Crying Wolf?
On the Price Discrimination of Online Airline Tickets

Thomas Vissers, Nick Nikiforakis, **Nataliia Bielova**, Wouter Joosen

Price discrimination

Andrew Sampson
@sampsonian

Ryanair exhibit A. Looked up fare yesterday, total £123.00. Returned today and fare is £237.00. Flushed cookies. Fare back to £123.00.

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2,674   199

3:18 PM - 22 Mar 2011

More evidence

March 23rd, 2011 • 50 Comments

Save money on Ryanair fares by… deleting your cookies?

By Andy Dawson

Posted by SB · March 23, 2011 at 11:32 am

RyanAir have been doing this for at least 2 years, it's a bit of a disgrace but I thought this was widely known!?

Posted by Ally · March 23, 2011 at 11:34 am

That is some cheeky cheeky shenanigans – I also doubt it'll be restricted to a RyanAir practice.

Posted by Richard · March 23, 2011 at 11:35 am

Yes – I have seen this on Ryanair many years ago – it "knew" I was looking for this fare and it bumped up the price each time I visited. New computer, back to normal prices.

Posted by Dickie Branson · March 23, 2011 at 12:30 pm

Have had similar experiences with both Easyjet and Virgin……

On Orbitz, Mac Users Steered to Pricier Hotels

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By DANA MATTIOLI

Updated Aug. 23, 2012 6:07 p.m. ET

Orbitz has found that Apple users spend as much as 30% more a night on hotels, so the online travel site is starting to show them different, and sometimes costlier, options than Windows visitors see. Dana Mattioli has details on The News Hub. Photo: Bloomberg.

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Price Discrimination

- ## What is **price discrimination**?
  Setting a different price based on an estimation of the amount the client is able/willing to pay

  - Massive amounts of **user-data** gathered on the web
    - ➤ natural fit to determine how much the user is willing to pay
      - Is the user a big spender?
      - Has the user searched for this before?
      - Is the user actively comparing products (potentially cross-site) ?
      - How bad does he want/need the product?
      - …

Hypothesis

- Discriminative factors:
  - Device and OS
  - Consumer profile (willingness to spend)
  - Previous search queries
  - Geographical location

- Hypothesis

  If airlines return different prices according to …

  we should observe a systematic price difference between emulated users who differ in those characteristics.

Large-scale analysis

Gathering the necessary data to test our hypothesis

Large-scale analysis: Overview

- ## Numbers:
  - 25 airlines, twice per day
  - 3 weeks
  - 66 user profiles
  - 2 geographical locations

  130,000+ search queries

- ## How?
  - A web scraper
    - Scrape **all airlines** with **all different user profiles**
  - Emulating real user interactions
    - CasperJS, PhantomJS

Large-scale analysis: User profiles

- **Browser and OS profiles**
  - User-Agent string and JS navigator object
    - IE 9 on Win7, Safari 6 on OSX 10.7, …

- **Consumer profiles**
  - Gathering cookies from relevant websites
    - Affluent, Budget and Flight Comparer

- **Cookie setting profiles**
  - Accepting/Blocking certain cookies
    - own cookies, with(out) consumer profile cookies, no third-party cookies

- **Geographical profile**
  - Scraper in runs in parallel on different locations
    - New York and Leuven

