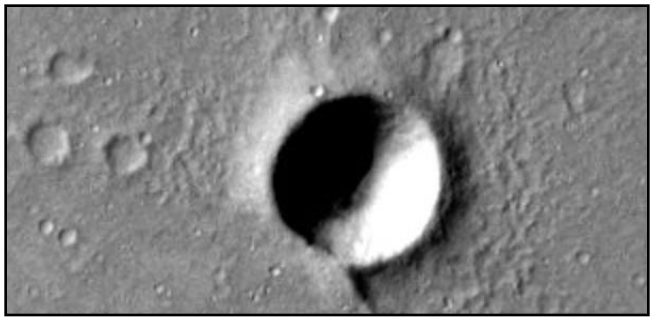
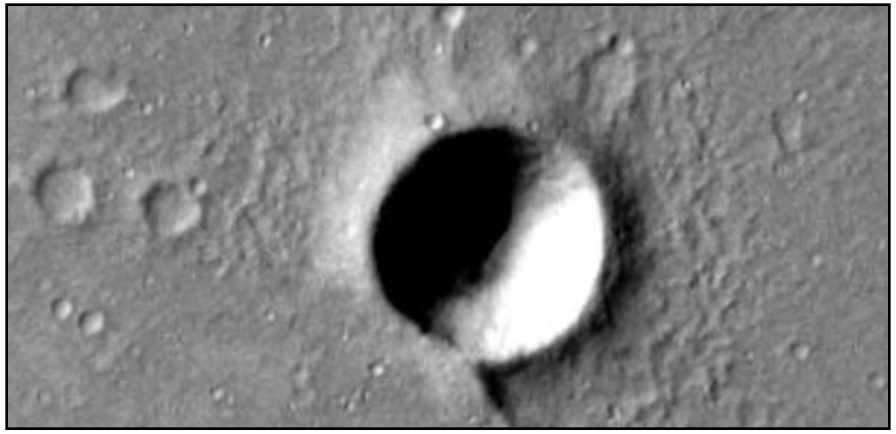
Exponential distribution

Not all things are Normal!



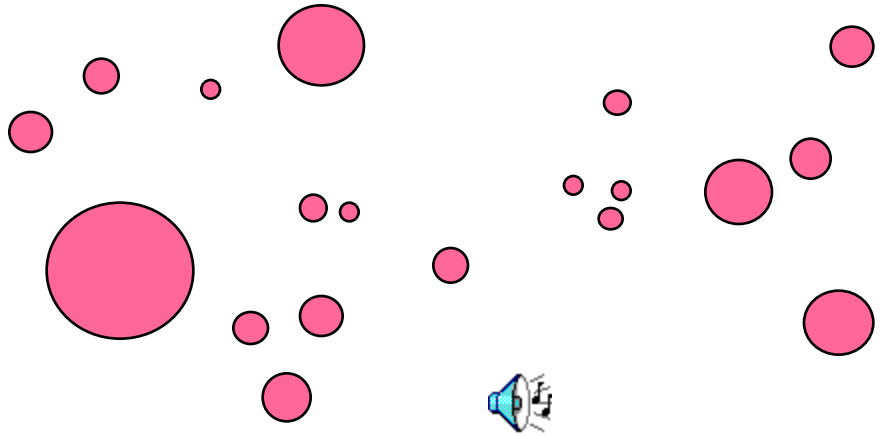
Craters of Mars

Air traffic delays



Craters of Mars:

An exponential distribution special



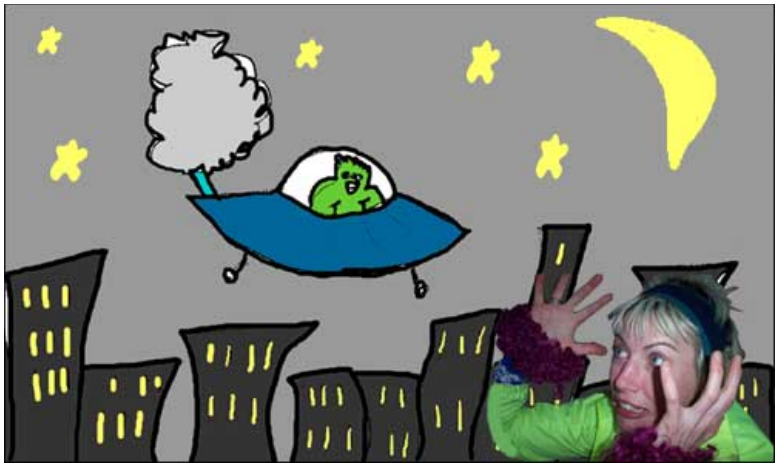
The Red Planet

…has captured our imagination from early on. Ancient Greeks and Romans related it to Mars, the belligerent God so anxious to go to war, he was…

Red In The Face!

Little Green Martians

In the 19th and 20th Centuries, many people believed Mars was inhabited by little green creatures who were ready to invade Earth without notice!



NASA's Mars Missions

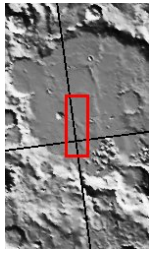
In 2001, Odyssey orbiter arrived to Mars on a mapping mission.

