Travel Itinerary Recommendation

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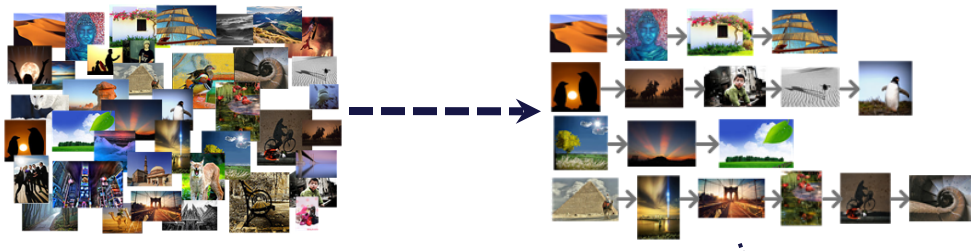
Extracting travel itineraries from Flickr

Goal: extract the itinerary of each traveler by mapping photos into Points Of Interest (POIs) and aggregate actions of many travelers into coherent queryable itineraries.

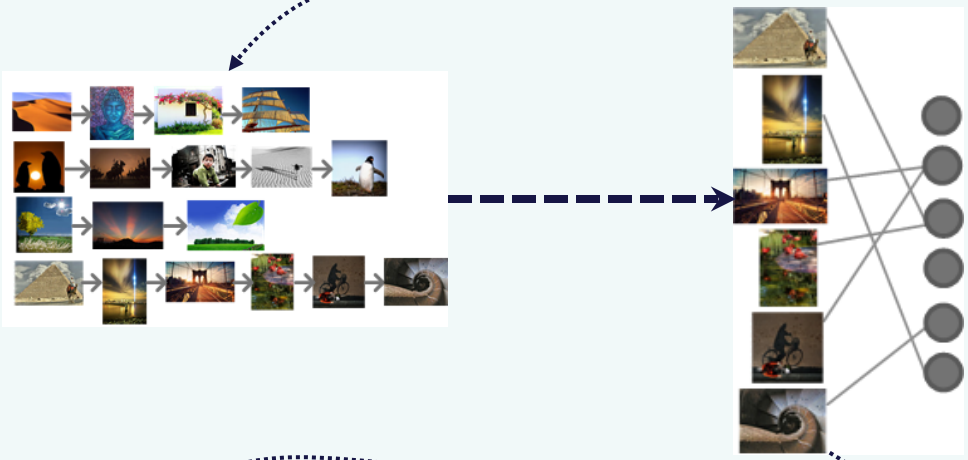
Automatic construction of travel itineraries using social breadcrumbs. Munmun De Choudhury, Moran Feldman, Sihem Amer-Yahia, Nadav Golbandi, Ronny Lempel, Cong Yu. HyperText 2010.

Photo Streams



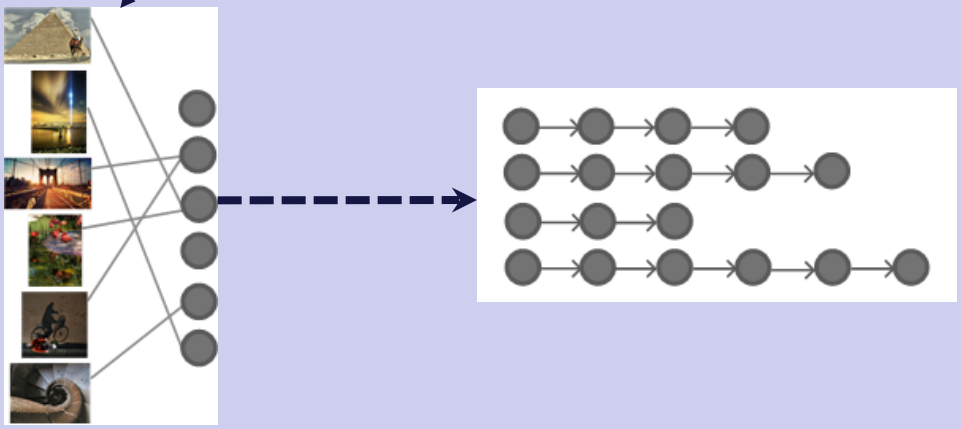
- Identify photos of a given city
- Filter out residents of a city
- Validate photo timestamps

