

Strategy Stitching in Large Extensive Form Multiplayer Games

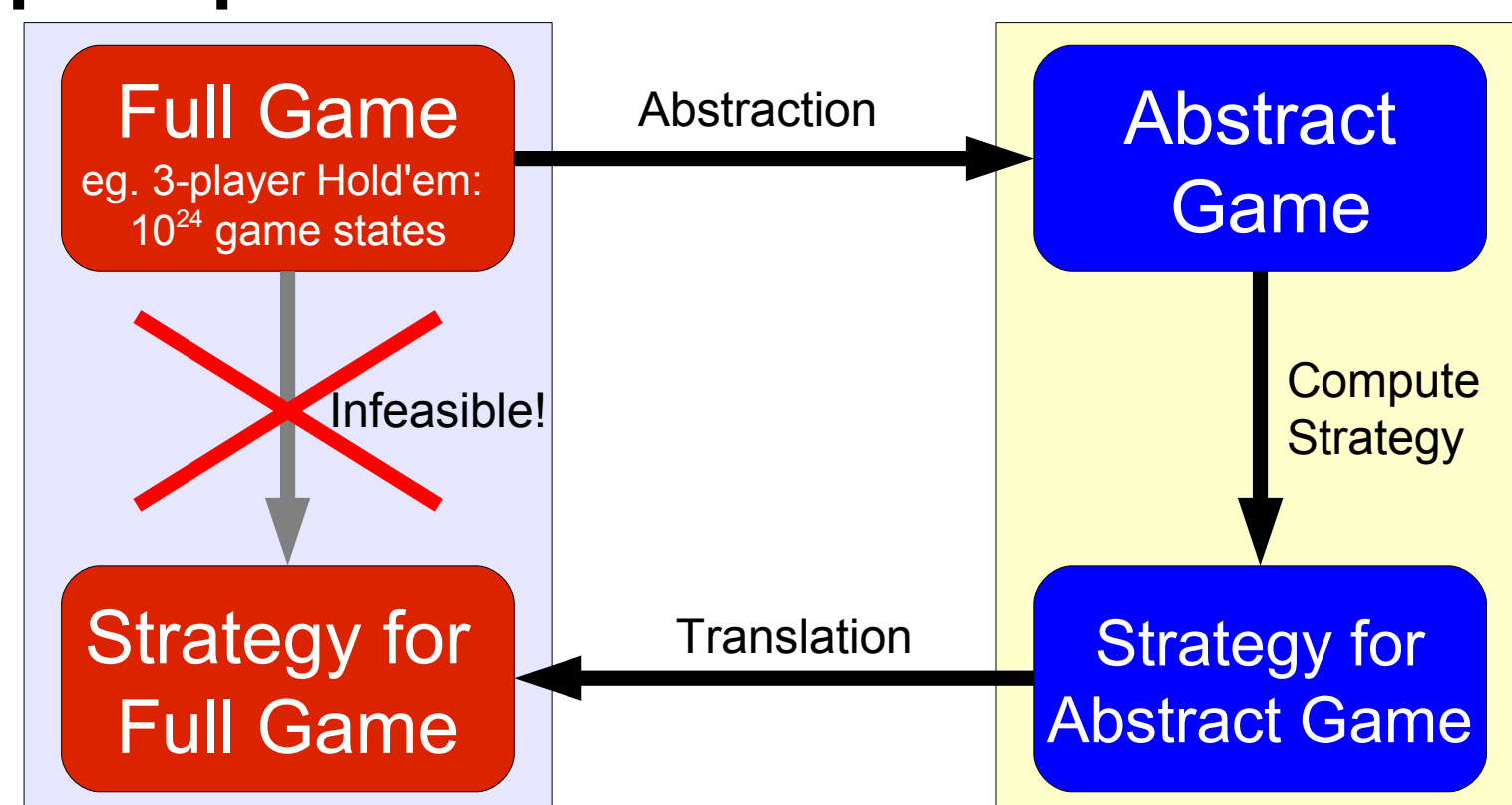
Richard Gibson and Duane Szafron