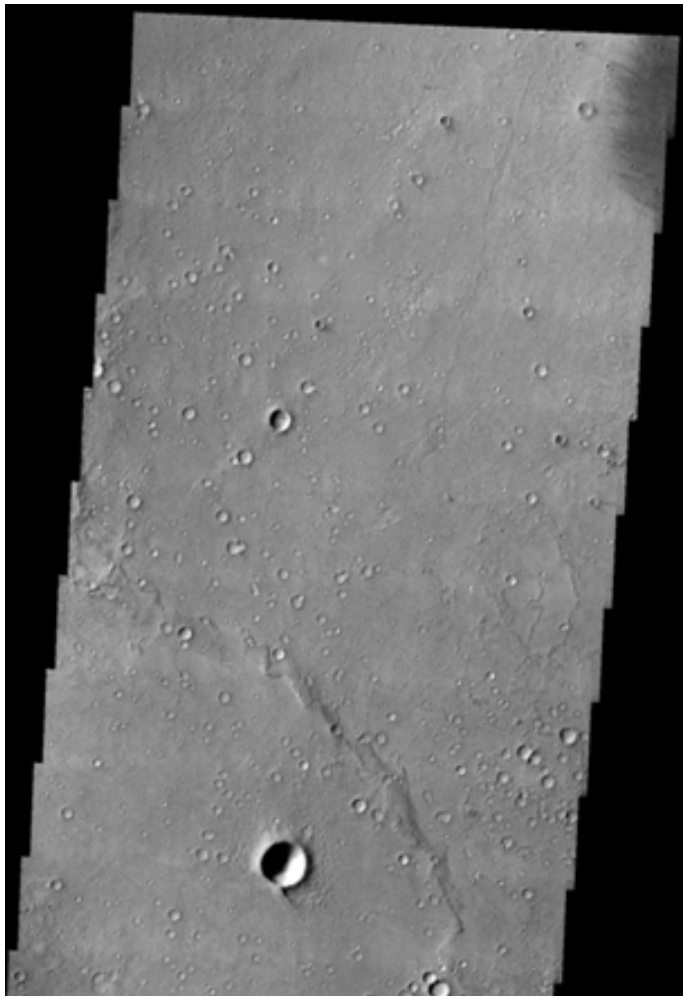
In 2003, NASA sent two Rovers to investigate whether Mars has any life-supporting elements such as water, and explore its natural resources.

Mars 2001 Odyssey

The Mars 2001 Odyssey orbiter launched from Kennedy Space Center on 7 April 2001. The orbiter arrived at Mars on 24 October 2001. Upon arrival, the orbiter went into an ~18-hour capture orbit. The orbiter spent the next several months achieving a circular mapping orbit by aerobraking (using the atmosphere to slow and shrink the orbit).

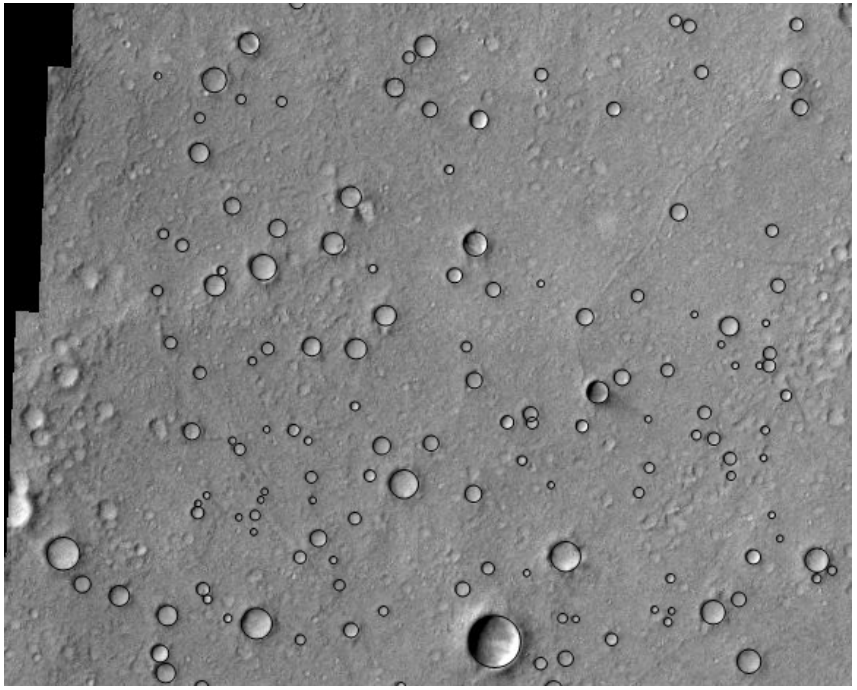
Mapping photos of the Central Gusev crater were released on January 14, 2004, by NASA, JLP, and ASU.





