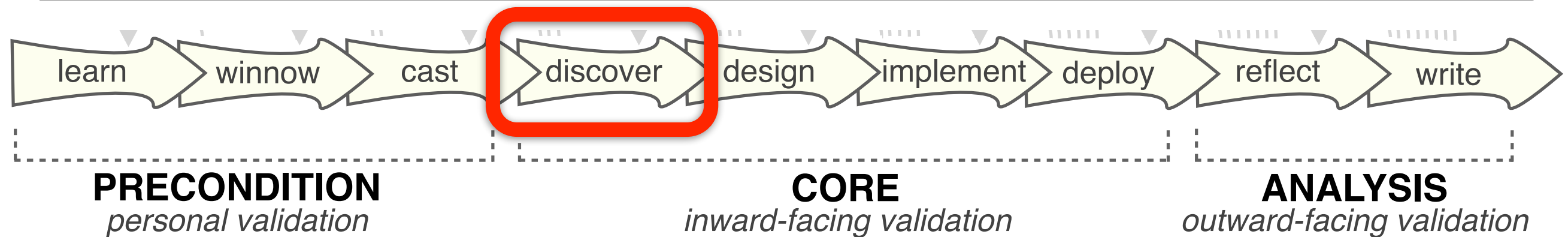
# Design study methodology



example: Cluster-Calendar, van Wijk and van Selow

- Overall goal: are there temporal patterns in power consumption?

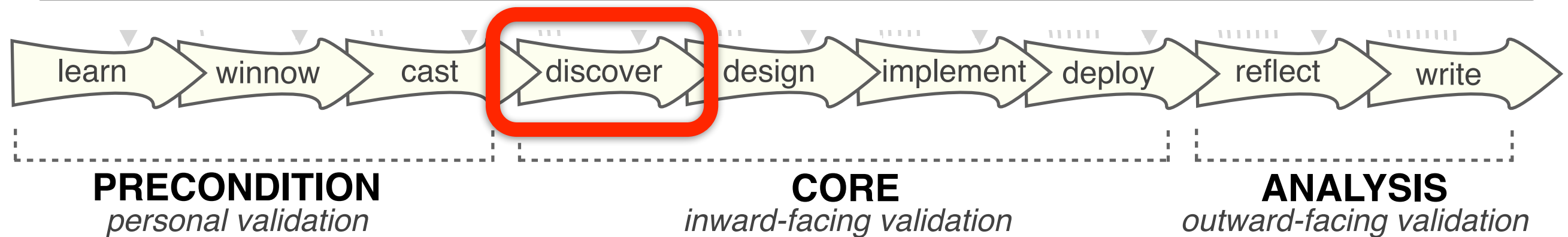
# Design study methodology



example: Cluster-Calendar, van Wijk and van Selow

- Data: ~50K pairs of (value, time)
- Tasks
  - Find standard day patterns
  - Find out how patterns are distributed over year, week, season
  - Find outliers from standard daily patterns
  - Want overview first, details on demand

# Design study methodology

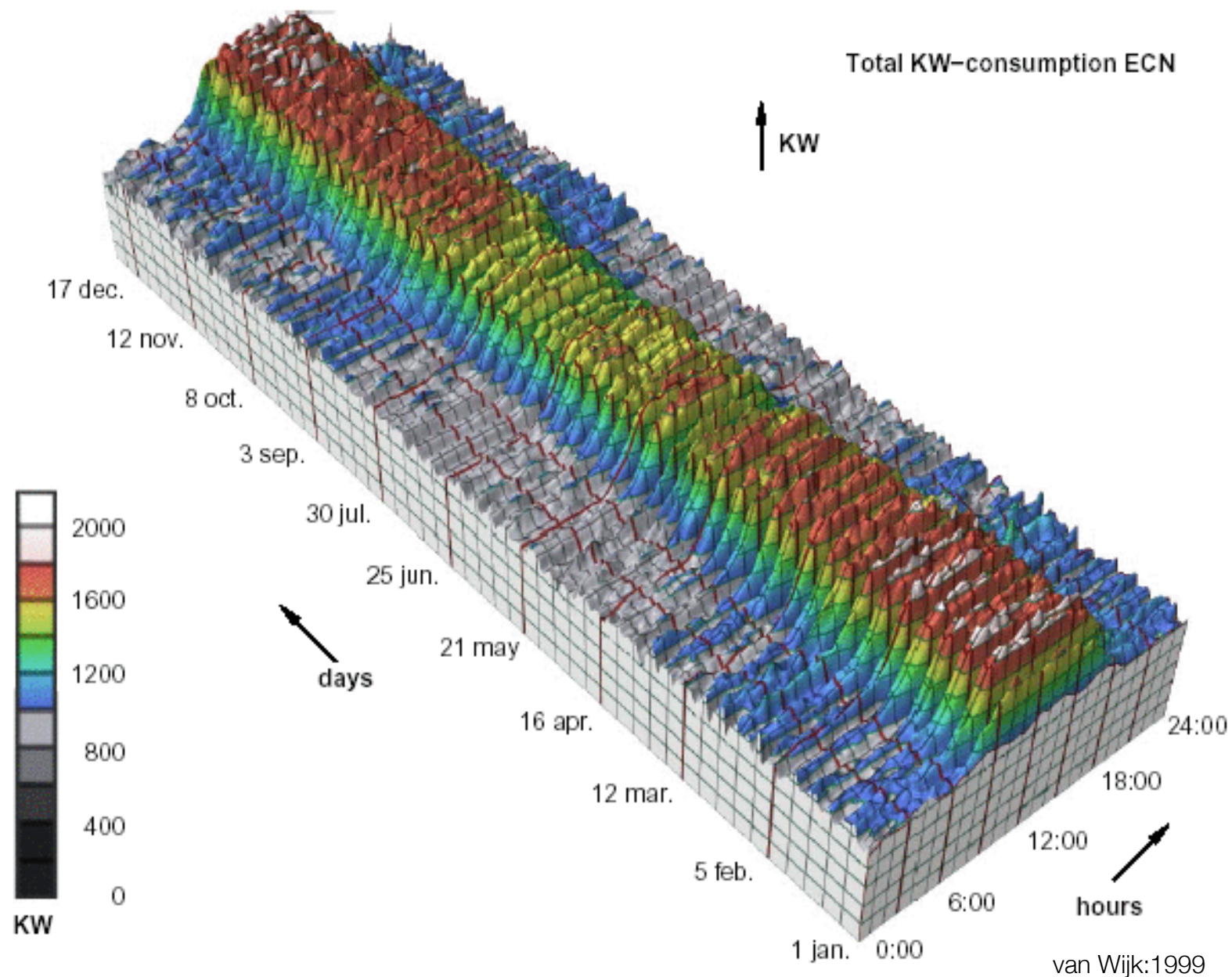


example: Cluster-Calendar, van Wijk and van Selow

- Limitations of previous work:
  - predictive mathematical models: details lost
  - scale-space approaches (wavelet, fourier, fractal): hard to interpret, known scales lost
  - 3D mountain diagram (x: hours, y: value, z: days)

