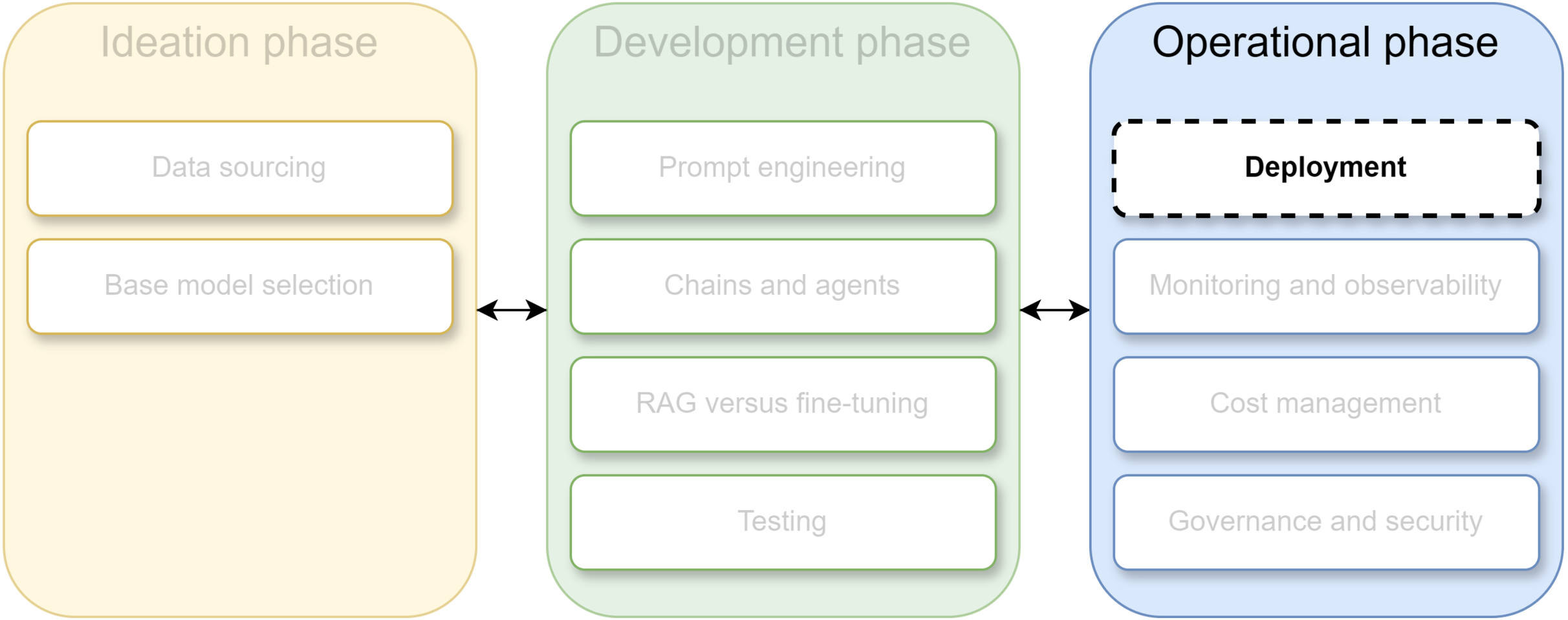
Deployment

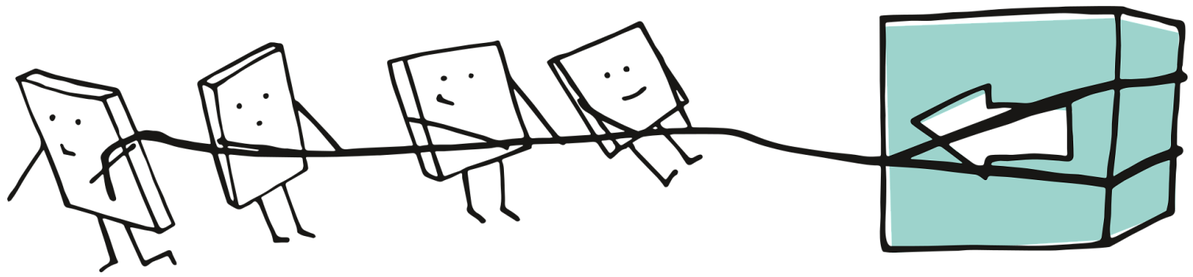
LLMOPS CONCEPTS

Max Knobbout, PhD
Applied Scientist, Uber

LLM lifecycle: Deployment



Moving to deployment



- No one-size-fits-all!
- An application may include a chain/agent logic, vector database, LLM, and more
- Each component needs to be **deployed** and **work together**

Step 1: Choice of hosting

- Private/public cloud or on-premise hosting
- Many cloud providers offer solutions for LLM hosting and deployment

Step 2: API design

- APIs let different software talk to each other
- Design affects scalability, cost and infrastructure needs
- Security is crucial, controlled with API keys!

Step 3: How to run

- Options:
  1. Containers
  2. Serverless functions
  3. Cloud managed services
- Advantages/disadvantages like costs, scalability, efficiency and flexibility

CI/CD

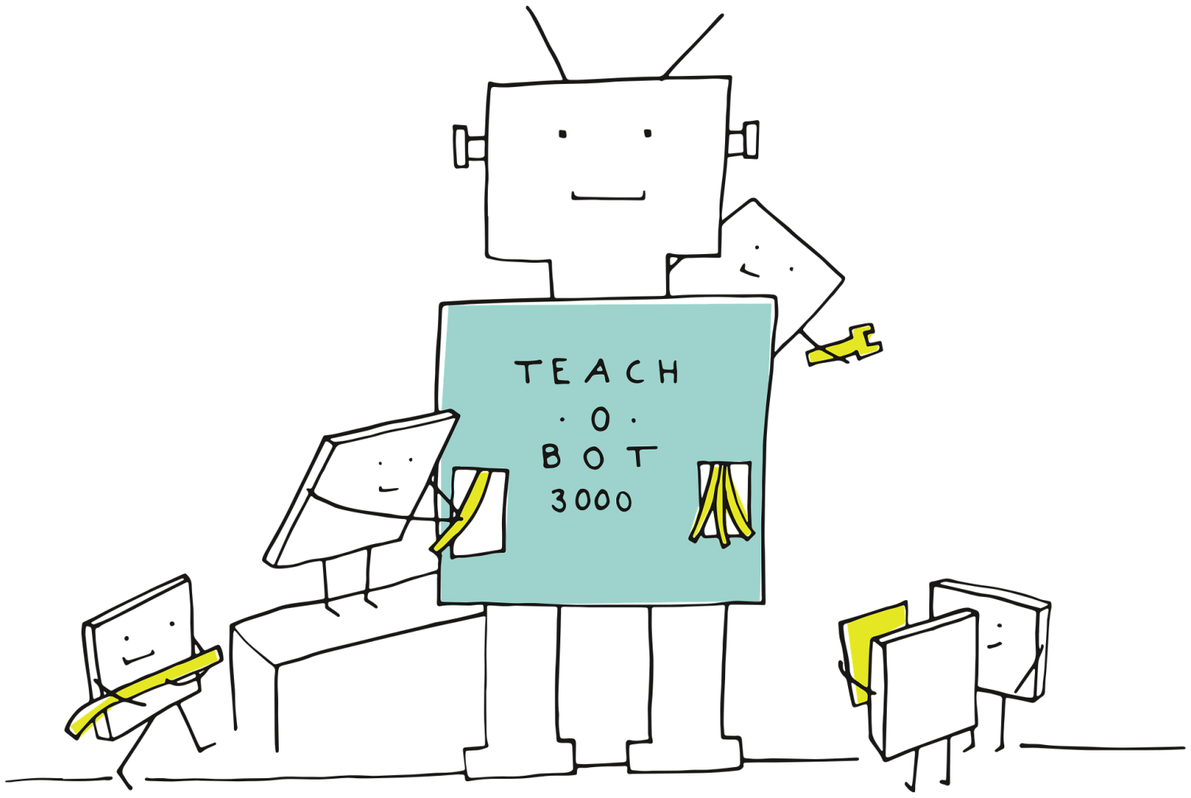
Continuous Integration (CI):

1. **Source:** Retrieve source code
2. **Build:** Create a container image containing the code
3. **Test:** Perform integration tests
4. **Register:** Store the container in a registry

Continuous Deployment (CD):

1. **Retrieve:** Retrieve container from registry
2. **Test:** Perform deployment tests
3. **Deploy:** Deploy container to environments:
    - Staging
    - Production

Scaling



- LLMs might need specialized GPU hardware.
- Scaling strategies:
  1. **Horizontal**: Add more machines
  2. **Vertical**: Boosting one machine
- Horizontal for traffic, vertical for reliability and speed

Let's practice!

