Quasi Rate Distortion Optimization for Binary Hashing

Yiding Liu, Wengang Zhou, and Houqiang Li
University of Science and Technology of China
liuyd123@mail.ustc.edu.cn, {zhwg,lihq}@ustc.edu.cn

Outline

- Introduction
- Our Work
- Evaluation
- Conclusion

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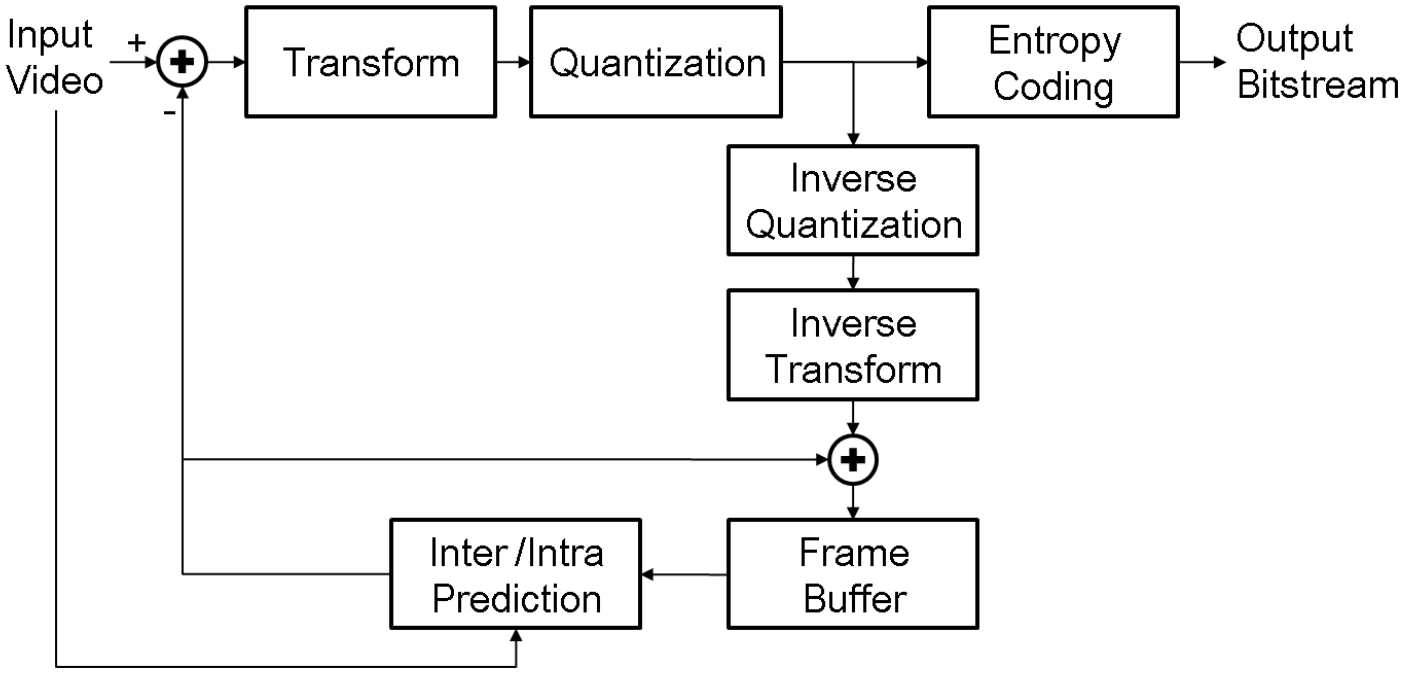
Introduction