Results

Plotting and searching

Plotting

- **Time-series for each profile**
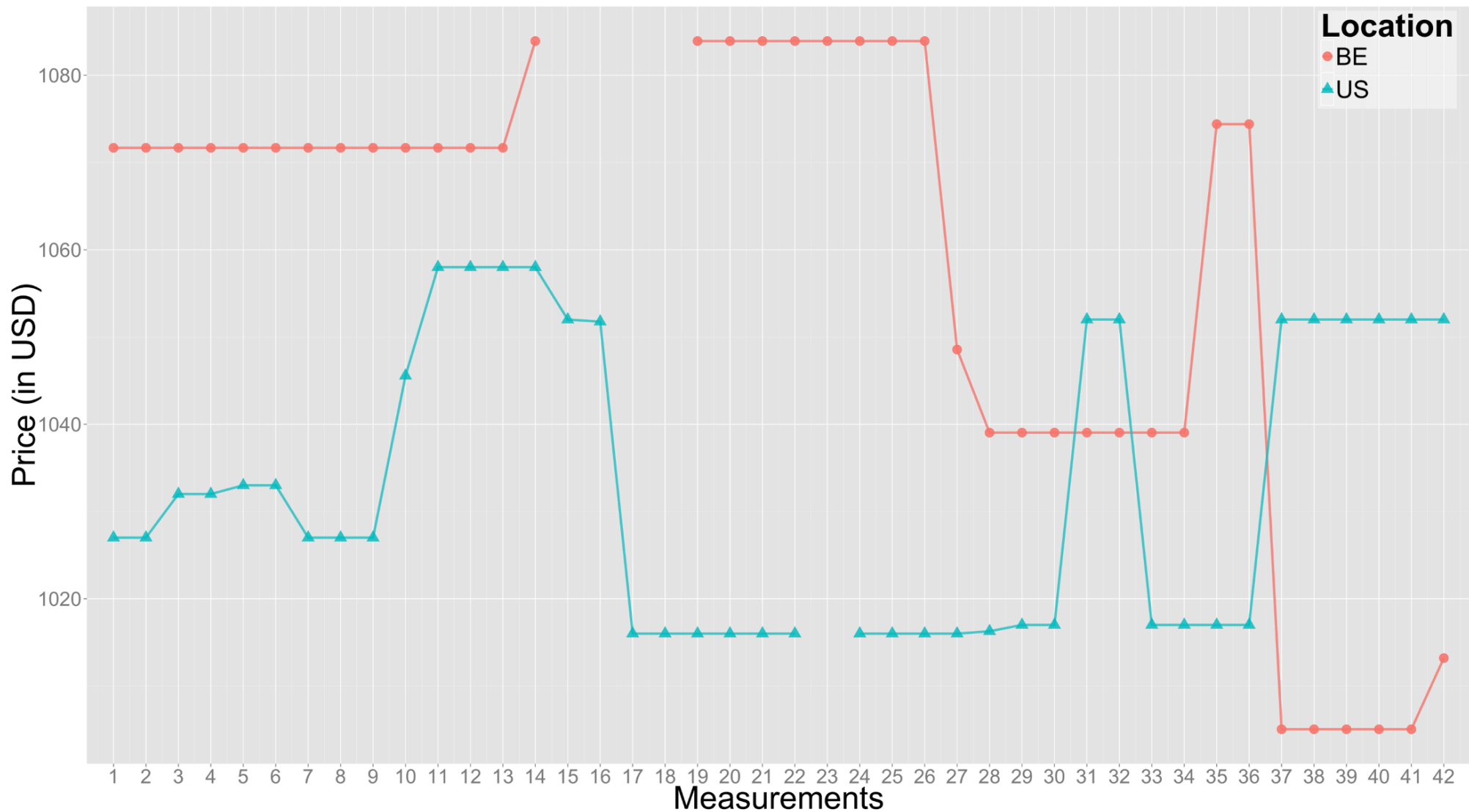 - Minimum, maximum and mean price per query

- **Majority of plots: no consistent price difference between the user profiles!**