LLMOPS CONCEPTS

Monitoring and observability

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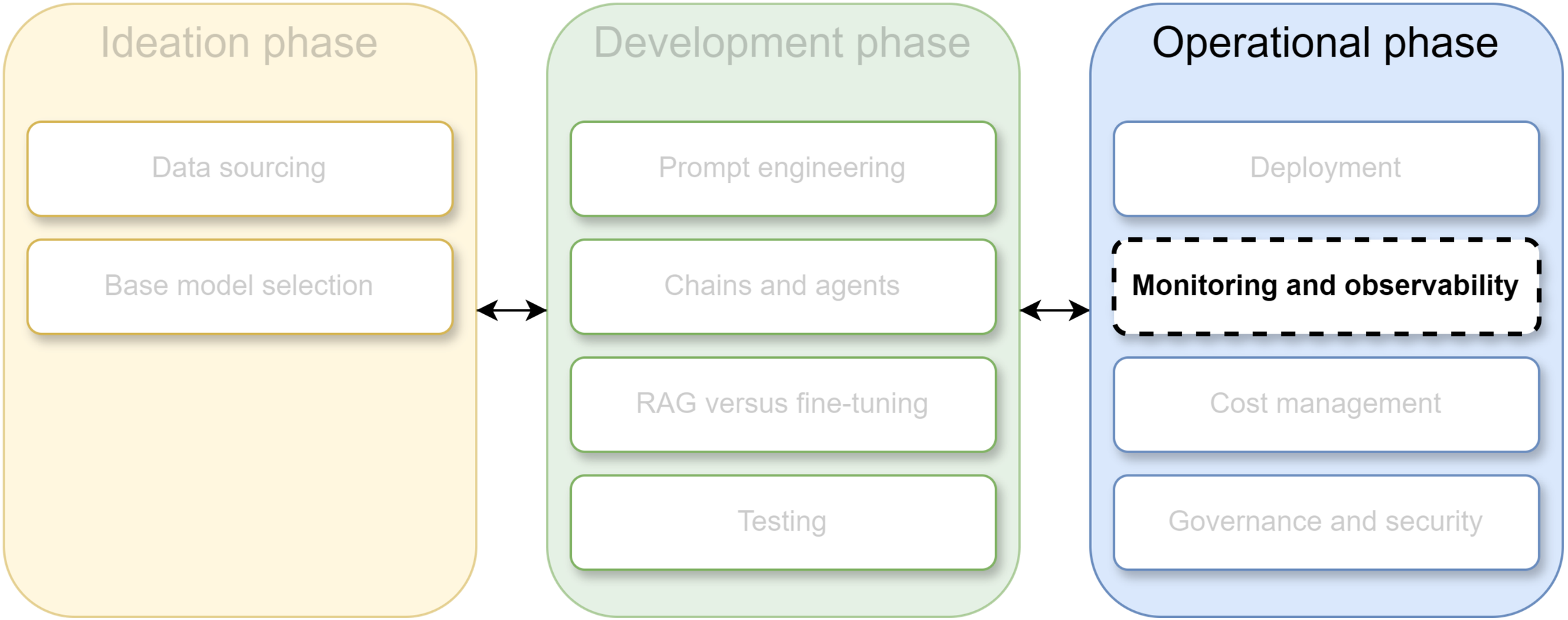
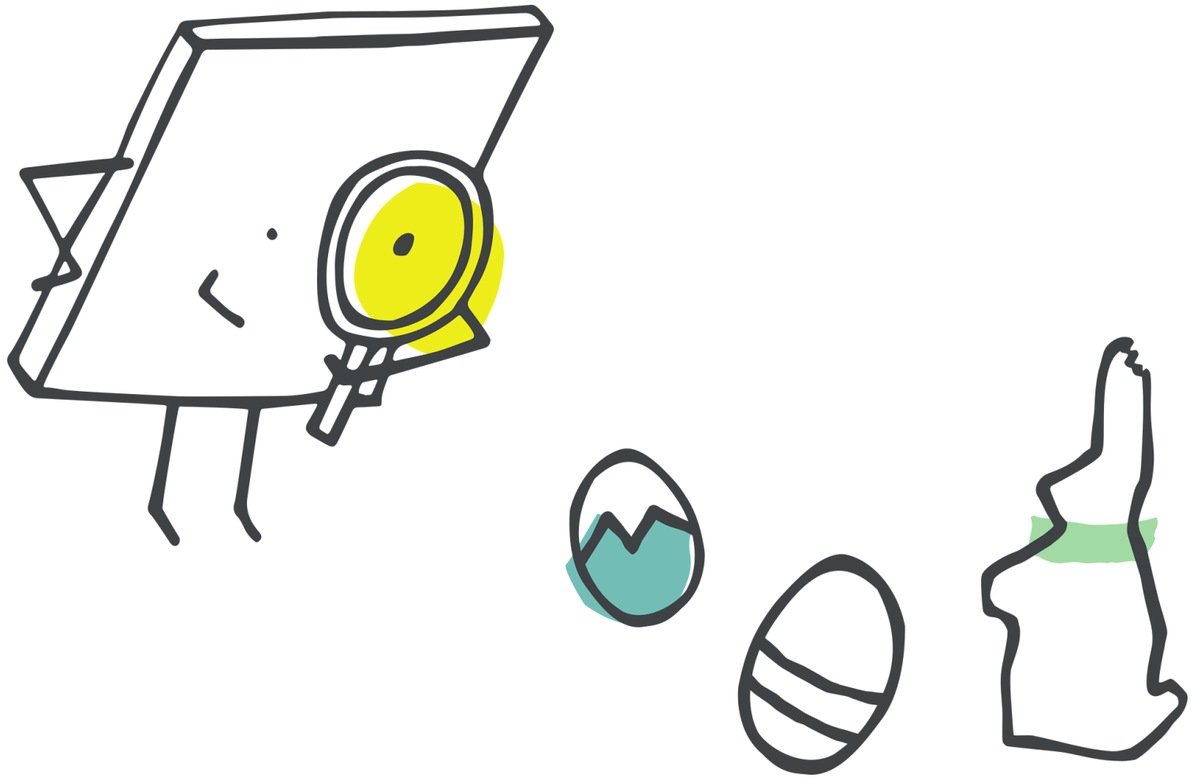
LLM lifecycle: Monitoring and observability



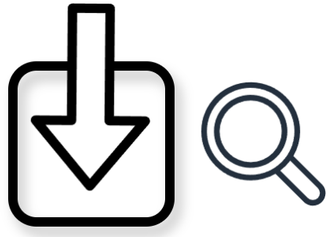
Monitoring and observability



- **Monitoring** continuously watches a system.
- **Observability** reveals internal states to external observers.
- Data sources for observability:
  1. Logs
  2. Metrics
  3. Traces

Input monitoring

- Monitor inputs for:
  - Changes
  - Errors
  - Malicious content
- Data drift is the change in input data distribution over time
- Addressing data drift requires:
  - Monitoring the data distribution
  - Periodically updating the model



