

Research Seminar 6. Solving Extensive Form Games by Computer

What is Gambit?

- a set of software tools for doing computation on finite, noncooperative games.
- These comprise a graphical interface for interactively building and analyzing general games in extensive or strategy form;
- a number of command-line tools for computing Nash equilibria and other solution concepts in games;
- and, a set of file formats for storing and communicating games to external tools.

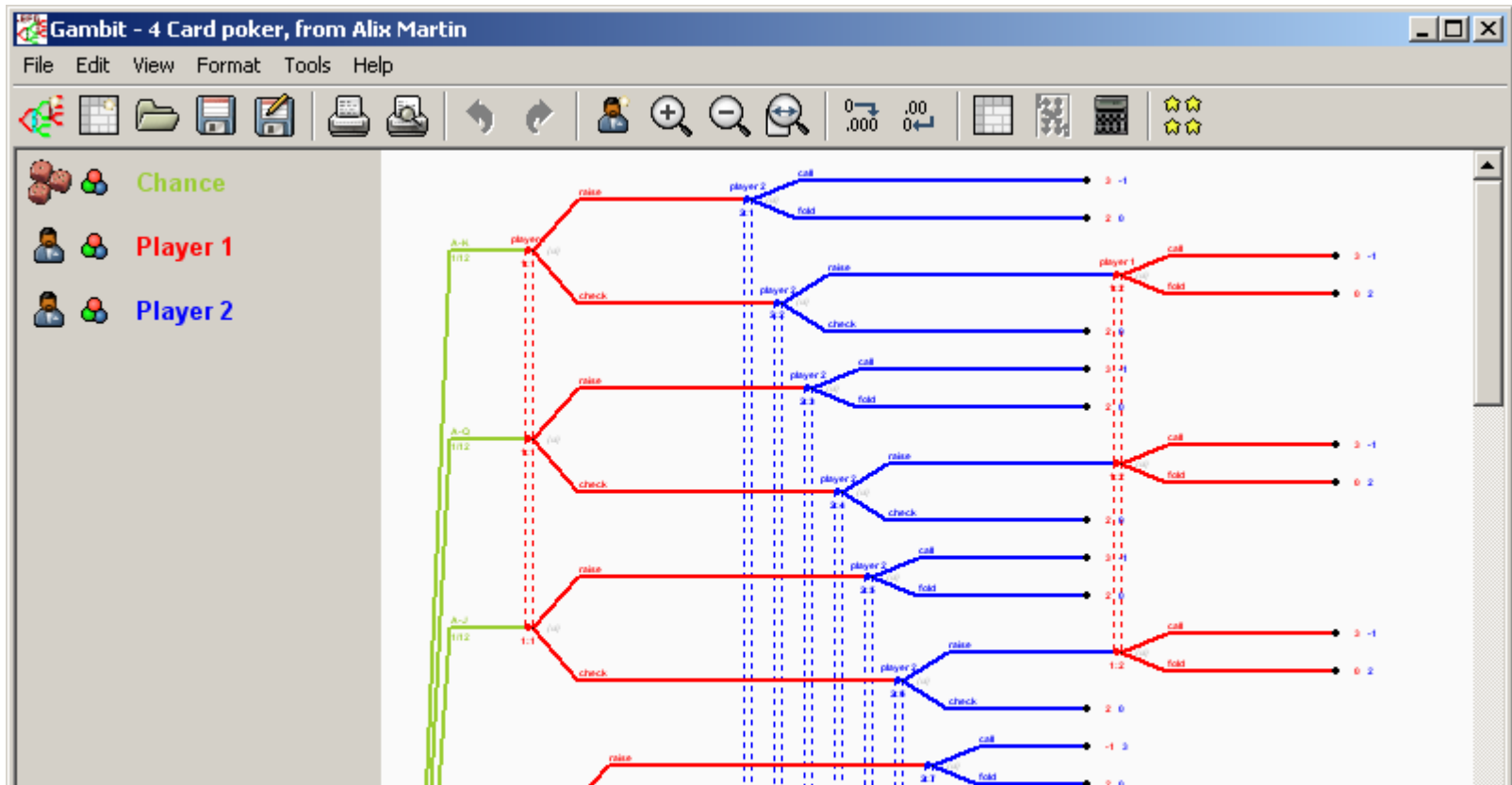
Gambit User Guide, <http://gambit.sourceforge.net>

Gambit: Where to Get It

- Gambit is open source software
- Downloads available from Sourceforge (see link) a leading mirror of open source software
- Available for Windows and Macintosh
- Includes an “application programming interface” to the language Python

