Forecasting Home Prices

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github.com/kkwteh/cdips_hpi_forecast

Opendoor

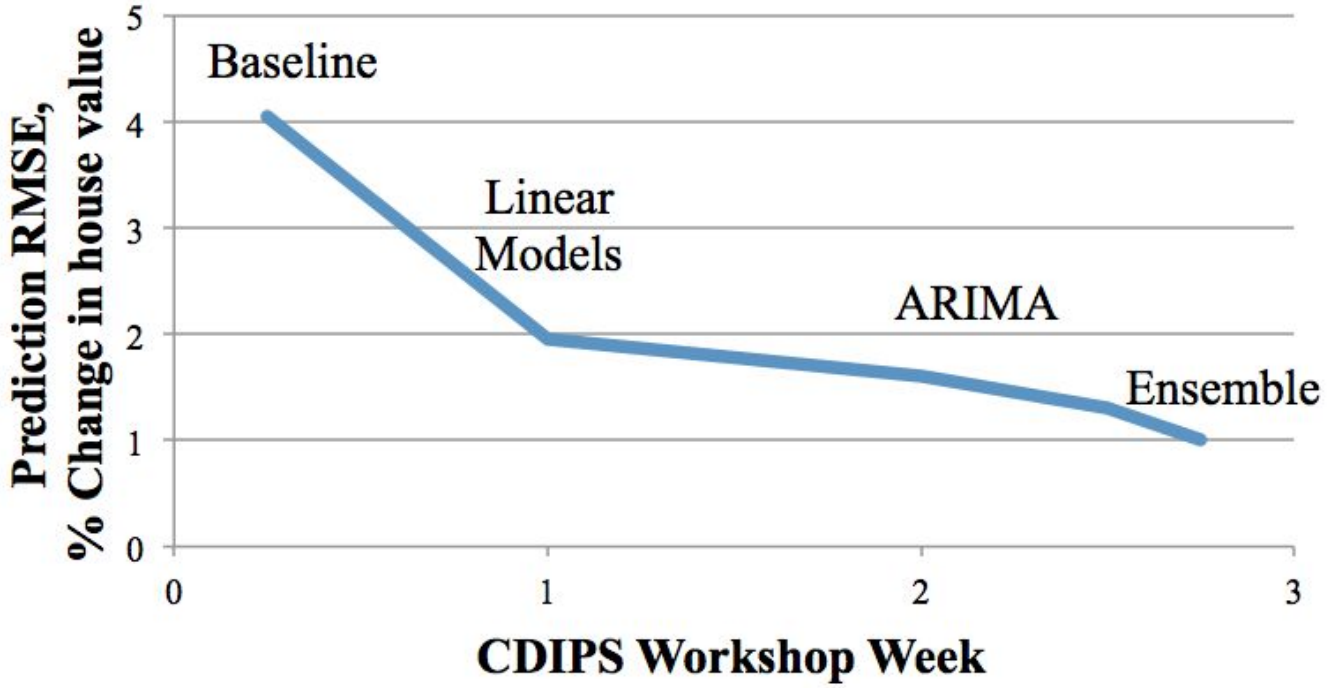
Opendoor buys houses and holds them 1-12 months until they find a seller

- Exposed to market volatility
- Price-sensitive sellers
- *Price must be competitive but factor in market risk*

CDIPS challenge:

- Forecast 6-month change in home price
- Metric: % change in housing price index

CDIPS project: Predict 6-month housing prices



Improving housing price prediction by 3% = reduce risk by $6000 per house!