Photo-POI Mapping



- Extract Candidate POIs
  - Lonely Planet/Y! Travel to extract landmarks
  - Yahoo! Maps API to retrieve their geo-locations
- Tag & geo-based POI association

Timed Paths



- Photo Streams Segmentation
  - Split the stream whenever the time difference between two successive photos is “large”
- Distillation of Timed Visits
  - <POI, start time, end time>
- Construction of Timed Paths
  - A sequence of Timed Visits

Problem definition

- **Definitions**
  - Each itinerary is a timed path
  - The set of timed paths implies a *weighted graph* G over POIs
  - An *itinerary* is a path in the graph G
  - The *value* of an itinerary is the sum of popularities of its POIs
  - The *time* of an itinerary is the sum of POI visit and transit times

- **Problem Instance ("Orienteering")**
  - Find an itinerary in G from a *source* POI to a *target* POI of budget (=time) at most B maximizing total value
  - The time budget B is typically whole days
  - *source* and *target POIs* provided by user (e.g. hotel)

Data preparation

- **Five popular and geographically distributed cities were chosen: Barcelona, London, New York City (NYC), Paris, and San Francisco**
- **For each city, we generate four itineraries using our system**

City	#POIs	#Timed Paths	Sample POIs
Barcelona	74	6,087	Museu Picasso, Plaza Reial
London	163	19,052	Buckingham Palace, Churchill Museum, Tower Bridge
New York City	100	3,991	Brooklyn Bridge, Ellis Island
Paris	114	10,651	Tour Eiffel, Musee du Louvre
San Francisco	80	12,308	Aquarium of the Bay, Golden Gate Bridge, Lombard Street

Itinerary generation

- **For each city, we generate four itineraries using our system.**
- **We first select the city's four most popular POIs and designate them as ℓ_1 (most popular) through ℓ_4.**
  - The popularity of a POI is determined by the number of distinct users who have provided a photo associated with the POI.
- **The four itineraries for each city are then constructed by setting the starting point and ending point as (ℓ_1, ℓ_3), (ℓ_1, ℓ_4), (ℓ_2, ℓ_3), (ℓ_2, ℓ_4), with a time budget of 12 hours.**

Example itinerary for NYC (single-day)

Time **09:00** : Start from **ground zero**
Time **09:00** : Spend 27 minutes at **ground zero**.
Time **09:27** : Transit to **empire state building** (estimated travel time: 52 minutes)
Time **10:19** : Spend 1 hour and 13 minutes at **empire state building**.
Time **11:32** : Transit to **new york public library** (estimated travel time: 15 minutes)
Time **11:47** : Spend 29 minutes at **new york public library**.
Time **12:16** : Transit to **radio city music hall** (estimated travel time: 24 minutes)
Time **12:43** : Spend 51 minutes at **radio city music hall**.
Time **13:34** : Transit to **central park** (estimated travel time: 23 minutes)
Time **13:57** : Spend 40 minutes at **central park**.
Time **14:37** : Transit to **rockefeller center** (estimated travel time: 33 minutes)
Time **15:10** : Spend 37 minutes at **rockefeller center**.
Time **15:47** : Transit to **grand central terminal** (estimated travel time: 22 minutes)
Time **16:09** : Spend 27 minutes at **grand central terminal**.
Time **16:36** : Transit to **chrysler building** (estimated travel time: 6 minutes)
Time **16:42** : Spend 31 minutes at **chrysler building**.
Time **17:13** : Transit to **brooklyn bridge** (estimated travel time: 32 minutes)
Time **17:45** : Spend 36 minutes at **brooklyn bridge**.
Time **18:21** : Transit to **statue of liberty** (estimated travel time: 21 minutes)
Time **18:42** : Spend 42 minutes at **statue of liberty**.
Time **19:24** : Transit to **little korea** (estimated travel time: 26 minutes)
Time **19:50** : Spend 31 minutes at **little korea**.
Time **20:21** : Transit to **ground zero** (estimated travel time: 38 minutes)