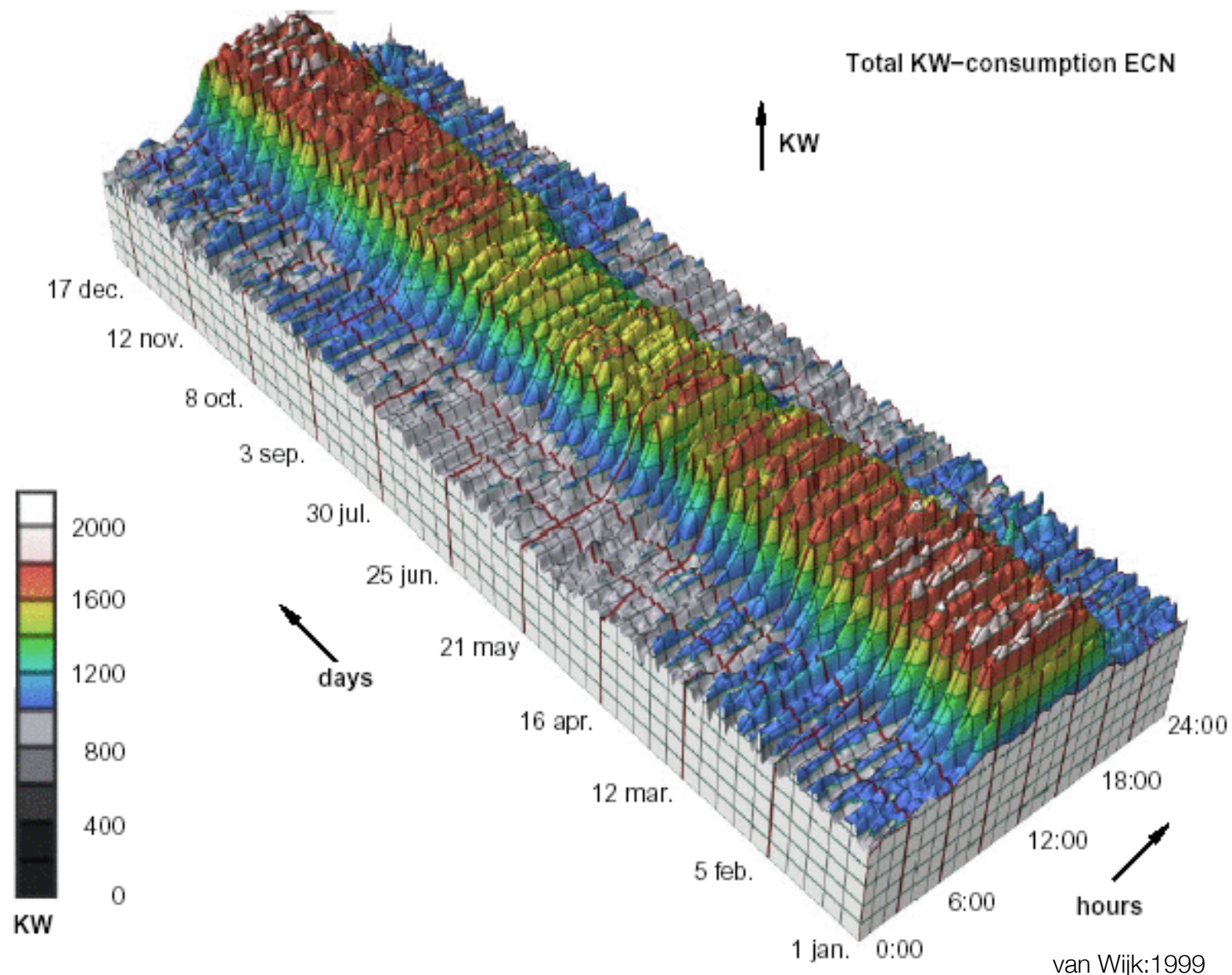
# Design study methodology

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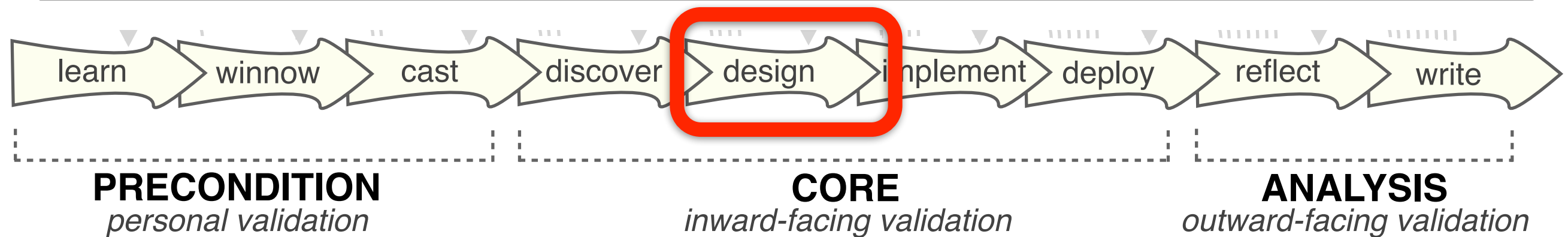
# Design study methodology

- Pretty, not so useful
- Daily, weekly patterns are hard to see





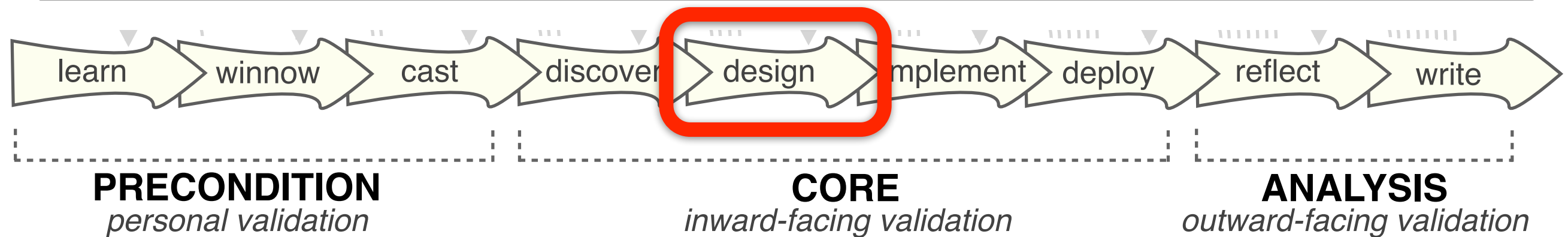
# Design study methodology



Data abstraction, visual encoding, interaction

- What data transformations are needed?
- What visual designs to use?
- How to tie this together with interaction?
- Don't code!

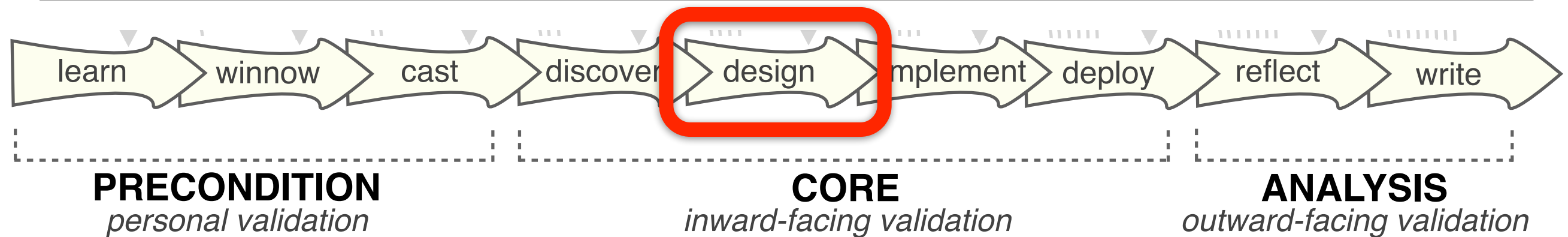
# Design study methodology



example: Cluster-Calendar, van Wijk and van Selow

- Data transform: hierarchical clustering

# Design study methodology

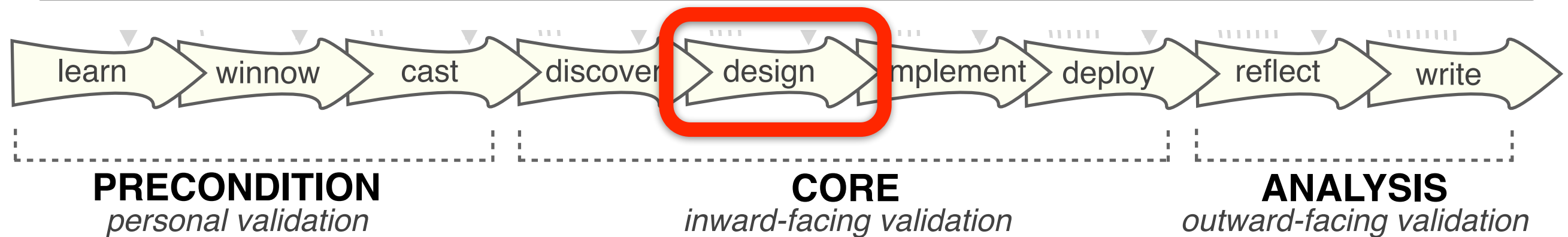


## example: Cluster-Calendar, van Wijk and van Selow

- Data transform: hierarchical clustering
- start with M day patterns
  - compute pair-wise differences, merge most similar
  - now we have M-1 patterns
  - repeat until we have 1 root cluster
- result: binary hierarchy of clusters