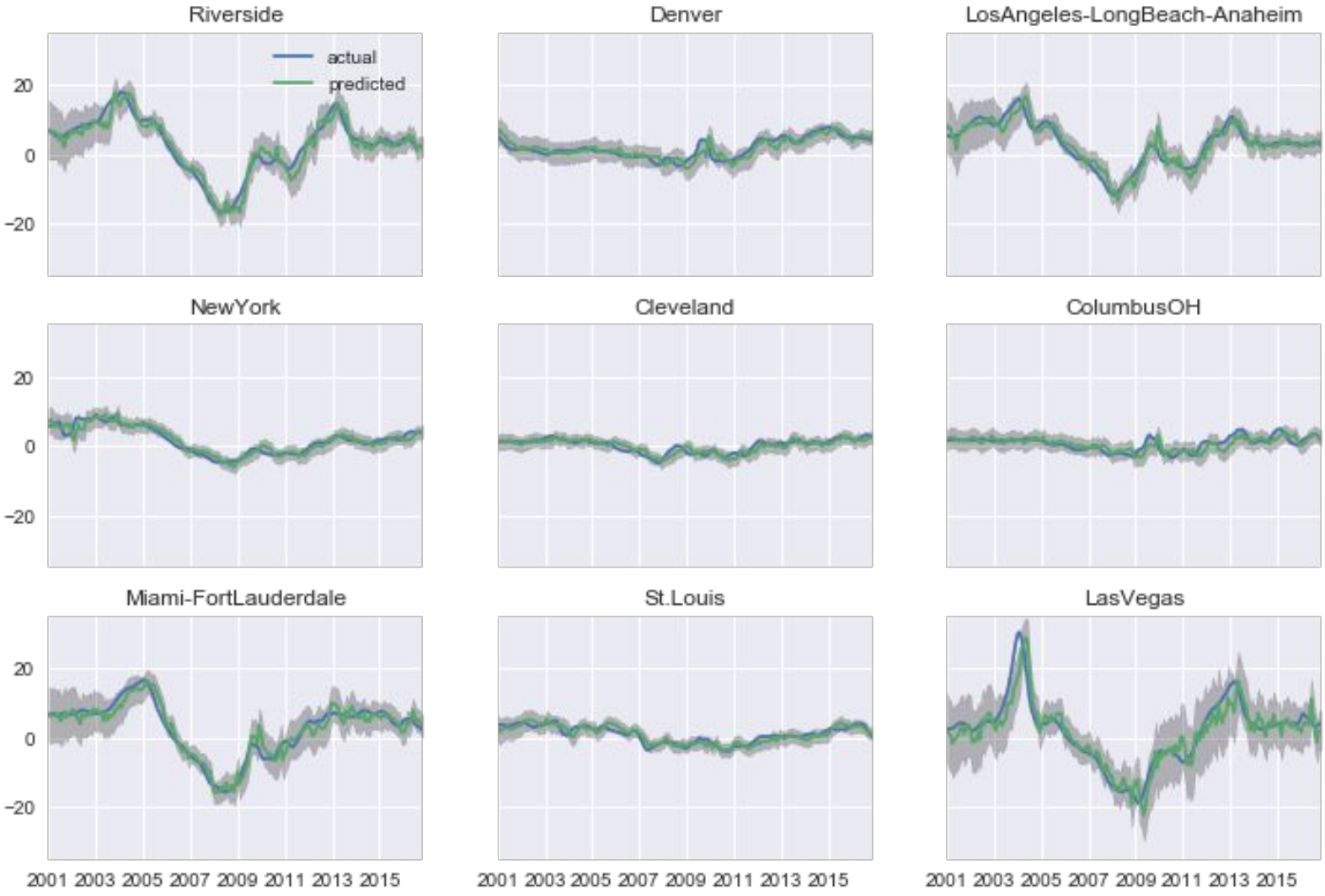
Model Details

- $ARMA(p, q)$ is a model for a time series data X_t indexed by time t :