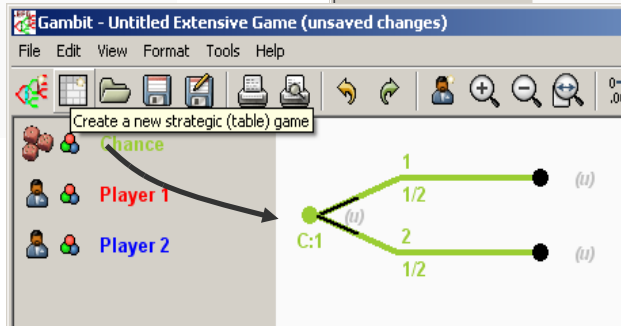
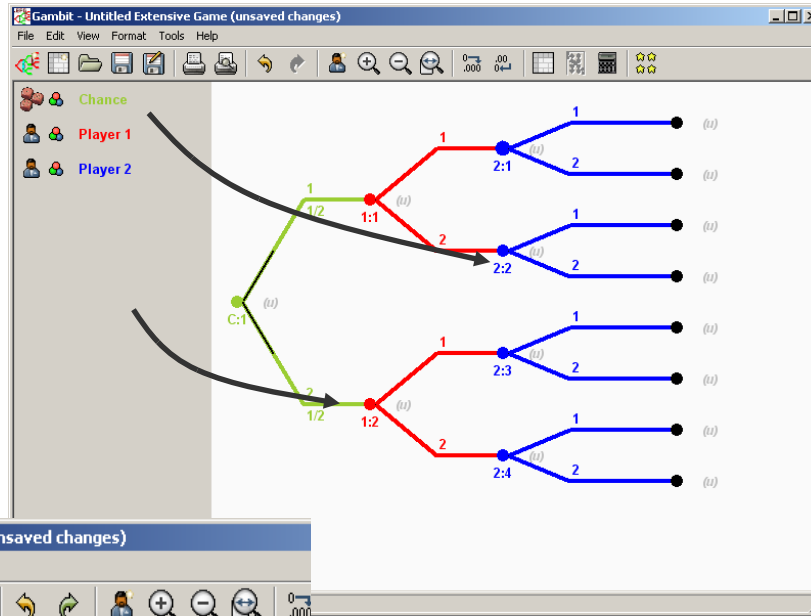
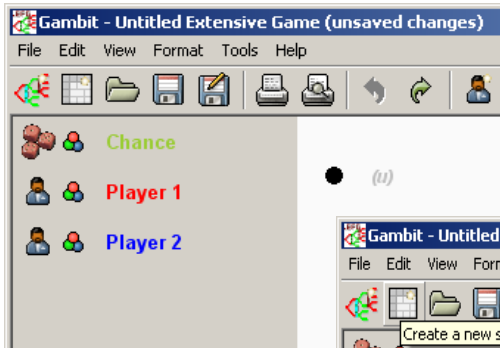


Sample Game: Four Card Poker



Dragging and Dropping Player Nodes to create a tree

Drag and drop player nodes to create a tree



You can also create games in strategic form

Adding Information Sets

The screenshot shows the Gambit software interface for an extensive form game. The game tree starts at a root node labeled 'C:1' with a chance node icon. Two branches lead to nodes labeled '1/2'. From each '1/2' node, Player 1 chooses between '1' and '2'. This leads to two information sets for Player 2, each labeled '1:1'. From each '1:1' node, Player 1 chooses between '1' and '2'. This leads to four information sets for Player 2, each labeled '2:1' or '2:2'. From each of these nodes, Player 2 chooses between '1' and '2'. The 'Node properties' dialog box is open, showing the 'Information set' dropdown set to 'Player 2, Infoset 2' and the 'Outcome' dropdown set to '(null)'. The dialog also includes 'Cancel' and 'OK' buttons.

Labelling Nodes and Moves

The screenshot displays the Gambit software interface for an extensive form game. The main window shows a game tree with the following structure:

- Root Node:** Nature (C:1) with probability 1/2 for 'Fast' and 1/2 for 'Slow'.
- Information Set 1:** Rose (1:1) at the top and Rose (1:1) at the bottom.
- Information Set 2:** Colin (2:1) at the top and Colin (2:1) at the bottom.
- Actions:** Rose can choose 'Down' or 'Up'. Colin can choose 'Right' or 'Left'.
- Payoffs:** Terminal payoffs are listed at the end of each branch.