- Video encoding procedure



Reference: https://en.wikipedia.org/wiki/High_Efficiency_Video_Coding

Introduction

- Rate Distortion Optimization

  - $\min\{D\}, subject\ to\ R \leq R_C$

  - $\min\{J\}, where\ J = D + \lambda R$

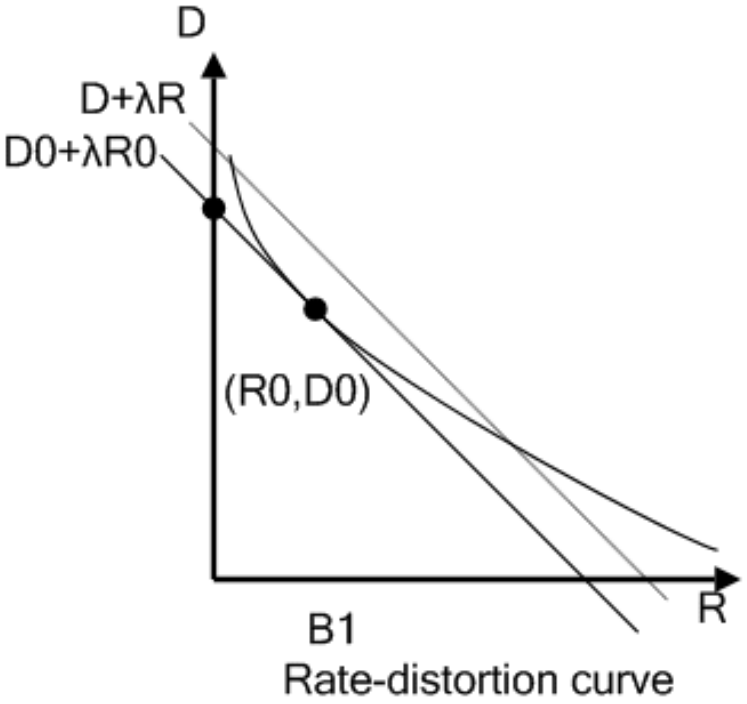
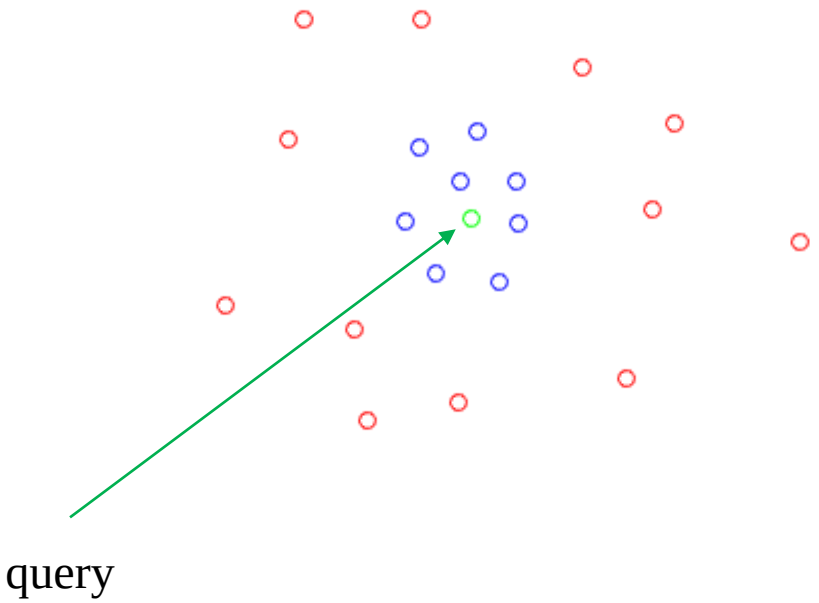


Figure Reference: http://dirac.sourceforge.net/documentation/algorithm/algorithm/rdo.htm