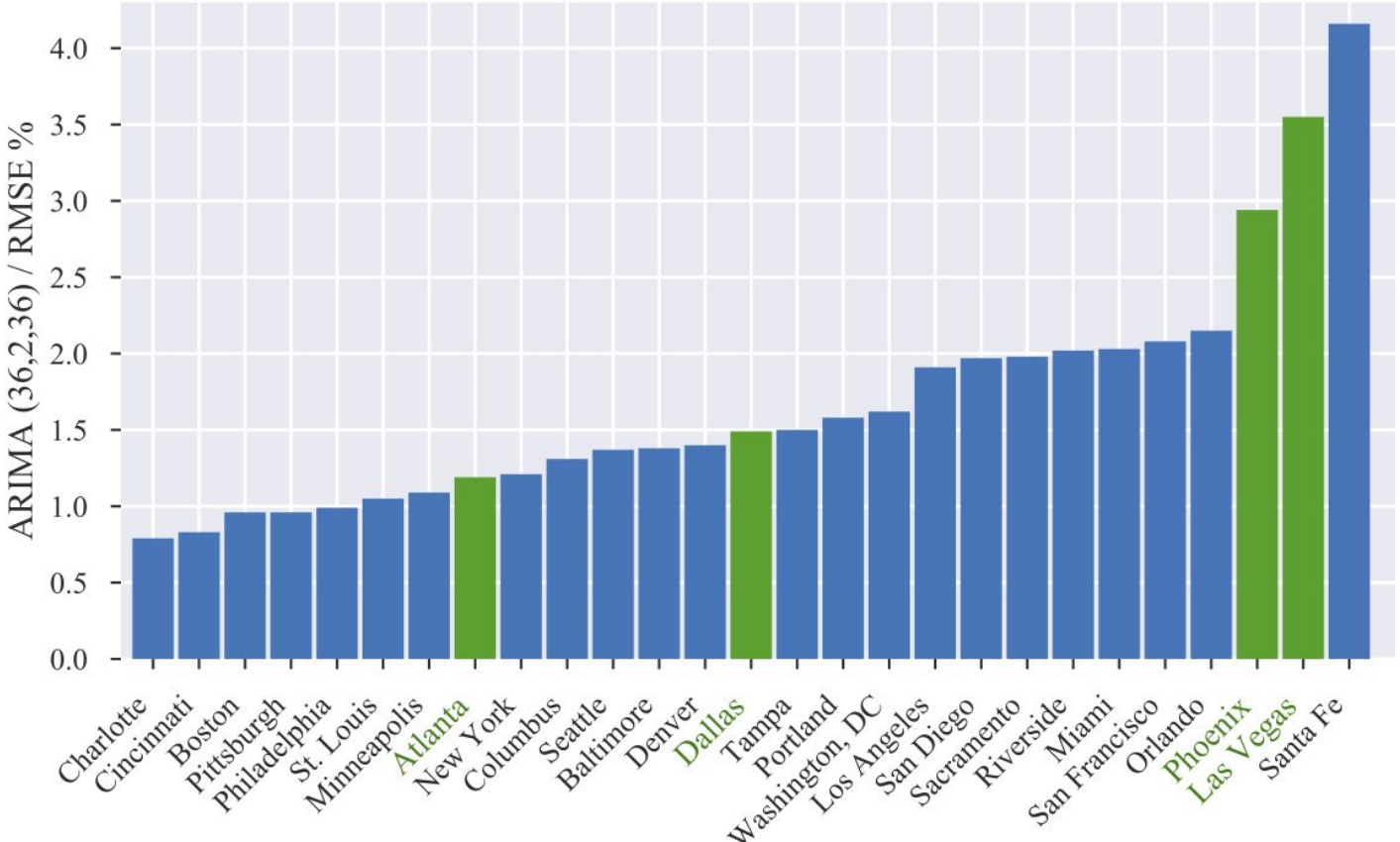
$$X_t - \alpha_1 X_{t-1} - \cdots - \alpha_p X_{t-p} = \varepsilon_t + \theta_1 \varepsilon_{t-1} + \ldots \theta_q \varepsilon_{t-q}$$

