

The sequencing of functions in time vs. the matrix.

Parallels in the debates in game theory and narrative analysis

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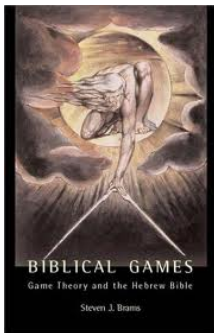
Workshop *What is a Game?*

Fresh perspectives on games and human behavior

London School of Economics, April 5, 2022

Applications of game theory to narrative

- Steven Brams, *Biblical Games*, 1980.



- Steven Brams, “Game theory and literature,” *Games and Economic Behavior*, 1994.
- Michael Chwe, *Jane Austen, Game Theorist*, 2013.
- Robert Bates, Avner Greif, Margaret Levi, Jean-Laurent Rosenthal, Barry Weingast, *Analytic Narratives*, 1998.

What is a “Narrative”?

In search of an analytic understanding of “Narrative” ...

In 2016, Philippe Mongin organized a Workshop on the “Limits and possibilities of narrative explanations,” the aim of which was to explore some connections between narrative and game theory.

Philippe Mongin’s Reading List

- Robert Bates, Avner Greif, Margaret Levi, Jean-Laurent Rosenthal, Barry Weingast, *Analytic Narratives* (1998).
- ⋮
- Steven Brams, *Game Theory and the Humanities* (2011).
- ⋮
- Roland Barthes, “The structural analysis of narrative” (1966)

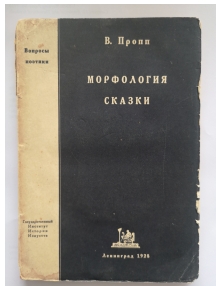
The French Structuralists

- Claude Lévi-Strauss, “La structure et la forme. Réflexions sur un ouvrage de [Vladimir Propp](#),” 1960.
- Claude Bremond, “Le message narratif,” 1964.
- A. J. Greimas, *Sémantique structurale*, 1966.
- *Communications 8, Recherches sémiologiques : l'analyse structurale du récit*, 1966:
 - Roland Barthes, “Introduction à l'analyse structural des récits.”
 - A. J. Greimas, “Éléments pour une théorie de l'interprétation du récit mythique.”
 - Claude Bremond, “La logique des possibles narratifs.”
 - Tzvetan Todorov, “Les catégories du récit littéraire.”

The Russian formalists (1910s to 1930s)

Society for the Study of Poetic Language in St. Petersburg: Viktor Shklovsky. *Moscow Linguistic Circle*: Roman Jakobson (1920 to the US), Boris Tomashevsky. Focus on the autonomous nature of poetic language and its specificity as an object of study for literary criticism.

V. Propp (1928): *Morfologija skazki*, “Morphology of the Tale.”



First English edition (1958): *Morphology of the Folktale* (intro. by Svatava Pirkova-Jakobson).

First French edition (1965): *Morphologie du conte*.

Second, revised, English edition (1968). *Morphology of the Folktale* (new introd. by Alan Dundes).

Picture: Courtesy by Daniel Kadnikov

Barthes, "Introduction to the structural analysis of narrative" (1966):

Is it possible to uncover, behind the temporal sequence of the narrative, an atemporal logic? Propp ... defended the principle that the chronological order is irreducible: to him time is the very stuff of reality, and for this reason, he insisted on rooting the tale in temporality. Yet Aristotle ... was already stressing the primacy of logic over chronology. And so have modern researchers (Lévi-Strauss, Greimas, Bremond, Todorov), all of whom would probably subscribe to this position of Lévi-Strauss: "The chronological order of succession is reabsorbed by an atemporal matrix."

V. Propp's analysis of the fairy tale

Propp's thesis

All fairy tales (magic tales, wonder tales), tales classified by Afanasyev under numbers 50–151, 93–270 in later editions, follow the same sequence of “functions.”

Propp's program

Propp's starting point: classification.

Usual classifications: tales of fantastic content, tales of everyday life, animal tales.

But: "The tale ascribes with great ease identical actions to persons, objects, and animals ... it [the classification of tales] must be transferred into formal, structural features."

Propp's method

Abstracts from the personal properties of the “dramatis personae.”