Goal of user study

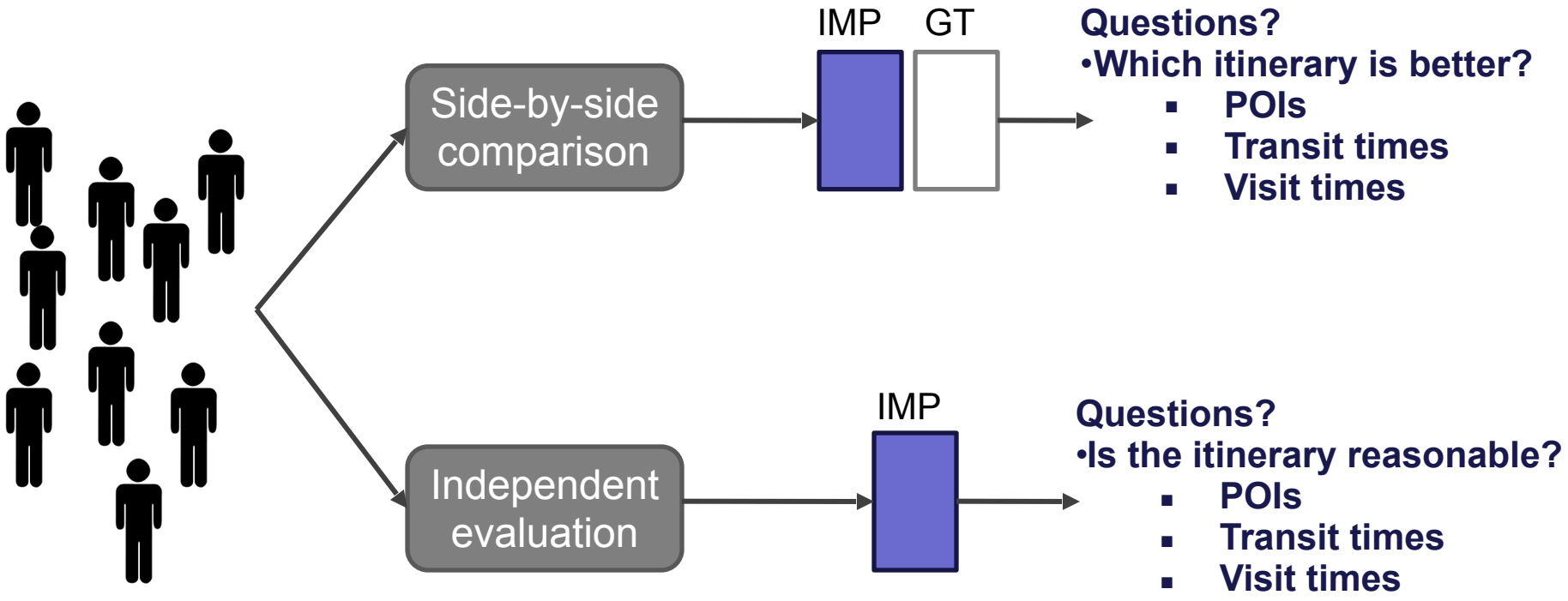
- **Estimate the usefulness of the itineraries from two aspects:**
  - overall utility of the itineraries
  - appropriateness of POIs
- **Challenge**
  - design a set of questions to AMT users and collect and interpret feedback
  - what is our ground truth?

Ground truth

City	Ground Truth Sources
Barcelona	www.barcelona-tourist-guide.com
London	www.theoriginaltour.com
New York City	www.newyorksightseeing.com
Paris	www.carsrouges.com
San Francisco	www.allsanfranciscotours.com

User study design summary

- **Side-by-side evaluation comparing our itineraries to ground-truths**
- **Independent evaluation examining our itineraries in detail**



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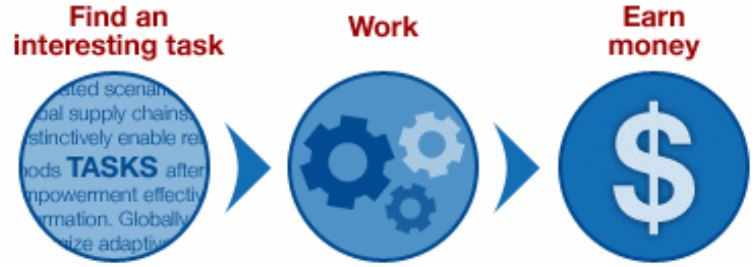

