Brains, not bullets
How to fight future wars?

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Brains, not bullets
How to fight future wars?
Observation: **Common patterns in**
(1) insurgent wars, relation to terrorism (Clauset),
(2) street gangs and online games

Explanation: **Common ways in which humans 'do' groups**

Theory: **Soup-of-groups**
No permanent hierarchy or leaders
**Beyond** power-law description

Practical use: **Create scenarios, discover**
black swans, risk, prediction

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10 injured in attack by Farc guerrillas, Buenaventura, Colombia — 2 shot dead in Shorja market, Baghdad — 11 police officers killed by explosives in Lashkar Gah, Afghanistan — 16 killed by suicide truck bomb in local restaurant, Ramadi, Iraq.....
cumulative frequency $P(X \geq x)$
casualty event size $x$

Afghanistan (a)
Iraq (b)
Colombia (c)
Peru (d)
Power-law analysis follows Clauset, Shalizi, Newman
arXiv:0706.1062

Global terrorism death + injury: 2.48(7)

But why should a 2.5 power-law be a 0’th-order approximation for diverse insurgent conflicts and terrorism?

→ our ‘soup of groups’ fission-fusion model NFJ et al. 2005
arXiv:physics/0506213 0605035
David Kilcullen, senior policy adviser to Condoleezza Rice

“...they’re not doing that because they want to reduce the number of Humvees we have in Iraq by one. They’re doing it because they want spectacular media footage of a burning Humvee.”

**THE BIGGEST GANG IN IRAQ**

US soldier on patrol in Mosul Iraq, "This is like a gang war, and we are the biggest gang."

\[
\frac{dR}{dt} = -gR^qG^p, \quad \frac{dG}{dt} = -rR^pG^q
\]
'soup of groups' model
(fission-fusion)

\[
\frac{\partial n_s}{\partial t} = -\frac{v s n_s}{N} + \frac{(1 - v)}{N^2} \sum_{s' = 1}^{s-1} s' n_{s'} (s - s') n_{s-s'} \\
- \frac{2(1 - v) s n_s}{N^2} \sum_{s' = 1}^{\infty} s' n_{s'}.
\text{for } s \geq 2
\]

\[
\frac{\partial n_1}{\partial t} = \frac{v}{N} \sum_{s' = 2}^{\infty} (s')^2 n_{s'} - \frac{2(1 - v)n_1}{N^2} \sum_{s' = 1}^{\infty} s' n_{s'}.
\]

Evolution of largest attack unit in time
(population = 1000 insurgents)
Modifying the probability of coalescence-fragmentation so that larger attack units are more rigid, gives
\[ \delta = 0.7 \] corresponds to a power-law with \( \alpha = 1.8 \)

Solve equations in steady-state:
\[ n_s \sim s^{-(2.5 - \delta)} \]

Modifying the probability of coalescence-fragmentation so that larger attack units are more rigid, gives
\[ n_s \sim s^{-\frac{5}{2}} = 2.5 \]
2.5 power-law distribution is an ‘attractor’ for many model generalizations:

1. Multiple (i.e. > 2) units coalesce
2. Fragmentation into units \( s_0 > 1 \)
3. Fluctuating population size \( N \)
4. Heterogeneous characters e.g. multiple factions/identities/roles

+ some realistic interventions etc.

Solve equations in steady-state:

\[
\log n_s \sim -\frac{5}{2} = 2.5
\]

Fragmentation into many small parts makes sense for conflict, and is key for power-law near 2.5

c.f. binary fission (Gueron-Levin)

**Ruszczzycki, NFJ et al.**

arXiv:0808.0032
Beyond power laws . . .

- **Afghanistan** (a)
  - Data points and agent model fits.
  - Cumulative frequency $P(X \geq x)$ vs. casualty event size $x$.

- **Iraq** (b)
  - Similar to Afghanistan.

- **Colombia** (c)
  - Similar to Afghanistan.

- **Peru** (d)
  - Similar to Afghanistan.
CS large

CS small

N small

N large

CL
deviation ⇒ dominant mechanisms in specific conflict

\[ N = N_A + N_B \] use empirical values . . .
number of events $n$ per day

- real war
- above random
- model war
- below random
- random war

Iraq
- days 0-180
- days 180-360
- days 360-540
- day 540+

Colombia
- days 0-500
- day 500+

Afghanistan
- day 500+

Peru
- day 1000+
a unified model of insurgent war

AGGREGATED VARIABLES

- number of attacks of size $s$ aggregated over time
  \[ \hat{n}_s = \sum_t n_s[t] \]
- number of attacks at timestep $t$ aggregated over size
  \[ \hat{n}[t] = \sum_s n_s[t] \]

START
GANGING IN CHICAGO
F.M. Thrasher's observations

Slope = -2.29

BANDITRY IN MANCHOUKUO DURING 1935
data from Japan and Manchoukuo Year Book 1938

Slope = -2.30
Online groups, e.g. guilds in World of Warcraft

Offline groups: LA street gangs

- Brick Block Boy Crips
- Crazy Brothers Clan
- Crazy Krooks
- Exotic Foreign Creation
- Insane Crips
- Long Beach Suicidal Punks
- Lunatics on Crack
- Naughty-nasty
- Tonga for Life
- Westside Longos etc.

- LA gang and World of Warcraft guild size distributions do not look similar
- neither one is a good power-law
- difficult for candidate model to reproduce group size distribution \textit{and} churn
- team model (dark blue) and empirical data (red) in good agreement
- kinship model (light blue) is not
- online server acts like offline ethnicity
**Key Components**

- **Model**
  - $p_i = 0.1 \ 0.3 \ 0.5 \ 0.7 \ 0.9 \ \Delta p_i = 0.1 \ 0.25$

- **Agents with specific range of attributes and tolerance**
  - Spectrum of attributes

**Team formation**

- Teams with members covering different attributes

**Kinship formation**

- Groups with members of similar attributes

**Implementation**

- $i^{th}$ agent randomly assigned attribute parameters $p_i$ and $\Delta p_i$
- $i^{th}$ agent assigned tolerance $\tau_i$
- $\tau_i = \tau$ for all agents
- Each time step, randomly pick an agent $i$

- Happy with current group?
  - No
  - leave
  - next time step

  - Yes
  - join a better group $J$?
    - No
    - consider group merger
    - next time step
  - Yes
    - next time step

- next time step
Derivatives: Trafficking drugs, stolen goods (including people) etc.

In progress...
Conclusions

1. **Common quantitative patterns in insurgent warfare & terrorism**
   - Generic way in which humans ‘do’ insurgency and terrorism
   - Similar soup-of-groups. No permanent network hierarchy or leaders needed

2. **Law for ‘Future’ Wars ?**
   - **Unified model of sizes and timings of events**
     - **Event sizes:**
       - v1.0: One population soup-of-groups $\rightarrow$ approximate power-law, slope near 2.5
       - v2.0: Two population soup-of-groups gives details beyond power-law
     - **Event timings:**
       - v1.0: Probability of acting
       - v2.0: Decision-making, driven by competition for limited resource (media attention)
     - **Group dynamics:**
       - v1.0: Probabilistic fission-fusion
       - v2.0: Character-based team formation. Connection to gangs, Internet warfare.