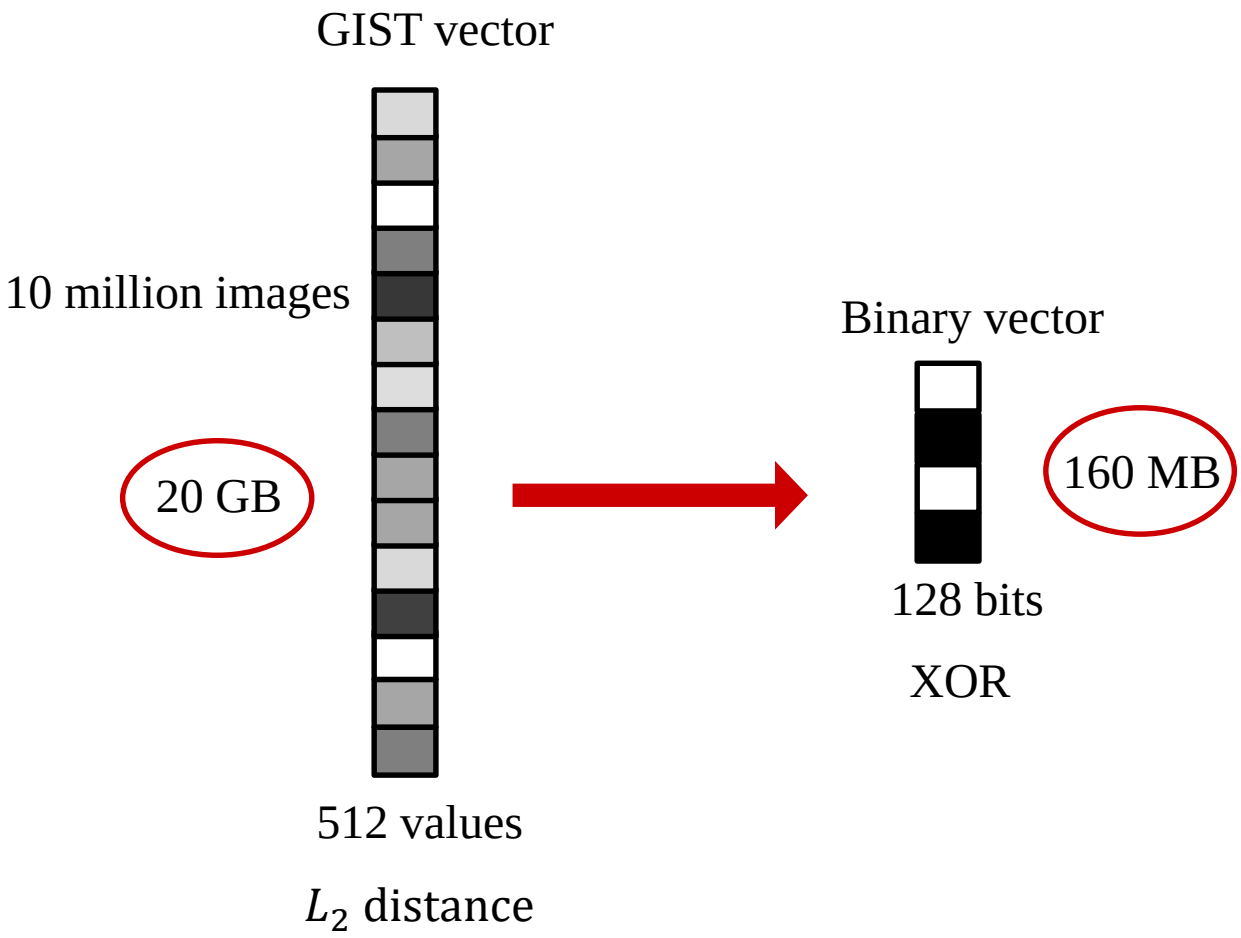
Introduction

- Approximate Nearest Neighbor (ANN) Search



Introduction

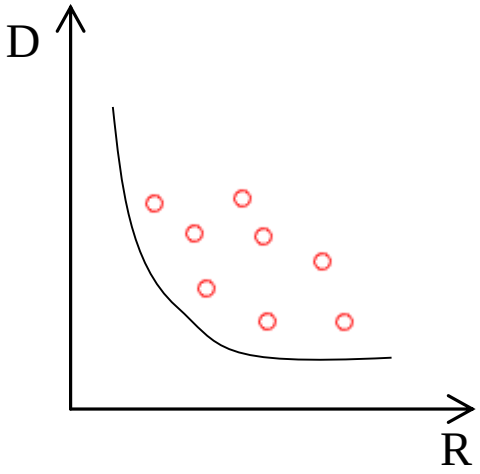
- Binary Hashing for Approximate Nearest Neighbor Search



Problem Formulation

- Traditional Hashing: $J = D$ in a certain R
- Rate Distortion Optimization $J = D + \lambda R$

- $D = 1 - mAP$
- $R = bit\ number$



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Direct evaluation

- Working points on L are optimal

  - for $p \in L,\ J(p) = d + \lambda r = const$

    $p(r, d)$ means a working point on D-R space
    $const$ is an arbitrary constant

  - $\lambda = \frac{const - d}{r}$

    The slope of $(0, const)$ and $(-r, d)$

r-d optimization based evaluation

- $J = D + \lambda R$

Derivative of J to R and set it to 0

- $\frac{\mathrm{d}J}{\mathrm{d}R} = \frac{\mathrm{d}D}{\mathrm{d}R} + \lambda = 0$