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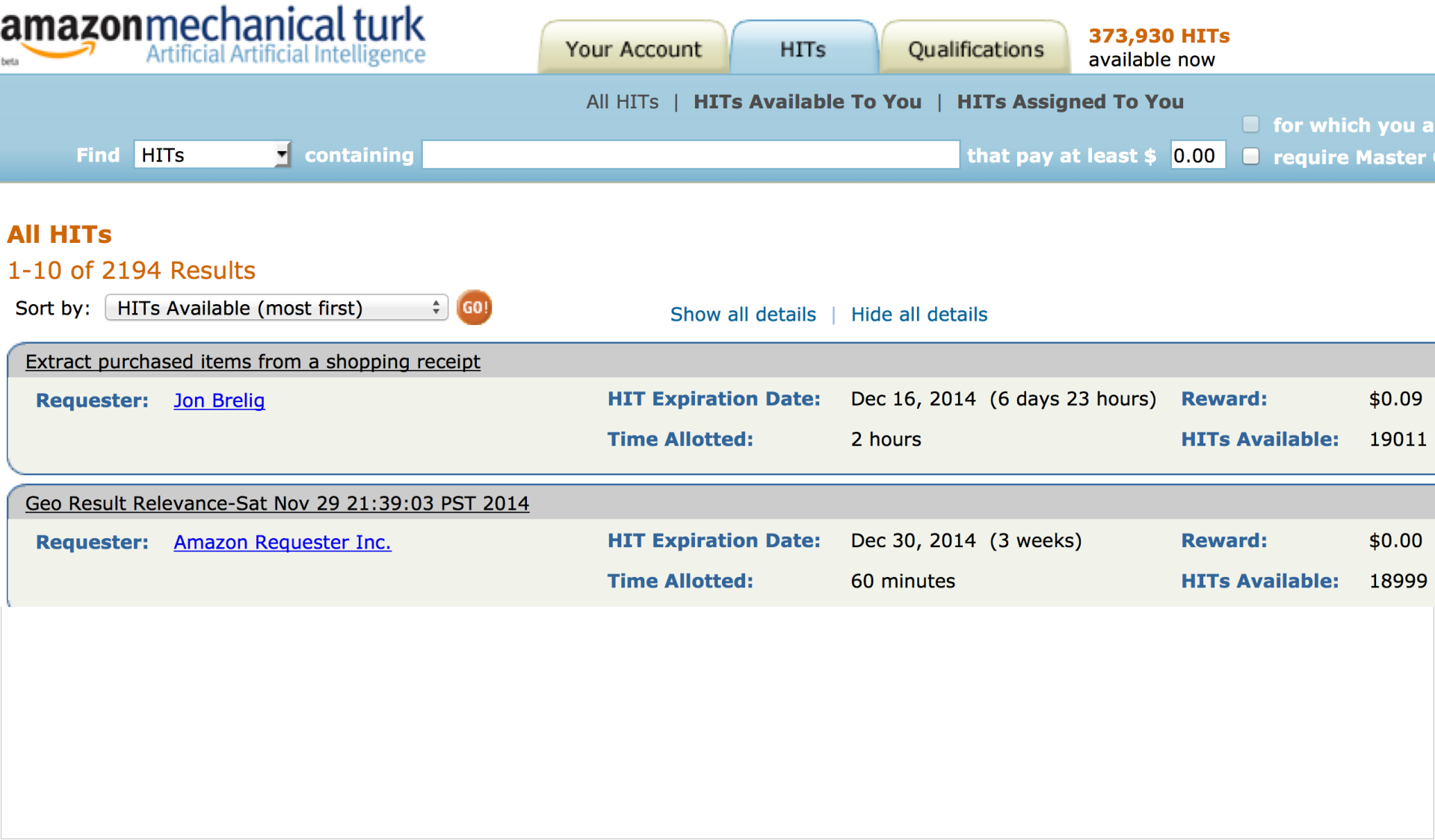
Get Started

Tasks on AMT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HITs
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373,930 HITs
available now
All HITs | HITs Available To You | HITs Assigned To You
Find HITs containing that pay at least $ 0.00
for which you a
require Master
All HITs
1-10 of 2194 Results
Sort by: HITs Available (most first) GO!
Show all details | Hide all details
Extract purchased items from a shopping receipt
Requester: Jon Brelig
HIT Expiration Date: Dec 16, 2014 (6 days 23 hours)
Reward: $0.09
Time Allotted: 2 hours
HITs Available: 19011
Geo Result Relevance-Sat Nov 29 21:39:03 PST 2014
Requester: Amazon Requester Inc.
HIT Expiration Date: Dec 30, 2014 (3 weeks)
Reward: $0.00
Time Allotted: 60 minutes
HITs Available: 18999

Comparative evaluation

Evaluation Questions:

I. Overall, which one of the above two proposed itineraries you would rate higher?
- Itinerary 1 is significantly more useful than Itinerary 2.
- Itinerary 1 is somewhat more useful than Itinerary 2.
- Both are similar.
- Itinerary 2 is somewhat more useful than Itinerary 1.
- Itinerary 2 is significantly more useful than Itinerary 1.