BACKGROUND

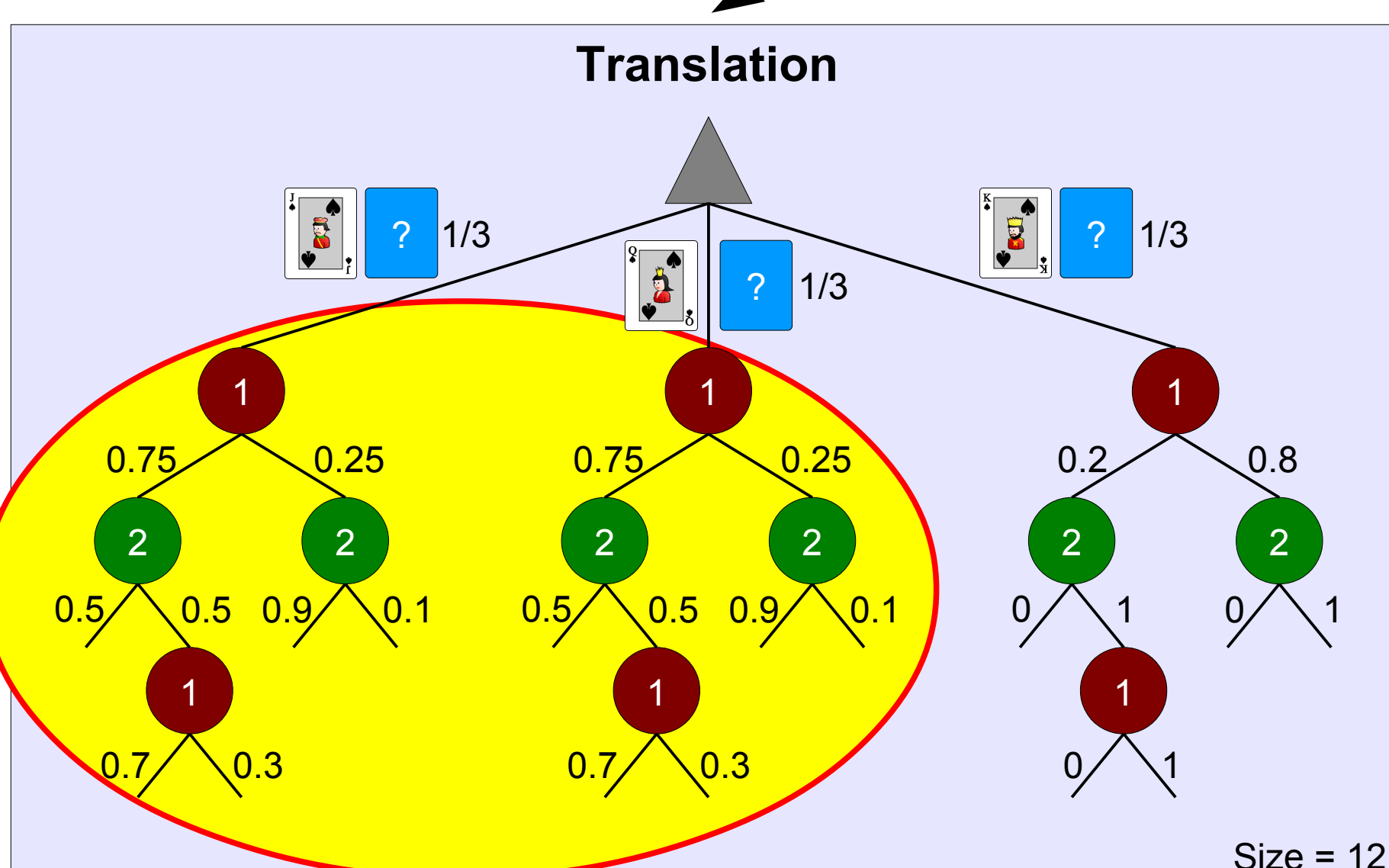
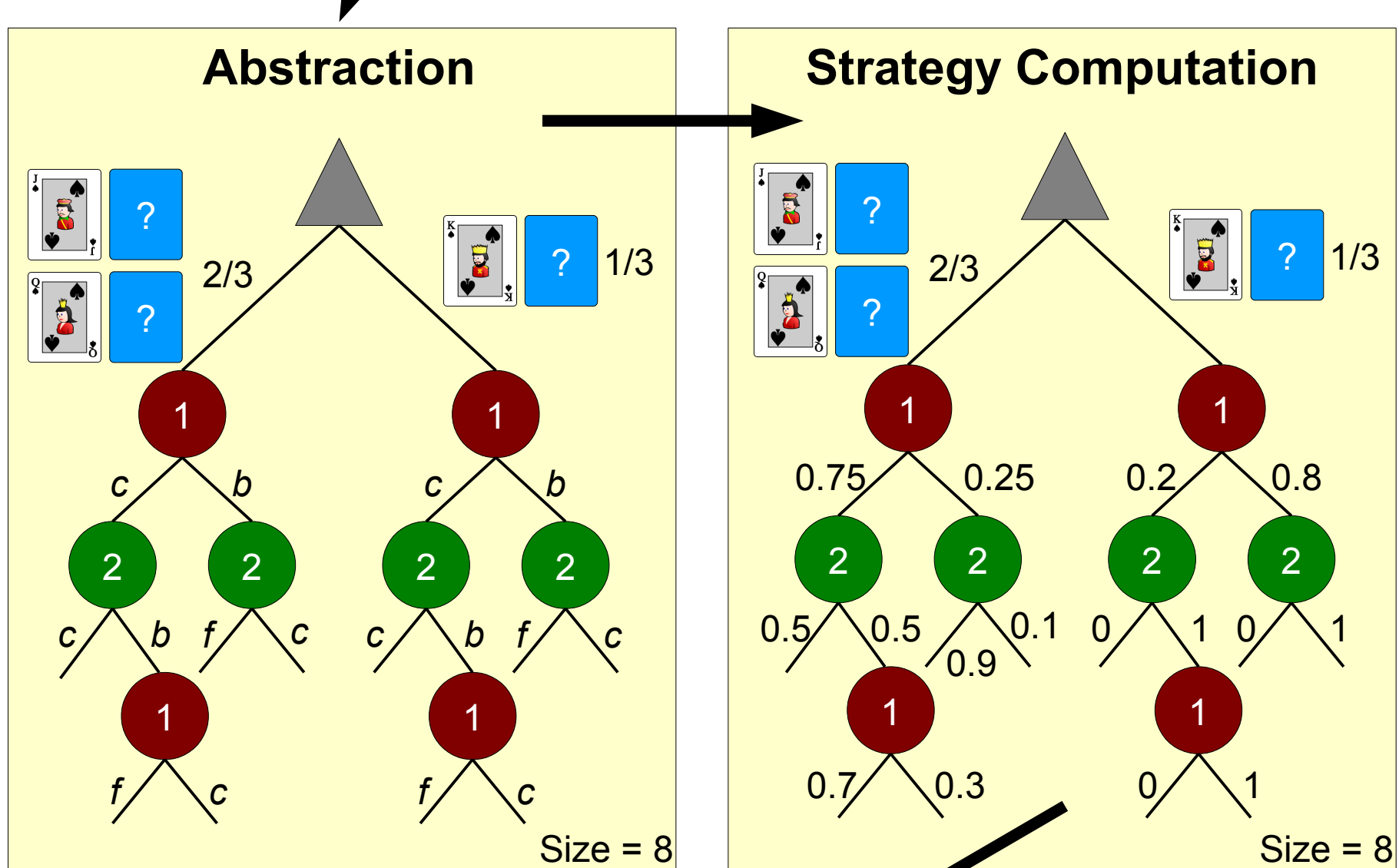
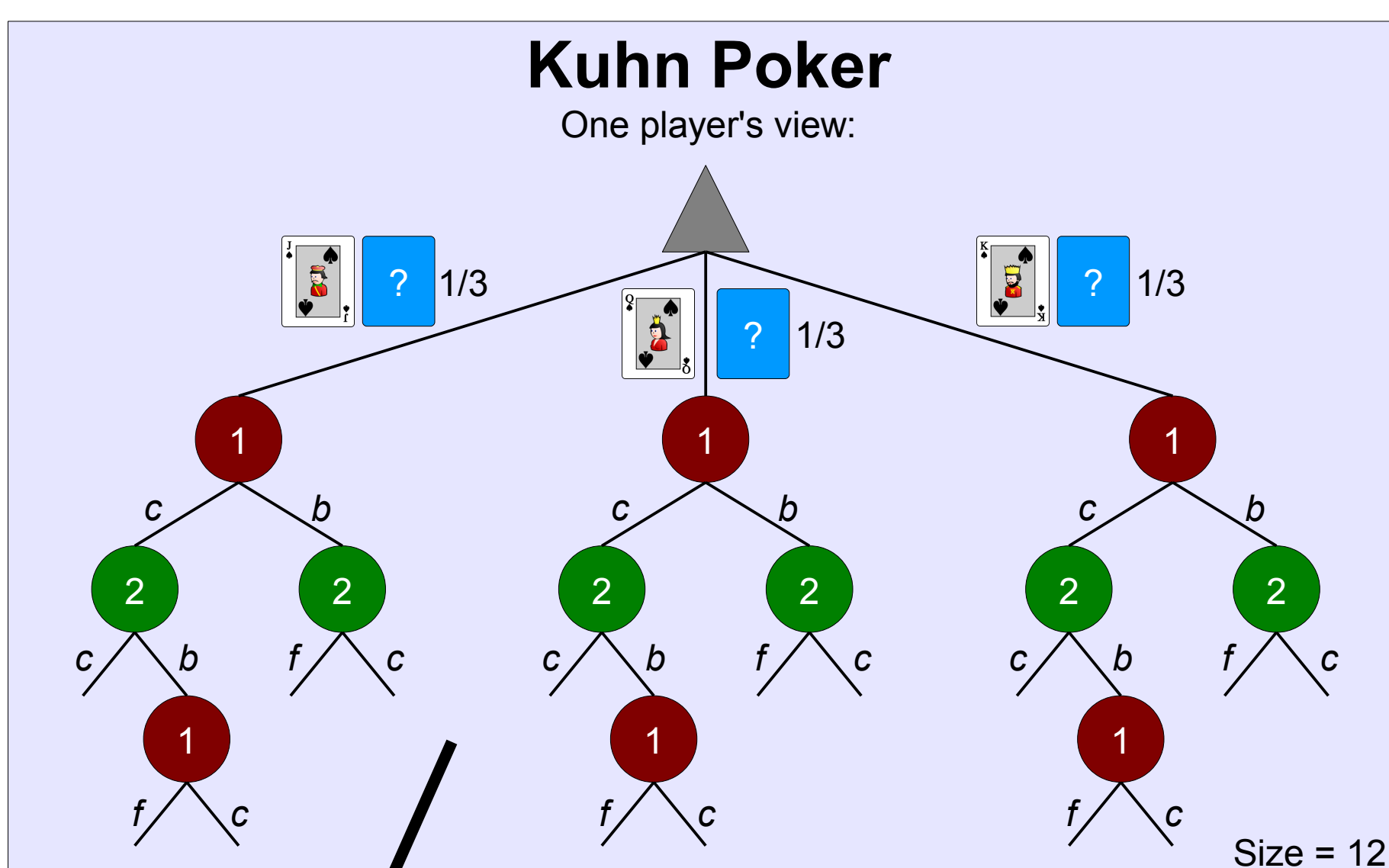