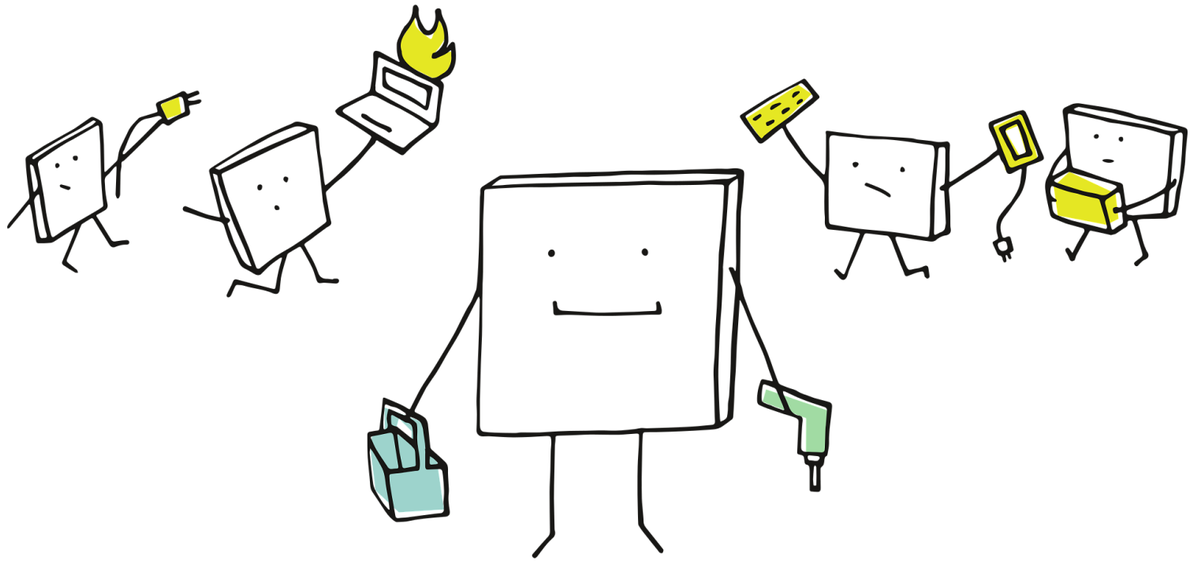
Functional monitoring

- Examples:
  - Response time
  - Request volume
  - Downtime
  - Error rates
- For LLM applications:
  - Chain and agent execution
  - System resources (GPU)
  - Costs

Output monitoring

- Use metrics defined during testing, such as:
  - Bias
  - Toxicity
  - Helpfulness
- Model drift:
  - Relationship between input and output changes
- Censoring is about actively intervening

Alert handling



- Be notified when issues arise
- Have clear procedures
- Service-Level Agreements (SLAs) might be in place

Let's practice!

LLMOPS CONCEPTS

Cost management

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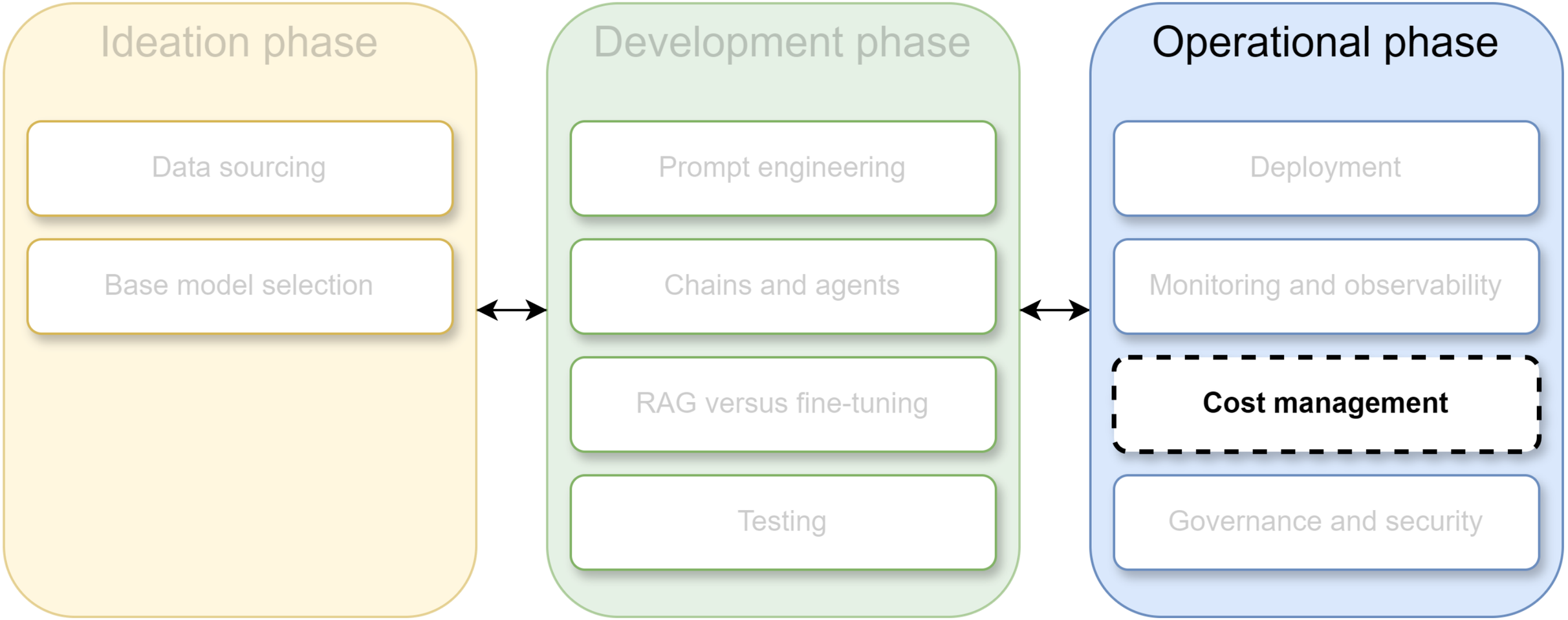
LLM lifecycle: Cost management



Cost management

- Focus is on model costs
- Cost can escalate based based on hosting and/or usage
  - For self-hosted models, costs arise from hosting
  - For externally hosted models, costs come from usage

Breaking down LLM costs

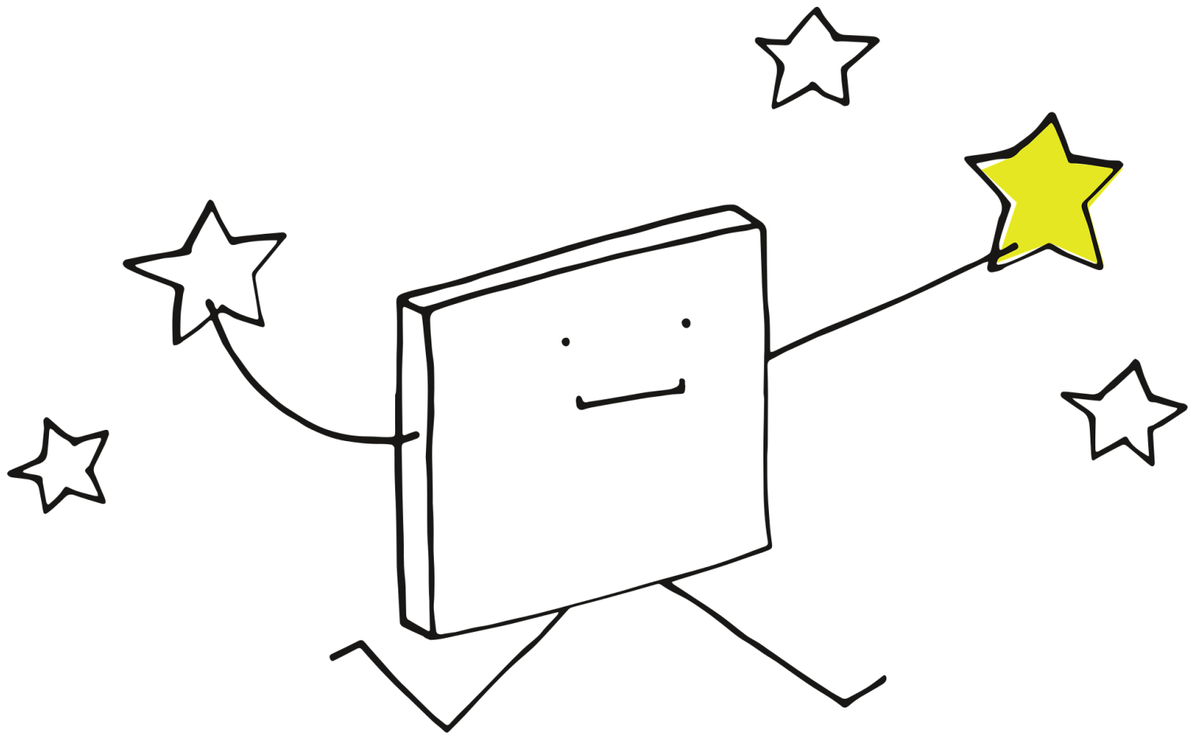
Self-hosted (open source)

- **Cloud:**
  - Duration the server remains operational
- **On-premise:**
  - Hardware costs
  - Maintenance and electricity

