Marketing the Cloud: A QoS-based Recommendation Approach

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Outline

❶ Introduction

❷ QoS Recommendation

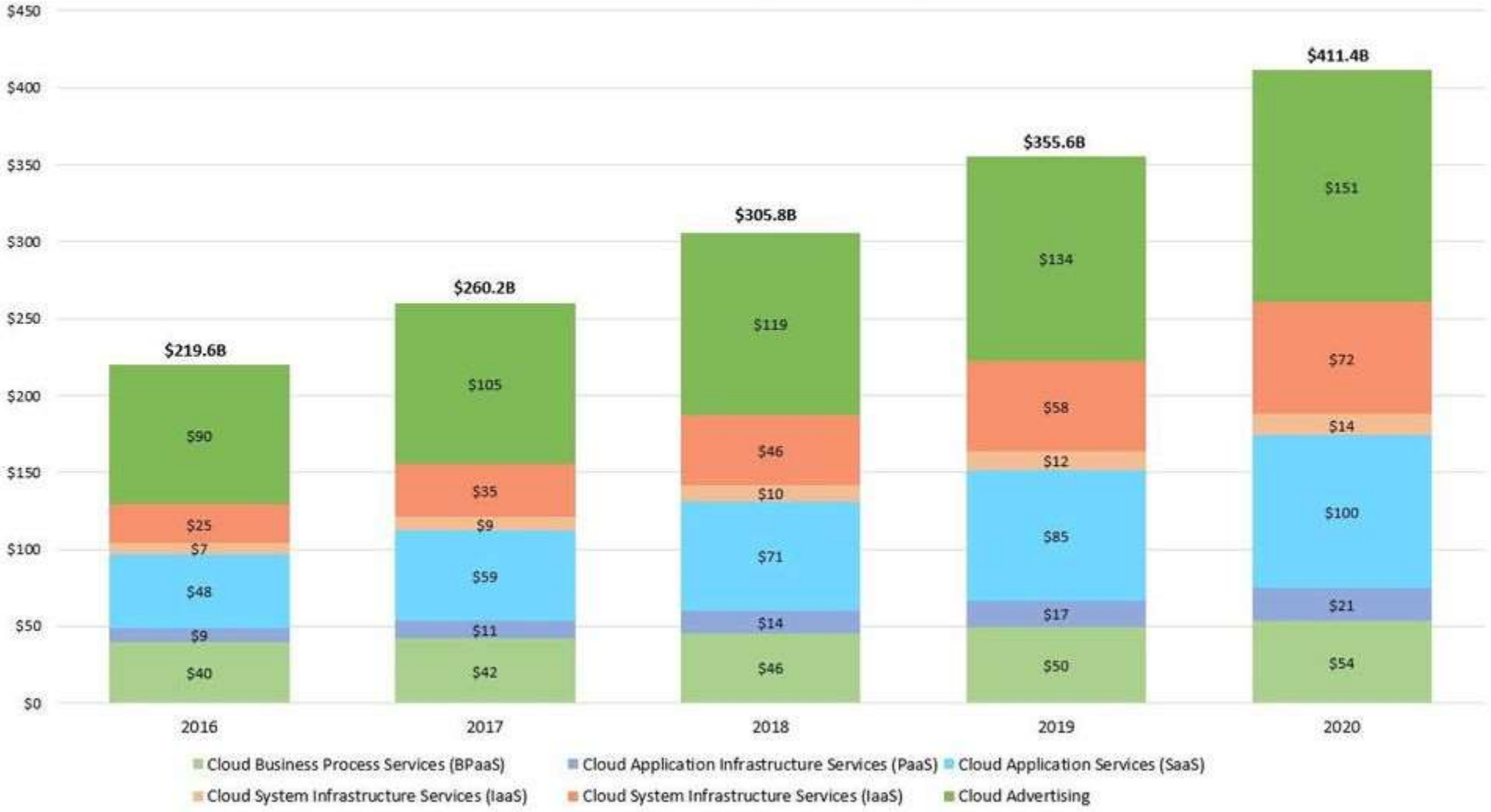
❸ Conclusion

Introduction

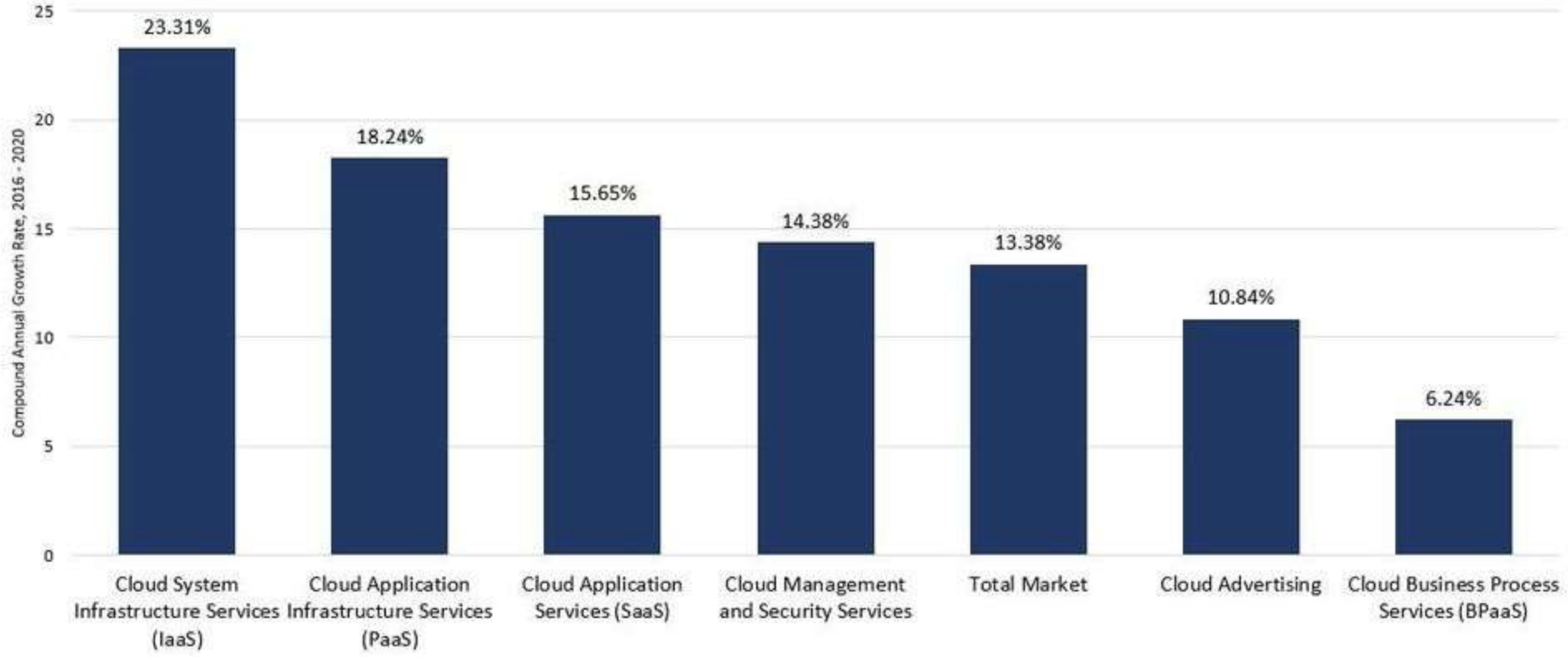
- **Cloud Services**
  - ✓ Internet-based IT services
  - ✓ Cloud service models: IaaS, PaaS, SaaS, etc.
  - ✓ Worldwide cloud service market will reach $411 billion in 2020 [Gartner 2017]

Worldwide Public Cloud Services Revenue Forecast (Billions of U.S. Dollars)

Source: Gartner (October 2017)



Compound Annual Growth Rates (CAGR) By Cloud Service Category, 2016 - 2020
Worldwide Public Cloud Services Revenue Forecast (Billions of U.S. Dollars)
Source: Gartner (October 2017)



Introduction (Cont.)

- **Product Quality**
  - ✓ Product quality relates directly to product value
  - ✓ A high-quality product does a great job meeting customer needs [Kelly & Williams 2017]

- **Quality Level**
  - ✓ How well a product performs its core functions
  - ✓ The right level of product performance is the level that meets the needs of your consumers [Kelly & Williams 2017]

Introduction (Cont.)

- **Quality of Service (QoS)**
  - ✓ Nonfunctional properties of cloud services
  - ✓ Include availability, reliability, security, etc.
  - ✓ An important differentiator among functionally equivalent services

Introduction (Cont.)

