Predicting Demand for Government Services during Disaster Events

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www.data61.csiro.au

Outline

- Background
- The Task
- Solution Overview
- Data Summary
- Web Portal
- Results
- Future Work

Background

- Smart Services Queensland (SSQ)
- Customer Service Advisor (CSA)
- Workforce planning
- SSQ during disaster events
- SSQ Forecast Analyst
- Case Studies
  - TC Oswald January 2013
  - TC Marcia February 2015
  - TC Debbie March 2017

The Task

- Workforce planning
  Achieving the right balance of call centre servicing without over provisioning during emergency events.
- Improved forecasting
  Modelling the number of expected calls relating to emergency events.
- Using historical call data during emergency events, (if possible):
  - characterise the emergency event underway
  - understand why people are calling
  - where are they calling from
  - profile the community
  - explore correlations

Solution Overview

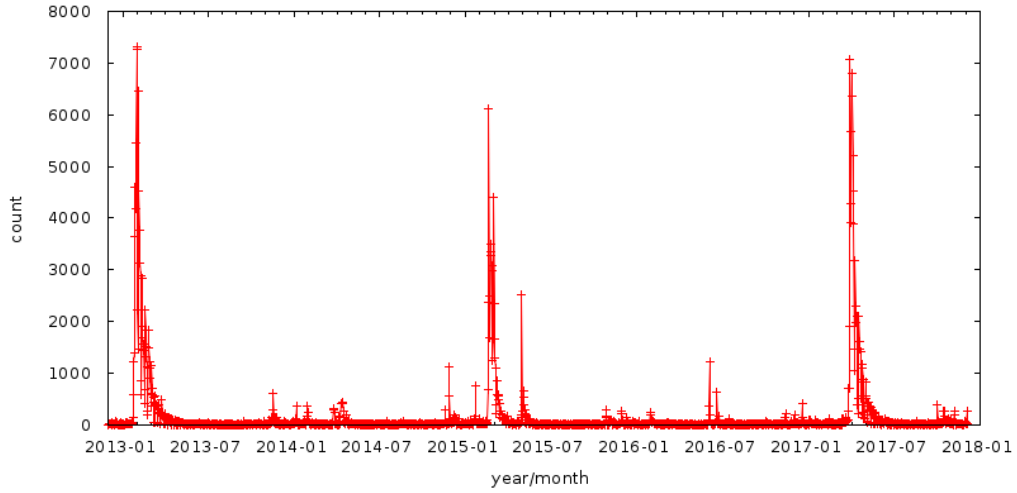
- Preliminary work
  - Requirements gathering
  - Business analysis
  - Identify relevant data
- Web Portal Development
  - Obtain relevant data
  - Establish data warehouse
  - Visual data explorer
- Data Analysis
  - Explore diverse data collection
  - Look for correlations
  - User behaviour modelling

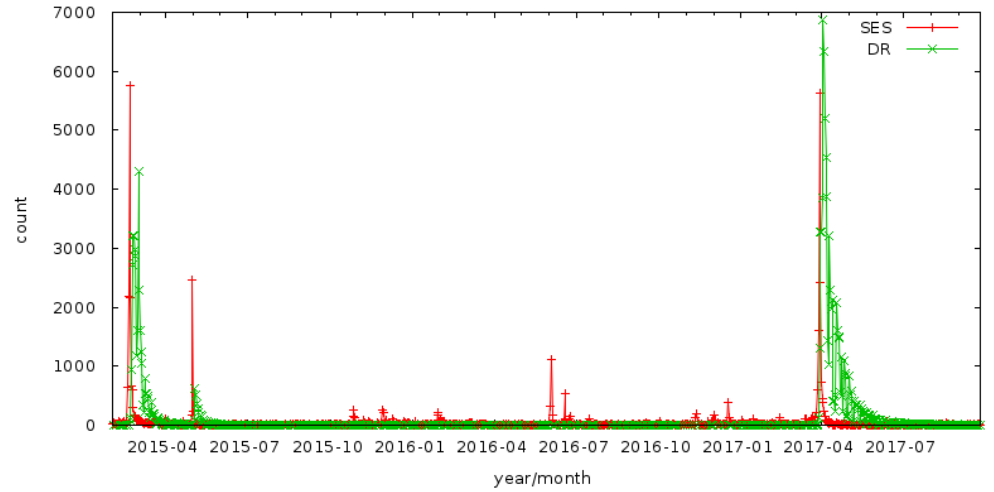
Data Summary

- SSQ call data
- Bureau of Meteorology (BOM) weather warnings
- BOM cyclone tracks
- Australian Bureau of Statistics (ABS)
- Geoscience Australia (GA) National Exposure Information System (NEXIS)
- Twitter

Data Summary: SSQ

- State Emergency Service (SES)
- Disaster Recovery (DR)
- Data profile:
  - who took the call
  - which queue
  - hold time
  - abandoned calls
  - call duration
  - reason(s)
  - …





Data Summary: BOM

TROPICAL CYCLONE ADVICE NUMBER 21
Issued at 1:52 pm EST on Monday 27 March 2017

Headline:
Severe Tropical Cyclone Debbie expected to intensity further on approach to the north Queensland coast.