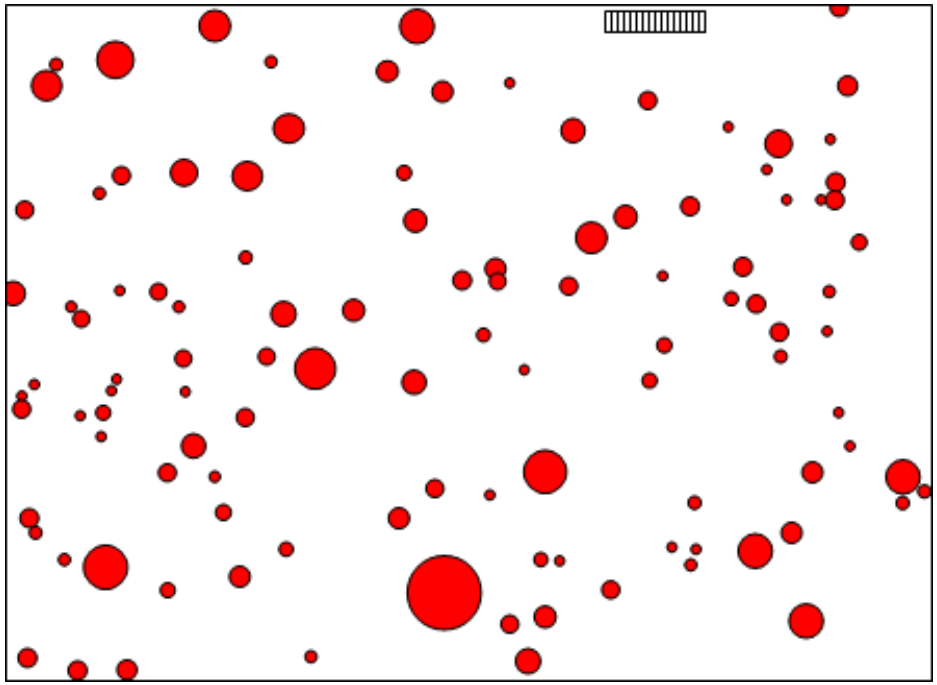
Sampling craters

Using Gusev's mapping photo, the diameter of Martian craters could be established visually.



Data collection

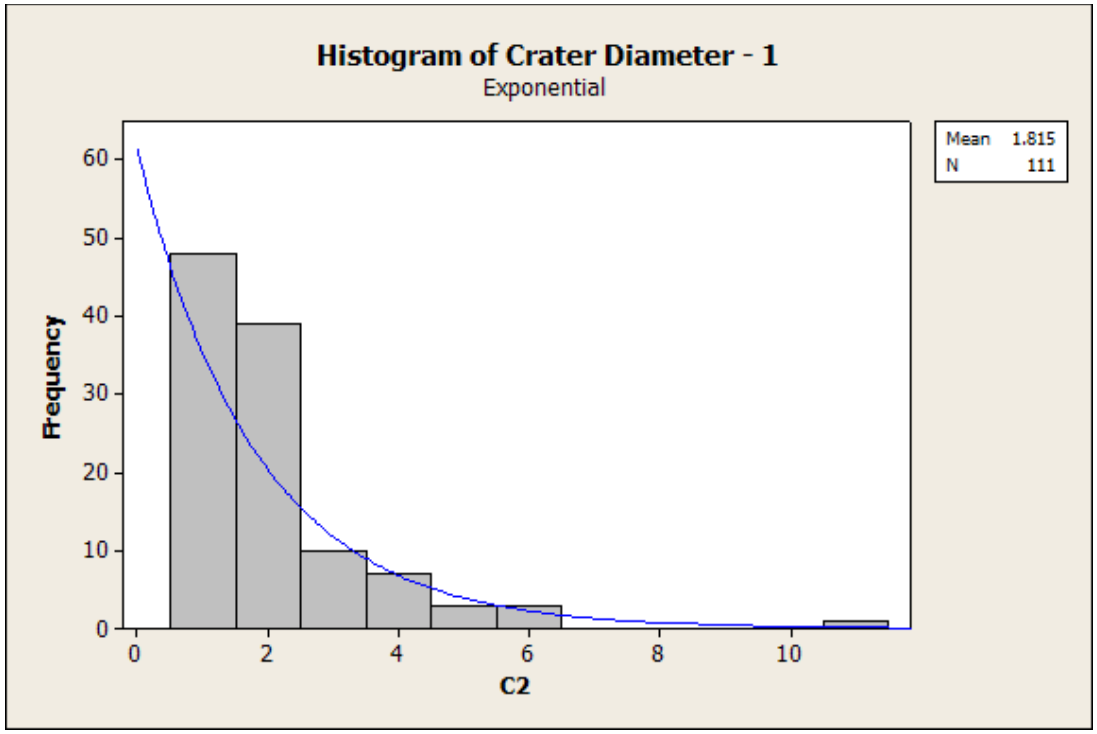
111 crater diameters were measured and recorded



	A
1	CraterDiameter
2	2
3	2
4	1.5
5	1.5
6	1.5
7	1.5
8	1.5

Distribution fitting

Using the statistical package MINITAB, an estimate of the exponential parameter λ was obtained.