For instance:

1. A tsar gives an eagle to a hero. The eagle carries the hero away to another kingdom.
2. An old man gives Sucenko a horse. The horse carries Sucenko away to another kingdom.
3. A sorcerer gives Ivan a little boat. The boat takes Ivan to another kingdom.
4. A princess gives Ivan a ring. Young men appearing from out of the ring carry Ivan away into another kingdom, and so forth.

“First of all, definition should in no case depend on the personage who carries out the function. [...] Secondly, an action cannot be defined apart from its place in the course of narration. [...]

Function is understood as an act of a character, defined from the point of view of its significance for the course of the action.

- 1. Functions of characters serve as stable, constant elements in a tale, independent of how and by whom they are fulfilled. They constitute the fundamental components of a tale.*
- 2. The number of functions known to the fairy tale is limited.*
- 3. The sequence of functions is always identical.”*

“The sequence of events has its own laws ... Theft cannot take place before the door is forced. ... Freedom within this sequence is restricted by very narrow limits which can be exactly formulated.”

“By no means do all tales give evidence of all functions. But this in no ways changes the law of sequence.”

“Tales with identical functions can be considered as belonging to one type. On this foundation, an index of types can then be created, based not upon theme features, which are somewhat vague and diffuse, but upon exact structural features.”

“We are led to the following completely unexpected phenomenon: functions cannot be distributed around mutually exclusive axes.”

4. *All fairy tales are of one type in regard to their structure.*

Propp's sequence

Initial situation (α)

Preparatory action

1. Absentation (β)
2. Interdiction (γ) [inverted form: order or suggestion]
3. Violation (δ) [inverted form: fulfillment of order or suggestion]
4. Reconnaissance [interrogation] (ϵ) [inverted form: victim questions the villain]
5. Delivery [of information] (ζ).
6. Trickery (η) [persuasion, magical means, deception, coercion]
7. Complicity (θ)

First move

8. Villainy (*A*) or Lacking (*a*)
9. Mediation, the connective incident (*B*)
[- seeker heros, - victim heros]
10. Beginning counteraction (*C*)
11. Departure (\uparrow)
12. First function of the donor (*D*)
13. Hero's reaction (*E*) [types of connection between D and E]
14. Receipt of a magical agent (*F*)
15. Spatial transference between two kingdoms, guidance (*G*)
16. Struggle (*H*)
17. Branding, marking (*J*)
18. Victory (*I*)
19. Liquidation (*K*) [paired with A; narrative reached its peak.]
20. Return (\downarrow)
21. Pursuit, chase (*Pr*)
22. Rescue (*Rs*)

Second move

[8–15 as above; but then new functions, as follows]

23. Unrecognized arrival (O)
24. Unfounded claims (L)
25. Difficult task (M)
26. Solution (N)
27. Recognition (Q)
28. Exposure (Ex)
29. Transfiguration (T)
30. Punishment (U)

31. Wedding (W)

Assimilation

“Assimilation”: two functions appearing in the form of the same action.

“In these instances it is always possible to be governed by the principle of *defining a function according to its consequences*. If the receiving of a magical agent follows the solution of a task, then it is a case of the donor testing the hero (D^1). If the receipt of a bride and a marriage follow, then we have an example of the difficult task (M).”

Double morphological meaning of a single function

Example: Prince forbids wife to leave the house. Old lady convinces her to go out to the garden to have a “look at god’s world”: violation of interdiction (δ) and heeding the persuasion of the villain (δ).

Remark: similar to the “coalescing of moves” in game theory.

Analysis complicated because sometimes an action that usually appears later in the narrative is transferred to the beginning, where it fulfills a function at the beginning of the narrative, while retaining the function that it typically has at the end of the narrative.

Example: Kissing the princess while riding at full gallop: dispatch of the hero (B) and difficult task (M).

Auxiliary elements

- Auxiliary elements for interconnection of functions: “an entire system for the conveying of information has been developed in the tale, sometimes in very artistically striking forms”:
 - one character *finds out* something from another (voluntarily, or not)
 - a character *sees* something
 - an object (or person) is brought
often related to public feasts
- “Auxiliary elements in trebling”

- “Motivations”: are rare.

“There is reason to think that motivations formulated in words are alien to the tale on the whole, and that motivations in general may be considered with a great degree of probability as new formations.”

“One may observe in general that the feelings and intentions of the dramatis personae do not have an effect on the course of action in any instances at all.”