Areas Affected:
Warning zone: Cardwell to St Lawrence including Townsville, Mackay, and the Whitsunday Islands, and inland of Bowen including Charters Towers.

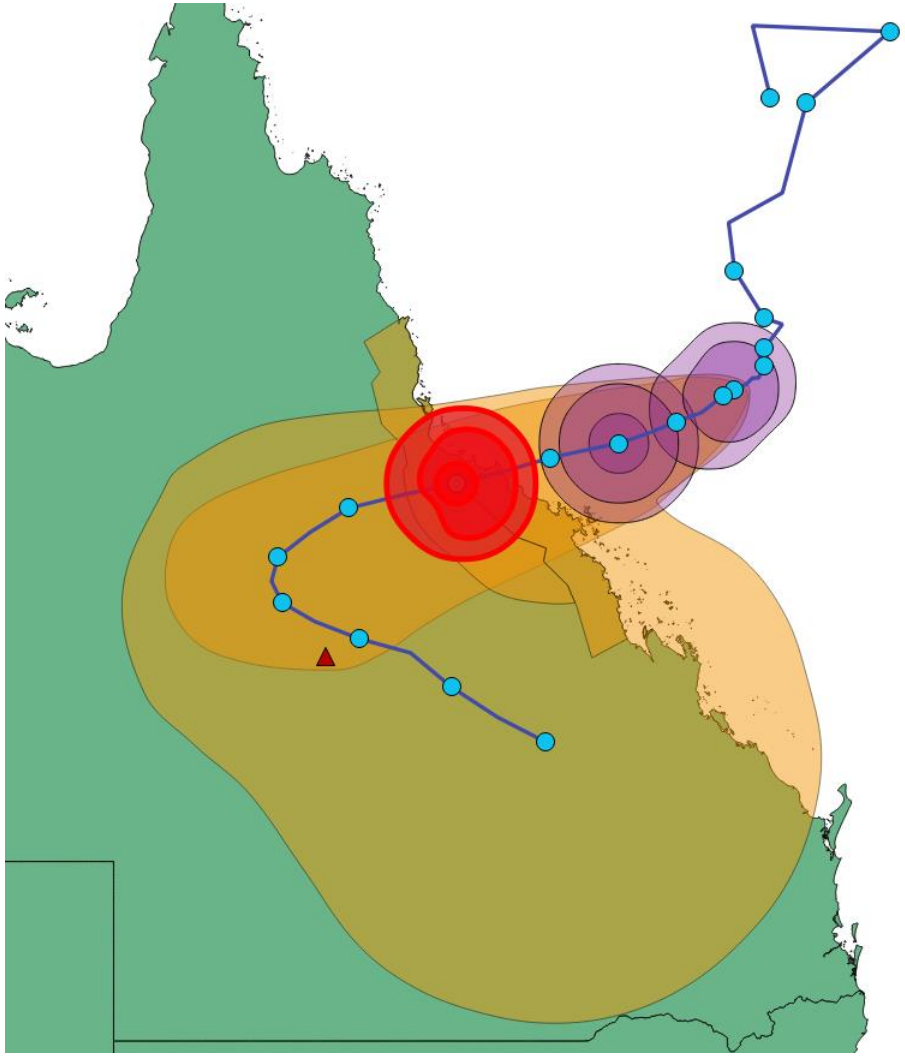
Watch zone: inland areas between Lucinda and Mackay including Pentland, and Mount Coolon.

Cancelled zone: None.

Details of Severe Tropical Cyclone Debbie at 1:00 pm AEST:
Intensity: Category 3, sustained winds near the centre of 150 kilometres per hour with wind gusts to 205 kilometres per hour.
Location: within 30 kilometres of 19.2 degrees South 150.3 degrees East, estimated to be 365 kilometres east of Townsville and 235 kilometres east northeast of Bowen.
Movement: southwest at 6 kilometres per hour.