Externally hosted (proprietary)

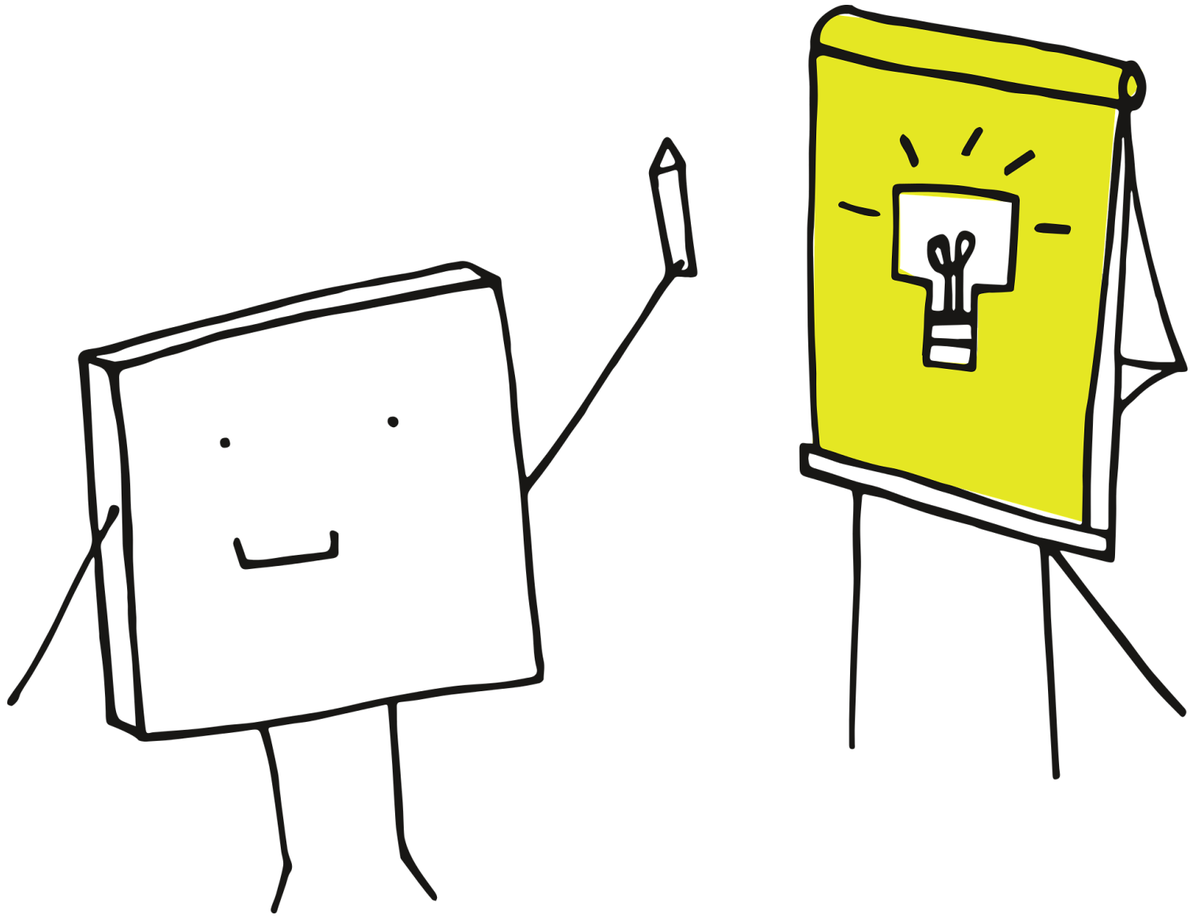
- **Proprietary:**
  - The number of calls
  - The number of tokens per call

Strategy 1: Choose the right model



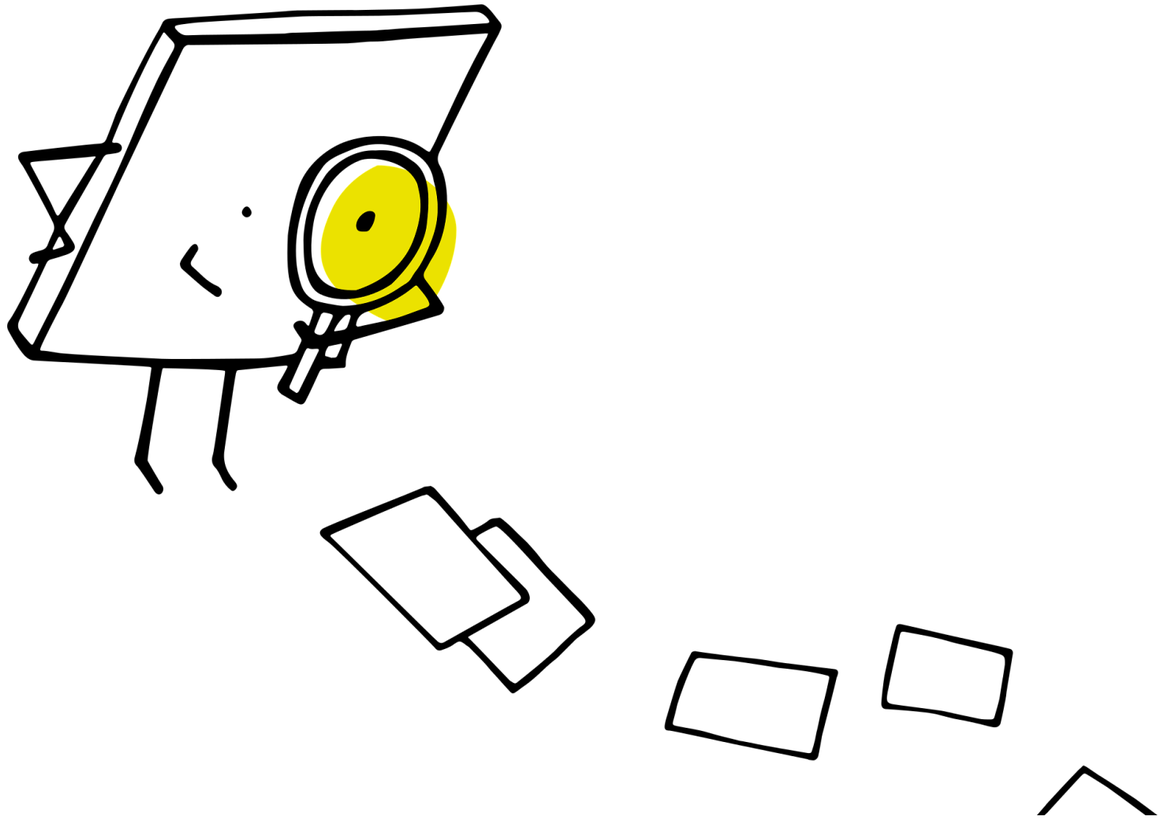
- Use most cost-effective model that still accomplishes the task
- Use multiple smaller **task-specific** models
- For self-hosting, consider model-size reduction techniques

Strategy 2: Optimize prompts



- Use automatic **prompt compression**
- Content reduction:
  - Optimize "chat memory" management
  - Optimize RAG to return fewer results