Goal: Build a world-class computer poker player

Typical procedure:



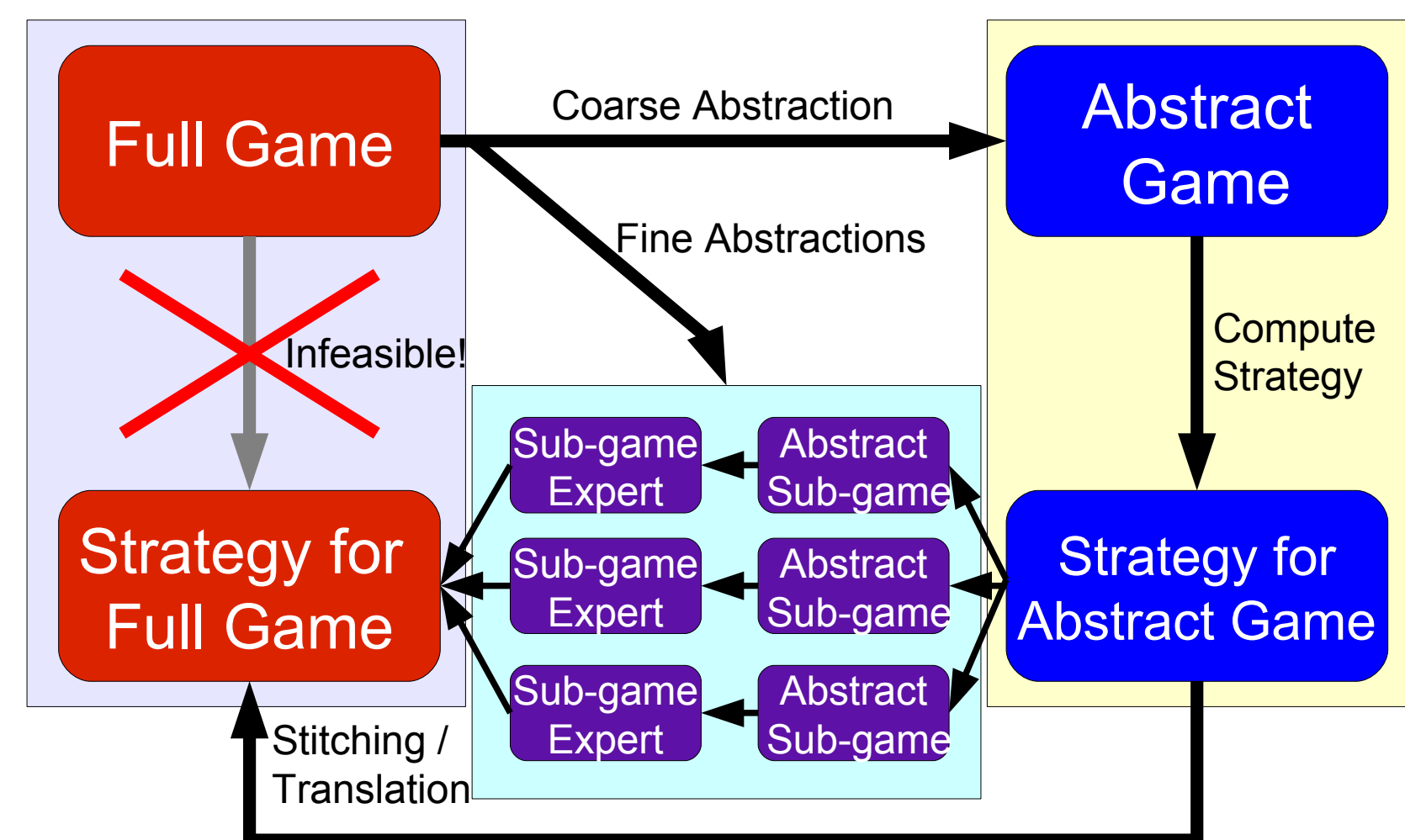
Example: Kuhn Poker (simple 2-player poker game):

- 3 card deck:
- Each player antes 1 chip and is dealt one private card.
- Each player can either check or bet 1 chip (no raises allowed).
- If one player bets, the other player may either fold or call.
- If neither player folds, player with highest card wins the antes and bets.