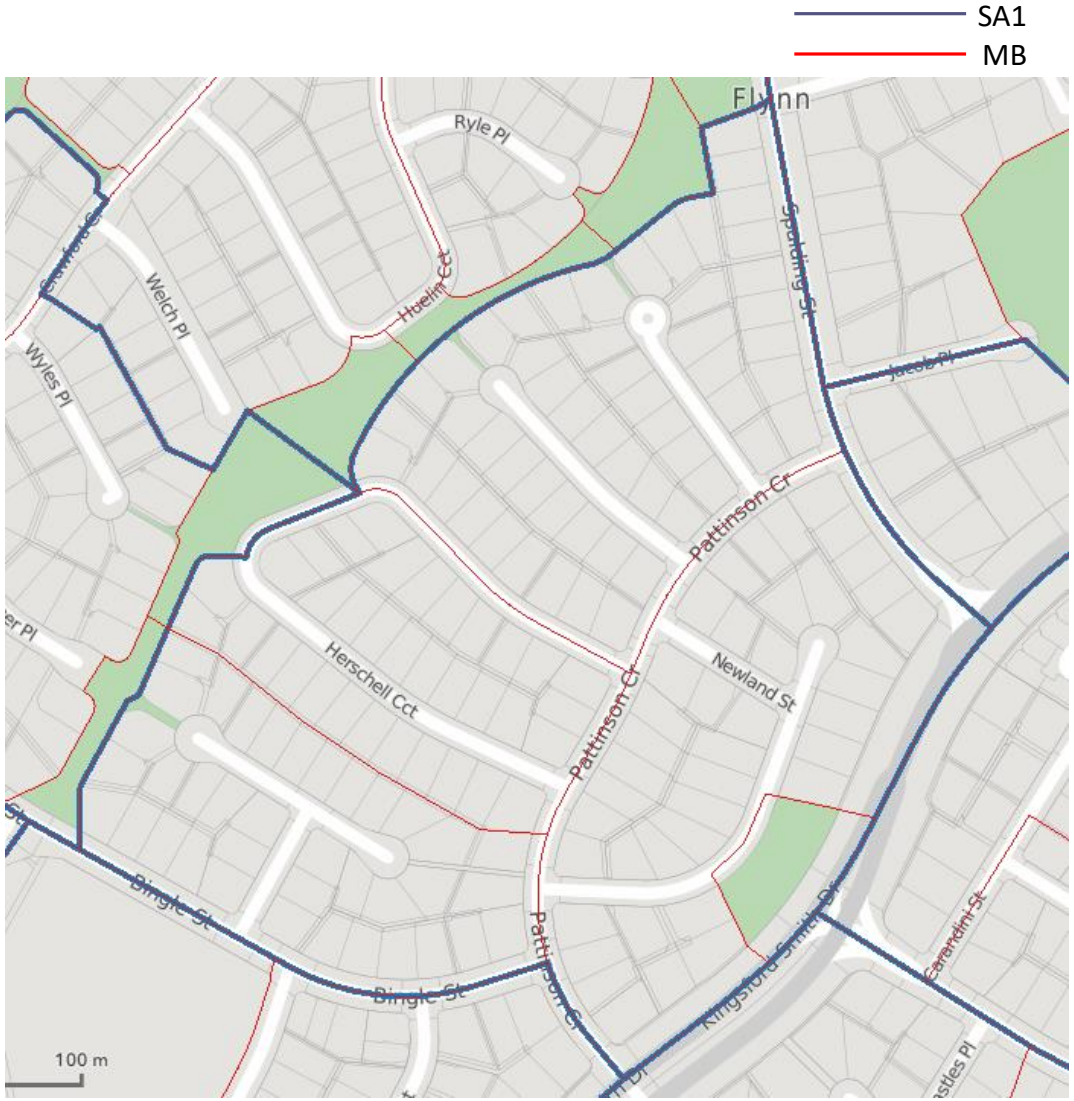
Severe Tropical cyclone Debbie strengthened into a category 3 system this morning, and is expected to intensify further as it continues to move west-southwest towards the north Queensland coast today and overnight tonight. Severe Tropical cyclone Debbie is forecast to make landfall as a category 4 tropical cyclone between Ayr and Cape Hillsborough, north of Mackay, on Tuesday morning.

