Enhancing the Configuration Tuning Pipeline of Large-Scale Distributed Applications Using Large Language Models (Idea Paper)

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Introduction

- Microservices architecture is replacing monolithic or multi-tier architecture
- Performance is crucial as these are usually customer-facing applications

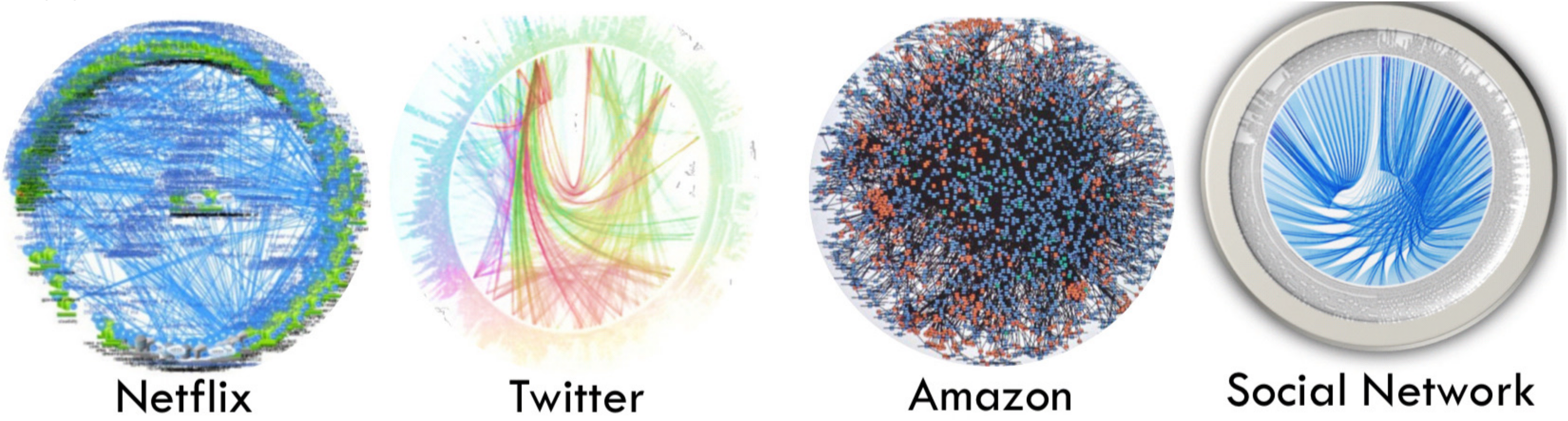
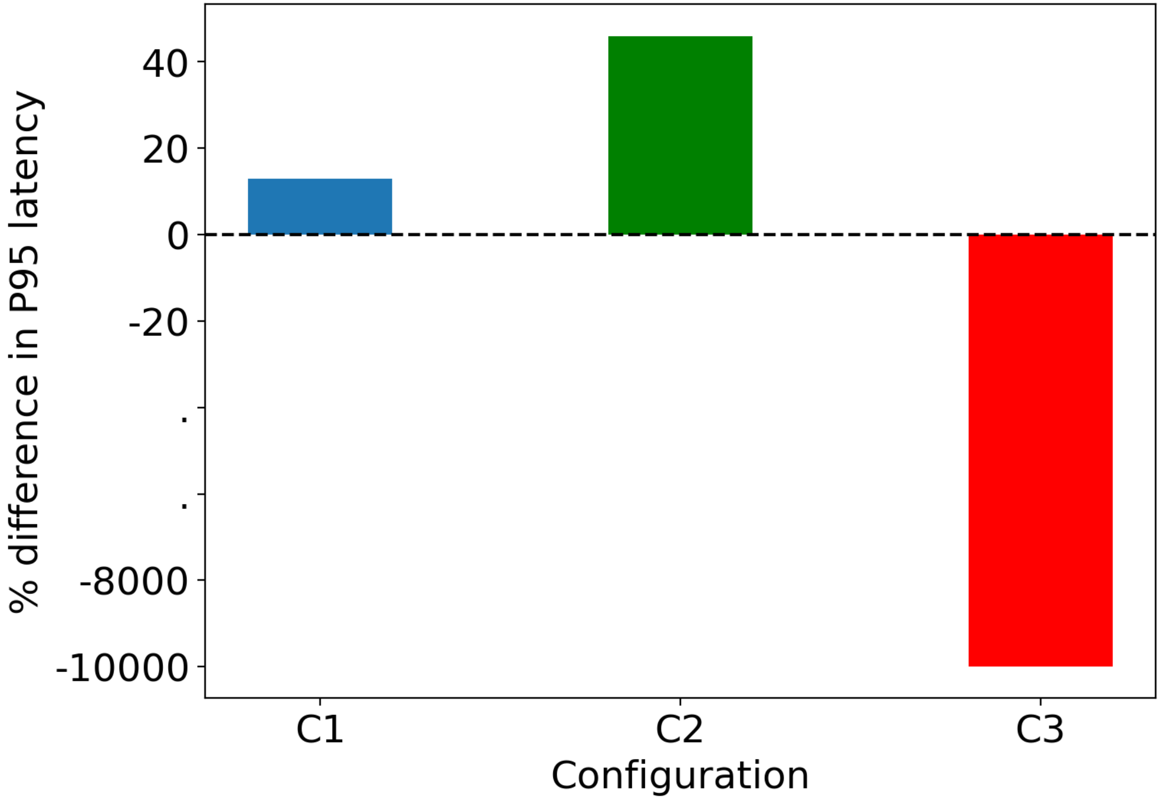


