Complex Systems Analysis of Hybrid Warfare

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Problem. Solved.



Complex Systems Analysis of Hybrid Warfare

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Outline

- Research Objective
- Methodology Overview: Complex Systems Analysis
- Introduction to the Toolset
- Context: Gray Zone Conflict in Moldova & Georgia
- Current Research
- Wrap-up & Next steps



Research Objective

- Develop a framework and toolkit that decision makers can use to assess complex problem spaces.
- *First year* focused on identifying conceptual tools, and documenting and testing them. *Second year* focuses on bridging the qualitative tools to quantitative tools.
- Presented research at Conflicts in the Gray Zone: A Challenge to Adapt conference in Budapest, Hungary, hosted by Hungarian Defence Forces General Staff, Scientific Research Centre.
- Improved methods to address problems that grapple with uncertainty.
- Develop language and tools that connect policy domain with engineering and tech domain.



Methodology Overview: Complex systems analysis

The toolset examines interactions within and between distinct systems, previously dealt with in isolation.



"You cannot meddle with one part of a complex system from the outside without the almost certain risk of setting off disastrous events that you hadn't counted on in other, remote parts. If you want to fix something you are first obliged to understand...the whole system." --Lewis Thomas (biologist and essayist), quoted in Business Dynamics, J. Sterman, 2000.

Contributions

- Ontology resolution
- Operationalization of systemigrams
- Visualizations of unstructured spaces
- Reduce bias, reveal assumptions and viewpoints
- A method for bridging qualitative and quantitative methods

Examples of Tools

Context Analysis



Context: Gray Zone Conflict

<u>Gray Zone warfare</u>: The *purposeful*, *aggressive*, *ambiguous*, and *integrated* use of multiple elements of power to achieve political or economic objectives, by a state or non-state actor, exceeding the threshold of normal national competition yet falling below the level of major interstate war.



"War below the lines"

Case Study: Moldova & Georgia

- Gaps in understanding links between Russian leadership's *stated objectives* vs. Russia's *actual foreign and security behavior*
- Both countries are gray zone conflict areas
- Russia's intervention in Ukraine pretext for Moldova & Georgia?
- Results capture emerging trends in the complex system that may not be obvious without a systemic analysis and capture gaps in existing literature, or predictive models of system performance.



Example Diagram (Systemigram)



Example Diagram (Systemigram)



Other tools tested

Problem and objectives tree



Stakeholder influence map



Current Research: Quantitative models

- Transform systemigrams into quantitative models
- Growing number of coding software and data tools to automatically extract stakeholders, sentiments, and events from multi-lingual databases and media publications on daily/real-time bases.



- Probe and test hypotheses against assumptions with conceptual tools and multilingual text-analytic techniques (using GDELT).
- Identify emergent correlations of sentiments and events behavior.
- Explore additional toolset computational & quantitative linkages: systems dynamics, social network, discreet event simulation, statistical modeling
- Research objective: The goal is a new generation of management planning and decision analysis tools that combines qualitative and quantitative approaches.

Background Information: the GDELT Database

- Global Database of Events Language and Tone
 - www.gdeltproject.org
- Contains events from online news sources
- Contains over 431 million events from 1979-Today, extracted from global broadcast, print, and online news sources in 100+ languages
- Events coded into Conflict and Mediation Event Observations (CAMEO) system, while capturing the world media through machine coding in near real-time
- 2K articles per 15min
- Hierarchical levels of granularity
- Accounts for supranational, state, substate, and non-state actors

13	THREATEN
130	Threaten, not specified below
131	Threaten non-force, not specified below
1311	Threaten to reduce or stop aid
1312	Threaten to boycott, embargo, or sanction
1313	Threaten to reduce or break relations
132	Threaten with administrative sanctions, not specified below
1321	Threaten to impose restrictions on political freedoms
1322	Threaten to ban political parties or politicians
1323	Threaten to impose curfew
1324	Threaten to impose state of emergency or martial law
133	Threaten political dissent, protest
134	Threaten to halt negotiations
135	Threaten to halt mediation
136	Threaten to halt international involvement (non-mediation)
137	Threaten with violent repression
138	Threaten to use military force, not specified below
1381	Threaten blockade
1382	Threaten occupation
1383	Threaten unconventional violence
1384	Threaten conventional attack
1385	Threaten attack with WMD
139	Give ultimatum

CAMEO Event Code 13 (THREATEN), with lower-level codes

16

Measuring Systemigrams

How can we make a qualitative model into a quantitative one?