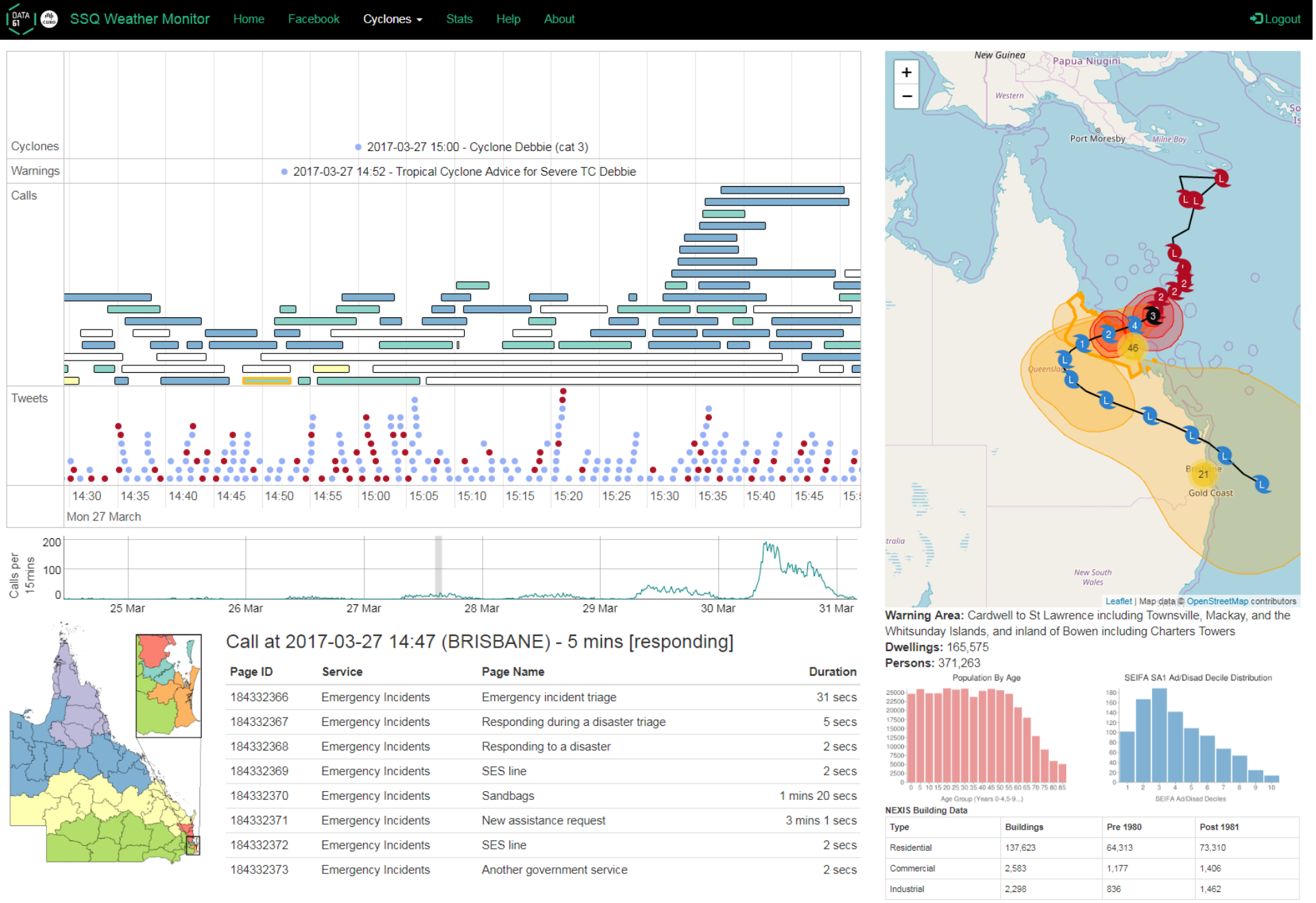
Hazards:
GALES are now occuring about the Whitsunday Islands, and are expected to extend to the exposed coast and islands elsewhere between Ayr and Mackay this afternoon. GALES could extend to remaining coastal and adjacent inland areas between Townsville and St Lawrence later today before potentially extending further north to Cardwell and further west to inland locations such as Charters Towers, Pentland and Mount Coolon on Tuesday.



Data Summary: ABS

- Australian Statistical Geography Standard (ASGS)
- Hierarchical non-overlapping regions for Australia
  - Mesh Blocks (MB): ~30-60 dwellings
  - Statistical Area Level 1 (SA1): 400 people
  - SA2: ~suburb; ~10,000 people
  - SA3: similar regional profile; ~100,000
  - SA4: ~400,000 people
  - Postcodes, suburbs, local gov areas, …
- ASGS is the basis for ABS data release:
  - Demographics
  - Socio-economic data
  - …





Call at 2017-03-27 14:47 (BRISBANE) - 5 mins [responding]