Image source: Gan et al., *ASPLOS'19*

Motivation

- Performance depends on the configuration of the application (here, social networking application)



- C1 – only *worker_process* tuned
- C2 – all parameters jointly tuned
- C3 – all parameters tuned but *worker_process* assigned a bad value

Motivation

- The first-step of configuration tuning – **parameters' meta-data extraction**
    - name, range, default, **dependencies,** etc.
- A stage that should be **revisited**
    - Application architecture
    - Software updates – parameter addition, deprecation
    - Deployment and hardware changes

Motivation

- **Very large** configuration space.
  - n – number of microservices
  - p – parameters per microservice
  - c – number of configurations per parameter
  - **Total possible configurations** $\approx c^{n*p}$

- Parameter dependencies are crucial for **reducing** configuration search space
  - Absolute – Redis' "*maxmemory*" and "*maxmemory-policy*"
  - Partial – Redis' "*maxmemory*" and container's "*mem-limit*"
  - Performance – MongoDB's "*concurrent_reads*" and "*cache_size*"

Motivation

- The meta-data of the parameters is found in
  - Product manuals, blogs, etc.
  - Source code and documentation
- Experimental feedback necessary to ascertain certain meta-data
  - Nginx "*threads*" and "*max_queue*" parameters
- A practitioner "**understands**" crucial information in the product manuals and, guided by empirical observations and telemetry, tunes the application to obtain optimal results

Can automatically extracted meta-data be coupled with experimental feedback to enhance configuration tuning pipeline in large-scale distributed applications?