II. How would you rate the set of points of interest included in the two itineraries?
- Itinerary 1 has significantly more appropriate points of interest than Itinerary 2.
- Itinerary 1 has somewhat more appropriate points of interest than Itinerary 2.
- Both are comparatively similar.
- Itinerary 2 has somewhat more appropriate points of interest than Itinerary 1.
- Itinerary 2 has significantly more appropriate points of interest than Itinerary 1.

III. How would you rate the transit times at the points of interest in the two itineraries (from a tourist perspective)?
- Itinerary 1 has significantly more accurate transit times than Itinerary 2.
- Itinerary 1 has somewhat more accurate transit times than Itinerary 2.
- Both are comparatively similar.
- Itinerary 2 has somewhat more accurate transit times than Itinerary 1.
- Itinerary 2 has significantly more accurate transit times than Itinerary 1.

IV. Any additional comments?

Overall itinerary quality comparison

Evaluation of the quality of suggested POIs

Transit time evaluation across consecutive POIs

Independent evaluation

Q1: Overall, would you rate the proposed itinerary as:
—Not at all useful to a tourist
—Not so useful to a tourist
—Somewhat useful to a tourist
—Very useful to a tourist

Q2: How would you rate the set of points of interest included in the itinerary?
—Make no sense
—Mostly inappropriate
—Somewhat appropriate
—Mostly appropriate

Q3: How would you rate the visit times at the landmarks, as proposed by the itinerary (from a tourist perspective)?
—Not accurate at all
—Somewhat accurate
—Mostly accurate
—Completely accurate
If you picked choices 3 or 4, did you find the visit times too short or too long?

Q4: How would you rate the transit times between the landmarks, as proposed by the itinerary (from a tourist perspective)?
—Not accurate at all
—Somewhat accurate
—Mostly accurate
—Completely accurate
If you picked choices 3 or 4, did you find the transit times too short or too long?

Evaluation measures

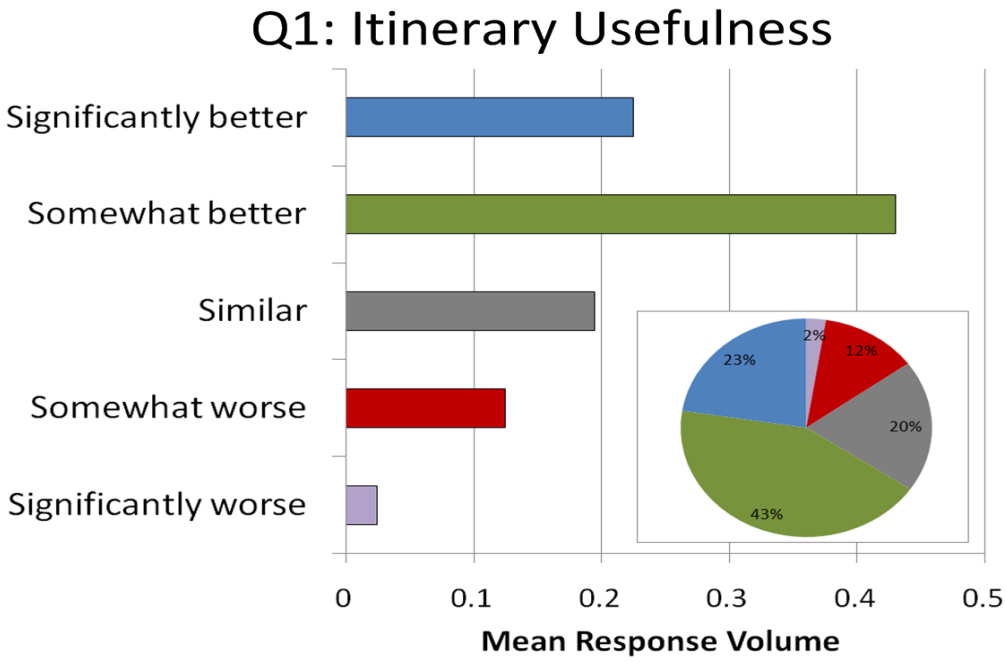
- *Mean Weighted Response (MWR)* – aggregate the responses to each question from the workers in the same group, into a single number. Take mean across different itineraries generated by our method.