Results
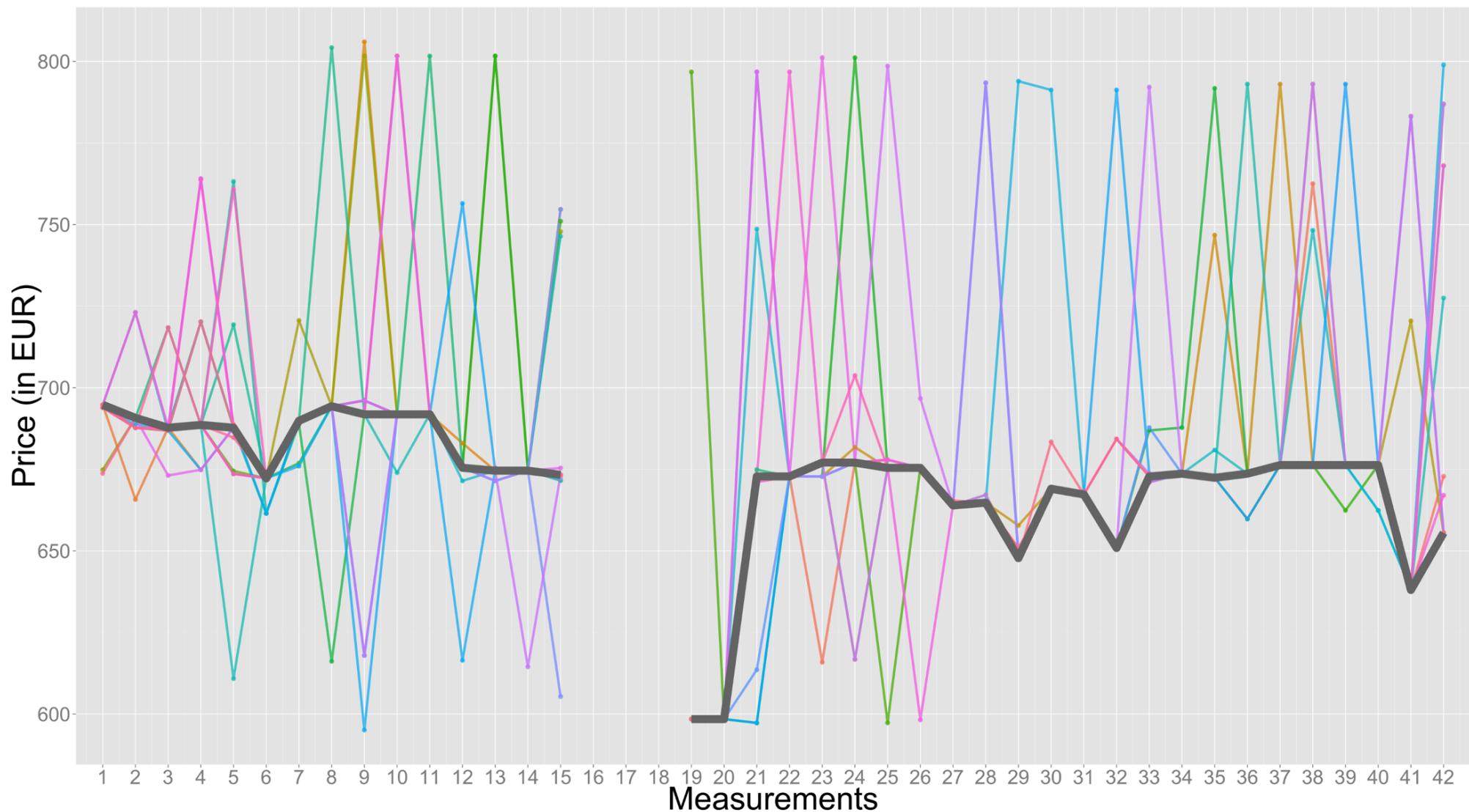
*Mean prices offered by **KLM** for all user profiles (BE) over 21 days, for the JFK - AMS route.*

13

Results

*Minimum price offered by **United Airlines** in Belgium and the United States over 21 days, for the SFO - BRU route.*