Page ID	Service	Page Name	Duration
184332366	Emergency Incidents	Emergency incident triage	31 secs
184332367	Emergency Incidents	Responding during a disaster triage	5 secs
184332368	Emergency Incidents	Responding to a disaster	2 secs
184332369	Emergency Incidents	SES line	2 secs
184332370	Emergency Incidents	Sandbags	1 mins 20 secs
184332371	Emergency Incidents	New assistance request	3 mins 1 secs
184332372	Emergency Incidents	SES line	2 secs
184332373	Emergency Incidents	Another government service	2 secs

Warning Area: Cardwell to St Lawrence including Townsville, Mackay, and the Whitsunday Islands, and inland of Bowen including Charters Towers
Dwellings: 165,575
Persons: 371,263

NEXIS Building Data

Type	Buildings	Pre 1980	Post 1981
Residential	137,623	64,313	73,310
Commercial	2,583	1,177	1,406
Industrial	2,298	836	1,462

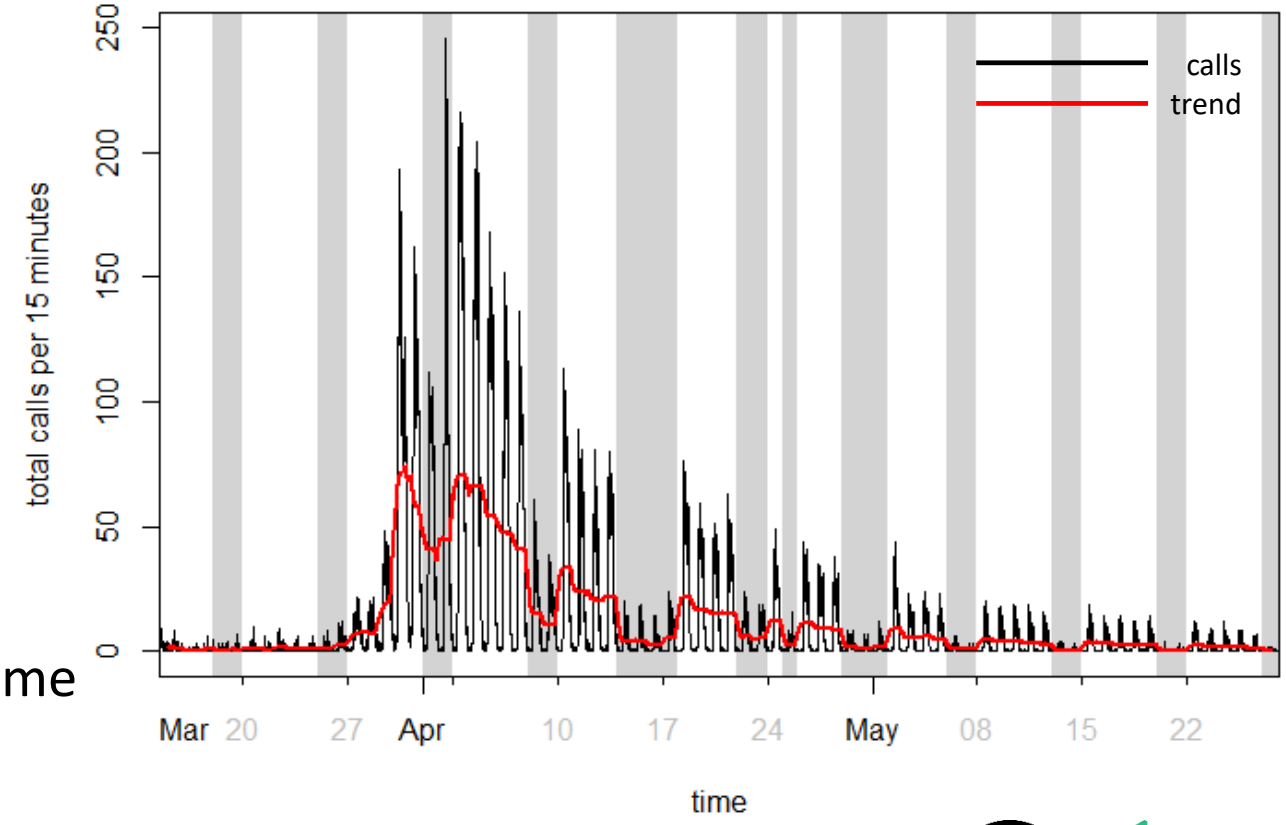
Web Portal

https://ssq.csiro.au/

Analysis

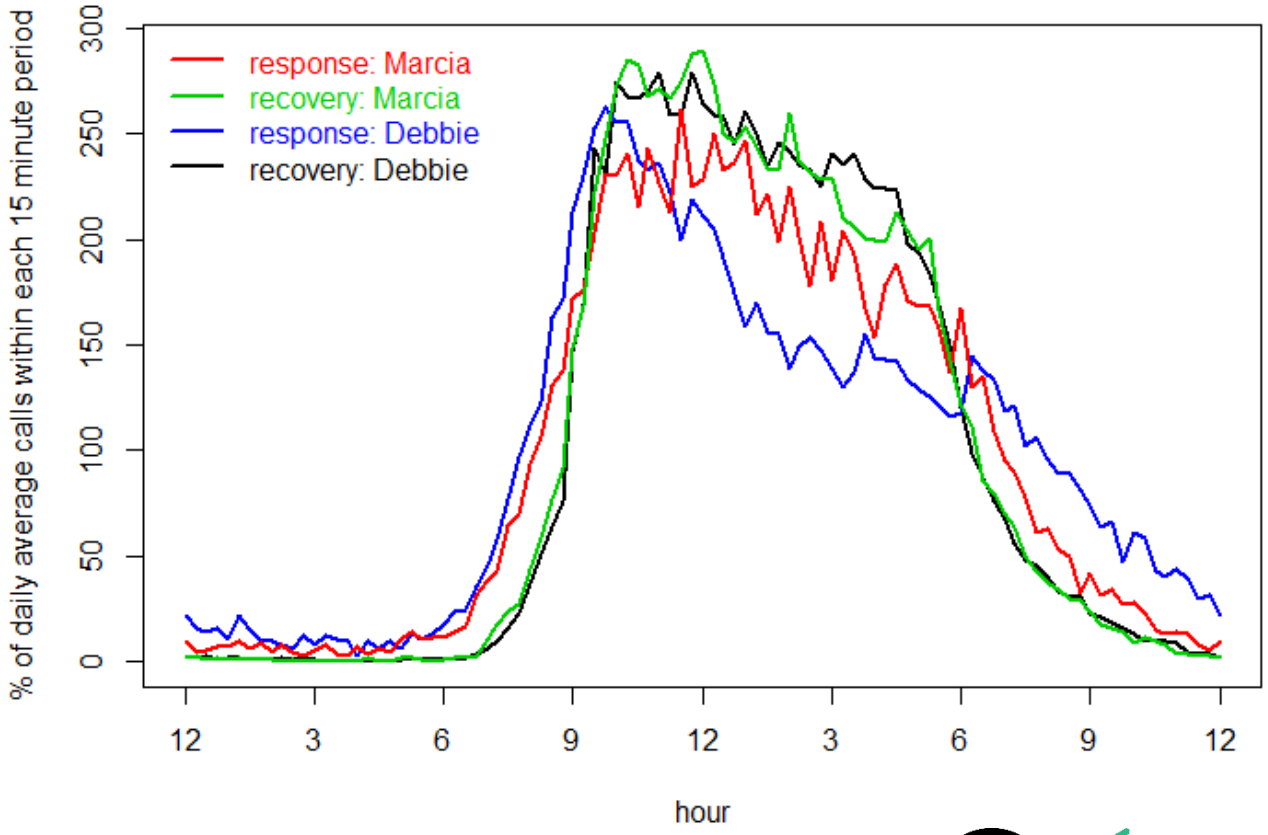
- Data combined into large CSV files and analysed with R
- Time period of 10 days prior and 60 days after Debbie and Marcia
- Overall pattern:
  - initial peak
  - exponential decay
  - lower calls on weekends/holidays
  - small peak on first workday of the week
- Variation within each day:
  - no calls overnight
  - morning peak, high most of the day
  - same daily call pattern regardless of volume