- $\lambda = -\frac{\mathrm{d}D}{\mathrm{d}R}$

r-d optimization based evaluation

- R-D models
  - Fitting problem as a simple method

- Quadratic model
  - $D = aR^2 + bR + c$
  - $\lambda = -\frac{\mathrm{d}D}{\mathrm{dR}} = -2aR - b$

    a given R → λ

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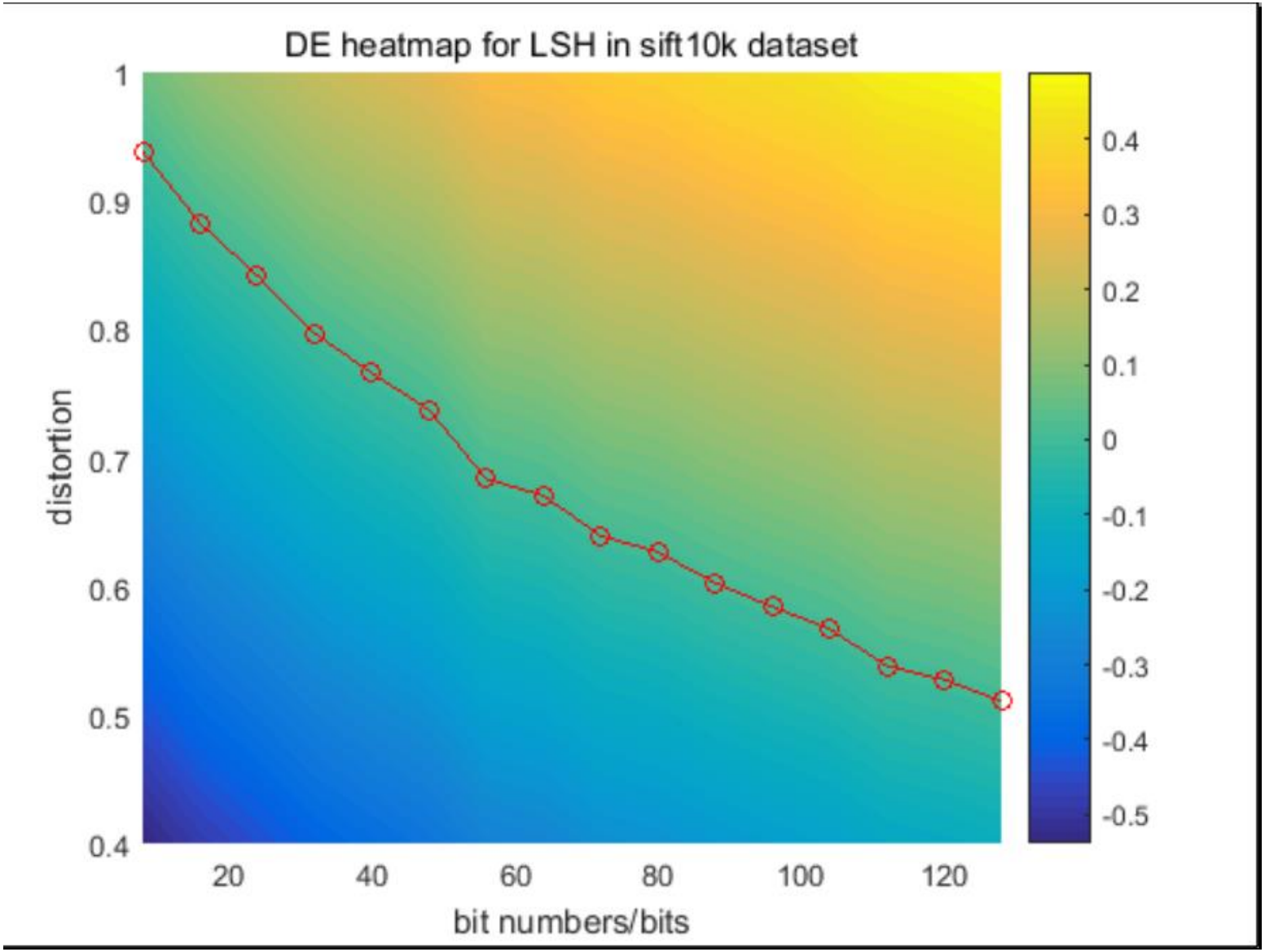
Dataset