Related Work

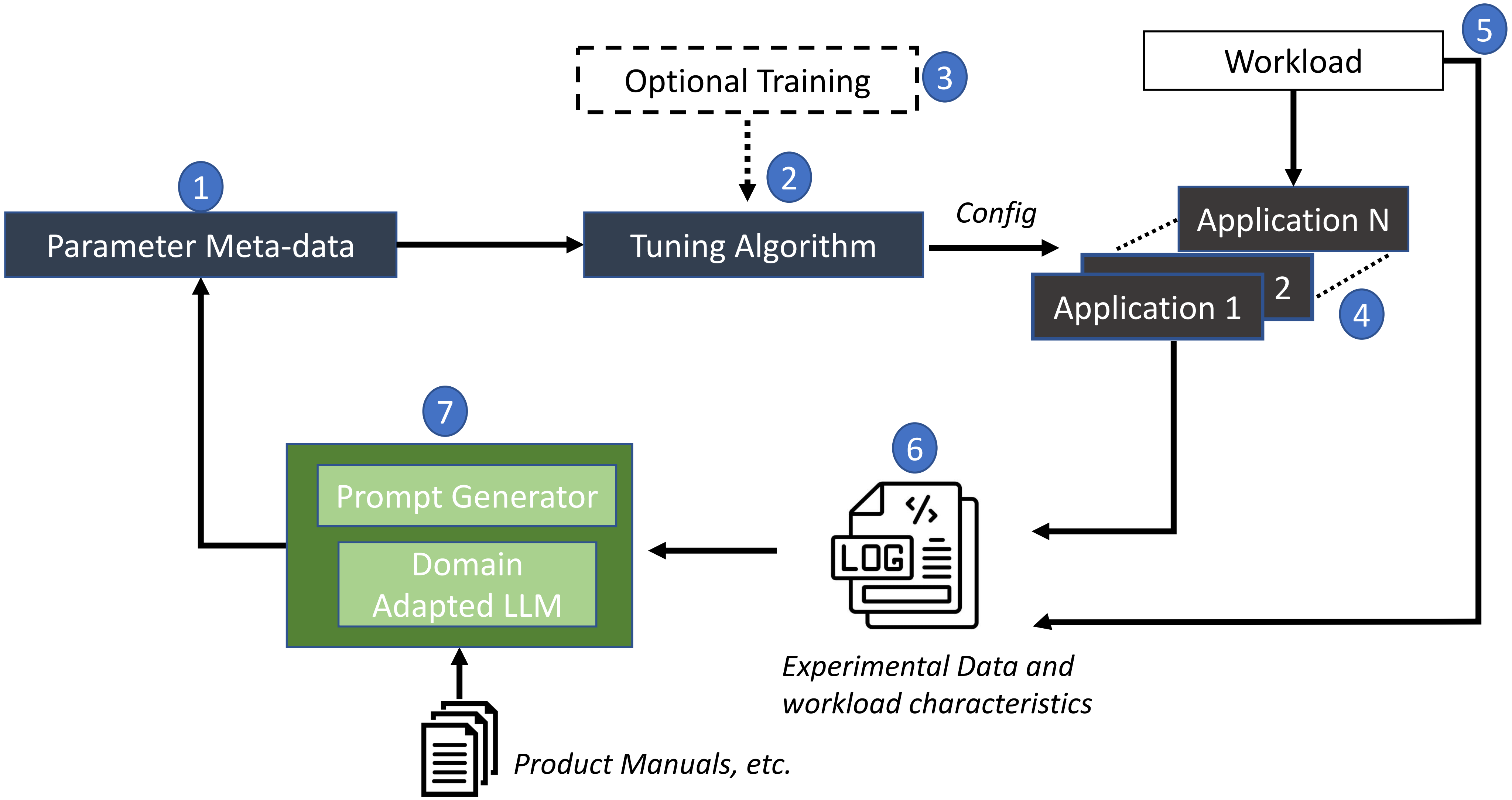
- DB-BERT
- SafeTune
- SPEX
- Prior works don’t utilize the full potential of NLP as they don’t:
  - Perform fully automated and exhaustive mining of text
  - Utilize language models for learning new associations and dependencies based on experimental feedback.