Iterative Refinement

Data integration is like ETL, an iterative process



Systemigram Edges map to SQL queries

	Emacs-x86_64-10_9@LPATLICLJF6.local
Actor 1 Name	MOLDOVAN
Actor 2 Code	MDAGOV
Actor 2 Name	MOLDOVA
Event Code	152: Increase military alert status
Note(s)	NaN
Reply to note (JPF)	NaN
Name: 0, dtype: object	
SELECT 0, "DATEADDED", co	<pre>ount(*) FROM export</pre>
WHERE ("Actor1Code"='MDA'	
or "Actor1CountryC	Code"='MDA'
or "Actor1Name"='M	10LDOVAN')
AND ("Actor2Code"='MDAGOV	<u>(</u> '
or "Actor2CountryCod	de"=' <u>MDAGOV</u> '
or "Actor2Name"='MOL	_DOVA')
AND ("EventCode"='152'	
<pre>or "EventRootCode"='</pre>	'15')
AND "SOURCEURL" != 'unspe	ecified'
GROUP BY "DATEADDED"	

Matching Articles to Edges

1 GLOBA		DATEADDED 🔽 Actor1Code 🔽	Actor2Code 🔽 Eve	entRootCode 🔽 EventCod	e 🔽 SOURCEURL
2	610293291	20161220190000 RUSGOV	MDA	5	54 http://www.moldpres.md/en/news/2016/12/20/16010127
3	610293292	20161220190000 RUSGOV	MDA	5	54 http://www.moldpres.md/en/news/2016/12/20/16010127
4	611278661	20161223171500 RUS	MDA	5	51 http://www.tol.org/client/article/26582-moldova-orthodox-church-elections-involvement.html
5	611278662	20161223171500 RUS	MDA	5	51 http://www.tol.org/client/article/26582-moldova-orthodox-church-elections-involvement.html
6	612620080	20161229113000 RUS	MDA	5	57 http://www.refworld.org/docid/5864c72e4.html
7	613425489	20170102010000 RUSGOV	MDA	5	51 https://www.washingtonpost.com/opinions/global-opinions/the-united-states-must-join-europe-to-
8	613425490	20170102010000 RUSGOV	MDA	5	51 https://www.washingtonpost.com/opinions/global-opinions/the-united-states-must-join-europe-to-
9	613641436	20170103003000 RUSGOV	MDA	5	51 http://www.centralctcommunications.com/bristolpress/article_53639d4a-d148-11e6-bc3d-3705ec8
10	613641437	20170103003000 RUSGOV	MDA	5	51 http://www.centralctcommunications.com/bristolpress/article_53639d4a-d148-11e6-bc3d-3705ec8
11	614021869	20170104091500 RUSGOV	MDA	5	51 http://www.dailyrepublic.com/opinion/statenationalcolumnists/russias-hacking-is-nothing-new/
12	614021870	20170104091500 RUSGOV	MDA	5	51 http://www.dailyrepublic.com/opinion/statenationalcolumnists/russias-hacking-is-nothing-new/
13	614133961	20170104170000 RUS	MDA	5	51 http://www.irishtimes.com/news/world/europe/moldova-s-new-leader-strips-ex-romanian-preside
14	614133962	20170104170000 RUS	MDA	5	51 http://www.irishtimes.com/news/world/europe/moldova-s-new-leader-strips-ex-romanian-preside
15	615367445	20170109103000 RUS	MDA	5	51 https://www.kyivpost.com/world/moldova-wants-bridge-east-west.html
16	615939042	20170111011500 RUS	MDAREB	5	51 https://www.theguardian.com/world/2015/feb/20/transnistria-russia-rouble-crisis