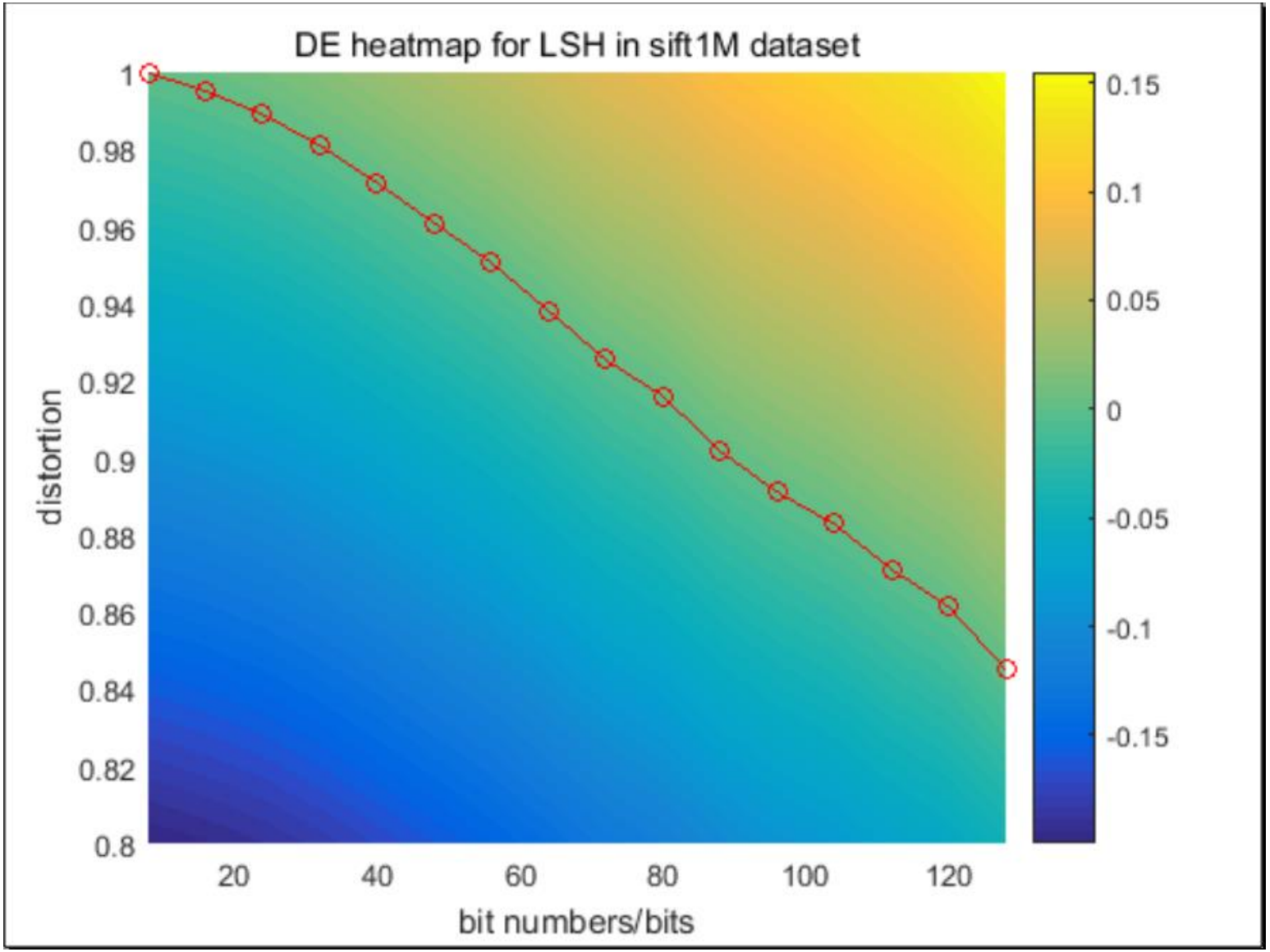
- Two different datasets

	ANN_SIFT10K	ANN_SIFT1M
Dimension	128	128
# Query vectors	100	10,000
# Base vectors	10,000	1,000,000
# Training vectors	25,000	100,000
# Ground truth	100	100