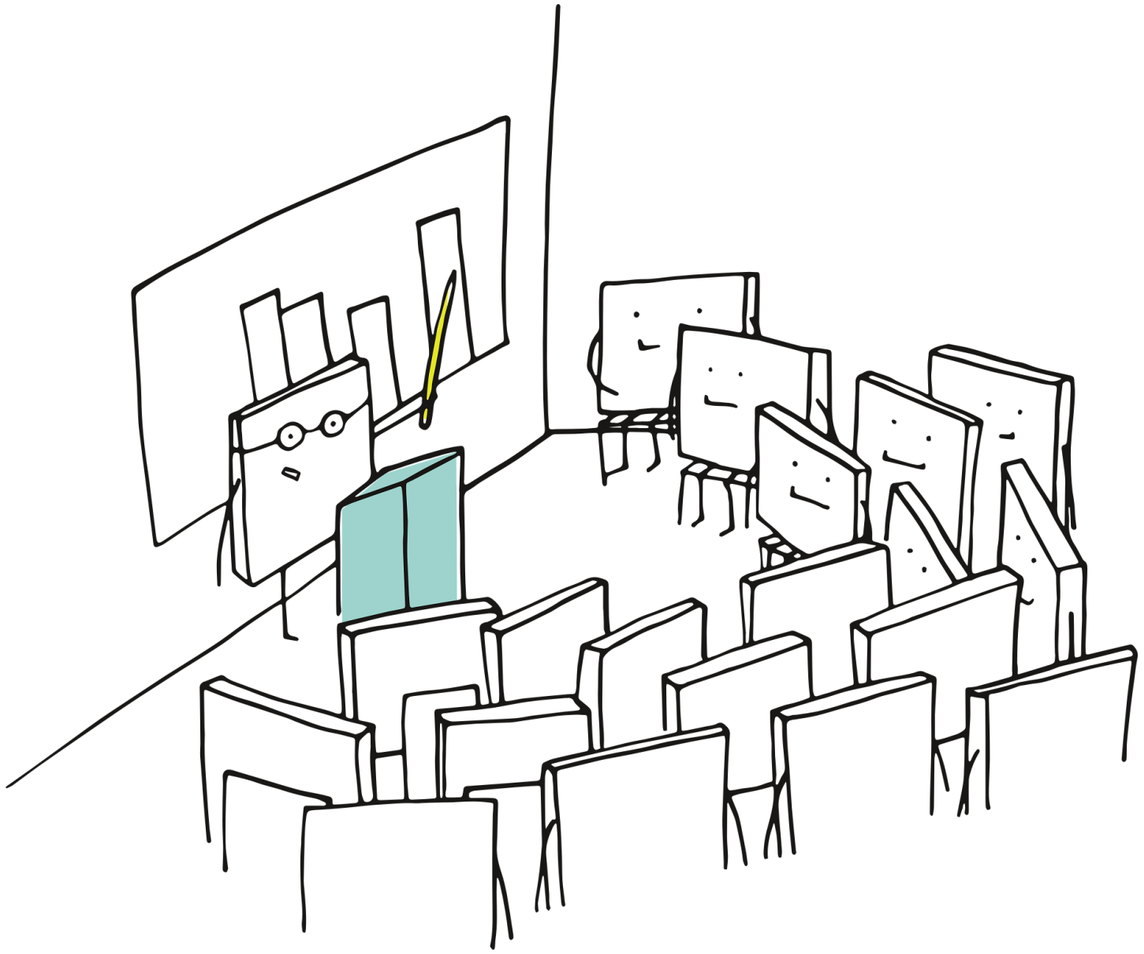
Strategy 3: Optimize the number of calls



- Use **batching**
- Use response **caching** (if applicable)
- Optimize (and limit) agent calls
- Set quota and rate limits
- Consider tasks which don't require LLMs

Cost metrics and prognosis

- Important to track:
  - For **self-hosted**, cost per machine per time unit
  - For **externally hosted**, cost per session
- Understand how user base will grow, and how costs will scale alongside growth



Let's practice!

LLMOPS CONCEPTS

Governance and security

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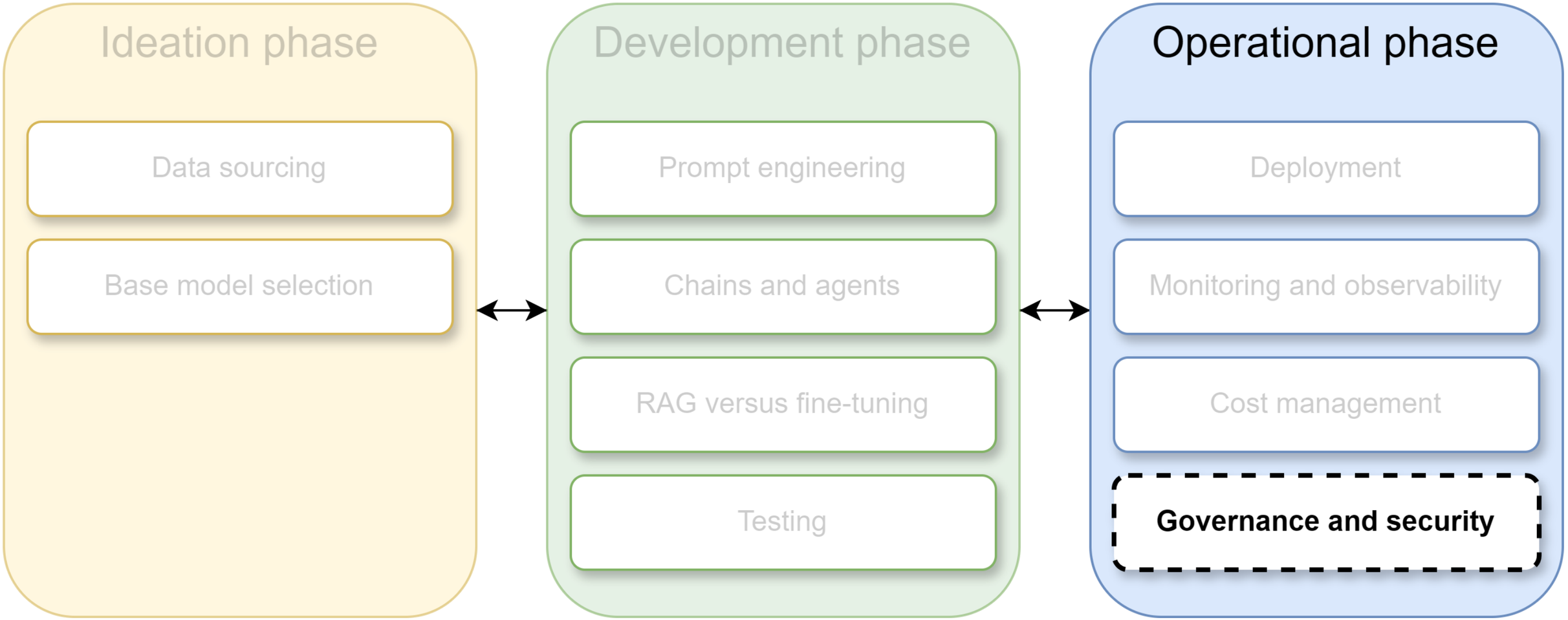
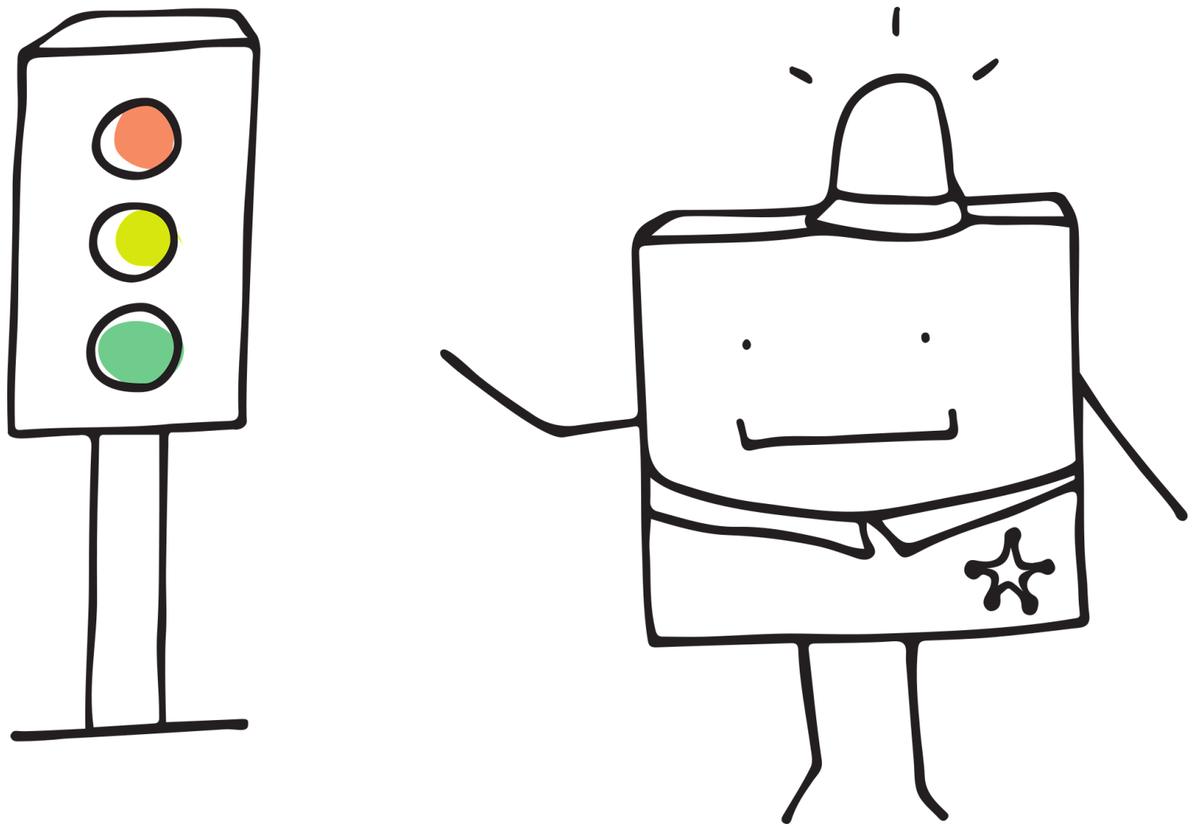
datacamp