TC Debbie



Analysis: daily seasonality

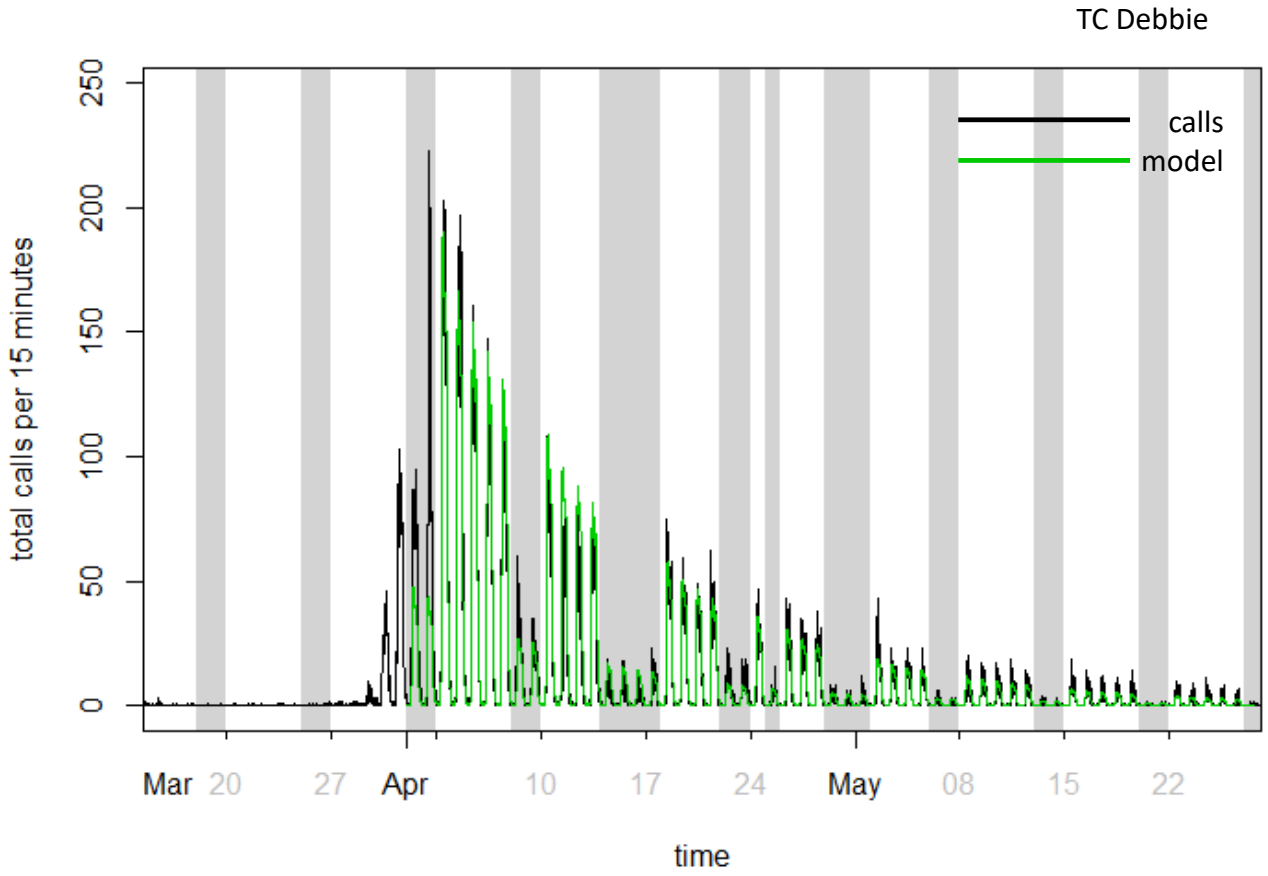
- Number of calls per 15 min, as a percentage of the daily average of calls per 15 min
- Shown for response/recovery calls for both Debbie and Marcia
- Observations:
  - most calls between 9am – 6pm
  - gradual decline from 10am – 5pm
  - similar for Debbie and Marcia, esp DR
  - more DR calls after 6pm, esp for Debbie



Modelling

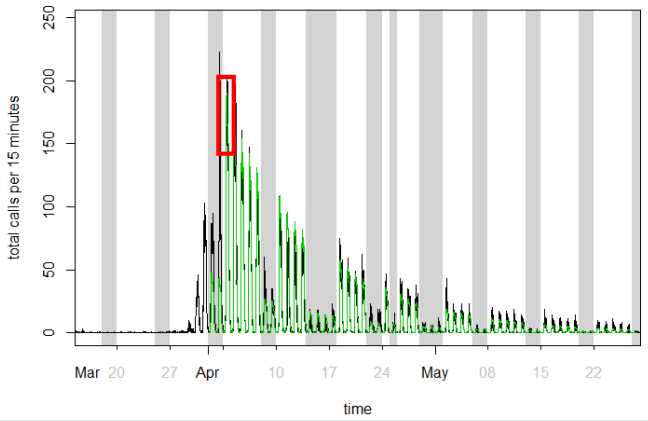
- The long decline for the Disaster Recovery (DR) calls suggests an exponential decay
- Model of DR calls:
  - calls $= S \times$ trend
  - trend $= cWMe^{kT}$

  - S daily seasonality
  - W weekend effect
  - M ‘Monday’ effect
  - T time
  - c, k regression constants