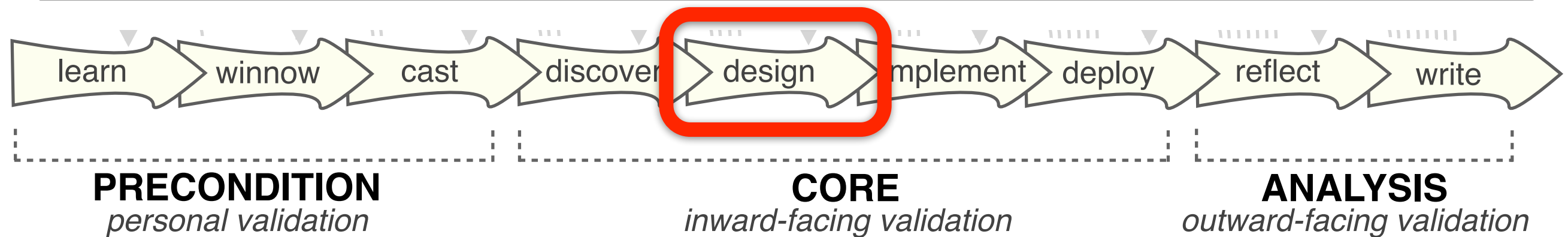
# Design study methodology



example: Cluster-Calendar, van Wijk and van Selow

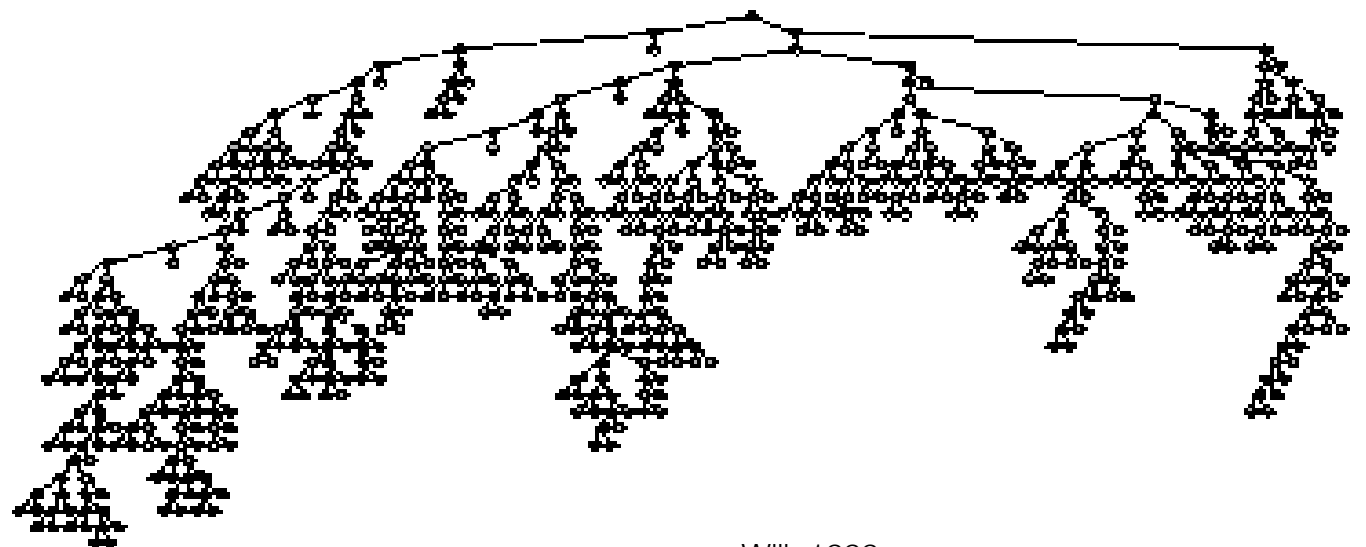
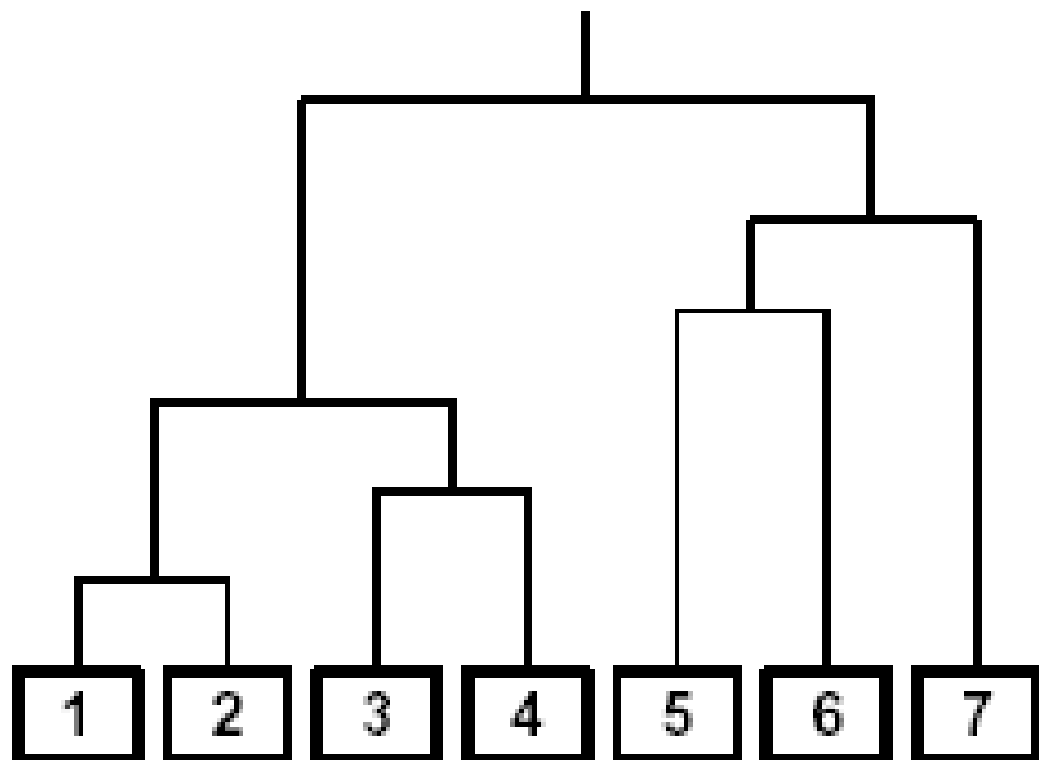
- Data transform: hierarchical clustering
- issues:
  - distance metric to use?
  - how to display the cluster?