ON THE NEWS: Air traffic delays

Airlines love to blame it on the weather, but a new USA TODAY analysis shows the airlines' own processes may be responsible

Pilot shortages, taking too long to refuel, and mechanical breakdowns, are now cited as main reasons. But bad weather can still cause a lot of trouble!

By ALAN LEVIN
USA TODAY
Dec. 21, 2007

USA TODAY

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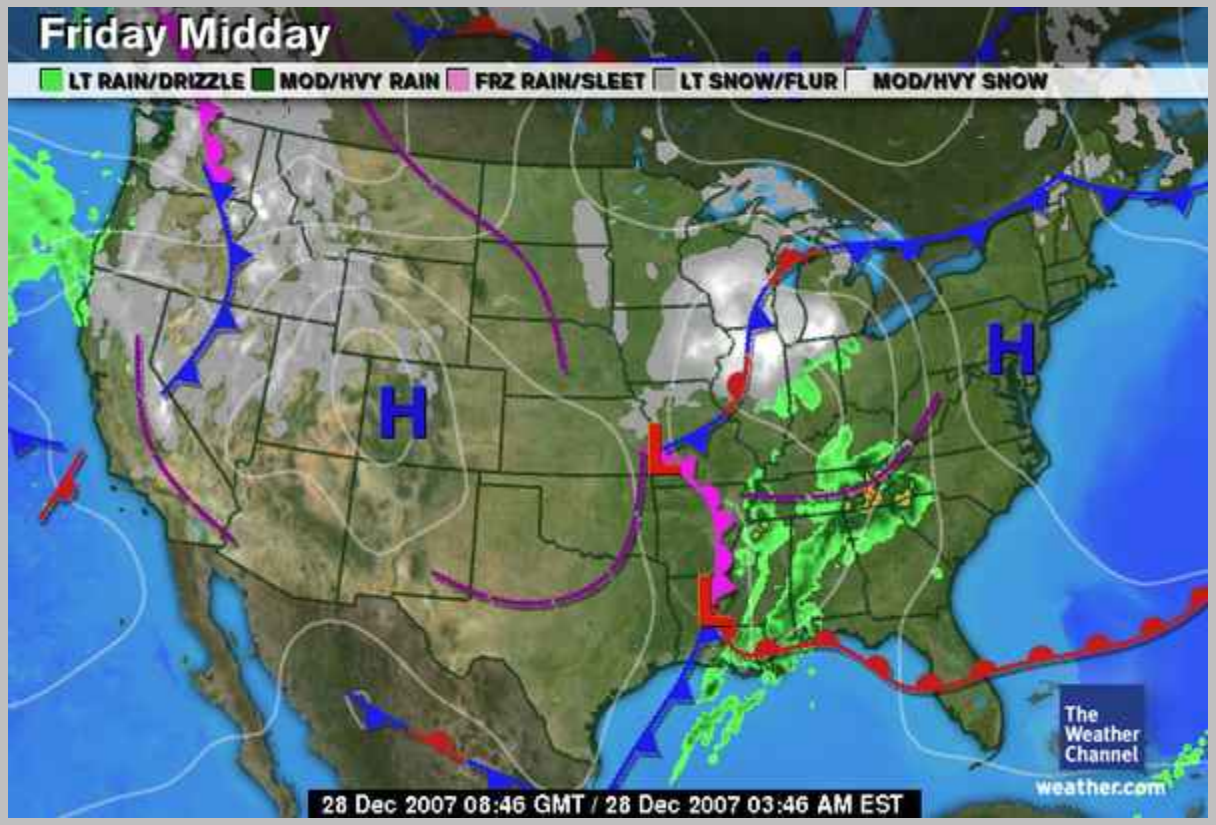
Flight delays caused by airline glitches are now creating longer passenger slowdowns than congestion in the skies, a USA TODAY analysis shows.

The data call into question a long-held notion about air travel delays - that bad weather and heavy air traffic cause the bulk of the waits that passengers endure. The newspaper's analysis shows that airline problems, such as pilot shortages, taking too long to refuel and mechanical breakdowns, are as much at the root of delays as anything else.