Realization of lack [coming to know something about oneself]: object lacking appears momentarily (leaving something behind) or in certain reflected forms (portraits, stories, dreams).

“Dramatis personae”

- “the sphere of action of the *villain*”: villainy (A), struggle (H), pursuit (Pr).
- “the sphere of action of the *donor*”: tests the hero (D), provision of the magical agent (F)
- “the sphere of action of the *helper*”: ...
- “the sphere of action of a *princess* (a sought-for person) and her *father*”: ...
- “the sphere of action of the *dispatcher*”: ...
- “the sphere of action of the *hero*”: ...
- “the sphere of action of the *false hero*”: ...

“Dramatis personae” ≠ “characters”:

- A “character” can be active in the role of more than one “dramatis persona.”

Notably, the *sought-for person* can also be the *hero*. This, so Propp,

- has consequences for how the storyteller relates the tale, and
 - could be used already to divide the tales in the studied corpus in two classes.
- More than one character can assume the role of a dramatis persona.

Attributes of Dramatis Personae

“The constancy of functions endures, permitting us to also introduce into our system those elements which become grouped around the functions. How does one create this system? **The best method is to make up tables.**

“Yet the study of attributes leads us to another highly important consequence. If one extracts all the basic forms for each heading and unites them into one tale, **such a tale will reveal that certain abstract representations lie at its core.** [...] The study of attributes makes possible a *scientific interpretation of the tale*. From the historical point of view, this signifies that the fairy tale in its morphological bases represents a *myth*.”

Propp relegates the study of these abstract representations and their historic roots to further investigation.

Is classification—on structural grounds—still possible?

Propp recognizes different “moves” within the same tale, which gives him several classes:

- Move I
- Move I — Move II
- Move I — Move II — Move I
- ...

Beyond that, so Propp, classification is possible only on grounds of variable elements, that is, the specific appearance of functions. Propp suggests to do so using function A *villainy* or *lack*.

Observations

from a game-theoretic perspective

- *Dramatis personae* – *players* in a game.
What defines them are not personal characteristics, but their role for the sequel of the narrative; as a game theorist, we could say, their strategic possibilities (their actions at information sets and their payoffs at end nodes).
- A kind of methodological individualism: The fact that the hero leaves home—is out there alone—constitutes him or her as an *individual*, someone who has to deliberate and take action alone: the kind of individual that we assume in game theory.
- Magical agent: is an *agent* in the true sense of the word, like in *principal-agent*: acts on behalf of the hero.

- Some of the functions, sometimes present themselves in the form of “games,” in the common sense of the word:
 - 16, “Struggle” (H), can take the form of a **card game** between the hero and the villain.
 - 25, “Difficult task” (M) can consist in solving a **riddle** or making a difficult **choice**.
- In some of the functions, game theorists, may find situation that can be model as a game:
 - 6. “Trickery.” The villain uses **persuasion** to make the victim act in a certain way.
 - 12. “First function of the donor” (the donor tests the hero, D) often takes the form of what game theorists would call a **sharing problem**.
 - 17. “Branding, marking” (J) as well as 29. “transfiguration” (T) can be interpreted as the acquisition of or the endowment with a **costly signal**.

On a more structural level:

- distributions of characters to dramatis personae is similar to distribution of information sets to players
- When from a pair of coupled functions the first is missing, this is similar to “coalescing of moves” in game theory.

Reception
by the French structuralists

Levi-Strauss's critique (*La structure et la forme*, 1960)

- Propp's analysis is as if looking at a language as consisting of *syntax* alone without a vocabulary.

Barthes (1966): "Sense does not sit at the end of the narrative; it runs through it."

- A structural analysis of the vocabulary – the dramatis personae – is also possible, and indeed necessary to complete the task of classification.
- *Myth and the tale are contemporaries*. The tale is not impeded by so many restrictions, which explains its richness.

Lévi-Strauss's critique, in part, falls short, in so far as it does not take into account some of Propp's accompanying studies:

- In “The transformations of fairytales,” published also in 1928, but as a separate article, Propp discusses the “variable elements” that appear in the functions of the tale as well as the kind of transformations that produce their variation.

In this article, he also talks of a “table [...] into which one could write all fairy tales; conversely, every tale that one could write into this table is a fairytale.”

- In “The Historical Roots of the Wondertale” (1946), Propp offers a historical study of the “variable elements.”