# Design study methodology

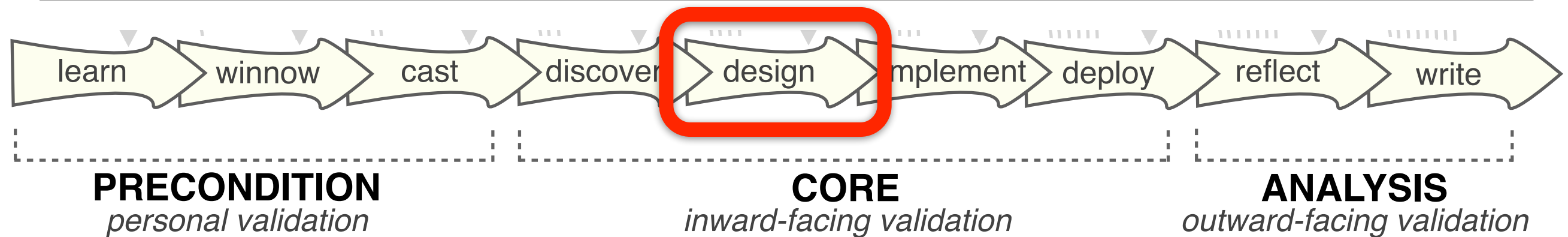


example: Cluster-Calendar, van Wijk and van Selow

- dendrogram

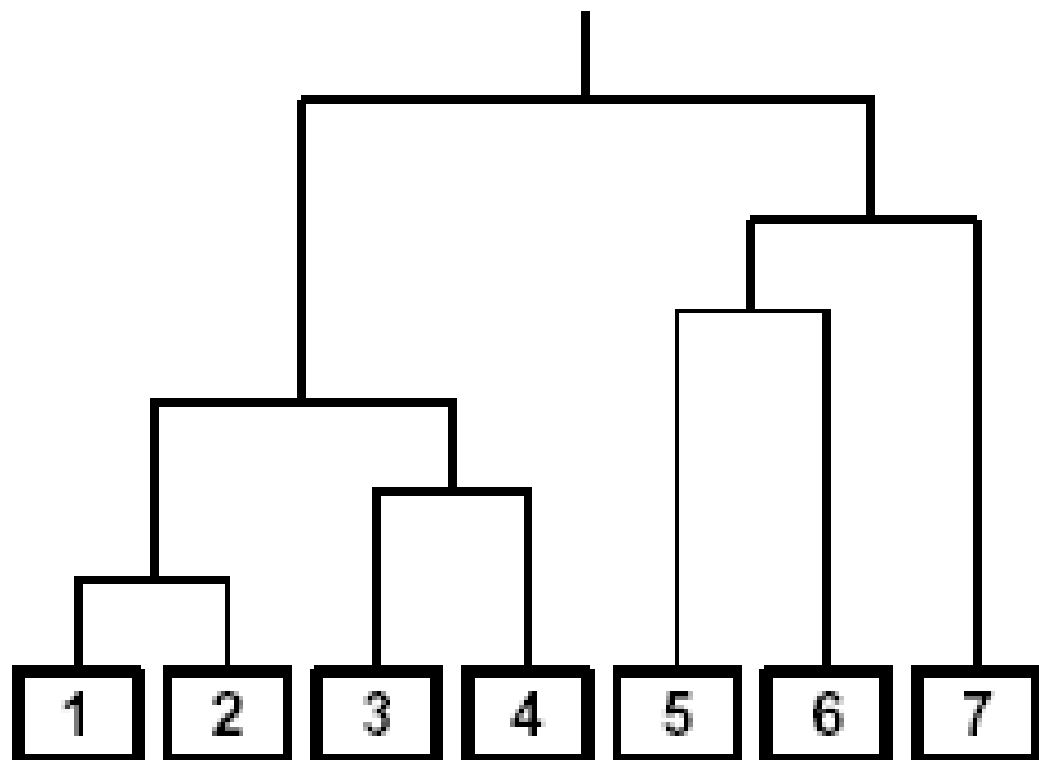


# Design study methodology

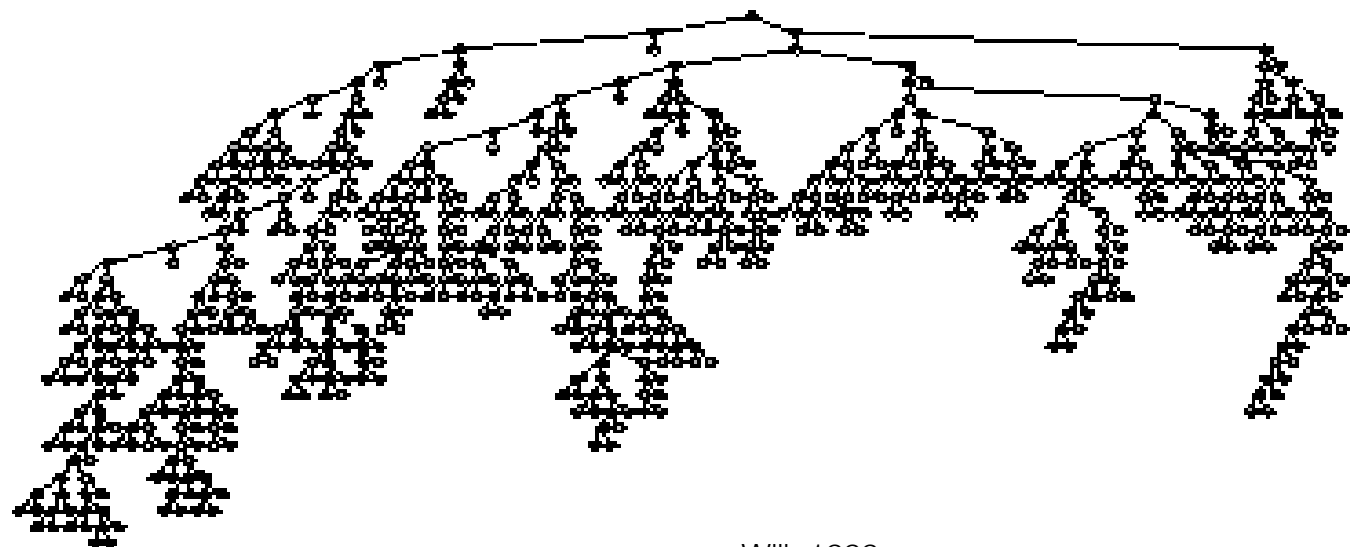


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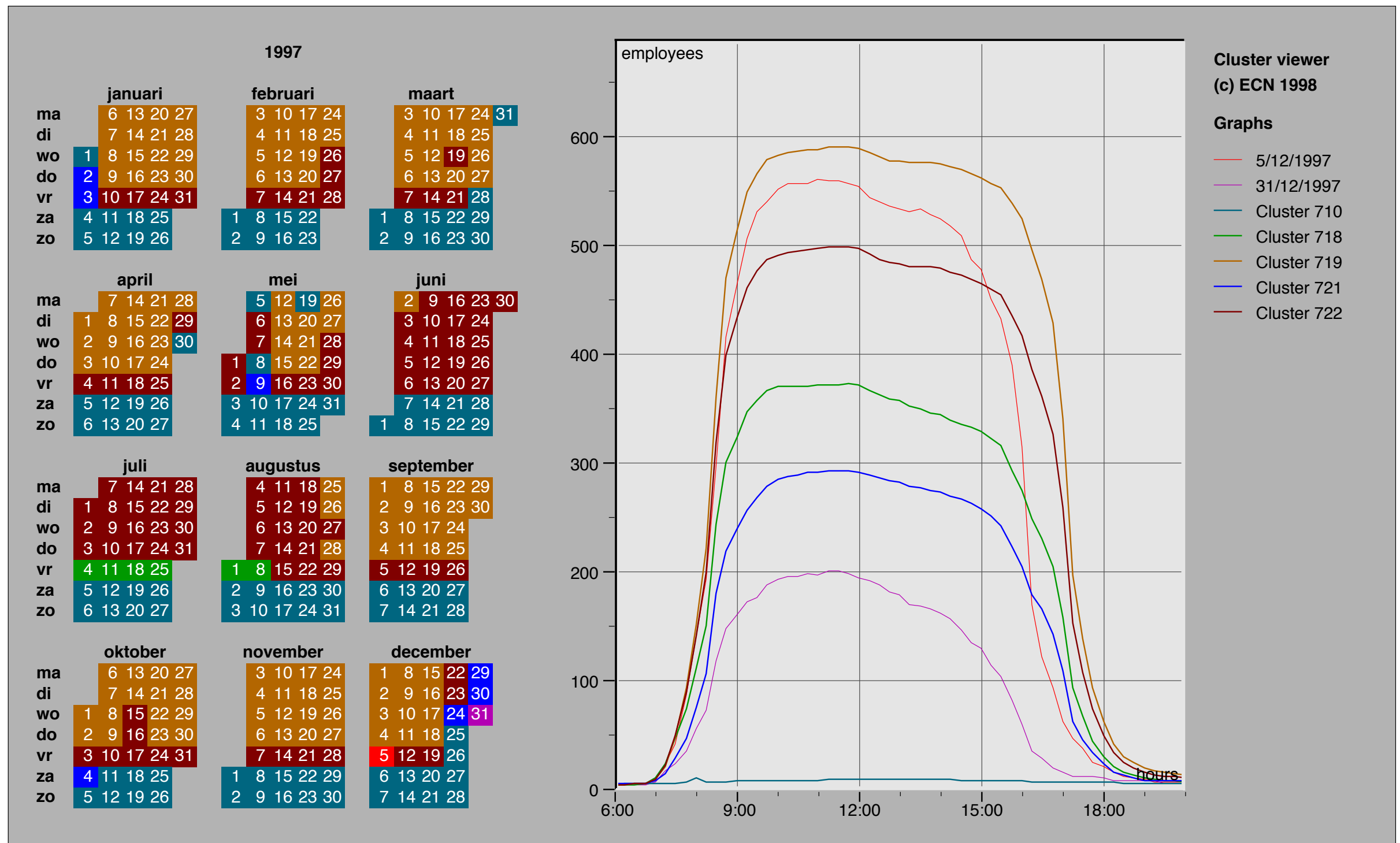
- dendrogram



Shows hierarchical structure  
but not time distribution!