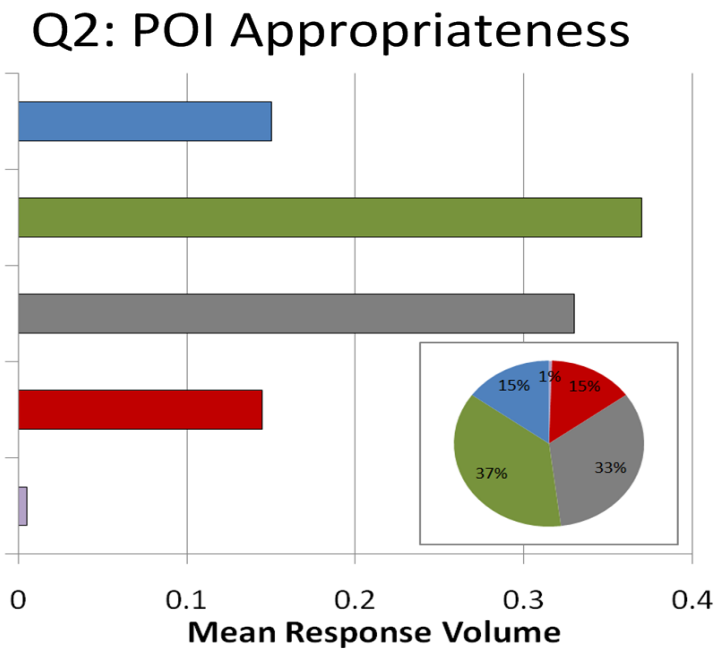
- *Mean Average Error Fraction (MAEF)* – compute the percentage of the number of POIs, visit times, or transit times, that are considered bad or inaccurate by a particular worker, out of the total number of POIs

Results for side-by-side comparison

$$\mathrm{MRV}(opt, q) = \frac{1}{n_q(opt)} \frac{1}{|\mathcal{C}|} \sum_{C \in \mathcal{C}} \sum_{\mathcal{I}} n_q^{\mathcal{I},C}(opt), \qquad (1)$$

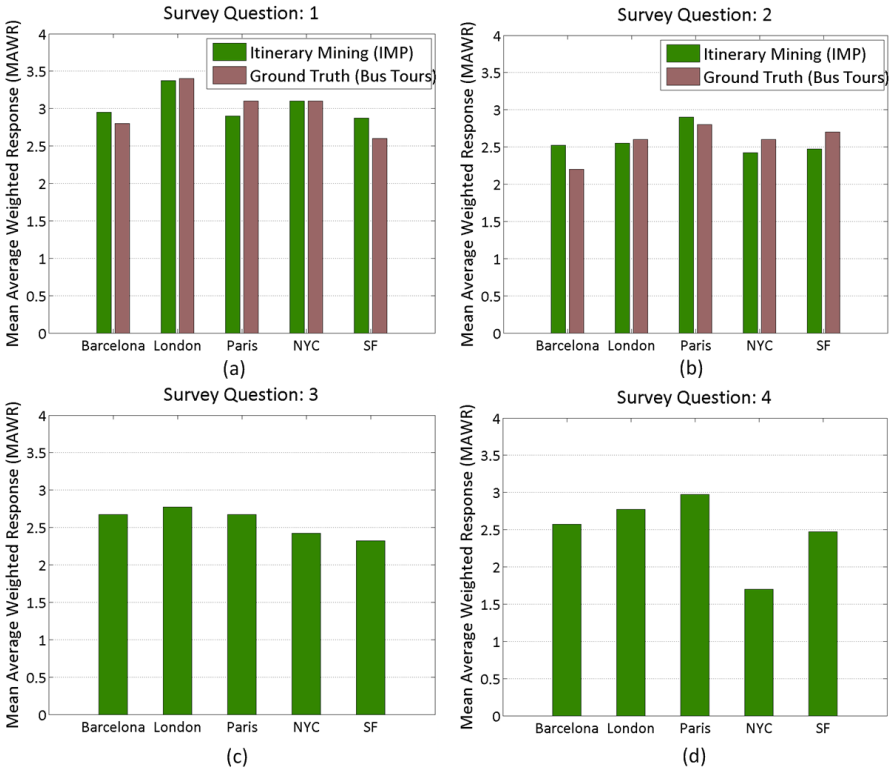
where $n_q^{\mathcal{I},C}(opt)$ is the number of workers who chose the option opt in question q for the HIT involving our system-generated itinerary I and city C; and $n_q(opt)$ is the total number of workers who responded to option opt for question q across all HITs.