17	616124319	20170111150000 RUS	MDA	5	50 https://www.memri.org/reports/russias-orbit-part-iii-new-pro-russian-president-moldova
18	616124320	20170111150000 RUS	MDA	5	50 https://www.memri.org/reports/russias-orbit-part-iii-new-pro-russian-president-moldova
19	616124321	20170111150000 RUS	MDA	5	57 https://www.memri.org/reports/russias-orbit-part-iii-new-pro-russian-president-moldova
20	616124322	20170111150000 RUS	MDA	5	57 https://www.memri.org/reports/russias-orbit-part-iii-new-pro-russian-president-moldova
21	616124323	20170111150000 RUS	MDA	5	57 https://www.memri.org/reports/russias-orbit-part-iii-new-pro-russian-president-moldova
22	616124324	20170111150000 RUS	MDAGOV	5	57 https://www.memri.org/reports/russias-orbit-part-iii-new-pro-russian-president-moldova
23	616124413	20170111150000 RUSMED	MDA	5	57 https://www.memri.org/reports/russias-orbit-part-iii-new-pro-russian-president-moldova
24	616709369	20170113060000 RUS	MDA	5	57 https://www.euractiv.com/section/europe-s-east/news/russia-defies-moldova-s-eu-pact-by-boostir
25	616709370	20170113060000 RUS	MDA	5	57 https://www.euractiv.com/section/europe-s-east/news/russia-defies-moldova-s-eu-pact-by-boostir
26	616709376	20170113060000 RUS	MDALEG	5	57 https://www.euractiv.com/section/europe-s-east/news/russia-defies-moldova-s-eu-pact-by-boostir
27	617961099	20170117153000 RUS	MDA	5	57 http://www.chron.com/news/world/article/Moldovan-president-visits-Russia-to-restore-ties-10862
28	617961100	20170117153000 RUS	MDA	5	57 http://hosted.ap.org/dynamic/stories/E/EU_RUSSIA_MOLDOVA?SITE=AP&SECTION=HOME&TEMPL
29	617961101	20170117153000 RUS	MDA	5	57 http://www.kansascity.com/news/business/national-international/article126947009.html
30	618010948	20170117181500 RUS	MDA	5	57 http://www.register-herald.com/region/moldovan-president-visits-russia-hints-of-ending-eu-pact/a
31	618071095	20170117221500 RUS	MDA	5	57 https://sputniknews.com/europe/201701181049700415-moldova-russian-peacemakers-protectors-s
32	618071096	20170117221500 RUS	MDA	5	57 https://sputniknews.com/europe/201701181049700415-moldova-russian-peacemakers-protectors-s
33	618593709	20170119070000 RUS	MDA	5	55 http://www.eurasiareview.com/19012017-putins-old-moldova-map-alarms-romania/
34	618593710	20170119070000 RUS	MDA	5	55 http://www.eurasiareview.com/19012017-putins-old-moldova-map-alarms-romania/
35	618608134	20170119080000 RUS	MDA	5	50 Gazeta/BBC Monitoring/(c) BBC
36	618608135	20170119080000 RUS	MDA	5	50 Gazeta/BBC Monitoring/(c) BBC
37	618608158	20170119080000 RUSPTY	MDA	5	50 Gazeta/BBC Monitoring/(c) BBC
38	619287790	20170121064500 RUS	MDA	5	51 https://www.rt.com/news/158164-moldova-rogozin-airspace-romania/
39	619287791	20170121064500 RUS	MDA	5	57 https://www.rt.com/news/158164-moldova-rogozin-airspace-romania/
	1				