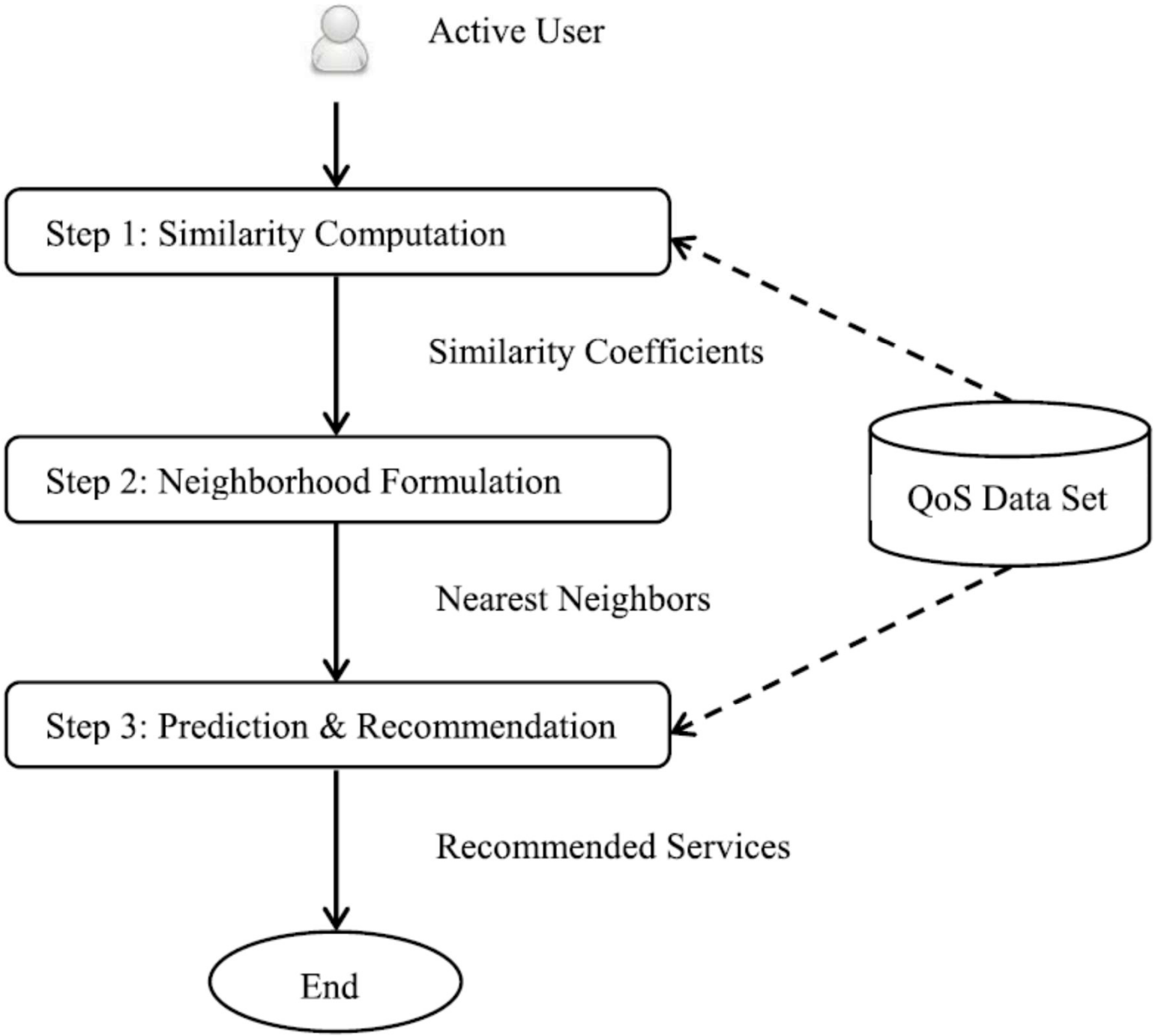
- **Service Level Agreement (SLA)**
  - ✓ A service contract defines the scope, quality, and responsibilities of a service
  - ✓ Amazon S3 SLA: 99.9% available, 10% service credit

QoS Recommendation

- **Motivation**
  - ✓ Aims to use recommender systems, i.e., collaborative filtering, to differentiate and market cloud services

QoS Recommendation (Cont.)

- **Collaborative Filtering**
  - ✓ CF makes automatic QoS predictions for a user, and recommends cloud services based on the opinions of other users who have the same or similar interests
  - ✓ RS can deliver value for both consumers and providers


Active User
Step 1: Similarity Computation
Similarity Coefficients
Step 2: Neighborhood Formulation
QoS Data Set
Nearest Neighbors
Step 3: Prediction & Recommendation
Recommended Services
End

QoS Recommendation (Cont.)

- **Similarity Computation**
  - ✓ Spearman's rank correlation coefficient is used to calculate the similarities for active user *a* and user *u*

$$s(a,u) = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

  - ✓ It measures how well the relationship between two variables can be described using a monotonic function

QoS Recommendation (Cont.)

- **Neighborhood Formulation**
  - ✓ The *k*-nearest neighbor technique is used to find a set of similar neighbors U_k

QoS Recommendation (Cont.)