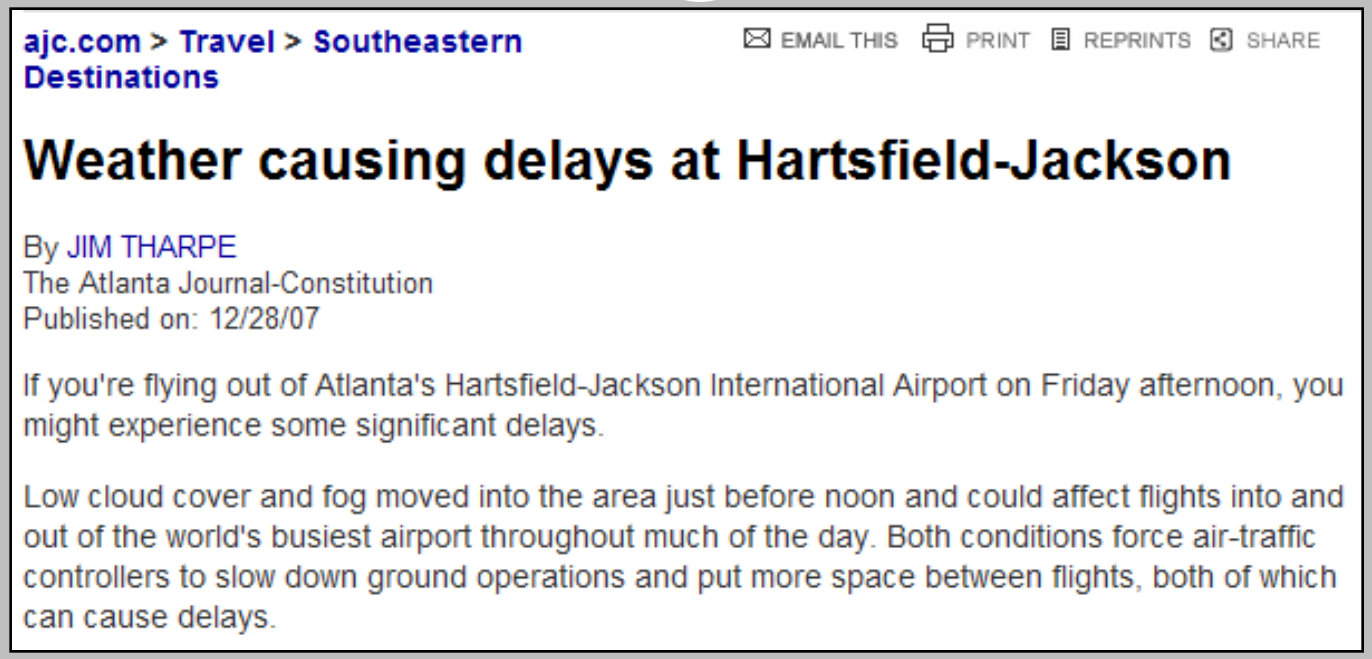
Airline issues triggered 23.8 million minutes of delay through October this year, according to the federal Bureau of Transportation Statistics (BTS). Delays attributed to the congested air-traffic system, the next largest cause, were 23.3 million.

A case study: Atlanta airport delays, Dec 28, 2007



- On Friday, December 28, 2007, a snow storm was developing in the Chicago area

A case study: Atlanta airport delays, Dec 28, 2007



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Weather causing delays at Hartsfield-Jackson

By JIM THARPE
The Atlanta Journal-Constitution
Published on: 12/28/07

If you're flying out of Atlanta's Hartsfield-Jackson International Airport on Friday afternoon, you might experience some significant delays.

Low cloud cover and fog moved into the area just before noon and could affect flights into and out of the world's busiest airport throughout much of the day. Both conditions force air-traffic controllers to slow down ground operations and put more space between flights, both of which can cause delays.

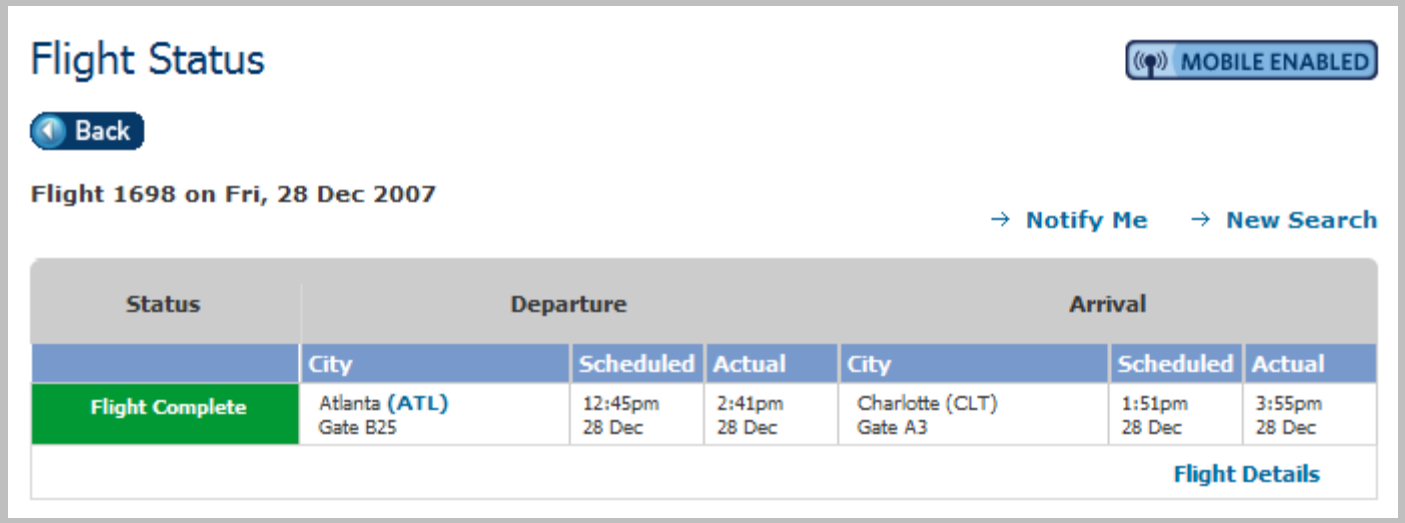
- Meanwhile, weather condition in the Atlanta area were deteriorating
- Flight delays at Atlanta's Hartsfield-Jackson airport can impact air traffic all along the East Coast