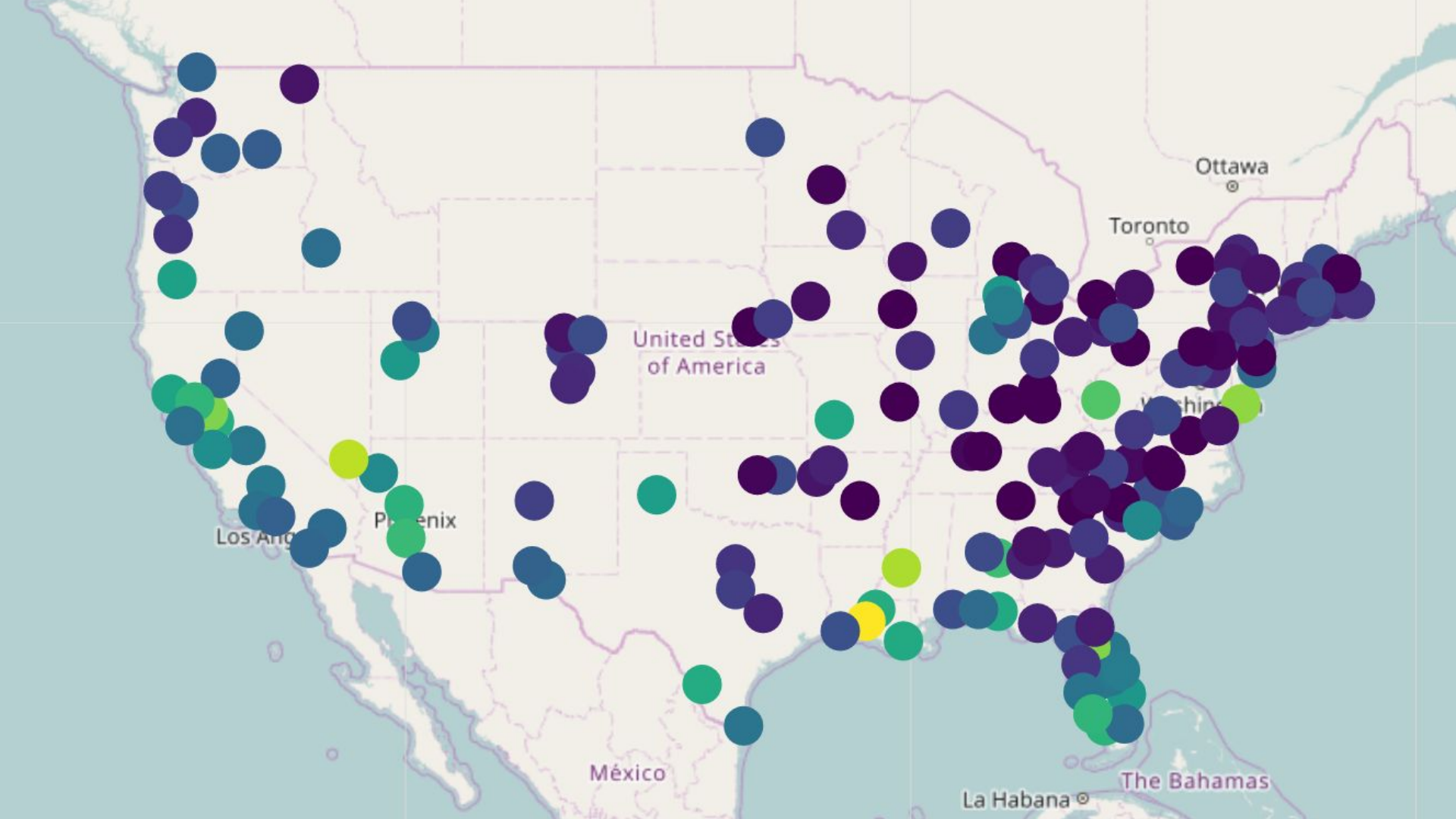
where α_i, θ_i are the parameters of the regression and ε_t are error terms.

- We use second-order seasonally-adjusted data: tuning p,q in $ARIMA(p, 2, q)$
- Boost model by training a Random Forest Regressor on ARIMA residuals and exogenous data


Riverside
Denver
LosAngeles-LongBeach-Anaheim
NewYork
Cleveland
ColumbusOH
Miami-FortLauderdale
St.Louis
LasVegas
actual
predicted
20
0
−20
2001 2003 2005 2007 2009 2011 2013 2015

What markets should OpenDoor explore next?

