Near-Optimal Budgeted Data Exchange for Distributed Loop Closure Detection
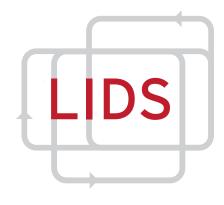
Yulun Tian   Kasra Khosoussi Matthew Giamou Jonathan P. How Jonathan Kelly

🤖 Alice's Images

🤖 Bob's Images
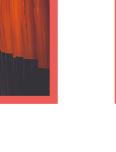
🤖 Eve's Images

🤖 Alice's Images

🤖 Bob's Images

🤖 Eve's Images

potential match
prob: 0.9

Alice's Images

Bob's Images

Eve's Images

potential match
prob: 0.5

🤖 Alice's Images

🤖 Bob's Images

🤖 Eve's Images

🤖 Alice's Images

Alice shares!

Bob's Images

Eve's Images

Alice's Images

Bob's Images

Eve's Images

Alice's Images

Bob's Images

Eve's Images
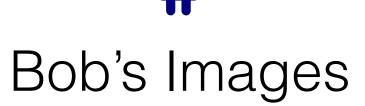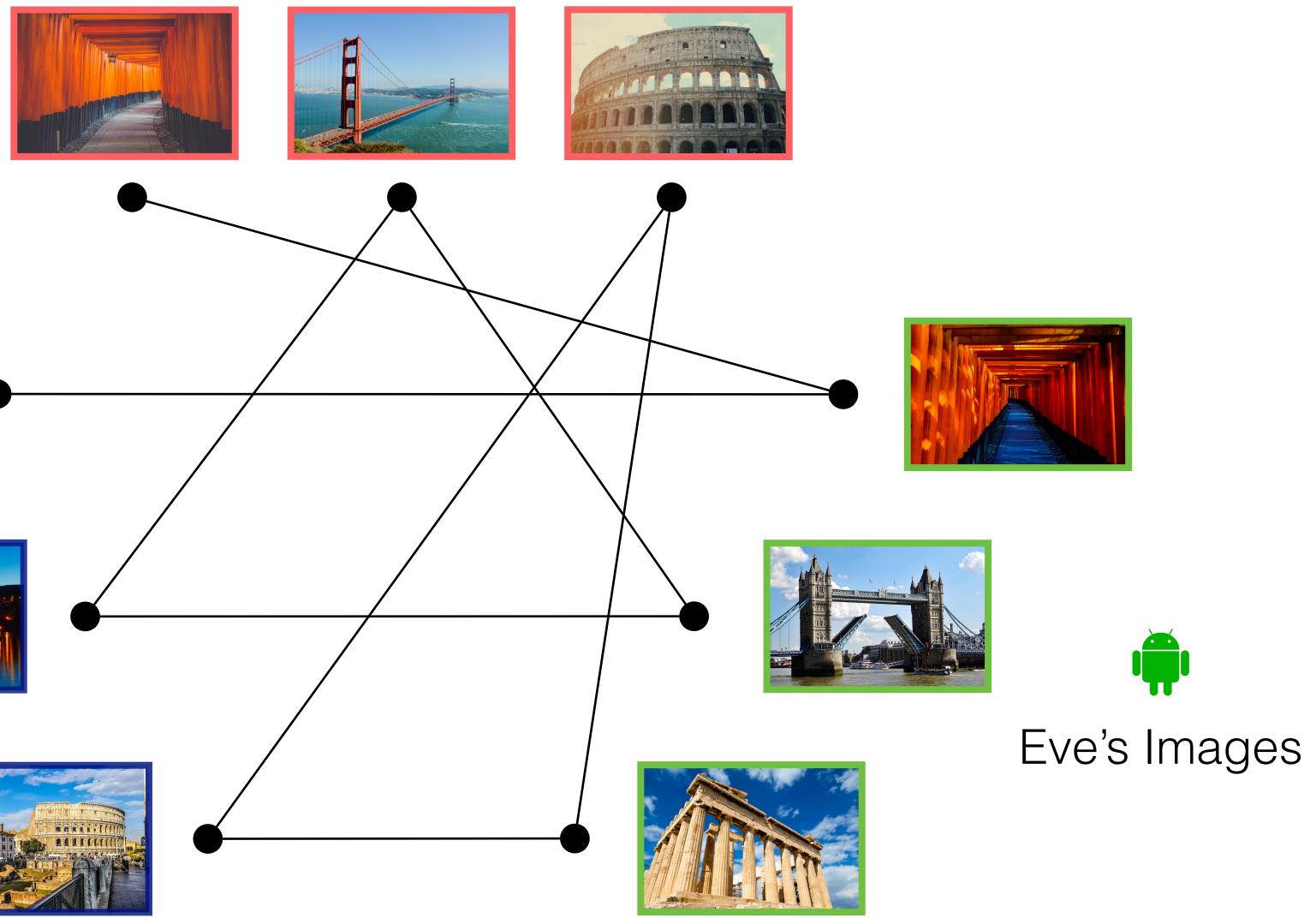
prioritize based on *expected* "utility"
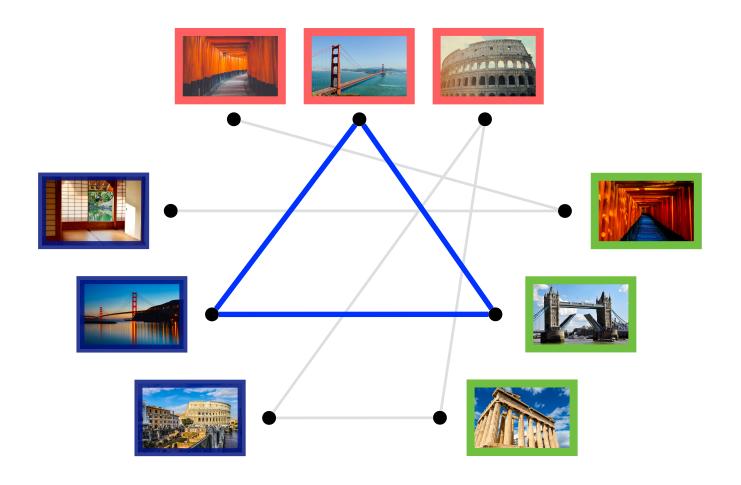
Expected Utility