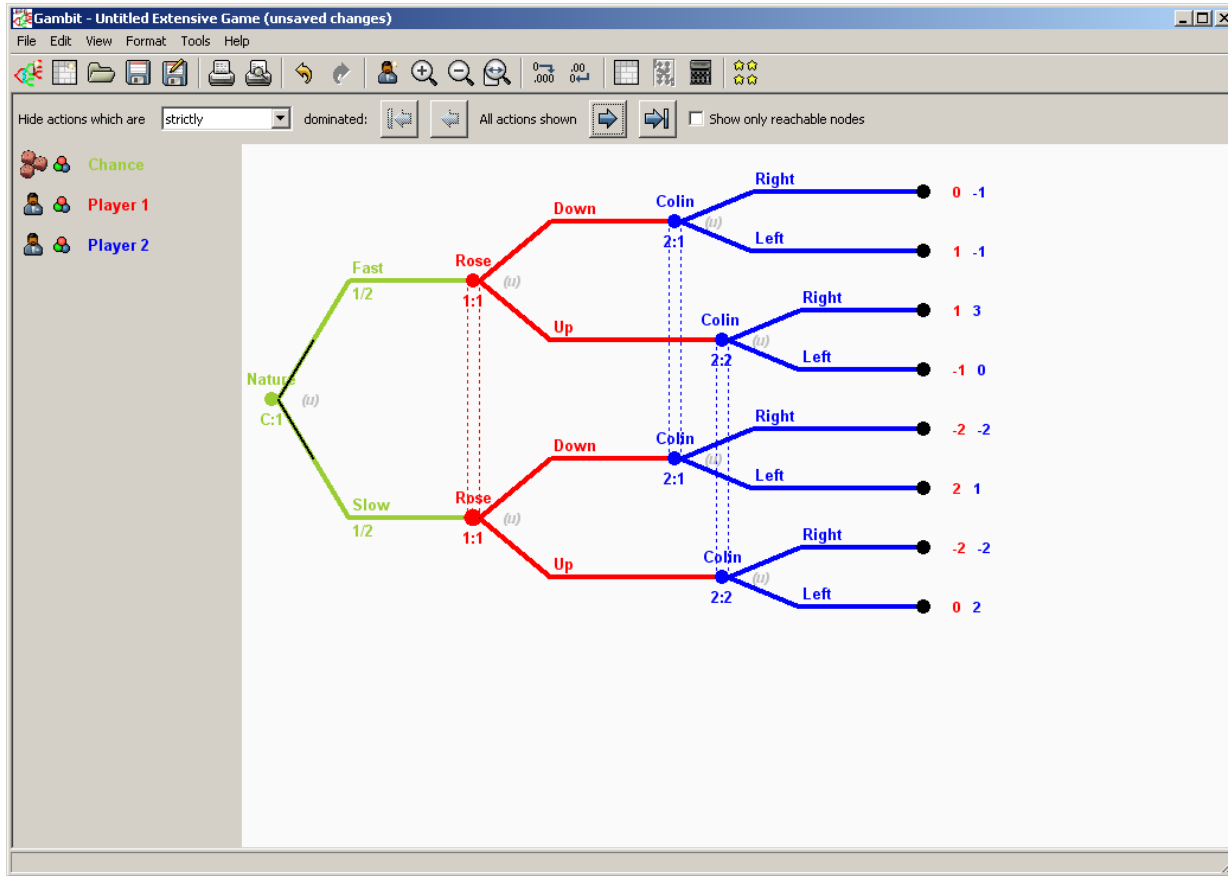
Two dialog boxes are open:

- Move properties:** Shows 'Information set label' (empty), 'Number of members: 2', 'Belongs to player: 2: Player 2', and an 'Actions' table.
- Node properties:** Shows 'Node label: Nature', 'Information set: Chance infoset 1', and 'Outcome: (null)'.

Actions	
	Label
1	Right
2	2

Node label	Nature
Information set	Chance infoset 1
This is the root node of the tree	
Outcome	(null)

Setting Payoffs and Probabilities



Computing Nash Equilibrium

Four equilibria

Click on equilibria to display the payoffs and play of the game

Computing Nash equilibria

The computation has completed.