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Iterative Refinement

Node 1	Node 2	Link	Actor 1 Code	Actor 1 Name	Actor 2 Code	Actor 2 Name	Event Code
Russie	Opposing Political Regimes: President igor Dodon	Developing closer ties to	RUS	RUSSIA	MDA	DODON	019: Express accord
			RUS	RUSSIA	MDA	DODON	030: Express intent to cooperate
			RUS	RUSSIA	MDA	DODON	012: Express intent to engage in diplomatic cooperation
Rocela	Moldova Economy: Import bans	Implemented to prevent EU export deception	RUSGOV	RUSSIA	MOLGOV	MOLDOVA	153: impose embargo, boycott, or sanctions
			Rus	RUSSIA	MDA	MOLDOYA	153: Impose embargo, boycott, or sanctions
			RUSGOV	RUSSIA	IGOEUREEC	EUROPEAN UNION	163: impose embargo, boycott, or sanctions
Russla	Moldovan migrants	Clearing entry for more	RUS	RUSSIA	MDA	MOLDOVAN	075: Grant asylum
			RUSGOV		MOLLAB	MIGRANT WORKER	073: Provide humanitarian aid
			RUSGOV		MOLLAB	MIGRANT WORKER	080: Vield
			RUS	RUSSIA	CVL	MIGRANT WORKER	075: Grant asylum
			RUS	RUSSIA	CVL	MIGRANT WORKER	073: Provide humanitarian aid