Results
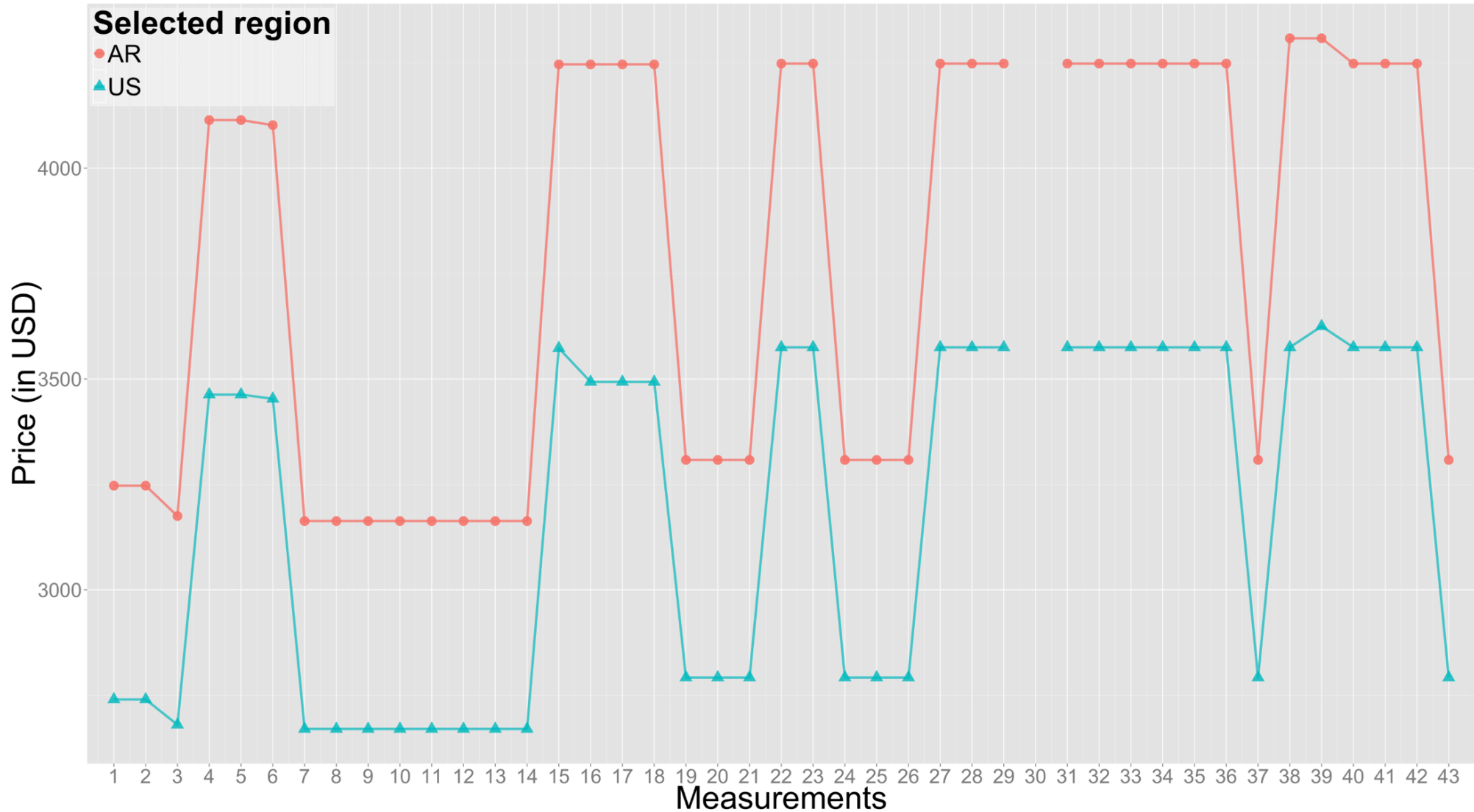
*Price for a SFO - BRU flight offered by **American Airlines** for the non-native (Argentina) and native (US) profile over 21 days.*

Alternative explanations

Phenomena that may *appear* as price discrimination, but that are <u>not</u>.

Alternative explanations

- Volatility of flight availability
  - [Available -> Unavailable -> Available] < 1 min

- Different regions, different facts
  - Taxes
  - Resident fare
  - Currency conversions

- Caching of prices
  - Websites serve cached prices for efficiency

Conclusion

Conclusion

- No clear evidence of systematic price discrimination
- Very hard to establish cause and effect
- Alternative explanations

- Dataset:

  http://people.cs.kuleuven.be/~thomas.vissers/data/price_discrimination.zip

- Publication:

  T. Vissers, N. Nikiforakis, N. Bielova, W. Joosen.
  Crying Wolf? On the Price Discrimination of Online Airline Tickets.
  Hot Topics in Privacy Enhancing Technologies (HotPETs 2014)

Open questions - challenges?

- **Are we missing something?**
  - More geographical locations?
    - Asia? Africa?
    - Or more fine-grained: different states, cities
  - Test with real discriminative factors instead of 'pretending'?
  - What about travel meta-search engines?
    - Kayak, Skyscanner, Orbitz,…

Follow-up

- Price discrimination found on e-commerce websites [1]
    - Data collection:
        - 300 real users vs. PhantomJS requests
        - 16 top-e-commerce websites
    - Results:
        - Cheaptickets and Orbitz: reduced prices to "members"
        - Expedia "steers" users towards more expensive hotels depending on cookies

[1] Measuring Price Discrimination and Steering on E-commerce Web Sites
Aniko Hannak, Gary Soeller, David Lazer, Alan Mislove, and Christo Wilson
In *Proceedings of the 14th ACM/USENIX Internet Measurement Conference (IMC'14)*, November 2014.

Job offers: 2 Postdocs

- Postdoc 1: Measurement and causation of user discrimination

  - Start: September 2017
  - Duration: 1 year

  http://www-sop.inria.fr/members/Nataliia.Bielova/postdoc1.pdf

- Postdoc 2: Web Tracking prevention and user discrimination

  - Start: January 2017
  - Duration: 1 year

  http://www-sop.inria.fr/members/Nataliia.Bielova/postdoc2.pdf