Greimas's (1966) development of Propp's model

- Greimas, taking up an idea already present in Propp's study, reduces Propp's sequence of 31 functions into a sequence of 20 functions by a "coupling of functions."

Greimas:

"The coupling of functions, defined as a categorization of functions, liberates the analysis, at least partially, from the order of the syntagmatic succession."

Greimas's condensed version of Propp's sequence¹

Preparatory action

1. Absentation (β)
2. Interdiction (γ) vs. Violation (δ)
3. Reconnaissance [interrogation] (ϵ) vs. Delivery [of information] (ζ)
6. Trickery (η) vs. Complicity (θ)

¹Names of functions here as in the official English translation, which sometimes differs from the literal translation of how Greimas renders these functions in French.

First move

5. Villainy (*A*) vs. Lacking (*a*)
6. Mediation, the connective incident (*B*) vs. Beginning counteraction (*C*)
7. Departure (\uparrow)
8. First function of the donor (*D*) vs. Hero's reaction (*E*)
9. Receipt of a magical agent (*F*)
10. Spatial transference between two kingdoms, guidance (*G*)
11. Struggle (*H*) vs. Victory (*I*)
12. Branding, marking (*J*)
13. Liquidation (*K*)
14. Return (\downarrow)
15. Pursuit, chase (*Pr*) vs. Rescue (*Rs*)

Second move

16. Unrecognized arrival (*O*)
[New act of villainy]²
17. Difficult task (*M*) vs. Solution (*N*)
18. Recognition (*Q*)
19. Exposure (*Ex*) vs. Transfiguration (*T*)
20. Punishment (*U*) vs. Wedding (*W*)

²Unfounded claims (*L*) in Propp's language.

- Greimas analyzes the functions of the preparatory sequence (Propp's functions 1–7) as the negatives of the functions that are acted out in the main sequence.
- Identifies within the consolidated sequence:

“Contracts” :

mediation : acceptance = a contract (A)

interdiction : violation = breaching of a contract (\bar{A})

- A contract (or the breaching of a contract) has consequences. The whole gives what Greimas call a “test” :

A = mediation : acceptance

F = confrontation : solution

non c = consequence

In the symbolic language used by Greimas:

“ C ” represents an act of communication;

“ c ” the emission of a sign; “non c ” its reception.

- In the main sequence, Greimas identifies three tests:
 - Qualifying test: reception of a magical agent
 - Main test: liquidation of the initial villainy or lack
 - Glorifying test: reconnaissance.

Observation:

These are moments that can also be modeled as “games,” in the game theoretic sense.

- Qualifying test: often takes the form of a sharing problem
- Main test: a zero-sum game
- Glorifying test: a knowledge-problem

- Absence and presence of the hero:
 - absence of the hero from home: \bar{p}
presence of the hero at home: p
 - presence of the hero at the location of the fight: $\overline{\text{non}p}$
absence of the hero from the location of the fight $\text{non}p$.
- rapid displacement: d , which, so Greimas, is not a functional element but part of the analysis of actants, because it represents intensity of desire.

Absence of the hero from home (+ intensified by rapid displacement) stands for solitude of the hero. Can be given an interesting interpretation for game-theoretic analysis: it allows to constitute the hero as an individual who acts on his or her own account.

Greimas's 4 basic categories

- Contract: fulfilled A or breached \bar{A}
- Struggle : F
- Communication, as a form of exchange: someone emits a sign (c), someone receives a sign (non c).
- Presence and absence of the hero: p and \bar{p}
[rapid displacement: d]

For Greimas, these are “anachronic categories’.’ However not in the sense that they could not be arranged in a temporal order, but in the sense that there is no specific order in which they have to be arranged; in the sense that they can be “freely combined.”

Still: There is, for Greimas, a remaining “diachronic” element, in the sense that it always has to present itself in a specific order: the “tests.”