MERADORO 🖬 DATEADORO 🖬 Americas	e 🖬 Alter2000 🖬 Even	etkoercode 🖬 Even	ricole 🖬 SOURCEURE 🛛 📓	
610293291 20161220190000 #USGOV	MDA	5	54 http://www.moldpres.md/en/news/2016/12/20/16010127	
610293292 20161220190000 RUSGOV	MDA	: 5	54 http://www.moldprex.md/en/news/2015/12/20/16010127	
611278661 20161223171500 RUS	MDA	5	51 http://www.toi.org/client/article/26582-moldova-orthodox-church-elections-involvament.html	
611278662 20161223171500 RUS	MDA	5	51. http://www.toi.org/client/article/26582-moldova-orthodox-church-elections-involvement.html	
613620080 20161229113000 RUS	MDA	5	57 http://www.mfworld.org/docid/5854c72e4.html	
613425489 20170102000000 RUSGOV	MDA	5	51 https://www.washingtorpost.com/opinions/global-opinions/the-united-states-must-join-europe-to-resist-russias-medding/2017/01,	/01/e9964cac-ceb5-11
613425490 20170102019000 RUSGOV	MDA	5	\$1 https://www.washingtonpost.com/opinions/global-opinions/the united states must-join europe to resist russias meddling/2017/01,	/01/e9964cac-ceb3-15
613641435 20170103003000 RUSGOV	MDA	5	51 http://www.centralctcommunications.com/bristolpress/article_5363964a-4146-11e6-bc36-3705ec8bC2ad.html	
613641437 20170109009000 RUSGOV	MDA	5	S1 http://www.centralcicommunications.com/bristolpress/article_53639d4a-d148-1186-bc36-3705ec8bC2ad.html	
614021869 20170104091500 RUSGOV	MDA.	5	51 http://www.dailyrepublic.com/opinion/statenationalcolumnists/russias.hacking.is.nothing.new/	
614021870 20170104091500 RUSGOV	MDA	5	51 http://www.dailyrepublic.com/coinion/statenationalcolumnists/russian-hacking-in-nothing-new/	
614133961 20170104170000 RUS	MDA	5	51 http://www.irishtimes.com/sews/world/aurope/moldous.s.new-leader-strips.ex-romanian-president of citizenship-1.2925504	
614133962 20170104170000 RUS	MDA	5	51. http://www.irishtimes.com/news/world/europe/moldous s-new-leader-strips-ex-romanian-president-of-citizenship-1.2925504	
615367445 20170109103000 RUS	NDA	5	\$1 https://www.ky/vpost.com/world/moldova-wares-bridge-east-west.html	
615939042 20170111011500 RUS	NDAKEB	5	51 https://www.theguardian.com/world/2015/feb/20/transnistria-russia-rouble-orisis	
616124319 20170111150000 RUS	NDA	5	50 https://www.memri.org/reparts/russias-orbit-part-ili-new-pro-russian-president-moldova	
616124329 20170111150000 RUS	MDA	5	50 https://www.memri.org/reports/russias.orbit.part-III-new-pro-russian-president-moldova	
616124321 20170111150000 RUS	MDA	5	57 https://www.memit.org/reports/russias-orbit-part-III-new-pro-russian-president-moldova	
616124322 20170111150000 RUS	MDA	5	57 https://www.memri.org/reports/nusias-orbit-part-III-new-pro-nusian-president-moldova	
616124323 20170111150000 RUS	NDA	5	57 https://www.memri.org/reports/russias-orbit-part-iii-new-pro-russian-president-moldova	
616124324 20170111150000 KUS	NDAGOV	5	57 https://www.memri.org/reports/nusias.orbit.part-III new pro-russian president moldova	
616126413 20170111150000 RUSMED	NDA	5	57 https://www.memri.org/reports/nusias-orbit-part-il-new-pro-nusian-president-moldova	
616709369 20170113063000 RUS	MDA	5	57 https://www.euractiv.com/section/europe-s-eart/news/nasila-defies-moldowa-s-eu-pact-by-boosting-transmitria-trade/	
616709370 20170113060000 RUS	MDA	5	57 https://www.euractiv.com/section/europe-s-east/news/nussia-defles-moldova-s-eu-pact-by-boosting-transmistria-trade/	
616709375 20170113060000 RUS	MDALEG	5	57 https://www.euractiv.com/section/europe-s-east/news/russia-defies-moldowa-s-eu-pact-by-boosting-transmistria-trade/	
617963099 20170117153000 RUS	NDA	5	57 http://www.shron.com/news/workit/article/Moldowan president visits Russia to restore ties 10862166.php	
617961100 20170117153000 RUS	NDA	5	57 http://hoxted.ap.org/dynamic/stories/E/EU_RUSSIA_MOLDOVA75ITE+APRSECTION=HOME&TEMPLATE-DEFAULT&CTIME+2017-01-1	7-15-00-38
617961101 20170117153000 RUS	NDA	5	57 http://www.kamascity.com/news/business/national-international/article126947009.html	
618010948 20170117181500 RUS	MDA	5	57 http://www.register-herald.com/region/moldown-president-visits-nasia-hints-of-ending-eu-pact/article_43940ddc-3bc2-5cc7-80fa-	c92cb48c3055.30ml
618071095 20170117221500 RUS	MDA	5	57 https://sputniknews.com/europe/20170118:049700415-moldova-nussian-peacemaken-protectors-stability/	
618071095 20170117221500 RUS	MDA	5	57 https://sputniknews.com/europe/201701181049700415-mcidows-ruscian-peacemaken-protectors-stability/	
618593709 20170119070000 RUS	MDA	5	55 http://www.eurasiareview.com/19012017-putite.old-moldova-map-alarms-romaria/	
618593713 20170119070000 RUS	MDA	5	55 http://www.eurasiannview.com/19012017-putins-old-moldova-map-alarms-romania/	
618608134 20170119080000 #US	MOA	5	50 Gazeta/85C Monitoring/(c) 88C	
618608135 20170119080000 #U5	MDA	5	50 Gaerta/BBC Monitoring/(c) BBC	
618608158 20170119080000 RUSPTY	MDA	5	50 Gazeta/BBC Monitoring/(c) BBC	
619287790 20170121064500 RUS	MDA		51 https://www.rt.com/news/158164-moldova-rogocin-aimpace-romunia/	
619287791 20170121064500 RUS	MDA.	5	57 https://www.rt.com/news/158164-molidava-roepsin-ainoace-comania/	

Quantitative Results

- Systemigram was coded into the CAMEO terms, then used a Python program and Postgres Database to automatically query the GDELT database to count the number of events relevant to each Systemigram node.
- Calculated the total number of events for that systemigram concept
- We are able to identify specific events in the signals captured through the GDELT data system including significant Russian troop movements that we characterized as *Russian Peacekeepers Deployed to Alleviate Frozen Conflicts.*
- These visualizations of the systemigram state reveal which concepts are linked in temporally correlated ways.