A case study: Data collection

AIRLINE/FLIGHT	DESTINATION	TIME	REMARKS	GATE	
Delta Flight #455	Pensacola	10:50A	Departed	A13	TRACK FLIGHT
Delta Flight #4821	Melbourne	11:00A	Departed	D27	TRACK FLIGHT
Delta Flight #6006	Asheville	11:15A	Departed	B19	TRACK FLIGHT
Delta Flight #6483	Detroit	11:35A	Departed	B36	TRACK FLIGHT

- As news stories started reporting flight delays, data on Delta flights departing from Hartsfield-Jackson airport (Atlanta) on Friday, December 28, 2007, were collected from the airport's Web site (www.atlanta-airport.com)
- Atlanta-based Delta is responsible for about 70-80 % of the Atlanta airport's flights

A case study: Data collection



Flight Status

MOBILE ENABLED

Back

Flight 1698 on Fri, 28 Dec 2007

→ Notify Me → New Search

Status	Departure			Arrival		
	City	Scheduled	Actual	City	Scheduled	Actual
Flight Complete	Atlanta (ATL) Gate B25	12:45pm 28 Dec	2:41pm 28 Dec	Charlotte (CLT) Gate A3	1:51pm 28 Dec	3:55pm 28 Dec

Flight Details

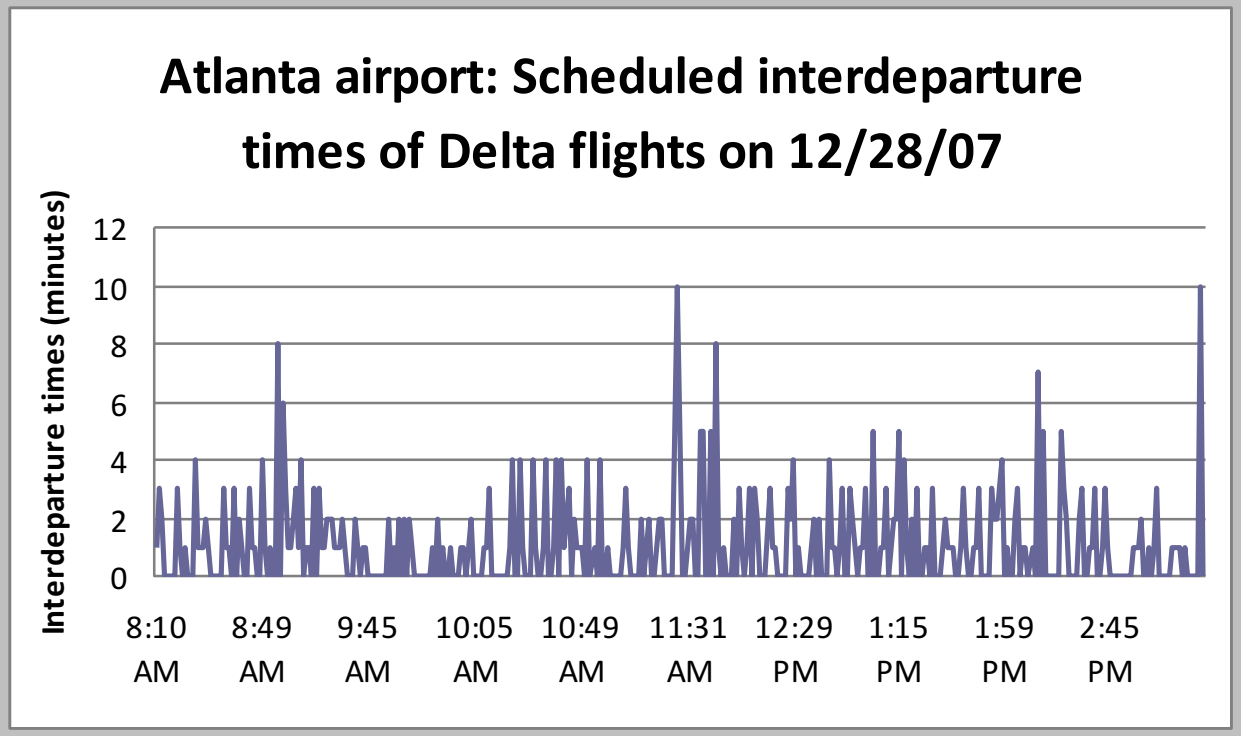
- Airport data were cross-checked with airline data obtained from Delta's Web site (www.delta.com), to establish the actual departure times

