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Estimation of frequency and duration of future Canadian Armed Forces Operations

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Outline

- Motivation
- Canadian Defence Policy
  - Concurrency mandate
- 5W Database
- Mapping Core Missions and Scenarios
- Frequency and Duration Estimates
- Summary

Strong, Secure, Engaged: Core Missions

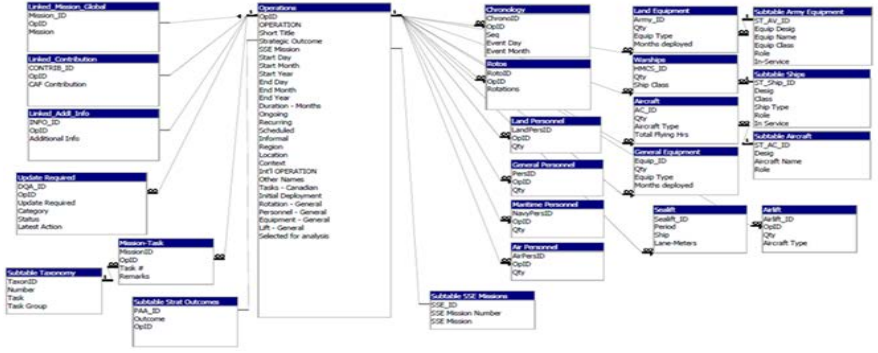
- Detect, deter and defend against threats to or attacks on Canada;
- Detect, deter and defend against threats to or attacks on North America;
- Lead and/or contribute forces to NATO and coalition efforts to deter and defeat adversaries, including terrorists, to support global stability;
- Lead and/or contribute to international peace operations and stabilization missions with the UN, NATO and other multilateral partners;
- Engage in capacity building to support the security of other nations and their ability to contribute to security abroad;
- Provide assistance to civil authorities and law enforcement, including counter-terrorism, in support of national security and the security of Canadians abroad;
- Provide assistance to civil authorities and nongovernmental partners in responding to international and domestic disasters or major emergencies; and
- Conduct search and rescue operations.

Strong, Secure, Engaged: Concurrency

- SSE demands CAF to be able to do following missions simultaneously:

“Who-What-Where-When Why of CAF deployments”

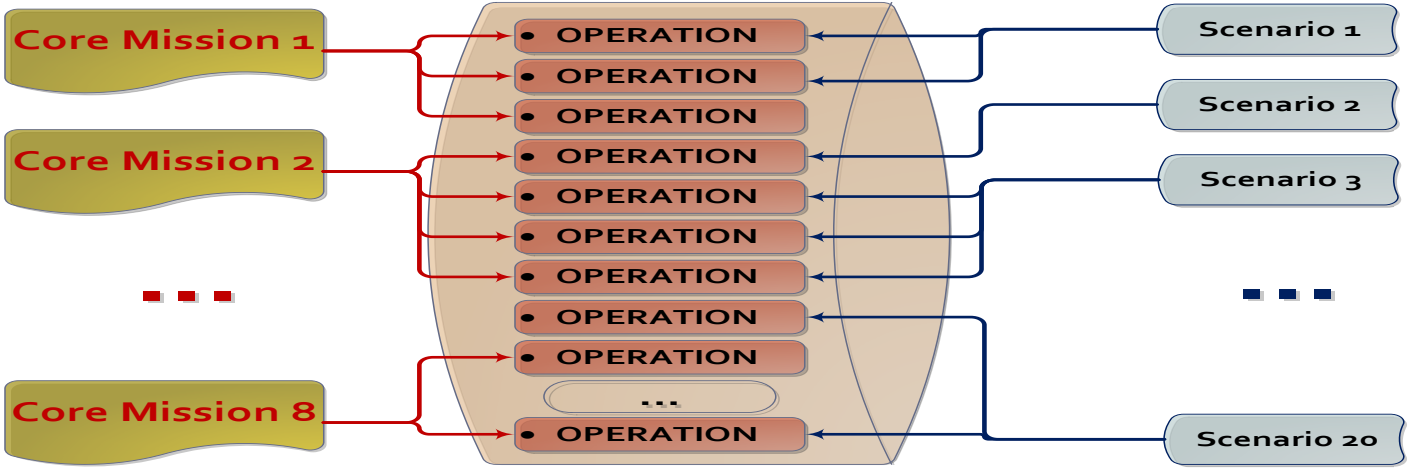
- Database of OPS post 1990
  - 2004: Basic spreadsheet
  - 2015: Updated and changed to relational database
- OPS mapped to SSE/FMSD scenarios
- Main Challenges:
  - There is no DB of record of historical CAF operations with sufficient details
  - Quality of historical data: incomplete, missions broken down across multiple OPS,
  - Subjectivity of the mapping of historical OPS to planning scenarios.