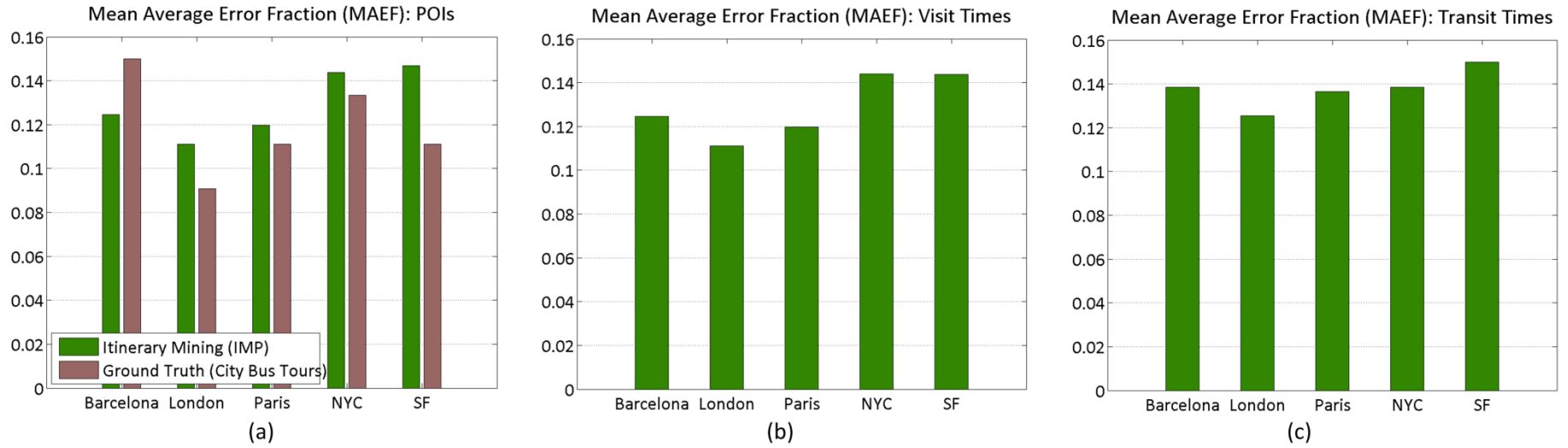


MWR for London Itineraries

London Itineraries	Q1	Q2	Q3	Q4
IMP It. 1	3.1	2.9	2.7	2.8
IMP It. 2	3.5	2.1	2.7	2.1
IMP It. 3	3.4	2.5	2.8	2.7
IMP It. 4	3.5	2.7	2.9	3.1
Ground Truth	3.4	2.6	2.6	2.6



The mean error fraction of (a) POIs, (b) Visit Times, and (c) Transit Times:



Summary and challenges

- **AMT enables scaling up user studies to hundreds, thousands of users**
- **AMT is just a hiring platform**
- **Experiment designer must "track" users and enforce consistency**
  - in group recommendations, have users really seen the movies they are asked to rate to build their profile?
  - in itinerary planning, do hired users really know about a city?

Filtering expert AMT workers

- **Multiple-choice questions on “less-known” POIs**

QUALIFICATION EVALUATION

Please choose the most suitable name of the point of interest based on your experience. This would judge your fitness to take the travel itinerary evaluation task in the next section.



○ Empire State Building	○ Flatiron Building	○ Herald Square
○ Rockefeller Center	○ Saint Patrick's Cathedral	○ Washington Sq Park
○ Chrysler Building	○ Trinity Church	○ Lincoln Center