- **Prediction and Recommendation**
  - ✓ A user-based CF is used to predict a rating for item i, where the contribution of a neighbor is weighted by its similarity with active user a

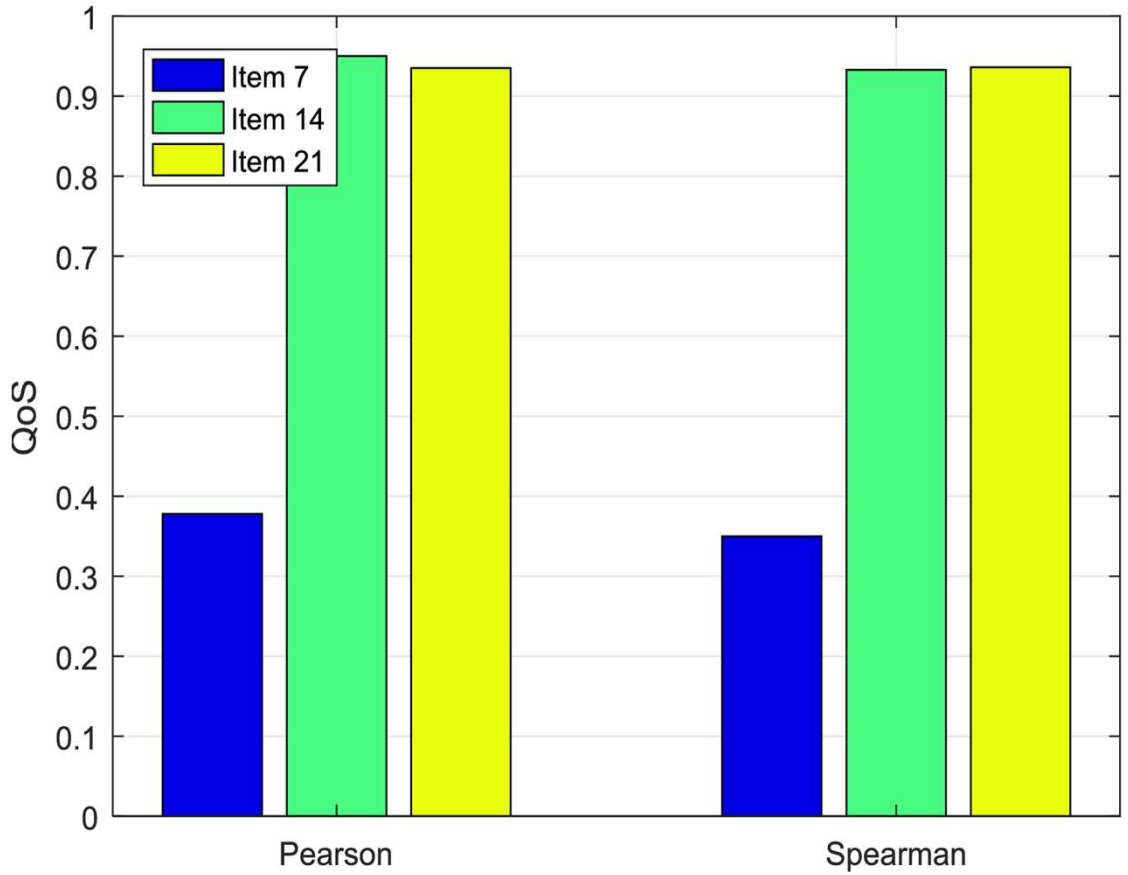
$$p(a,i) = \overline{r_{a.}} + \frac{\sum_{u \in U_k} s(a,u)(r_{u,i} - \overline{r_{u.}})}{\sum_{u \in U_k} s(a,u)}$$

QoS Recommendation (Cont.)

- **Monte Carlo Simulations**
  - ✓ Results show that a CF approach using the Spearman coefficient performs better than a CF approach using the Pearson coefficient
  - ✓ The proposed CF approach can achieve more reliable rankings than the CF approach using the Pearson coefficient

QoS Recommendation (Cont.)

- **An Unreliable Ranking by Pearson**



QoS Recommendation (Cont.)

- **Next Steps**
  - ✓ Propose a mixed approach to achieve better performance
    - Investigate learning-to-rank approaches that aims to optimize rank-based measure
  - ✓ Use Spark to implement large-scale collaborative filtering that can process large datasets
    - Investigate Alternating Least Squares (ALS) for collaborative filtering

QoS Recommendation (Cont.)

- **Representative Paper**
  - ✓ **Xianrong Zheng**, Li D Xu, and Sheng Chai, QoS Recommendation in Cloud Services, IEEE Access, vol. 5, 2017.

Conclusion

❶ **Cloud Services**

❷ **QoS Recommendation (A Mixed Collaborative Filtering Approach)**

Thank you!