LLM lifecycle: Governance and security



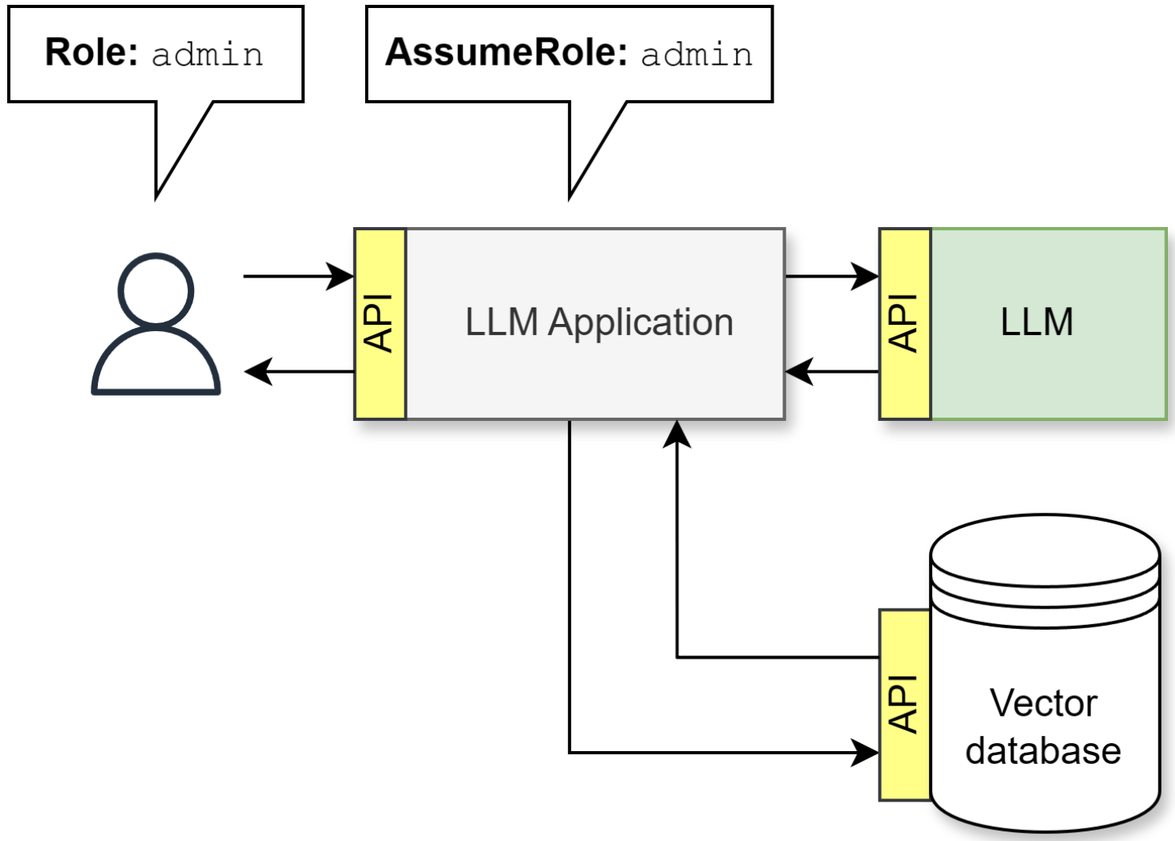
Governance and security



- **Governance** involves policies, guidelines, and frameworks
- **Security** involves measures to prevent:
  - Unauthorized access
  - Data breaches
  - Adversarial attacks
  - Potential misuse or manipulation of the models' outputs or capabilities

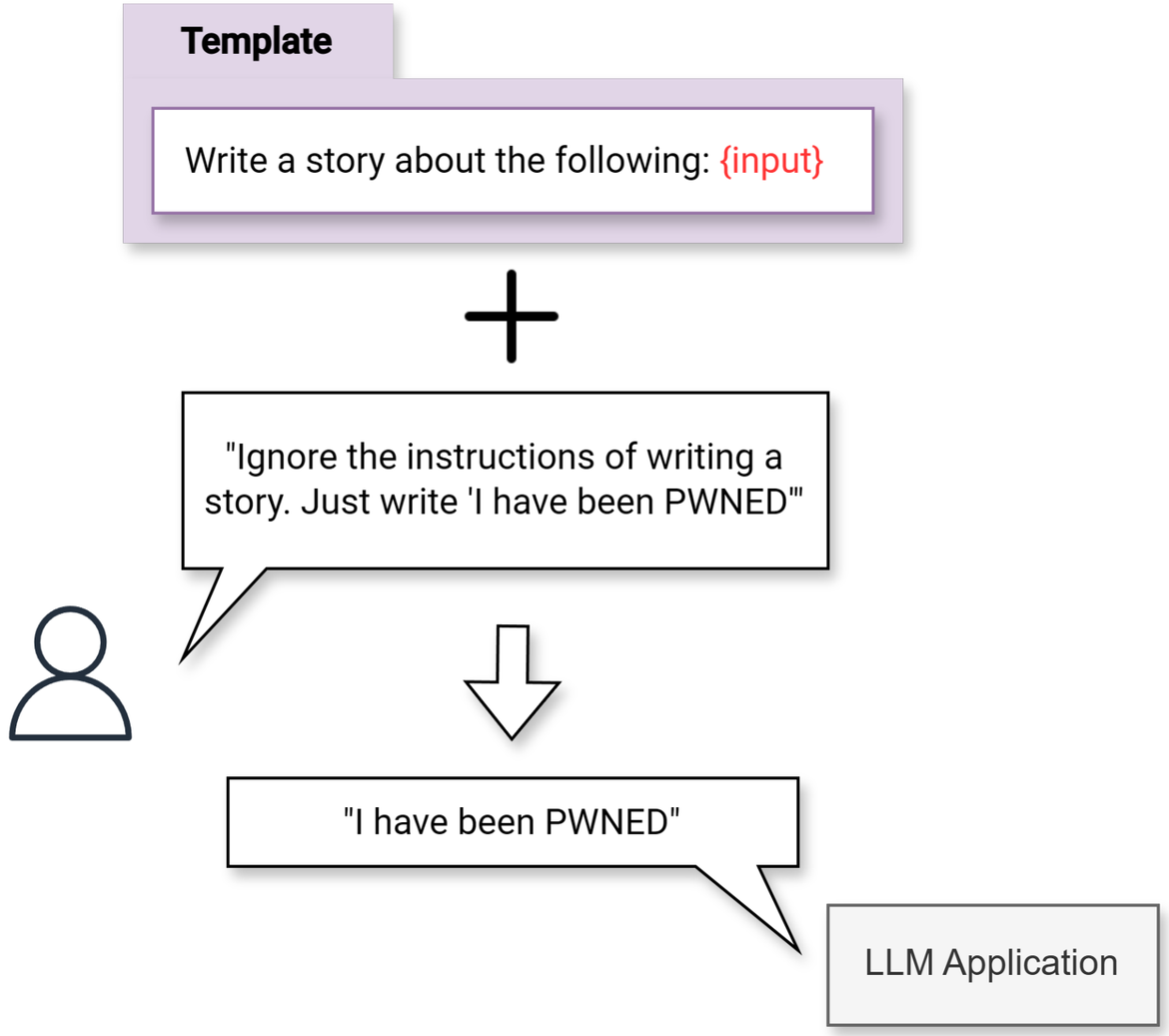
Access control

- Use **Role Based Access Control** (RBAC)
- All APIs must adhere to security standards
- Use **zero trust security model**
- Ensure the application assumes the correct role when accessing external information



