### What is Colored Trails?

**Description**
- The Colored Trails (CT) framework is a test-bed for modeling and learning decision-making in social contexts.
- CT is a board game that can be played by people, computers, or heterogeneous groups.
- The game board is a grid of colored squares. Each player has a piece on the board, a designated goal square, and a set of colored chips (resources) it can use to reach its goal.
- To move its piece to a neighboring square, a player must have a chip of the same color as the square.
- When one or more players lack the resources needed to reach the goal, they may negotiate chip exchanges.
- A player's score may depend upon her own location, remaining resources, and/or those of other players.
- The game's complexity can be varied by changing the board layout, chip distributions, and scoring function.
- CT provides an analogue for task settings in multi-agent systems: chips represent resources; goal squares represent objectives; players achieve objectives by exhausting resources as they move across the board.

![Snapshot of the CT GUI interface for a 2 player game. The "me" player needs a cyan chip to get to goal while "sun" can independently get to the goal. The "me" player has offered an exchange of 1 purple chip in return for a 1 cyan chip.](image)

### Iterated Two-Player Game

**Scenario**
- Two players play a series of take-it or leave-it CT rounds.
- Each round differs in board layout, players' roles, chip distribution and dependency relationships between players.
- Collected data includes 57 games, each played by different pairs of people. Each game consists of between 2 to 8 take-it or leave-it CT rounds. Proposer and responder roles switch at each round.
- Objective is to build a computer player that could outperform both humans and game theoretic computer players in varying game contexts.

**Challenges**
- Because players’ reciprocate each others’ actions, need to decide model how actions affect their reputation.
- Reason about the future consequences of players’ actions.
- Must predict strategies for both proposers and responders because roles are switched at each game.
- Each round of play is not independently identically distributed, reasoning about players’ offers in future rounds affects their strategies in current rounds.

### Multi-agent Diagram of $n$ Game ($n$ rounds)

![Diagram of multi-agent game structure](image)

**Proposed Model**
- Each players’ reputation is represented as a “merit” scalar with range $[1,1]$. The “merit” is computed as the difference between players’ material benefit and their entitled benefit, given by the Nash Bargaining equilibrium strategy.
- CT rounds are conditionally independent of each other given players’ merits and their types.
- A player’s utility for a potential action is a weighted summation of social preferences of potential action.
- Other player’s “merit”.
- Future ramifications of potential action by sampling games from the future.
- Use a mixture model of types. Each type has a separate weight distribution for social preferences.

### Computing Ramification of Action

![Diagram of computing ramification of action](image)