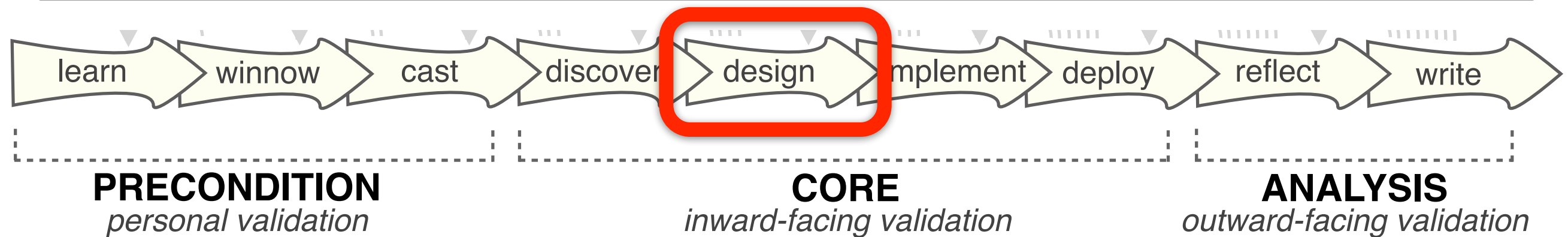
# Design study methodology



Overview

Detail

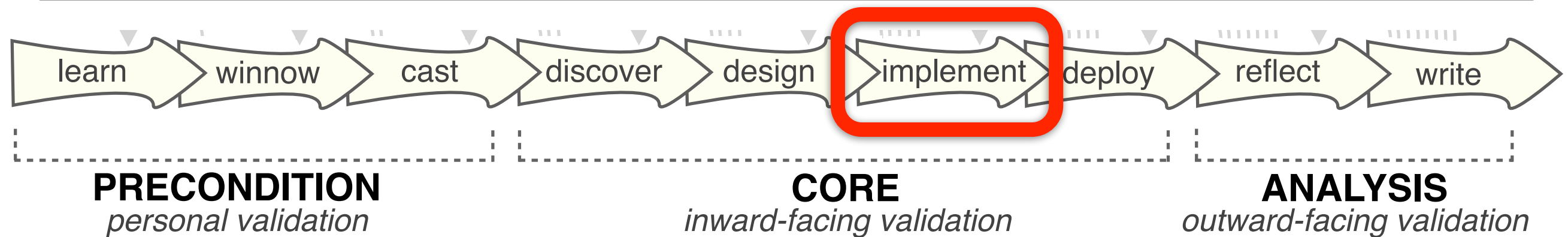
# Design study methodology



example: Cluster-Calendar, van Wijk and van Selow

- clusters: data transformation to aggregate data
- calendar: familiar visual representation for time
- linking: interactive exploration of the data
- task analysis guided choices: 3D extrusion and dendrogram don't work

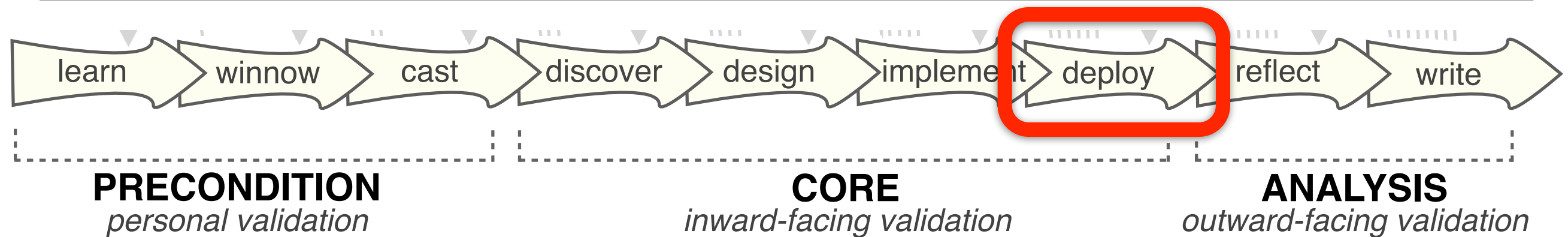
# Design study methodology



Yay coding!

- Need to test design hypotheses
- Rapid prototyping (will probably throw away alot of code)
- Breaking bugs vs annoying bugs
- Fast usability testing

# Design study methodology

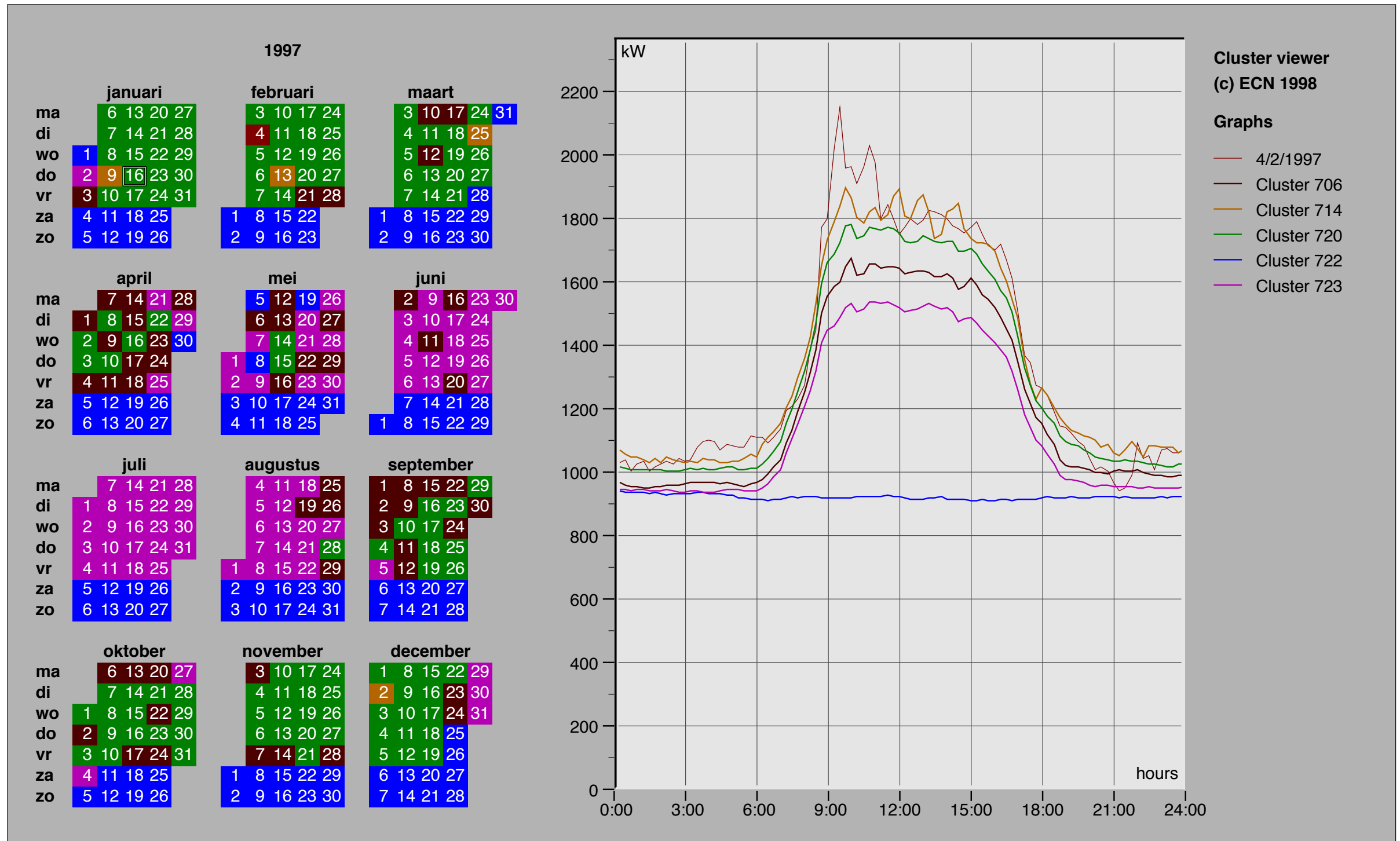


## Hand-off to the users

- Domain experts need to play with software
- What works, what doesn't?
- How to evaluate?
- May need to redesign/reimplement a lot

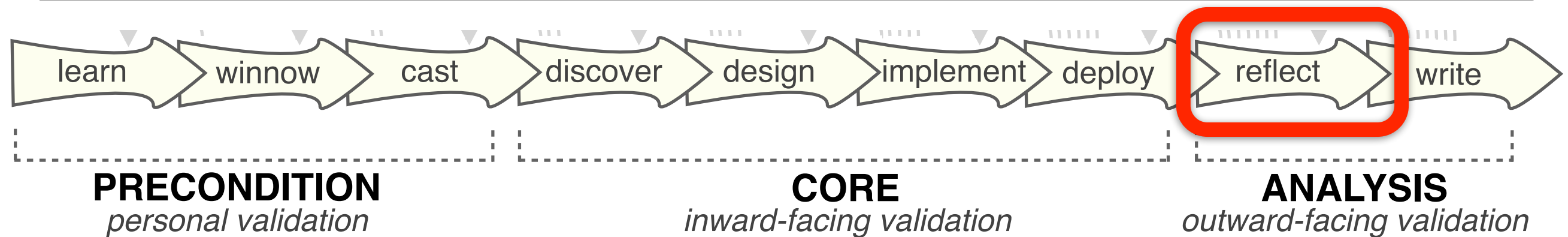
# Design study methodology

## Critique?





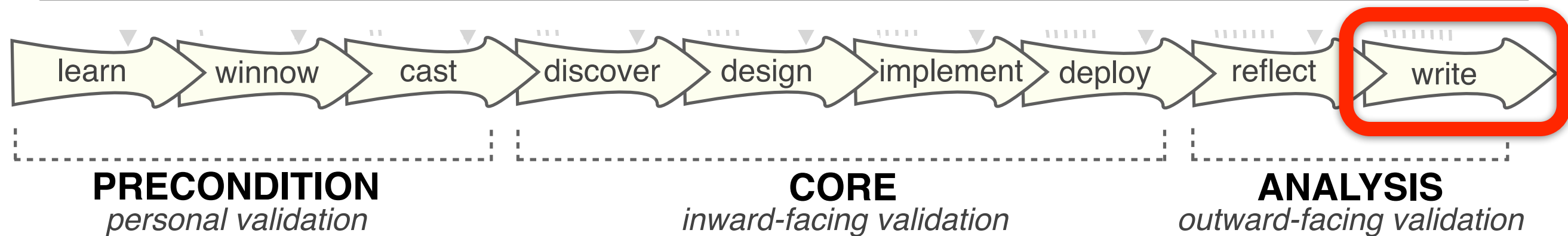
# Design study methodology



Refine, reject, propose guidelines

- Compare to existing design guidelines
- Confirm which ones worked
- Reject which ones didn't work
- Come up with new guidelines