Remark: Greimas's test is like a narrative description of a play of a game:

A = mediation : acceptance (= the players accept to play a game)

F = confrontation : solution (= play of the game)

non c = consequence (= definition of payoffs)

Greimas's transcription of Propp's sequence

$\bar{p} \bar{A} \bar{C}_1 \bar{C}_2 \bar{C}_3 p A_1 \bar{p}_1 (A_2 + F_2 + \text{non } c_2) d \overline{\text{non } p_1} (F_1 + c_1 + \text{non } c_3) \text{non } p_1 d F_1 p_1 (A_3 + F_3 + \text{non } c_1) C_2 C_3 A (\text{non } c_3)$

When we try to match this to the consolidated sequence of Propp's functions that Greimas proposes:

Preparatory action

1. Absentation \bar{p}
2. Interdiction – Violation \bar{A}
3. Reconnaissance – Delivery \bar{C}_1
6. Trickery – Complicity \bar{C}_2

First move

5. Villainy vs. Lacking \bar{C}_3
6. Mediation, the connective incident vs. Beginning counteraction p, A_1
7. Departure \bar{p}_1
8. First function of the donor vs. Hero's reaction $A_2 + F_2$
9. Receipt of a magical agent $\text{non } c_2$
10. Spatial transference between two kingdoms, guidance $d, \overline{\text{non } p_1}$
11. Struggle vs. Victory F_1
12. Branding, marking c_1
13. Liquidation $\text{non } c_3$
14. Return $\text{non } p_1$
15. Pursuit, chase vs. Rescue d, F_1, p_1

Second move

16. Unrecognized arrival p_1
New act of villainy. [Propp: unfounded claims]
17. Difficult task vs. Solution $A_3 + F_3$
18. Recognition non c_1
19. Exposure vs. Transfiguration C_2

31. Punishment vs. Wedding $C_3, A, (\text{non } c_3)$

Greimas's matrix

V. LA STRUCTURE DU MESSAGE

Nous présentons, sous forme d'un tableau, les principaux résultats obtenus dans l'interprétation de ce mythe bororo :

Contenus	inversés		posés	
	corrélés	topiques		corrélés
Résultats des transformations	non V + M	M + non V	V + non M	$\frac{\text{non M} \rightarrow \text{M}}{\text{non V vs V}}$
Dimension culturelle	sexuelle	culinaire		naturelle
Perspective stylistique	consommateur	objet de consommation		producteur

Alan Dundes's account of the Propp–Lévi-Strauss debate

Foreword to second English edition of Propp (1968): Dundes distinguishes between “two distinct types of structural analysis in folktale”:

- “One is the type of which Propp’s *Morphology* is the exemplar par excellence. In this type, the structure or formal organization of a folkloristic text is described following the **chronological order of the linear sequence of elements in the text as reported from an informant.**” “Syntagmatic.”
- “The other type of structural analysis in folklore seeks to describe the **pattern (usually based upon an a priori binary principle of opposition)** which allegedly underlies the folkloristic text. This pattern is not the same as the sequential structure at all. Rather the elements are **taken out of the ‘given’ order and are regrouped in one or more analytic schema.**” “Paradigmatic.”

Dundes:

“In fact, Lévi-Strauss’s position is essentially that the linear sequential structure is but apparent or manifest content, whereas the paradigmatic or schematic structure is the more important latent content. Thus the task of the structural analyst, according to Lévi-Strauss, is to see past or through the superficial linear structure to the ‘correct’ or true underlying paradigmatic pattern of organization.”

Observation: similarities in debates

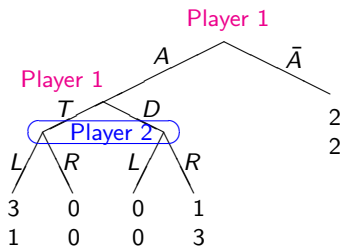
Propp French Structuralists
“temporal sequence” – “atemporal matrix”

Barthes (1966):

Is it possible to uncover, behind the temporal sequence of the narrative, an atemporal logic? Propp [...] defended the principle that the chronological order is irreducible: to him time is the very stuff of reality, and for this reason, he insisted on rooting the tale in temporality. Yet Aristotle [...] was already stressing the primacy of logic over chronology. And so have modern researchers (Lévi-Strauss, Greimas, Bremond, Todorov), all of whom would probably subscribe to this position of Lévi-Strauss: “The chronological order of succession is reabsorbed by an atemporal matrix.”

