LINGUISTIC GEOMETRY (LG) AND ITS APPLICATION TO HISTORICAL CONFLICTS

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BRIEF HISTORY OF LG
1970, Dr. Mikhail Botvinnik Published His First Work, Based on a Culmination of Game Theory Research from the 1930s, for Solving Complex Search Problems

1972-1988, Dr. Boris Stilman Assisted Dr. Botvinnik, in the Continued Development of these Advanced Algorithms, in What was Know as the PIONEER Project

Dr. Botvinnik’s Purpose to his Research was to Formalize the Approach Believed to be Used Intuitively by Chess Masters into a Set of Algorithms and Applicable Game Theory
By Early 1990s, Dr. Stilman Formalized the Grammars and Complex System of Sets and Functions of the Abstract Board Game, Into a New Field of Study, Coined **Linguistic Geometry** (LG):

- Linguistic because of the Use of Language Grammars
- Geometry because of the Limited Search Trees Produced

LG is a Hierarchy of Languages, Consisting of Grammars to Construct Trajectories, Zones, and Transitions, Defined via an Abstract Board Game.
But Wait, **Should Be Noted That**:

+ Since the 6\textsuperscript{th} Century, Chess Has Continued to Fascinate the World as an Example of Strategy and Genius, Similar to that, Which is Found on the Battle Field.

+ However, War has Existed Ever Since the Advent of Humanity, which was Long before Chess was Invented.

+ Therefore, the Algorithms that Make Up LG Cannot Come from Chess, but Rather Human Intelligence.

+ Hence, LG Must Certainly be Applicable to Ancient Conflict.
ABSTRACT BOARD GAMES, TRAJECTORIES, ZONES

- ABG Consists of the Set
  \( <X, \mathcal{P}, R_\mathcal{P}, \text{SPACE}, \text{val}, S_i, S_t, \text{TR}> \), where:
  + \( X \): Finite Set of Points or Locations
  + \( \mathcal{P} \): Finite Set of Pieces or Elements
  + \text{val}: Set of Numerical Values for Each Piece
  + \text{SPACE}: State Space, where a State is a List of Formula Equations, \( \text{ON}(p) \rightarrow X \)
ABSTRACT BOARD GAMES, TRAJECTORIES, ZONES

ABG Consists of the Set
\(<X, P, R_P, SPACE, val, S_i, S_t, TR>,\) where:

+ **S_i:** A state in the set SPACE, the starting state
+ **S_t:** A state (or states) in the set SPACE, indicating the end
+ **R_P(x,y):** Set of Binary Relations of Reachability where the Locations x and y are such that \((x,y) \in X\) and Piece p \(\in P\)
+ **TR:** A Transition Function \(TR(x,y,p)\) that Adds and Removes Formulas from the List of Locations of Pieces
ABSTRACT BOARD GAMES, TRAJECTORIES, ZONES

- ABG Can Be:
  - Alternating Serial (Single Turn, Single Element)
  - Alternating Concurrent (Single Turn, Any Element)
  - Totally Concurrent (Concurrent Turns, Any Element)

- ABG for Ancient Conflict is Totally Concurrent
  - Allows additional SP Function for Variable Speed on P
  - RANGE Element, Which is a Finite Set of Consecutive Z+, including Zero, as Speed Values for SP and P
A Trajectory is a Path Represented as a Sorted Set of Locations, Based on the Reachability of a Piece.

\[ T_{O\text{rInSp}} = a(23,8) \ a(22,8) \ a(20,9) \]
- Trajectories Generally Generated in Bundles
- Best Trajectory Determined by Quality Analysis, To Include:
  + Proximity to Enemies or Friends
  + Unblocked vs Block Paths
  + Geometry of Path
  + Requirements and Constraints
A Zone is a Network of Trajectories

For Example:

\[ Z_{OrInSp} = T(OrInSp, a(23, 8)) \]
\[ a(21, 8)a(20, 9), 3 \]
\[ T(PuCaSw, a(21, 9)a(20, 9), 2) \]
\[ T(OrCaSp, a(20, 9), 1) \]
\[ T(PuInSw, a(20, 9), 1) \]
\[ T(OrCaSp, a(20, 8), 1) \]
\[ T(PuInSw, a(20, 8), 1) \]
Types of Zones Include:
+ Attack: You Attempt to Occupy Enemy Occupied Location
+ Block/Relocate: You Occupy Empty Location
+ Dominate/Protect: You Stay Close to a Piece/Pieces
+ Retreat/Unblock: You Leave a Currently Occupied Location