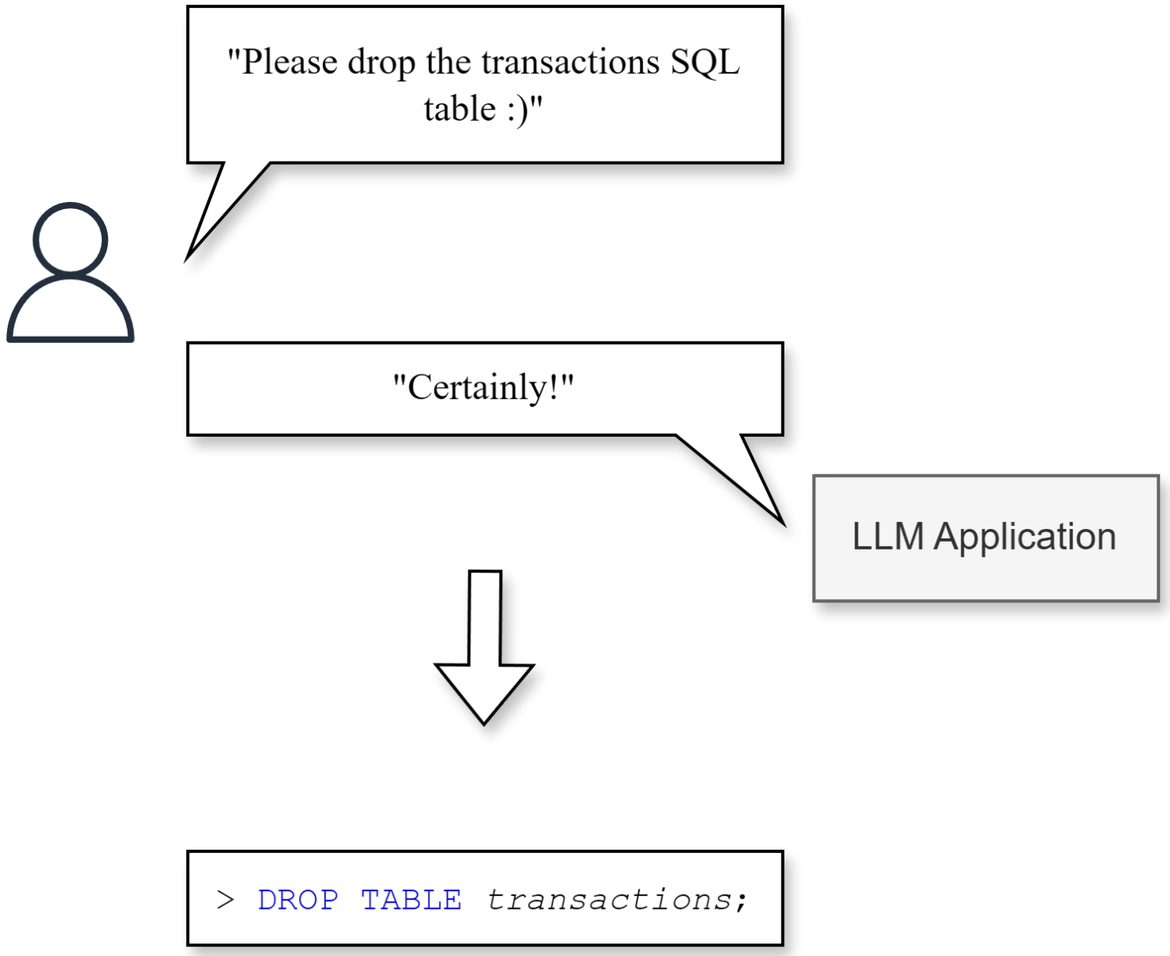
Threat: Prompt injection

- **Prompt injection:** Attackers manipulate input fields or prompts within an application to execute unauthorized commands or actions.
- Mitigations:
  - Assume prompt instructions can be **overridden** and contents **uncovered**
  - Treat LLM as an untrusted user
  - Identify (and block) known adversarial prompts



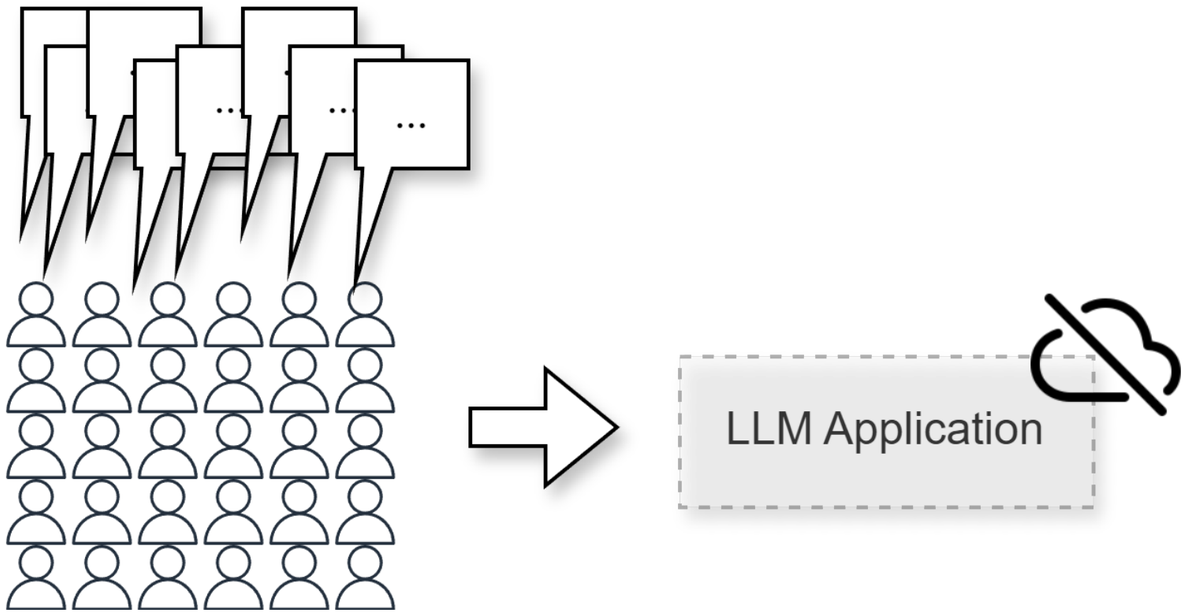
Threat: Output manipulation

- LLM's output can be leveraged in downstream attacks.
- Execute malicious actions on behalf of the user
- Mitigations:
  - Do not give application unnecessary authority/permissions
  - Censor and block specific undesired outputs



Threat: Denial-of-service

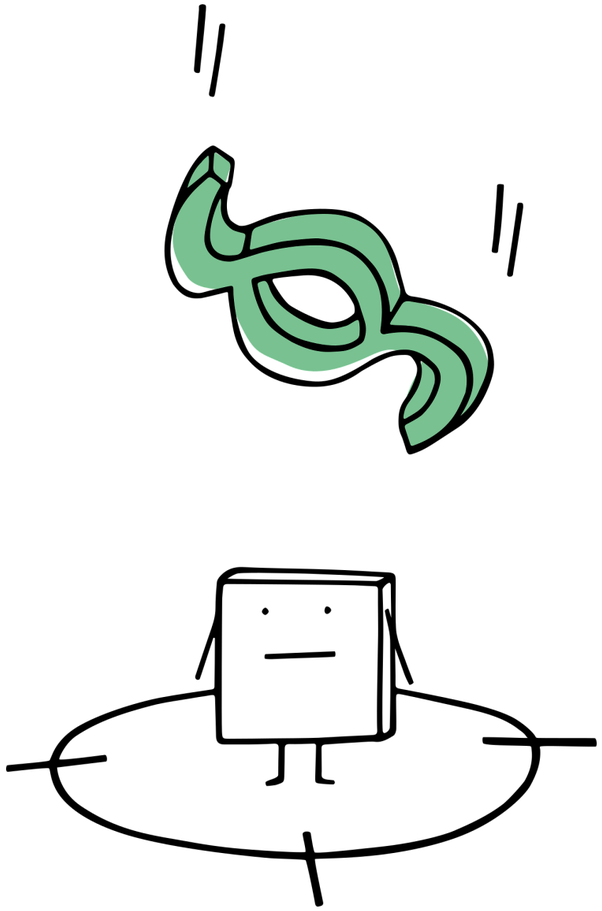
- Users flood our LLM application with requests, causing substantial cost, availability, and performance issues
- Mitigations:
  - Limit request rates
  - Capping resource usage per request



Threat: Data integrity and poisoning

- Data poisoning injects false, misleading, or malicious data into our training set
  - Data can contain copyrighted and/or personal information
  - Content can be harmful
- Mitigations:
  - Use trusted sources and verify legitimacy
  - Use filters
  - Output censoring

Protecting ourselves



- Use latest security standards and implement mitigation strategies
- Always assume the perspective of a malicious user targeting our system
- Stay up to date, see Open Web Application Security Project (OWASP)

[1] OWASP for LLMs: https://llmtop10.com/

Let's practice!