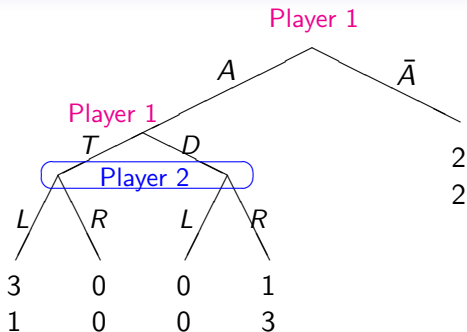
In game theory:

extensive form (game tree) — normal form (game matrix)



	L	R
\bar{A}	2,2	2,2
AT	3,1	0,0
AD	0,0	1,3

The debate of the extensive form vs.
the matrix
in game theory



	L	R
\bar{A}	2,2	2,2
AT	3,1	0,0
AD	0,0	1,3

“extensive-form”



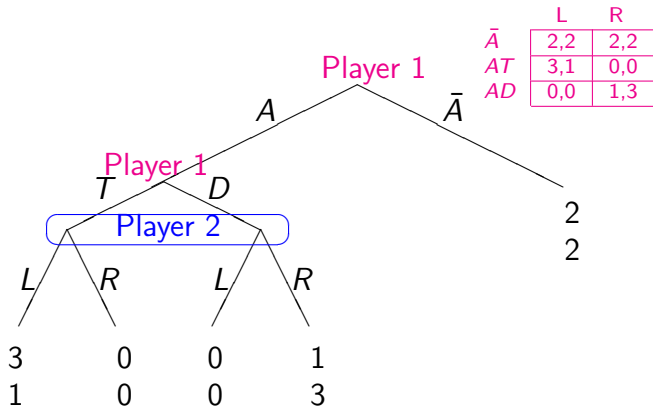
“normal form”

Every extensive form maps to a matrix (normal form). But one matrix can, and regularly is, the image of several extensive forms.

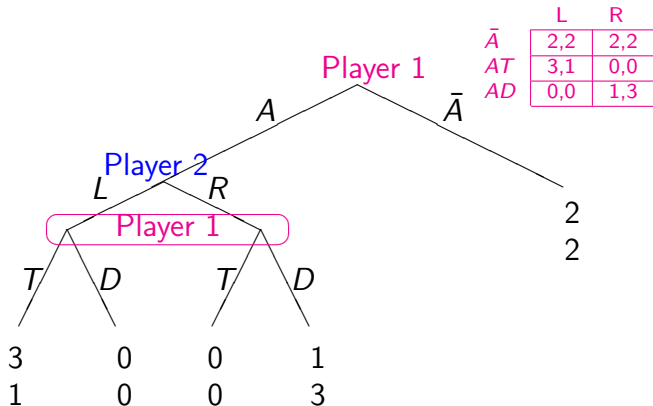
The idea of normal-form “invariance”

- **Dalkey (1952)**: investigates one transformation that leaves the reduced normal form, the matrix, invariant: inflation-deflation of information sets
- **Thompson (1952)**: 4 transformations that leave the reduced normal form, the matrix, invariant:
 - (1) inflation-deflation of information sets,
 - (2) interchange of simultaneous moves,
 - (3) coalescing of moves,
 - (4) addition of a superfluous move
- **Elmes et Reny (1994)** show the following astounding result:
(2), (3), and (4) are sufficient to **transform one extensive form into any other extensive form that has the same reduced normal form (matrix)**.