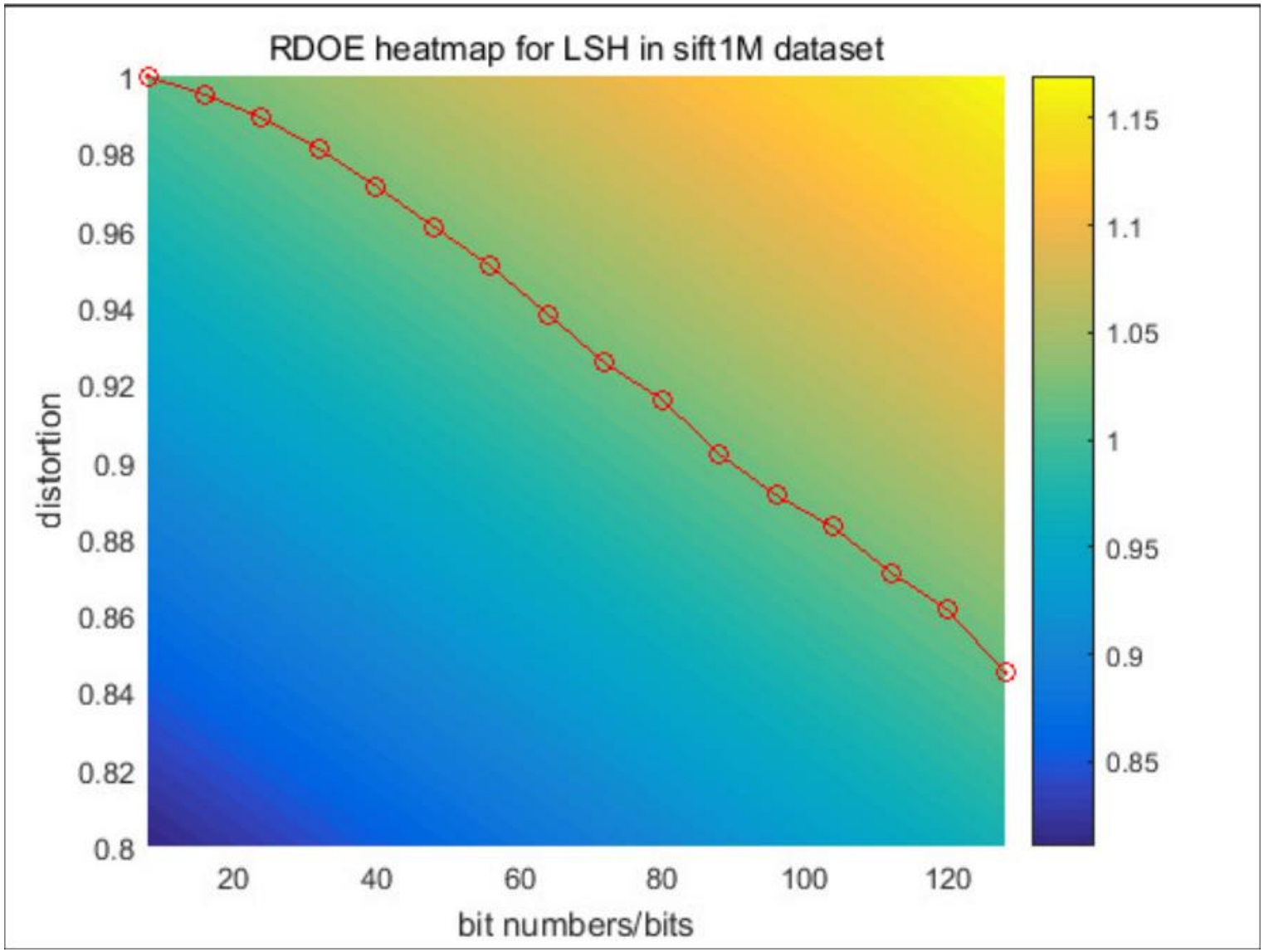
Evaluation DE, 10k dataset



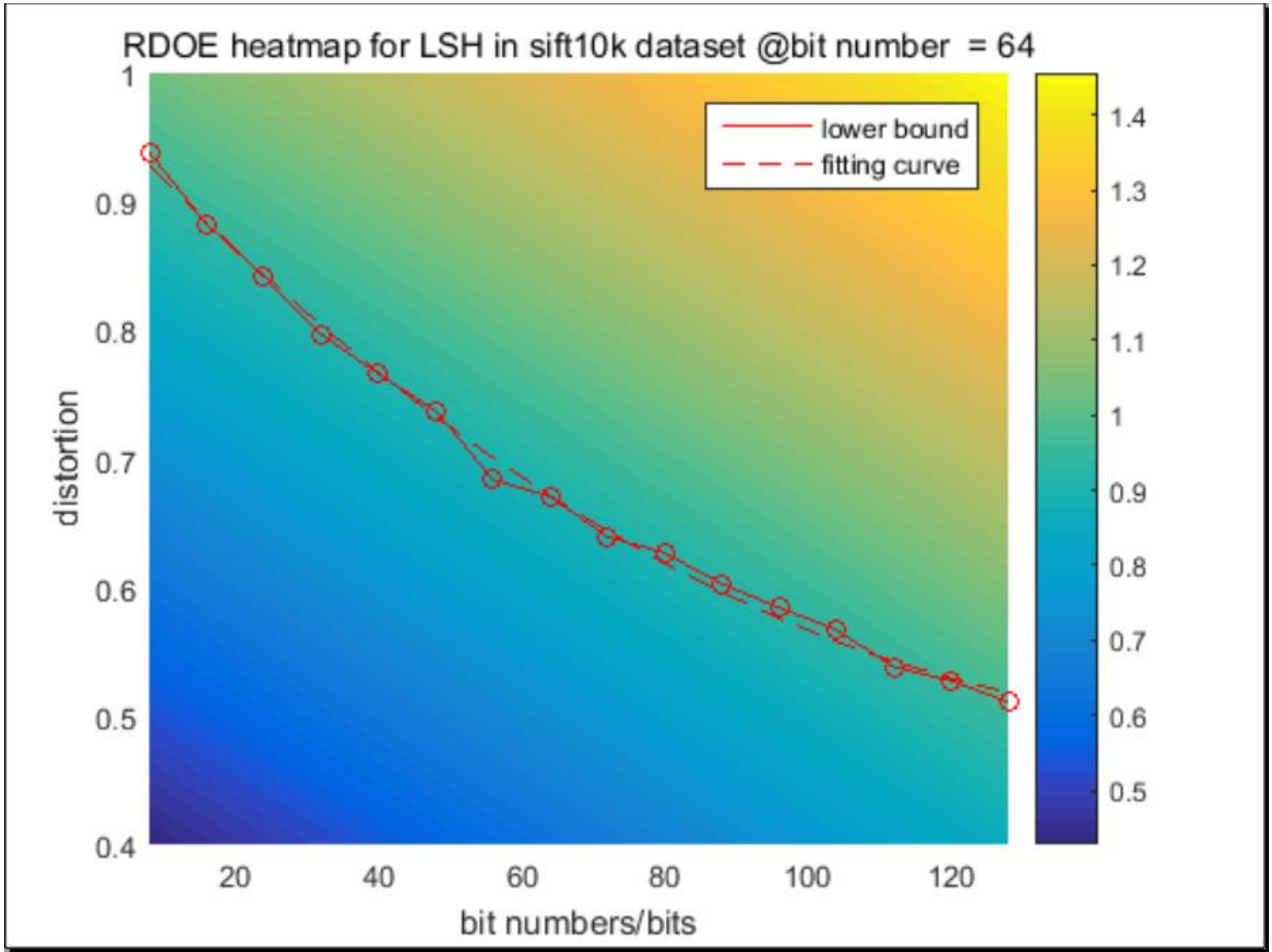
Evaluation DE, 1M dataset

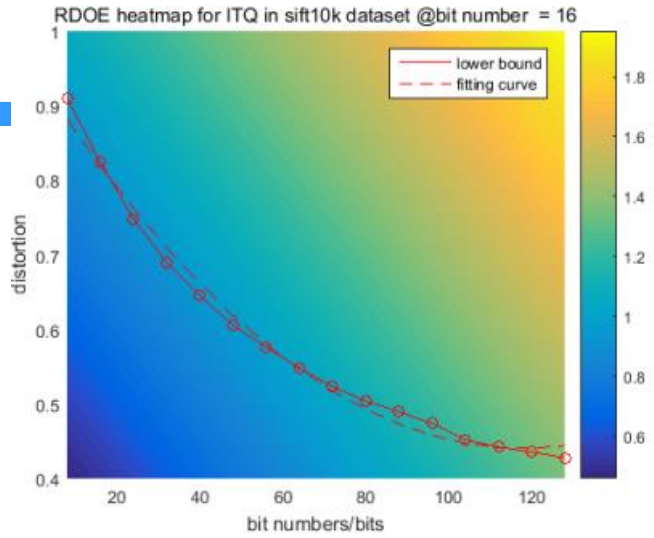


Evaluation RDOE, 1M dataset

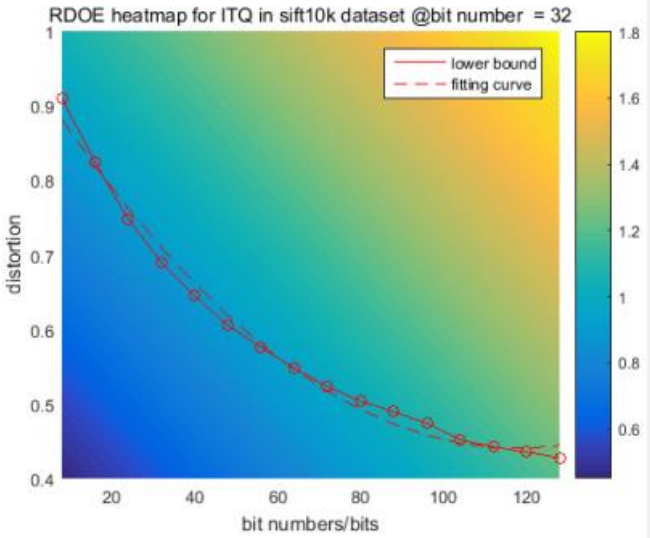


Evaluation RDOE, 10k dataset