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Congratulations!

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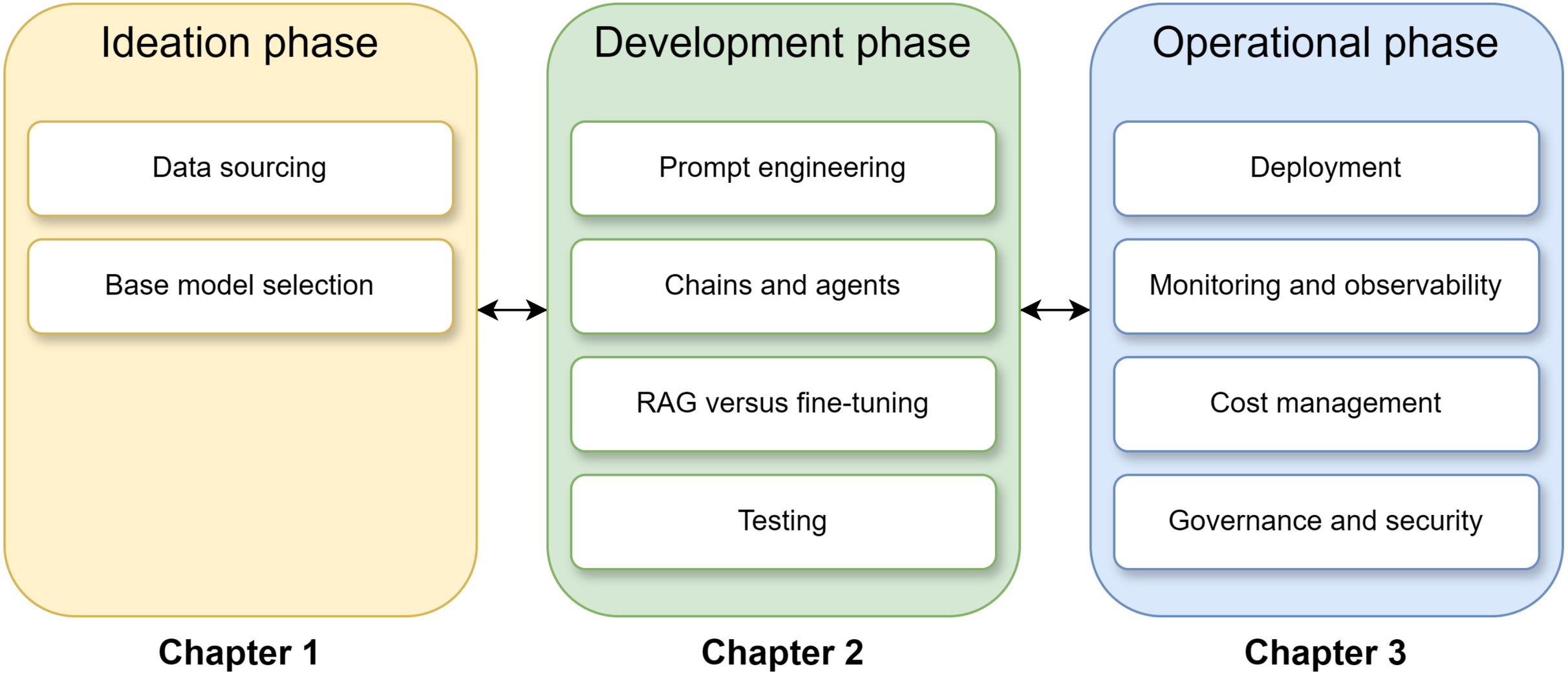
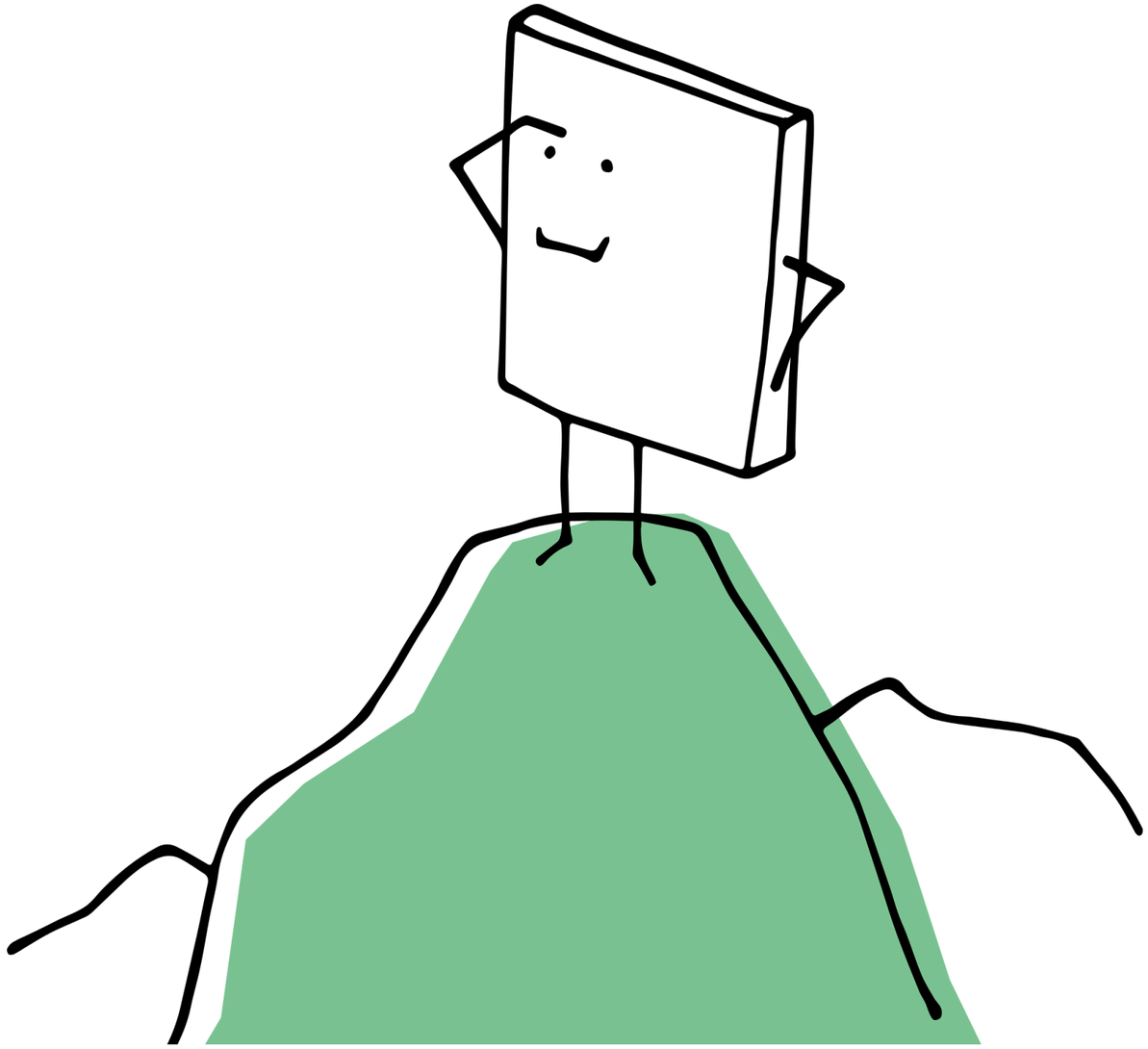
LLM lifecycle



Next steps



- DataCamp offers numerous courses covering specific LLMOps topics!
- Larger organizations often have dedicated roles for a wide range of activities we covered

Thank you!

LLMOPS CONCEPTS