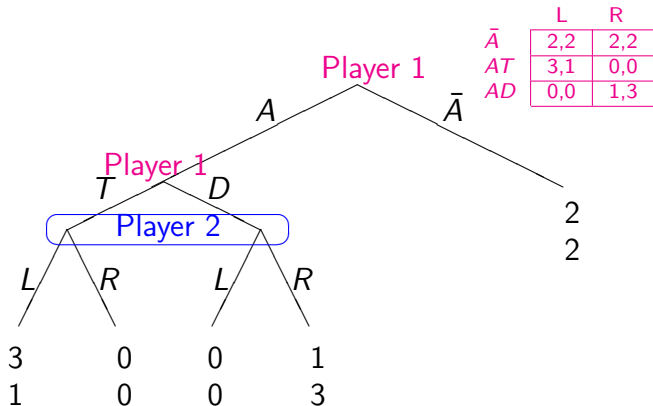
Interchange of simultaneous moves



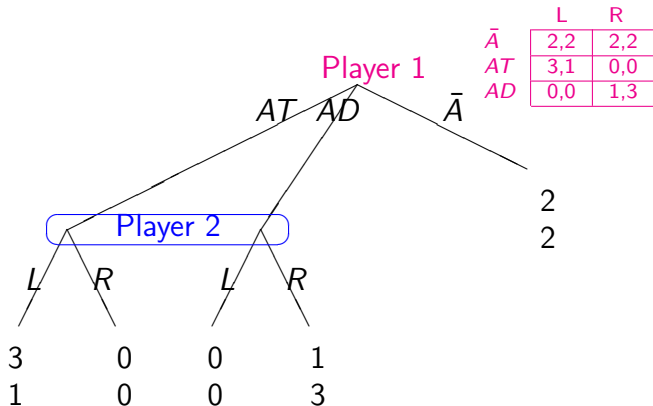
Interchange of simultaneous moves



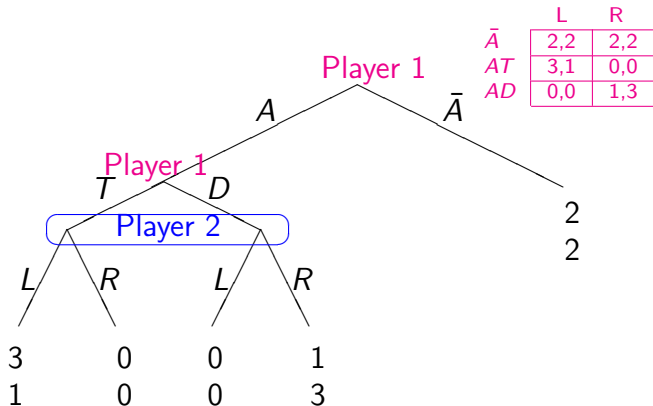
Coalescing of moves



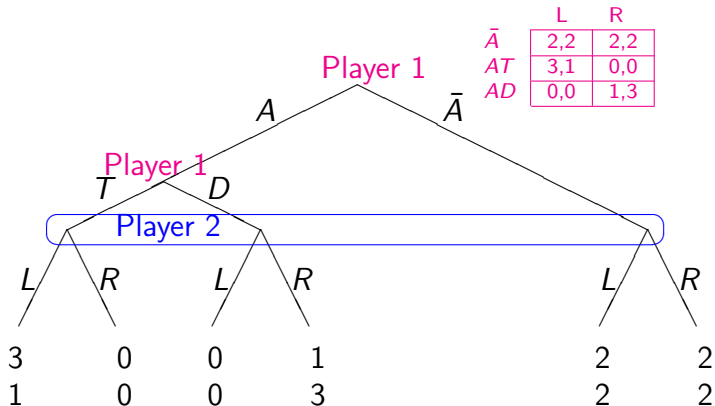
Coalescing of moves



Addition of a superfluous move



Addition of a superfluous move



Debate in game theory:

Should extensive-form games that map to the same matrix be considered as strategically equivalent?

Should solution concepts for games be defined on the extensive form or the normal form?

Two positions: often – maybe too casually – paraphrased in the following way:

the specific extensive form matters

Selten (1975)

\Leftrightarrow

only the normal form matters

Kohlberg and Mertens (1986)

Kohlberg and Mertens (1986):

Use the idea of **invariance** as a refinement criterion.

A 'good' solution for a game should be stable under any extensive form that has the same normal form.

A transposition

Use the idea of invariance – of the matrix of a narrative – for classification.

- Do this on the kind of matrix proposed by Lévi-Strauss, Geimas.
- Building on Greimas: re-write a condensed version of Propp's sequence as a game (by attributing payoffs at endnodes).

Use of game theory for an analysis of narrative?







Robert Aumann: game theory is








a way of talking about many sciences, many disparate disciplines. [...] does not use different, ad hoc constructs to deal with various specific issues, [...] rather it develops methodologies that apply in principle to all interactive situations, then sees where methodologies lead in each specific application. But rather than being an umbrella for all those disciplines, it's perhaps better to think of it as a way of thinking about certain aspects of each—the interactively rational aspect. There are many things in these disciplines that have nothing to do with this aspect.





Science is often characterized as a quest for truth, where truth is something absolute, which exists outside of the observer. But I view science more as a quest for understanding, where the understanding is that of the observer, the scientist. Such understanding is best gained by studying relations—relations between different ideas, relations between different phenomena; relations between ideas and phenomena. Rather than asking “How does this phenomenon work?” we ask, “How does this phenomenon resemble others with which we are familiar?” Rather than asking “Does this idea make sense?” we ask, “How does this idea resemble other ideas?”





Robert Aumann (interviewed by S. Hart 2005)

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