- Caveats:
  - The decision to execute a particular mission driven by a variety of geopolitical and strategic considerations not captured by the historical analysis
  - Should be used in conjunction with the professional judgement informed by foresight documents

SSE Core Missions and FMSD Scenarios

- Mapping of SSE Core missions to historical missions
  - Assessing rate of occurrence and duration of these missions for capability-based planning and FMSD



- A set of vignettes developed for FMSD demand analysis
  - Different variants for different operational focus
  - Between 17 and 28 vignettes (70 – 80 variants) (20 used in this paper)
  - Historical analysis to inform professional military judgement

Frequency Estimates

- OPS follow a Poisson distribution: mean frequency

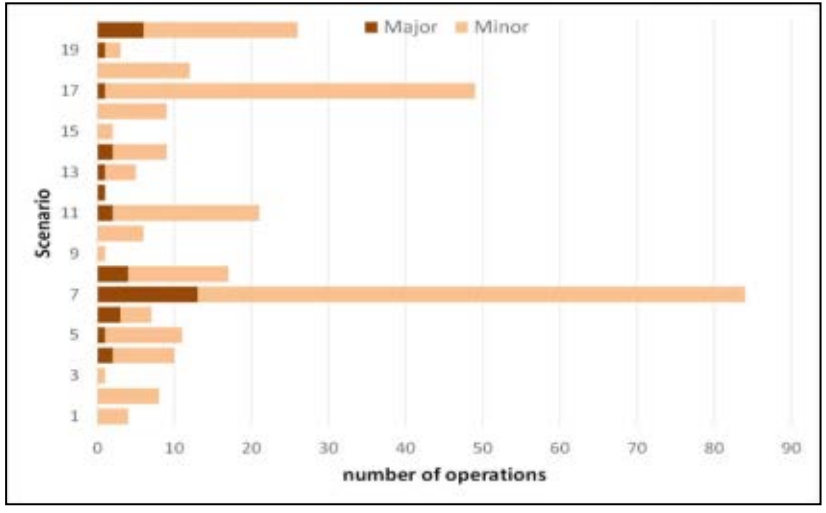
$$< F_i > = N_i / T$$

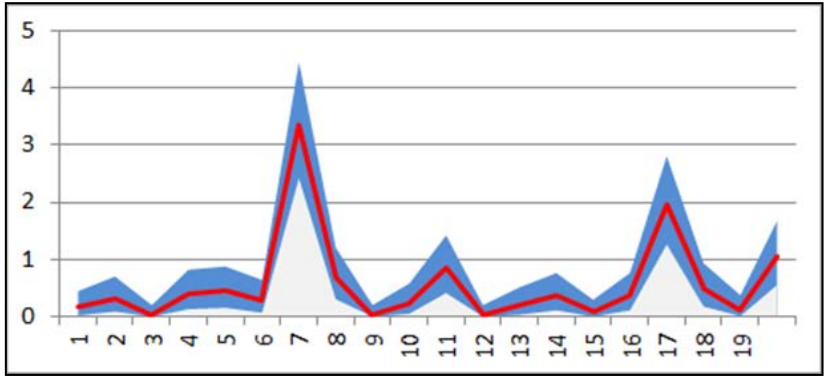
(N_i is the number of operations corresponding to scenario *i*, and *T* is the length of the period covered by the database (25 years)).

- Johnson-Neyman method to estimate for the lower (L) and upper (U) bounds:

$$L = \frac{1}{2y}(\chi^2)^{-1}\left(\frac{1+c}{2}, n\right)$$

$$U = \frac{1}{2y}(\chi^2)^{-1}\left(\frac{1-c}{2}, n\right)$$





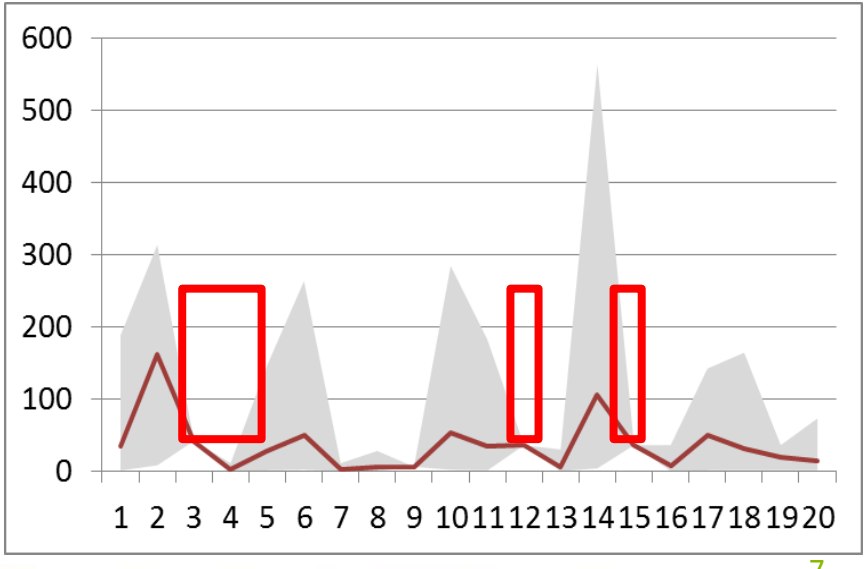
Duration Distribution

- Two types of distributions prevalent
  - exponential distribution

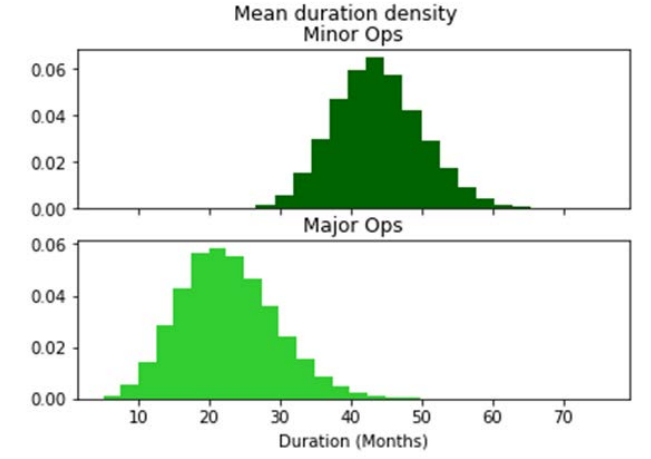
    $$p(x) = \Lambda\, exp(-\Lambda(x - X_{min}))$$

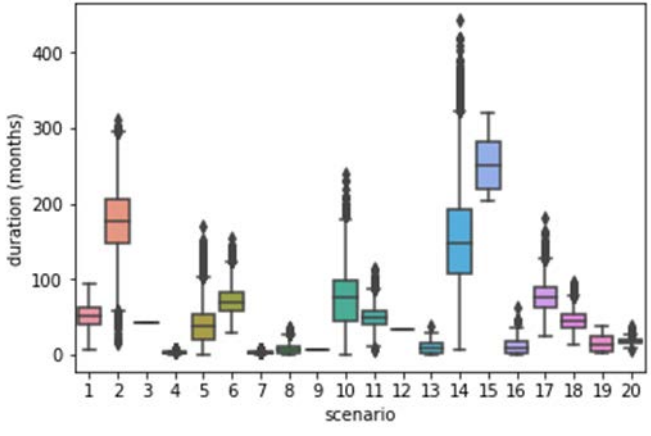
    with X_{min} as the lower bound of the distribution (zero, there can be no negative duration)
  - Two of the scenarios exhibited somewhat bimodal behaviour → uniform distribution

    $$p(x) = \frac{x - X_{min}}{(X_{max} - X_{min})}$$
  - fitted these few scenarios best.
- Four of the scenarios did not have enough corresponding OPS; eliminated from the analysis



Bootstrap Duration Estimates

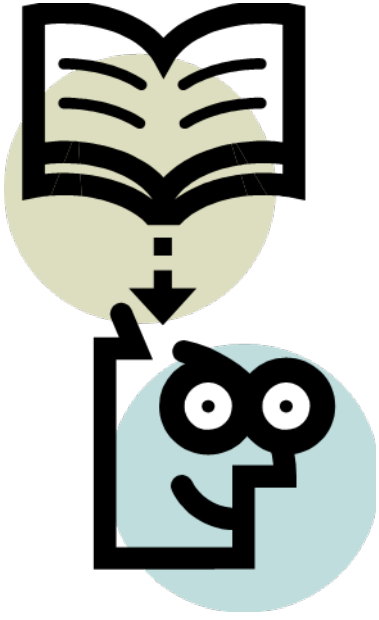




- Only done for scenarios with 4 or more operations; otherwise the estimated duration was a mean of OPS durations.
- 20,000 samples generated for mean scenario duration.
- The resulting estimates were shorter by as much as a factor of two than the parametric estimates
- This suggests that the parametric estimates using infinite distribution function might not have sufficiently reflected the data.

Conclusions and Recommendations

- Estimates of the frequency and durations for a set of scenarios were obtained from historical data.
  - For the duration, the non-parametric estimates yielded shorter time span than the maximum likelihood method.
  - The obtained probability distributions from the historical analysis complemented the policy and foresight documents in informing the SME judgement.
- Further in-depth analysis of the data is currently planned:
  - Consider the sequencing/concurrence limitations and changes in policies.
  - Seasonality of some of the types of operations (were not needed now since FMSD process only looks at long-term force structure implications).
  - Possibly, we may attempt to development forecast models that could be used to explore implications of possible different future policies on the demand.



Questions?