# Design study methodology

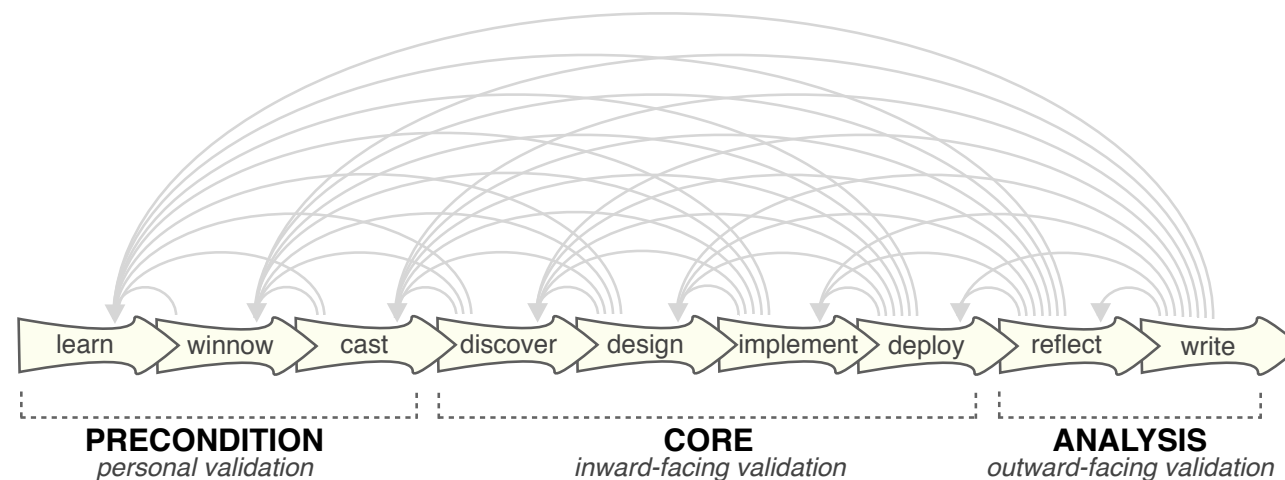


Yay words!

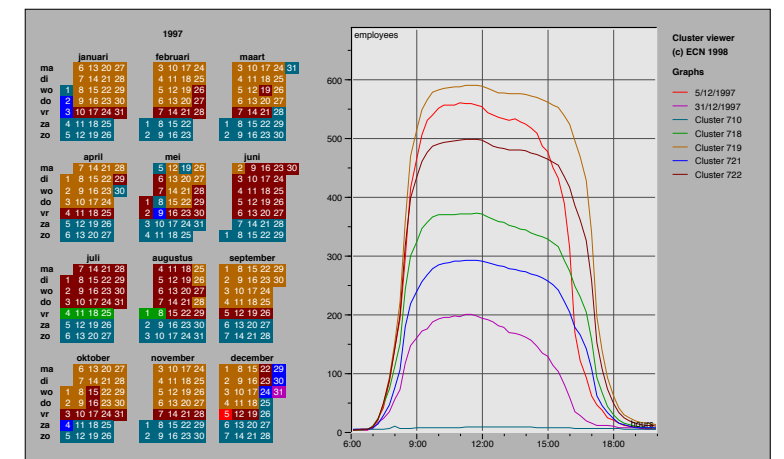
- Forces clear articulation of problem, tasks, solution
- Who else does my study help? - transferability!  
--> Design study contributions come in different guises: Seven guiding scenarios.  
Michael Sedlmair. BELIV 2016.
- Think carefully about what readers will care about
- This takes time to do well!

# Making the right tool

Questions  
Data  
Tasks



Design study methodology



van Wijk:1999

# Where are design studies?

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## **Domain situation**

Observe target users using existing tools

What are people doing?

What are their goals?

## **Data/task abstraction**

What are data/tasks to accomplish these goals?

## **Visual encoding/interaction idiom** Justify design with respect to alternatives

How do I show/interact with the data?

## **Algorithm** Measure system time/memory Analyze computational complexity

How do I make this all work?

Analyze results qualitatively

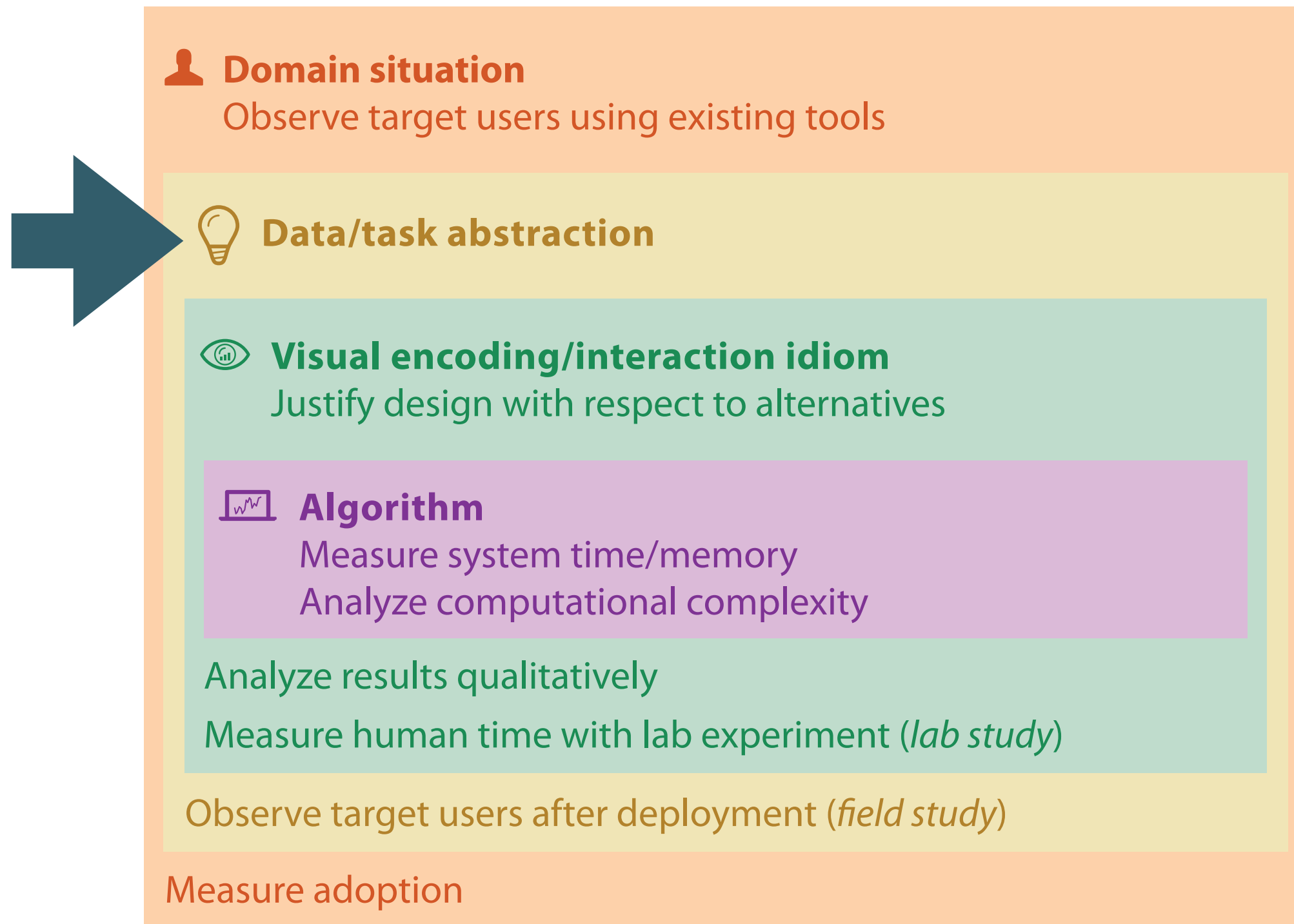
Measure human time with lab experiment (*lab study*)