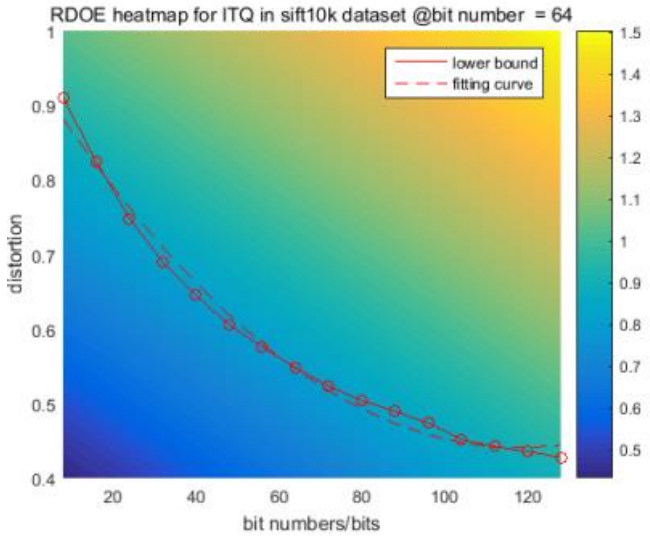




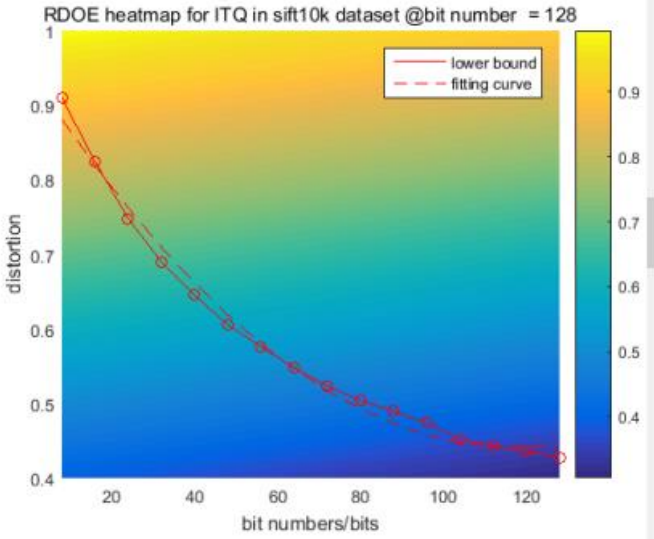
(a) 16 bits



(b) 32 bits



(c) 64 bits



(d) 128 bits

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Conclusion

- Evaluation method on hashing methods
  - If a hashing method works well on a certain experiment
  - Make a decision when the bit number are also taken into account
- Finding a reasonable λ
  - Direct evaluation
  - Rate-distortion optimization based evaluation
- Future works
  - Reasonable lower bound
  - Other areas which can be applied rate-distortion optimization to

- Thank you!
- Any questions?