$$f : 2^{\mathcal{L}_{\text{All}}} \rightarrow \mathbb{R}_{\geq 0}$$
$$\mathcal{L} \mapsto \mathbb{E}\big[\text{"information" gain after verifying } \mathcal{L}\big]$$

Monotone (information never hurts)

Submodular (diminishing return)
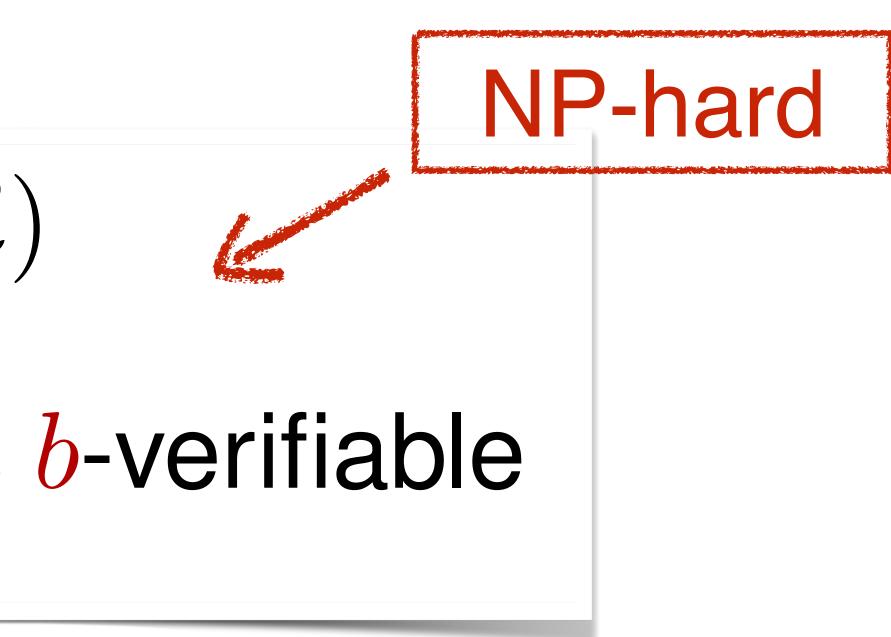
Budgeted Data Exchange Problem (*b*-DEP)