A case study: Data collection

A	B	C	D	E	F
Flight	Delta flight	Destination	scheduled	actual	actual interdept.
1	Flight #4828	Nashville	7:45 AM	8:10 AM	1
2	Flight #546	W. Palm Beach	7:55 AM	8:11 AM	1
3	Flight #1036	Chicago-O`hare	8:00 AM	8:11 AM	0
4	Flight #5128	Syracuse	8:00 AM	8:15 AM	4
5	Flight #1818	Ft.Lauderdale	8:15 AM	8:17 AM	2
6	Flight #6495	St. Louis	8:20 AM	8:18 AM	1
7	Flight #854	Washington-lad	8:24 AM	8:20 AM	2
8	Flight #1797	Tampa	8:10 AM	8:23 AM	3
9	Flight #1585	Orlando	8:25 AM	8:23 AM	0
10	Flight #4685	Tallahassee	8:13 AM	8:26 AM	3

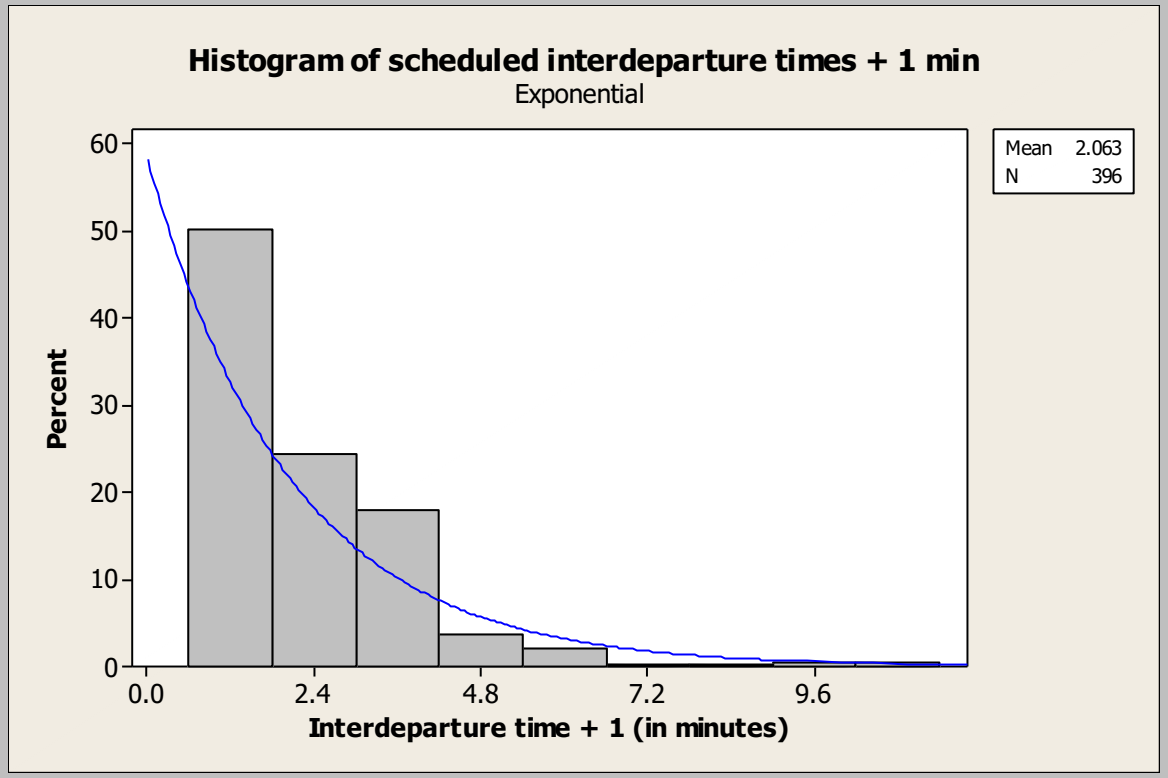
- Between 8:10 AM and 3:10PM on 12/28/2007, 397 Delta flights were scheduled to depart from Atlanta, but only 286 actually departed
- 30 flights were canceled and most others were delayed, typically by 2-3 hours
- Actual departure times were ordered and first differences were calculated to obtain 285 inter-departure times