Proposal

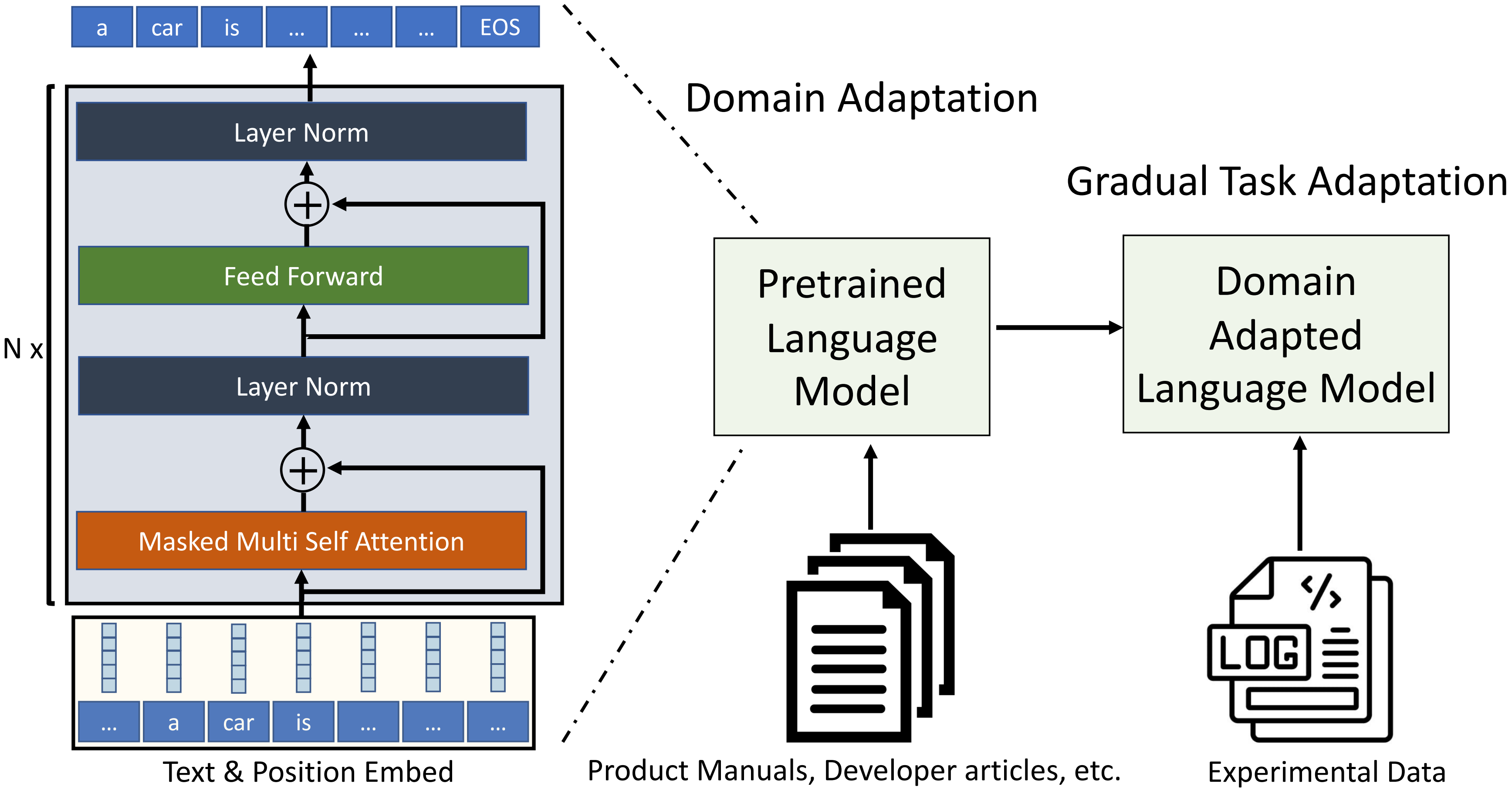
Large Language Models (LLMs) for enhancing the configuration tuning pipeline!

- Meta-data extraction using a targeted language model
- Enhance the configuration tuning pipeline using the LLM
- In-house knowledge system

Envisioned Pipeline



LLMs in Configuration Tuning



LLMs in Configuration Tuning

- Domain adaptation
  - Mitigate against domain shift
- Prompt engineering
  - “The default value of ldapUserCacheStalenessInterval is”
- Building an in-house knowledge system
  - {"prompt": "<verbal description of the workload and the architecture of the application >", "completion": "<optimal subset of parameters>"}

Planned Evaluation and Conclusion

- Quality of meta-data generated
- Developer hours saved
- Quality of impactful parameters
- Generalization