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Toronto
United States of America
Phoenix
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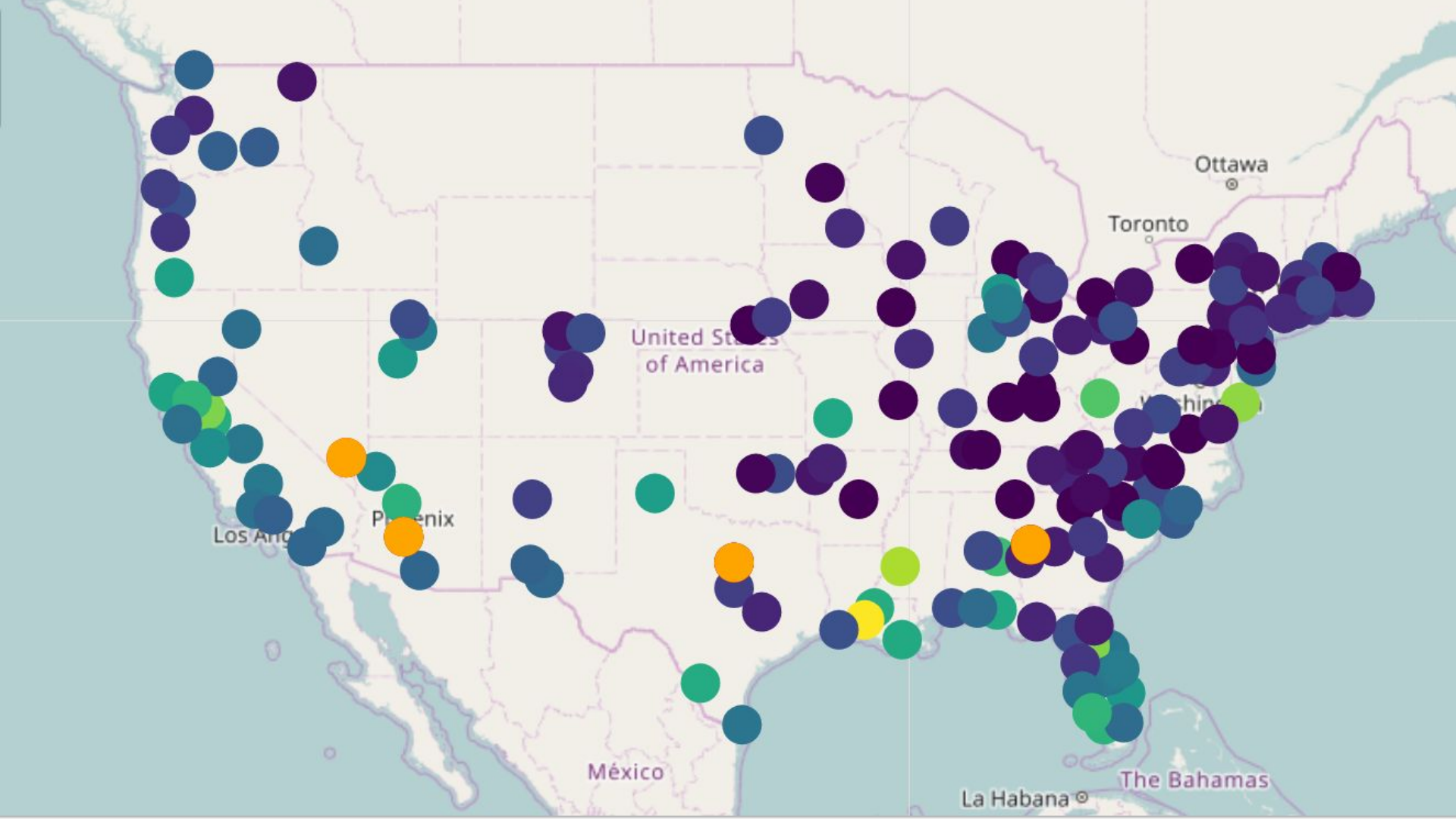
The Bahamas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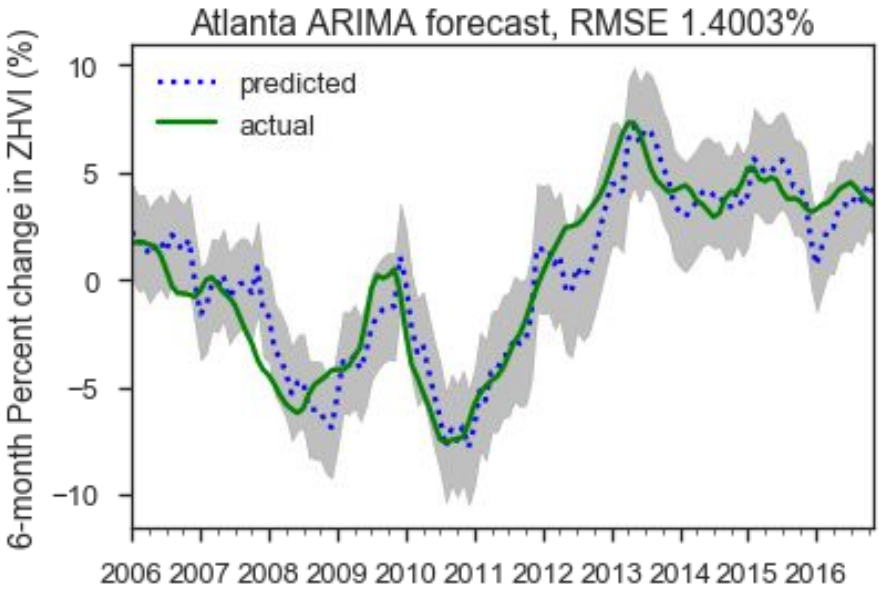
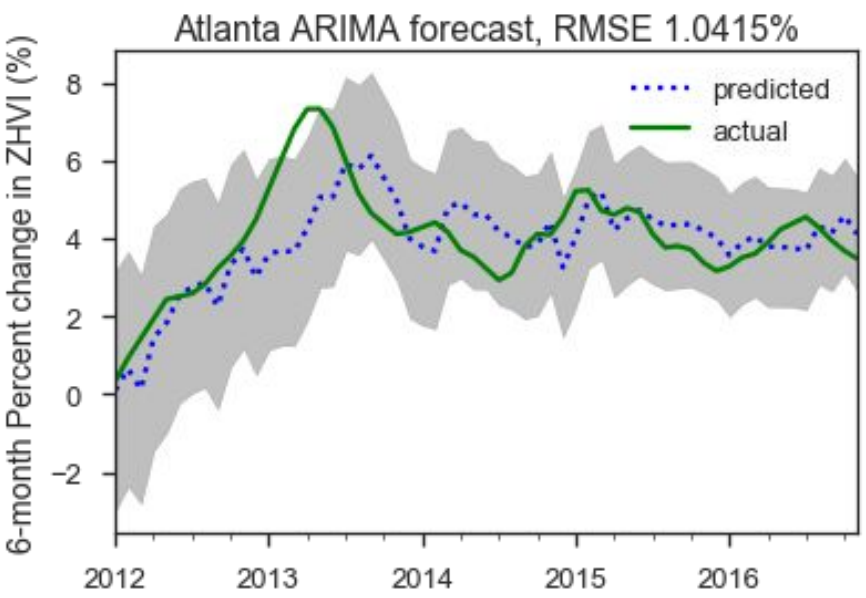
How does the Recession affect our predictions?

It's much easier to forecast post-recession… RMSE improves by 30%





Can we predict the next recession?

No. However, we can help Opendoor be prepared for the next recession:

- Predict increasing volatility
- Provide confidence intervals

Thanks!

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Additional notes for Opendoor: Key learnings

ARIMA models: surprisingly powerful

Housing market has long time lags- ARIMA(36,2,36) minimizes cross-validation error

Zillow market data (median number of days on market, rent cost, etc), provides significant improvement in prediction (~0.4%) but not available for recession backtesting

Smaller markets are generally less predictable, but there is significant variance in large markets (e.g. Las Vegas vs. Atlanta)

Additional notes for Opendoor: Future Steps

If we had more time:

- Collect and test more datasets to build a better second-stage regressor:
  - Mortgage rates
  - Earnings of Fortune 500 companies in each metro area
  - REIT and homebuilder stock prices
  - Weekly jobless claims
- Explore vector auto-regressive models using housing market data
- Explore recurrent neural networks instead of ARIMA predictions
  - Challenge: limited training data