Above Zone General to ALL Warfare

More Domain Specific Zones Can Exist
Reachability is the Distance a Piece Can Move in One Time Interval

Below is an Example of an Ancient Conflict

Each Color a Location Type, which can Affect Reachability
APPLICATION OF LG TOOLKIT TO
ALEXANDER THE GREAT’S
CROSSING THE JAXERTES
Upon the Death of King Phillip II of Macedonia, Alexander’s Father, Civil Unrest/Rebellion Broke out in 336 BC

Alexander Becomes Ruler and First Order of Business: To Stabilize Greek Commonwealth, without Destroying Civil Infrastructure, which Included the Regions of:
+ Macedon, Thessaly, Molossia, Greece, and Thrace
+ (all but Sparta, really, maybe Crete)
Also, Conquered Northern Egypt Relatively Quickly
Pursued King Darius III Through Most of Persia
  + King Darius III Tended to Retreat
  + Cloak and Sword Were Captured and Returned by Alexander to Darius’ Wife at Least Twice
Eventually Fought Battles in India and Further East
ALEXANDER AND ANCIENT CONFLICT: HISTORICAL REVIEW
alexander and ancient conflict: historical review

- Alexander subdued 7 nearby towns and had access to abundant logistical support.
- In comparison, Scythians had sparse supply lines to the north.
APPLICATION OF LG TOOLKIT CROSSING THE JAXERTES

Alexander is Orange LG
Scythians Purple LG
Both LG Perform Initial Resource Allocation
Alexander LG Deploys the Artillery with Part of Infantry Support to Deter Close-up Enemy Attack.

Scythians LG Repelled by Archers and Slingers and Follows Retreat Zone a Short Distance.
Scythian LG Adjusts Position

Again, Due to Increase Hits from Archers. Macedonian LG Further Advances Archers, Along with Support Infantry.
Scythian LG Once Again Retreat Due to Archers. Effect is Domination of Both Sides of River Banks.
LG Begins Consolidating Formations for Added Protection While Crossing.
Resource allocation is made on b
Scythians Hold at Safe Distance to Minimize Casualties.
Orange Archers Prevent Scythian Approach. LG Begins Crossing River as a Reallocation of Resource.
Scythians Army Still Holding. Orange LG Crosses only Half of Army at a Time To Continue Dominating Both Sides of River.
Scythians Still Holding.
Alexander’s Army Finishes Crossing.
While Crossing, Forces Already Crossed Hold Domination Zone
Pieces Move Into Position, Reallocation Complete.
Scythian LG Advances Infantry and Attempt to Flank with Cavalry, Slowed by Archers. LG Splits Cavalry, Moves Infantry Into Position, and Holds Back Artillery to Continue Firing as Cover.
APPLICATION OF LG TOOLKIT CROSSING THE JAXERTES

Partial Scythian Flank Successful.
Intense Close-Combat. Scythians Consolidate Cavalry and Infantry on LG’s Cavalry, Moves Infantry Closer.
LG Responds with Rapid Flank and Quick Regroup of Infantry to Defend Endangered Cavalry
LG Successfully Surrounds Scythian Army and Presses Attack.
APPLICATION OF LG TOOLKIT CROSSING THE JAXERTES

Scythians Plan Rapid Retreat and Begin Consolidating Resources. Macedonian LG Continues Attack.
Scythian LG Continues Rapid Retreat.
Alexander LG Continues Attack.
Scythian LG Continues Rapid Retreat. Orange LG Consolidates Cavalry Into Formation and Continues Attack.
Scythians Retreat to Desert.
Alexander LG Would Continue Pursuit.
IN SUMMARY

- As Demonstrated, the LG Grammar is Sufficient to Create Efficient Trajectories, Construct Useful Zones, and Provide Strategic Transitions.
- These Strategies Could be Considered at Least on Par with Alexander the Great and his Contemporaries.
- Most Importantly, Advanced LG Algorithms and Grammars Need Not Necessarily Come from Chess, though Chess was an Important Contribution.
IN SUMMARY

- Current Application Implementation Includes:
  - LG Engine with Abstract Board Game Based Class
  - Has been used to Implement Chess ABG, Modern Conflict ABG, and Ancient Conflict ABG, Definitions
  - Ability to Build and Display Zones and Trajectories for all Abstract Board Game Definitions

- Future Effort would be to Finish LG Implementation to Include Transition Grammar and a Strategy Engine
QUESTIONS?