Observe target users after deployment (*field study*)

Measure adoption

# Where are design studies?

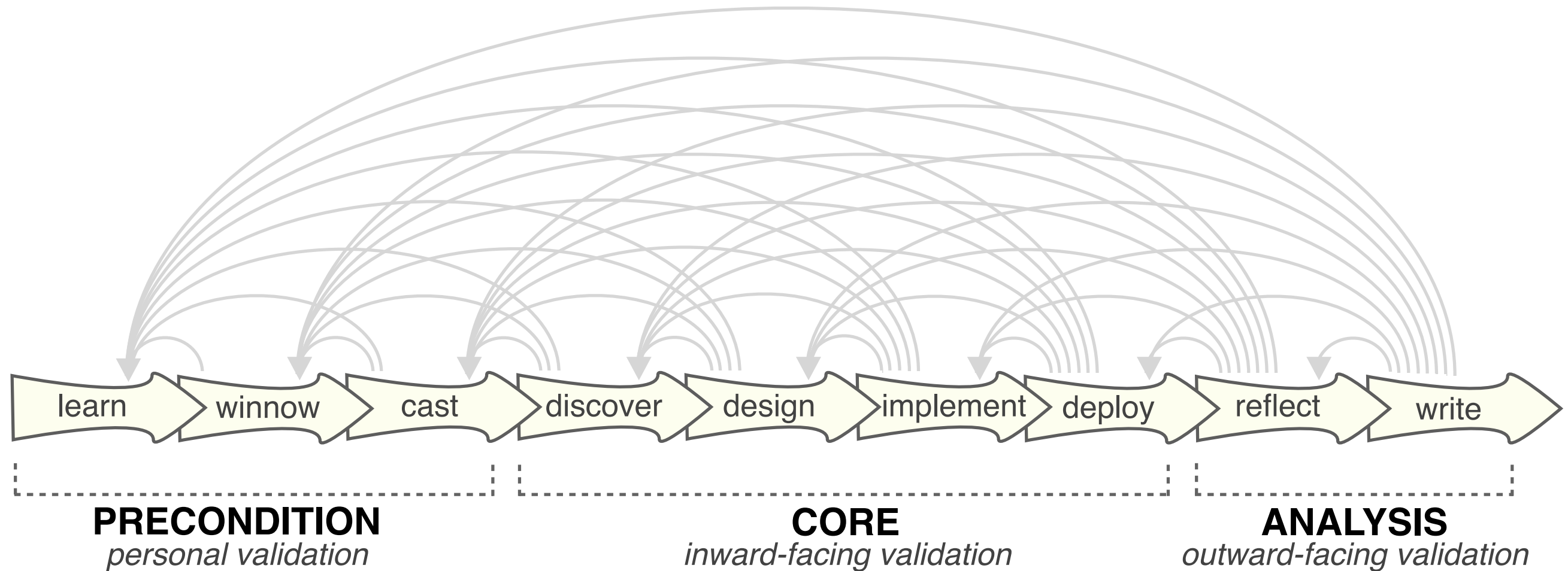
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# Pitfalls

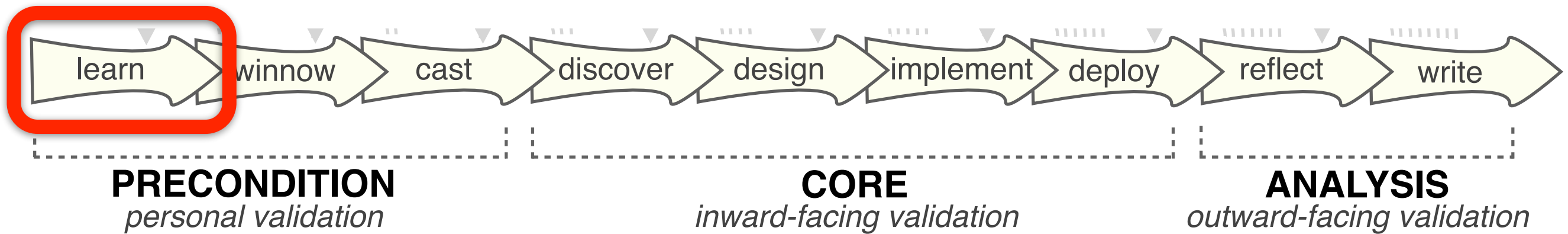
# Pitfalls

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#1: Don't skip steps!

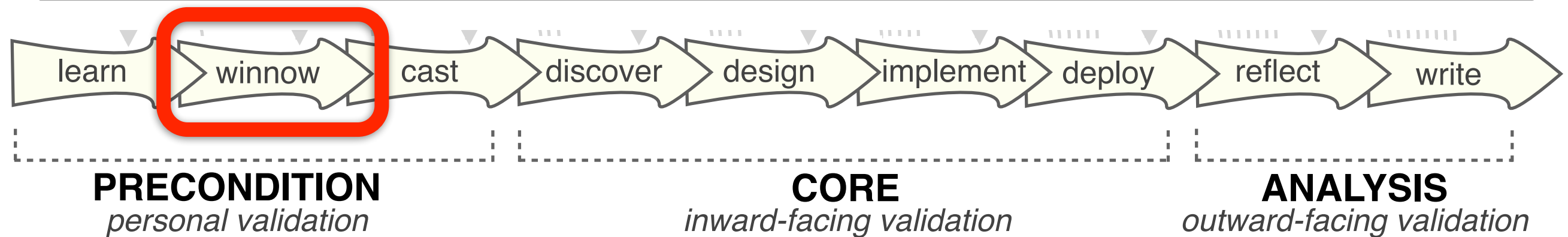
# Pitfalls



- insufficient knowledge of literature

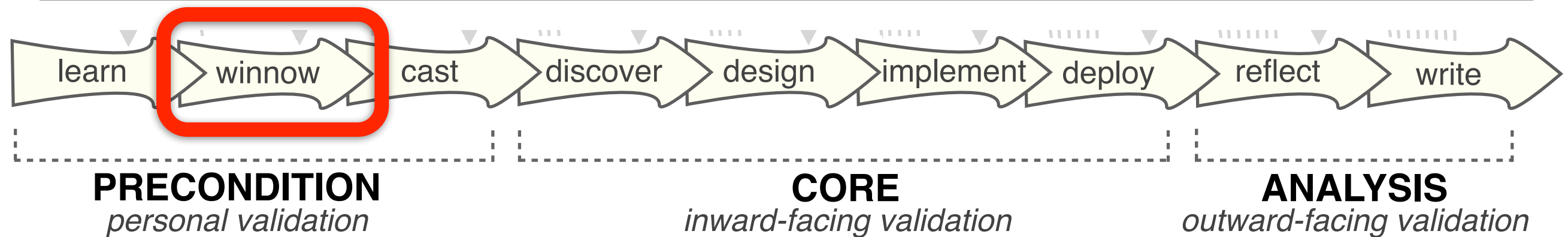


# Pitfalls



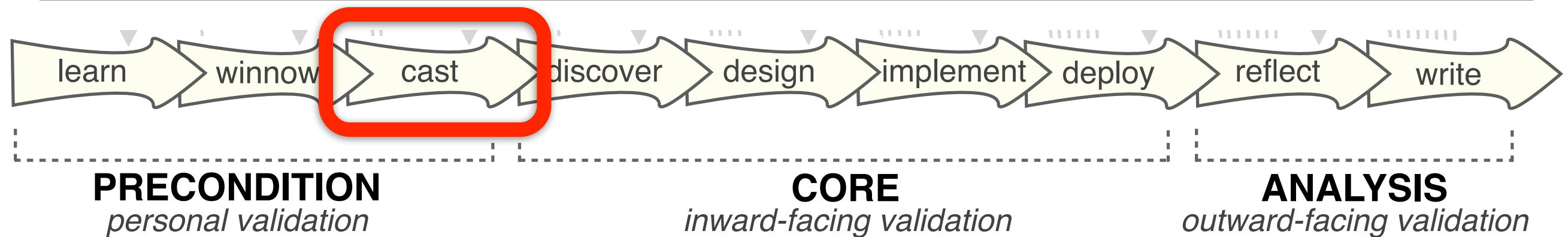
- collaboration with the wrong people
- **no real data available**
- insufficient time available from collaborators
- **no need for visualization: automate**
- no need for research: engineering project