NP-hard

$$\max_{\mathcal{L} \subseteq \mathcal{L}_{\text{All}}} \quad f(\mathcal{L})$$

$$\text{s.t.} \quad \mathcal{L} \text{ is } b\text{-verifiable}$$
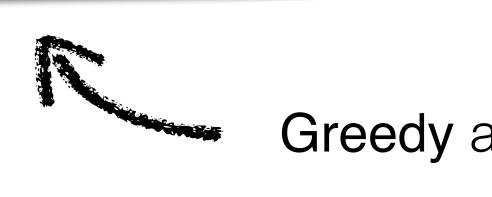
Deciding *b*-verifiability: Vertex Cover Problem (**NP-complete**)
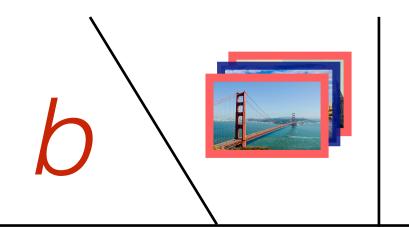
Theorem (apx factor preserving reduction)**.**
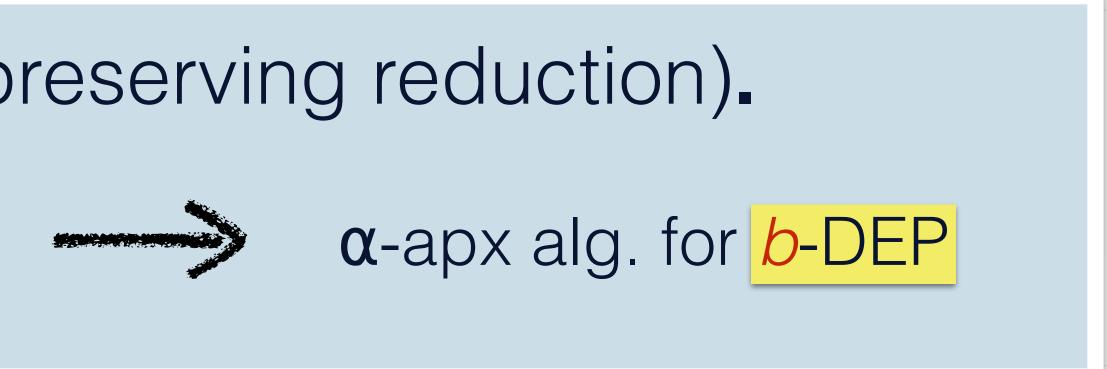
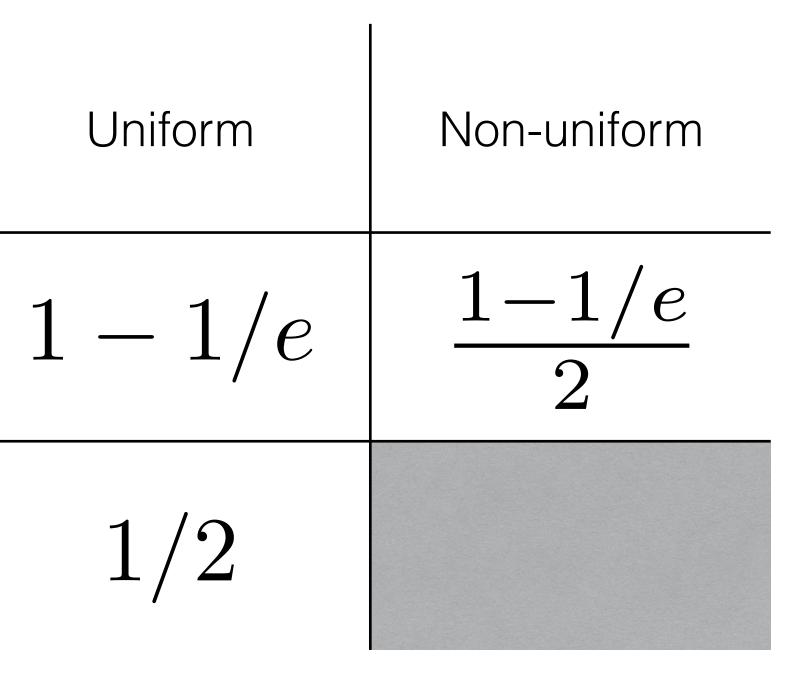α-apx alg. for monotone submodular maximization $\longrightarrow$ α-apx alg. for b-DEP

Def. ALG ≧ α OPT

Greedy algorithm apx factors **α**

b	Uniform	Non-uniform
Team	$1 - 1/e$	$\dfrac{1-1/e}{2}$
Individual	$1/2$	

Experiments - KITTI dataset

$\mathcal{G}_x = (\mathcal{V}_x, \mathcal{E}_x)$

$w : \mathcal{V}_x \to \mathbb{R}_{>0}$

$p : \mathcal{E}_x \to (0, 1]$

Alice's Images

Bob's Images

Eve's Images

Optimal Lossless Exchange

Comm. Budget b = 3