Weather Index Project: Investigating the effect of weather on flight delays

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Agenda

- Background
  - Industry
  - Flight Delays
  - Goals & Objectives
- Data Processing
- Analysis
- Future Actions
BACKGROUND

U.S. Airline Industry

- Carry over 1/3 of the world's total air traffic
- 737.4 million passengers in 2011
- Valued at $187b in 2011 with a forecast value of $316b in 2016 (70% increase)
- Commercial aviation contributes 8% of US GDP

Huge and economically-significant industry - an integral part of the creation of a global economy
An average of 688,000 flights (20% of total flight operations) are delayed per year in the past ten years.

delayed_flight.png

1http://newscenter.berkeley.edu/2010/10/18/flight_delays/
Flight Delays - Impact

- Domestic flight delays imposed a $32.9 billion cost on US economy in 2007
- Half the cost was borne by passengers

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>Cost (in billions)</th>
</tr>
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<tbody>
<tr>
<td>Costs to Airlines</td>
<td>$8.3</td>
</tr>
<tr>
<td>Cost to Passengers</td>
<td>$16.7</td>
</tr>
<tr>
<td>Costs from Lost Demand</td>
<td>$3.9</td>
</tr>
<tr>
<td>Total Direct Cost</td>
<td>$28.9</td>
</tr>
<tr>
<td>Impact on GDP</td>
<td>$4.0</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$32.9</strong></td>
</tr>
</tbody>
</table>

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Weather Delays

**Weather Conditions**
- Thunderstorms
- Ceiling and Visibility
- In-flight icing
- Turbulence

**Airport Operations**
- Degrade airport capacity
- Hinder ground operations
- Close airports

**Flight Operations**
- Re-routing/diversions
- Delays

**Additional costs**
- Lost revenues
- Excess maintenance costs
- Additional fuel costs
To develop a sophisticated database tool that
- contains ten years’ worth of weather data and the matching ten years’ worth of flight data
- spans all major US airports and all major carriers
- enables a wide range of detailed analysis of link between weather and flight delays
Which weather factor impacts on-time performance the most?

How long do weather delays typically last?

Which airport’s weather has the biggest impact on the system as a whole?

Under which weather conditions is WN performance better than other carriers? Under which weather conditions is it worse?
Flight Data

- Extracted from Bureau of Transportation Statistics (BTS)
- 10 years of complete domestic flight records from 2003 to 2012
- Total 120 files with >67,000,000 records
DATA PROCESSING

Weather Data

• Extracted from National Oceanic and Atmospheric Administration (NOAA)
• 10 years of data: 2003-2012
• >41,000,000 records
• 7 weather factors:
  ❖ Wind direction
  ❖ Wind speed
  ❖ Ceiling height
  ❖ Visibility
  ❖ Air temperature
  ❖ Dew point
  ❖ Sea level pressure
DATA PROCESSING

Challenges & Solutions

- Handling voluminous data
- Linking the flight and weather data
- Converting time zones and observing daylight savings
- Interpreting units

Solutions:

- Python Scripts
- Dedicated server instance on phpMyAdmin
- MySQL Timezone description table
Weather-Related: Visibility

Average visibility across the day at SFO

Visibility Distance (miles)

Hour of the day

2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
ANALYSIS

Flight Performances Related: Cancellations

Percentage of cancelled flights of WN across different regions

- Midwest: 14% 22% 17%
- Northeast: 83% 83% 26%
- South: 3% 19% 2%
- West: 2% 1% 2%

Percentage of cancelled flights of non-WN across different regions

- Midwest: 6% 13% 5%
- Northeast: 74% 74% 4%
- South: 5% 4% 5%
- West: 3% 5% 5%
Merging weather and flight data

Arrival on-time performance against visibility distance in 2012 at HOU

![Graph showing the relationship between percentage of flights delayed and visibility distance.](image)
Future Actions

- Develop a tool that forecasts daily on-time performance based on given weather factors for better recovery decision-making.
- Identify baseline levels.
- Quantify system-wide effects.
- Utilize historical data to assist in the block-scheduling process.
Thank You

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