Node 1	Node 2	Link	Actor 1 Code	Actor 1 Name	Actor 2 Code	Actor 2 Name	Event Code
Russie	Opposing Political Regimes: President igor Dodon	Developing closer ties to	RUS	RUSSIA	MDA	DODON	019: Express accord
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Russia	Moldova Economy: Import bans	Implemented to prevent EU export deception	RUSGOV	RUSSIA	MOLGOV	MOLDOVA	153: impose embargo, boytott, or sanctions
			Rus	RUSSIA	MDA	MOLDOYA	153: impose embargo, boycott, or sanctions
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Russia	Moldovan migrants	Clearing entry for more	NUS	RUSSIA	MDA	MOLDOVAN	075: Grant asylum
			RUSGOV		MOLLAB	MIGRANT WORKER	073: Provide humanitarian aid
			RUSGOV		MOLLAB	MIGRANT WORKER	080: Yield
			RUS	RUSSIA	CVL	MIGRANT WORKER	075: Grant asylum
			RUS	RUSSIA	CVL	MIGRANT WORKER	073: Provide humanitarian aid

Figure: Example CAMEO coding from Systemigram nodes

Month	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	19	Total
201612	25	6	44	13		2	50	43	2515	5437				54	4				8193
201701	49	58	37	58	17	6	231	115	7856	9861	41		18	182	72		20	4	18625
201702	24	57	25	18	2	2	317	161	6909	10616	27		6	122	32	4	20		18342
201703	44	49	35	37	21	1	244	173	6558	11034	14		9	176	34		43		18472
201704	19	20	10	31	4	4	177	112	5318	10403	17		9	172	22		7	2	16327
201705	28	29	11	24	8		170	82	5900	7729	11		21	122	48		6		14189
201707	44	72	39	80	13		171	202	6452	11060	7		12	676	96	1	13		18938
201708	44	63	23	53	8		113	97	3303	6540	43		18	346	74		9		10734
201709	51	60	15	26	13		221	120	3504	6625	16	45	21	142	32		17		10908
201710	18	34	6	11	9	1	173	82	2577	4048	13		9	34	10	1	12		7038
201711	13	34	6	26	3	3	165	123	3620	7635	22		6	76	16		15		11763
201712	25	12	22	7	10	2	199	106	4956	8776			12	8	2		5	1	14143
201801	12	16	10	10	2	4	183	119	3888	5548	8		3	64	36		15		9918
201802	15	15	20	16			146	152	4850	6646	1	5		42	12		18		11938
201803	10	4	17	11	4		296	186	6193	10409			3	50	12	6	5		17206
201804	10	8	19	8	4	1	193	120	4513	8186	3		3	80	34		8	9	13199
201805	18		18	13	6		351	163	2466	5120	10			42	10		7		8224
Total	449	537	357	442	124	26	3400	2156	81378	135673	233	50	150	2388	546	12	220	16	228157



Evolution of Moldova System Concepts 0-19 over the time between 12/2016-5/2018

Temporal view of systemigram evolution. You can see from the Orange time series a peak and trough corresponding to 07/2017 and 12/2017 which are periods of Russian troop withdrawals. This corroborates our understanding of this concept as "Russian Troops Deployed to Alleviate Frozen conflicts.

Conclusions

- Qualitative Systems Models can be converted to Quantitative models with collaboration between SMEs and quant researchers
- Data integration must be iterative with the final analysis
- Systemigrams can be measured and analyzed based on OSINT data sources



Problem. Solved.

Thank you!

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