Number of equilibria: 4

#	1: 1	1: 2	2: 11	2: 12	2: 21	2: 22
1	1	0	0	0	1	0
2	1	0	0	0	0	1
3	0	1	0	1	0	0
4	0	1	0	$\frac{4}{5}$	0	$\frac{1}{5}$

Gambit - Untitled Extensive Game (unsaved changes)

File Edit View Format Tools Help

Tools: Dominance Equilibrium Qre

dominated: All action

Chance

Player 1
Payoff: -1/2

Player 2
Payoff: 1

Nature

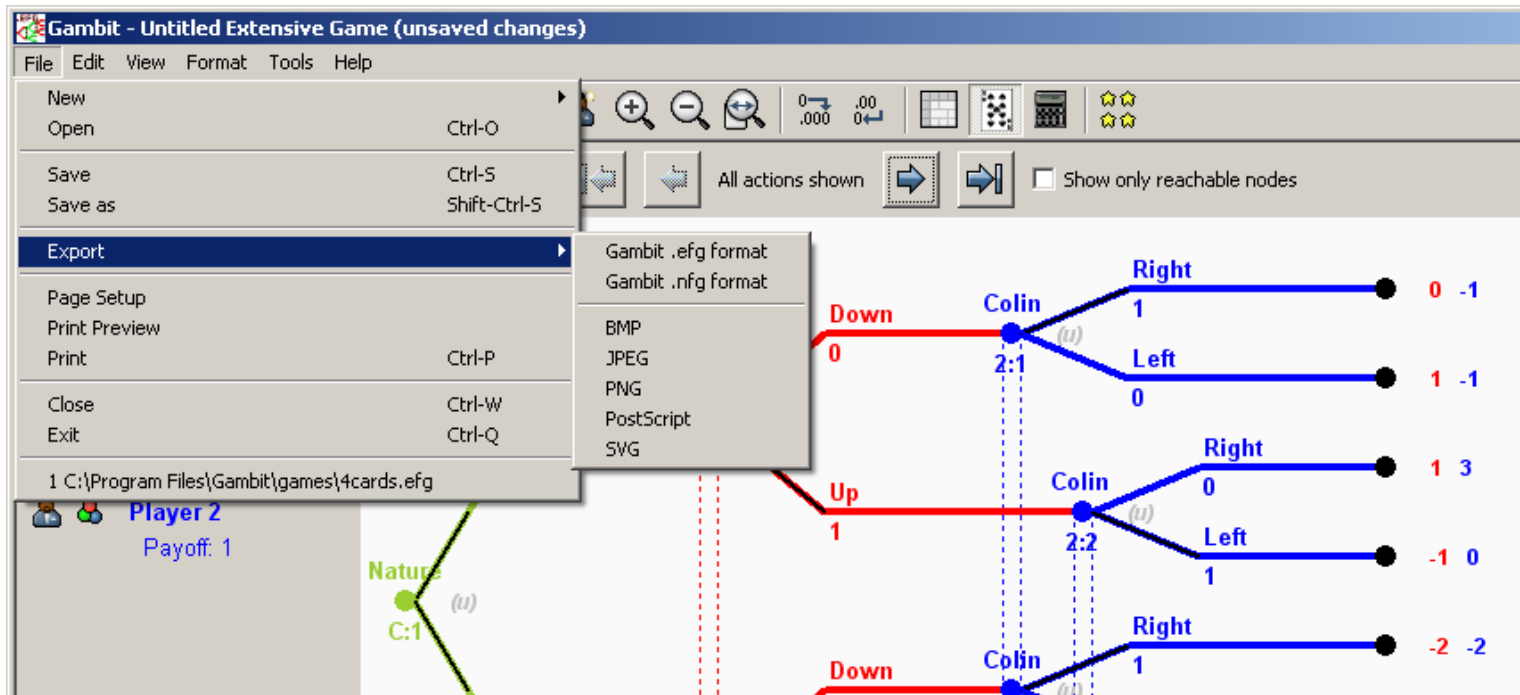
Fast
1/2

Rose
1:1

Discussion of Equilibria

- Two solutions found by both Gambit and us
 - Rose “Down” and Colin “Left”
 - Rose “Down” and Colin “Left if Down”
- Two solutions found only by Gambit
 - Rose “Up” and Colin “Left if Up”
 - Rose “Up” and Colin mixed “Left” and “Left if Up”
- We eliminated weakly dominated solutions; Gambit did not

Exporting Trees to Gambit Files or Graphics



Other Features and Bugs

- Quantal Response Equilibrium: Gambit includes an evolutionary mechanism for computing equilibria which involves players trying out strategies, and doing more of those which work the best
- Dominated Strategies: This feature of Gambit doesn't seem to work for extensive form games, resulting in errors and maybe even crashes