Data collection: Scheduled departures



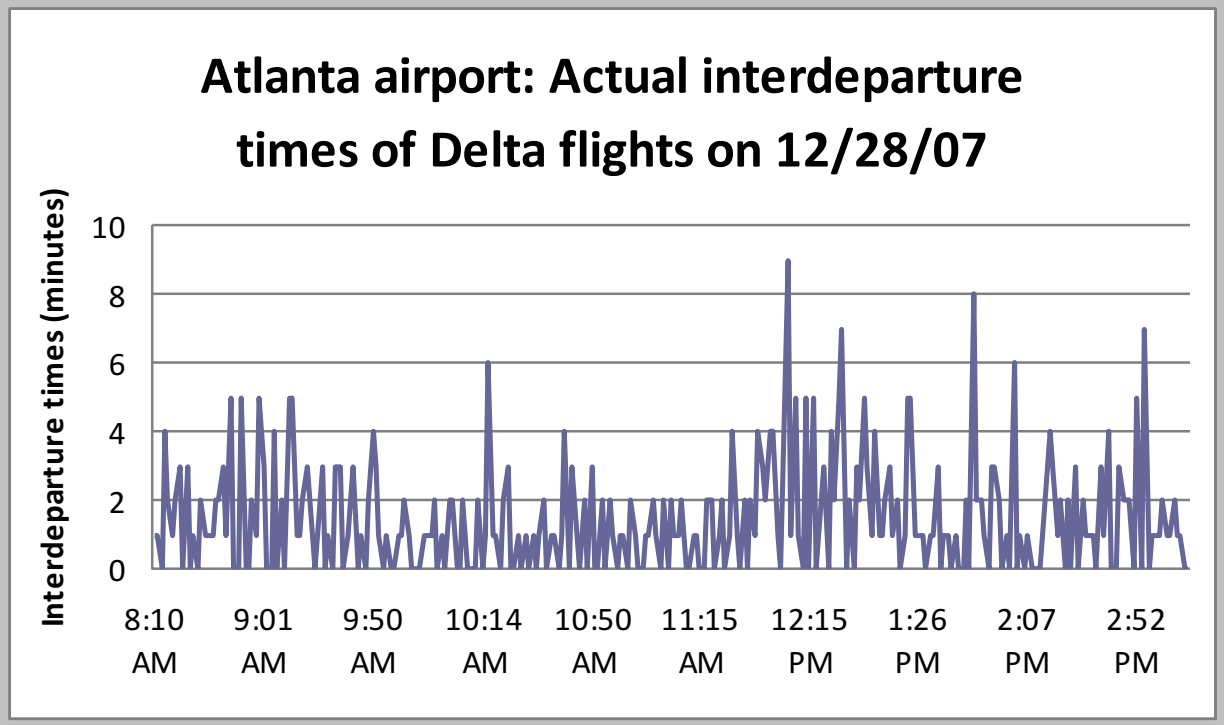
- This time series plot shows the 396 inter-departure times for the 397 Delta flights that were scheduled to fly out of Atlanta on 12/28/2007, in the 8:10 AM – 3:10 PM period

Scheduled departures : Distribution analysis



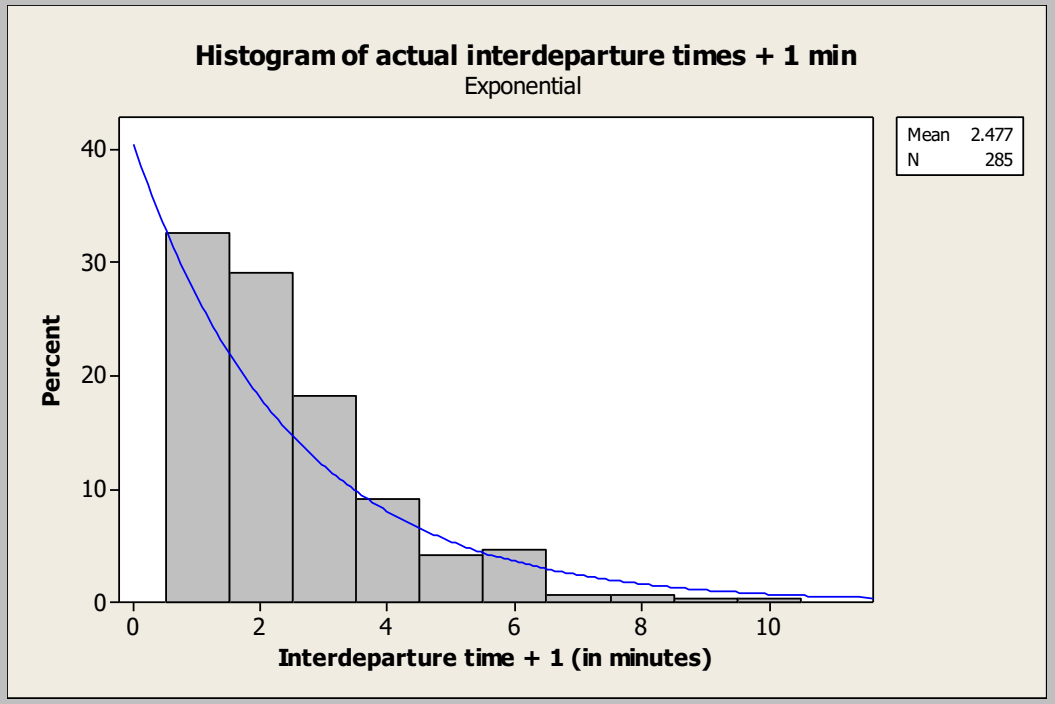
- The inter-departure data might follow an exponential distribution

Data collection: Actual departures



- A time series plot of the 285 actual inter-departure times reveals a possible change-point around 12 noon

Actual departures : Distribution analysis



- The inter-departure data **did not** fit an exponential distribution very well
- However, a poor fit might be due to the presence of change-points

Exponential Distribution afterthoughts

Q: So, how is all that related to our Regression Analysis course?

A: Regression Analysis assumes a **Normal distribution** of the data. Knowing that some things naturally follow a distribution which is far from being normal, allows us to anticipate a violation of the normality assumption.

The problem can be fixed by applying a **transformation** of the data (more details later).