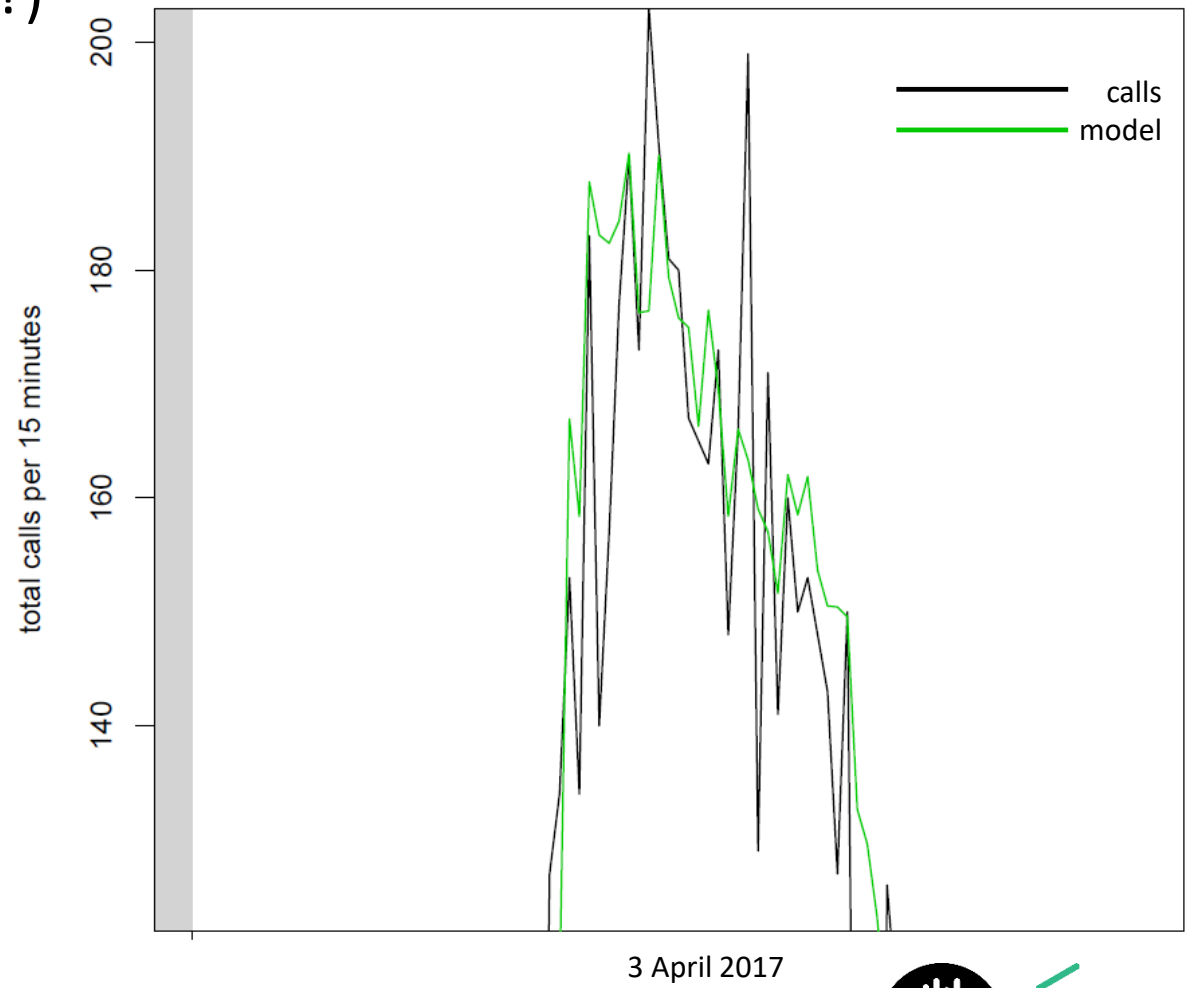


Results: Disaster Recovery call predictions

- Too low over first two days (weekend effect?)
- Exponential decay fits well
- Errors have a σ of 6.5 calls per 15 min (or 9.2 calls, if include the initial errors)
- p values < 0.001
- Decline per day of calls 7.6%
- Weekends decline 77.6% from the trend
- Monday effect increase of 5.6%



TC Debbie



Summary

- The prototype website:
  - review emergency events as they progress
  - provides data about the impacted regions
  - potential for faster intelligence gathering to support workforce planning
- Modelling the Disaster Recovery calls:
  - based on the daily seasonality of the call centre data
  - applied to the trend line, accurately predicts the number of calls per 15 minutes
  - estimate the number of expected calls, once the initial call peak has occurred

Future Work

- Make the web site real-time – live forecasting
- How to integrate the call centre data?
- Use for scenario planning

- Identify the call peak?
- Need more data to improve/validate the model
- Self updating model?
- Model smaller events
- Model time spent on call, rather than number of calls?

THANK YOU

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