# Pitfalls



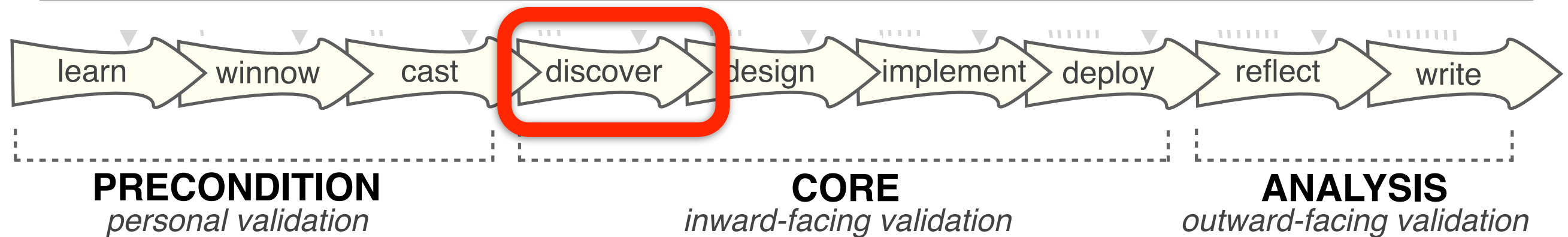
- **is this interesting to me?**
- existing tools are good enough
- **not an important/recurring task**
- no rapport with collaborators

# Pitfalls



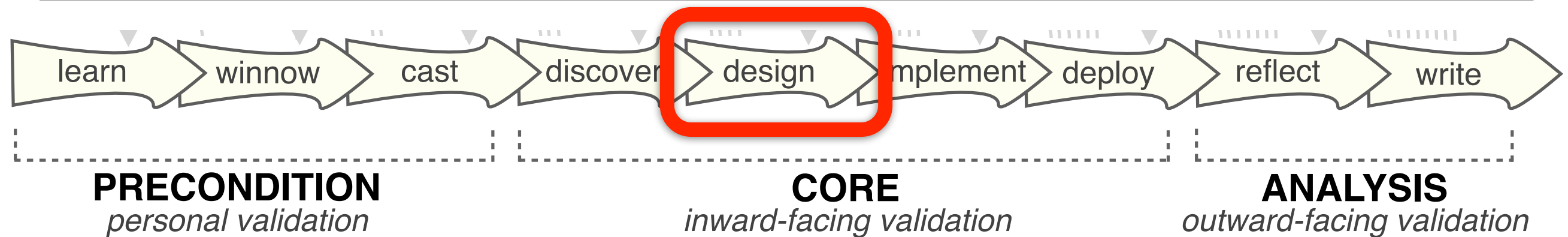
- not identifying front-line analyst and gatekeeper
- assuming same role distribution across projects
- mistaking tool-builders for real end users

# Pitfalls



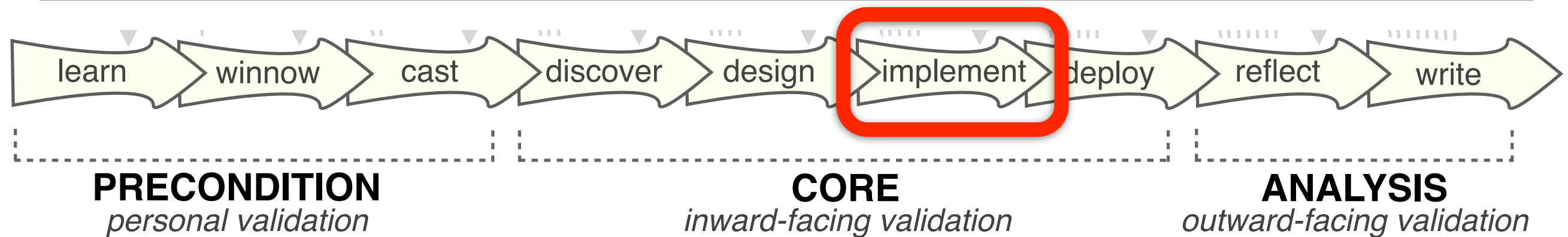
- ignoring practices that currently work well
- expecting *just talking* or *fly on the wall* to work
- domain experts design the visualizations
- too much/too little domain knowledge

# Pitfalls



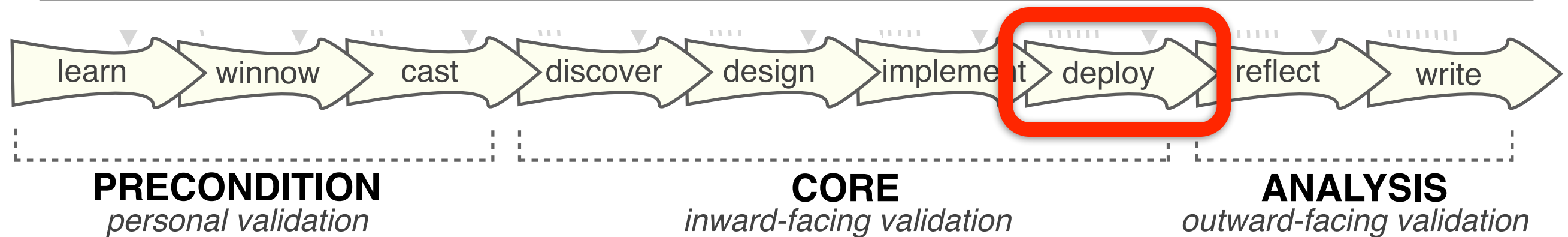
- too little abstraction
- **design consideration space too small**
- mistaking technique-driven and problem-driven work

# Pitfalls



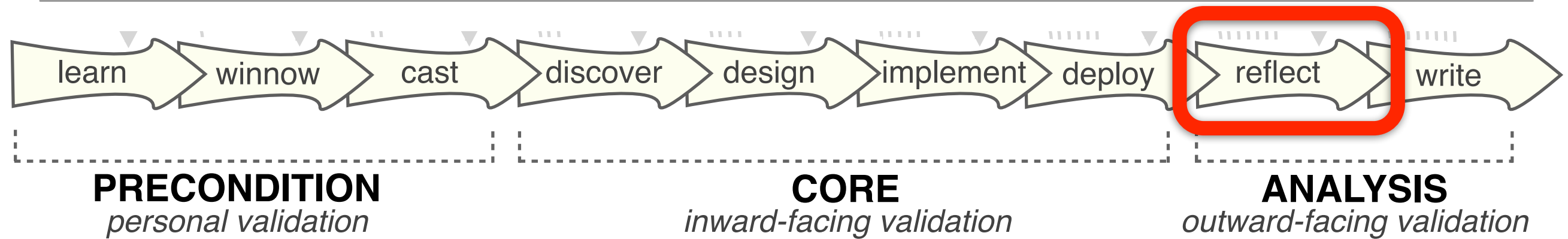
- **non-rapid prototyping**
- **usability: too little/too much**

# Pitfalls



- **insufficient deploy time**
- non-real task/data/user
- *liking* a tool is not validation!

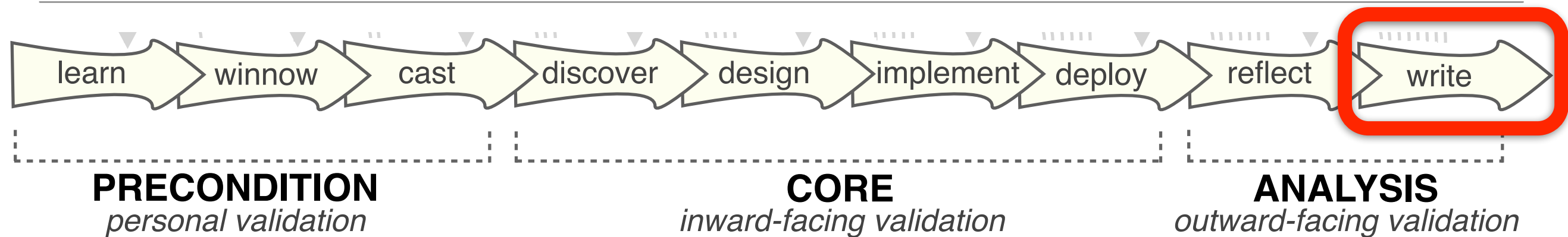
# Pitfalls



- failing to improve guidelines



# Pitfalls



- **not enough writing time**
- no technique contribution  $\neq$  write a design study
- too much domain background
- chronological story vs concentrating on results
- **premature end to the project**

# Additional reading

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- Design study methodology: Reflections from the trenches and the stacks. Michael Sedlmair, Mariah Meyer, and Tamara Munzner. IEEE Trans. Visualization and Computer Graphics 18(12):2431-2440, 2012.
- Cluster and Calendar based Visualization of Time Series Data. Jarke J. van Wijk and Edward R. van Selow. Proc. InfoVis 1999, p 4-9.
- MizBee: A Multiscale Synteny Browser. Miriah Meyer, Tamara Munzner, and Hanspeter Pfister. IEEE Trans. Visualization and Computer Graphics 15(6):897-904 (Proc. InfoVis 09), 2009.