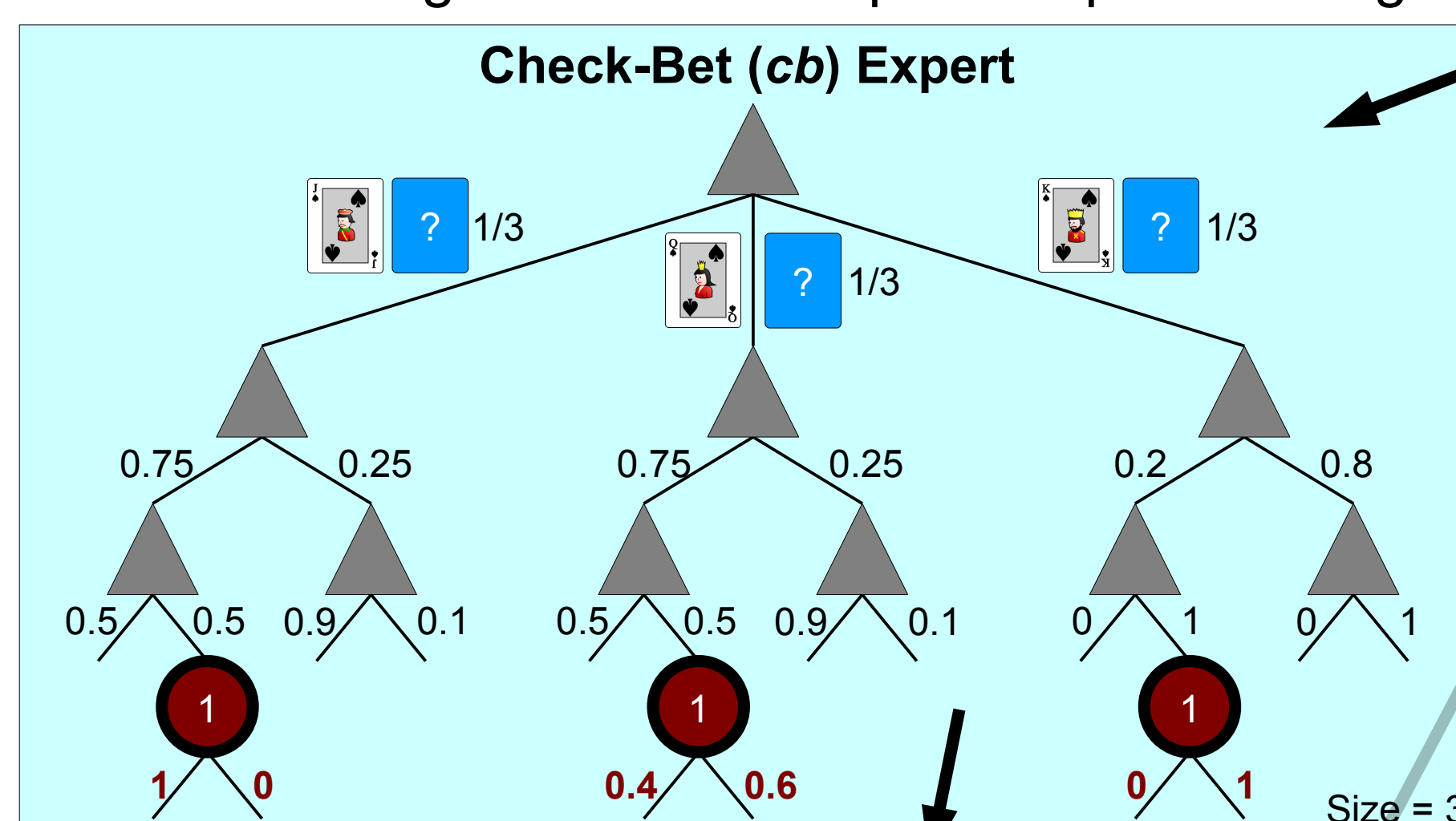


PROBLEM: May want to treat Jack and Queen differently!

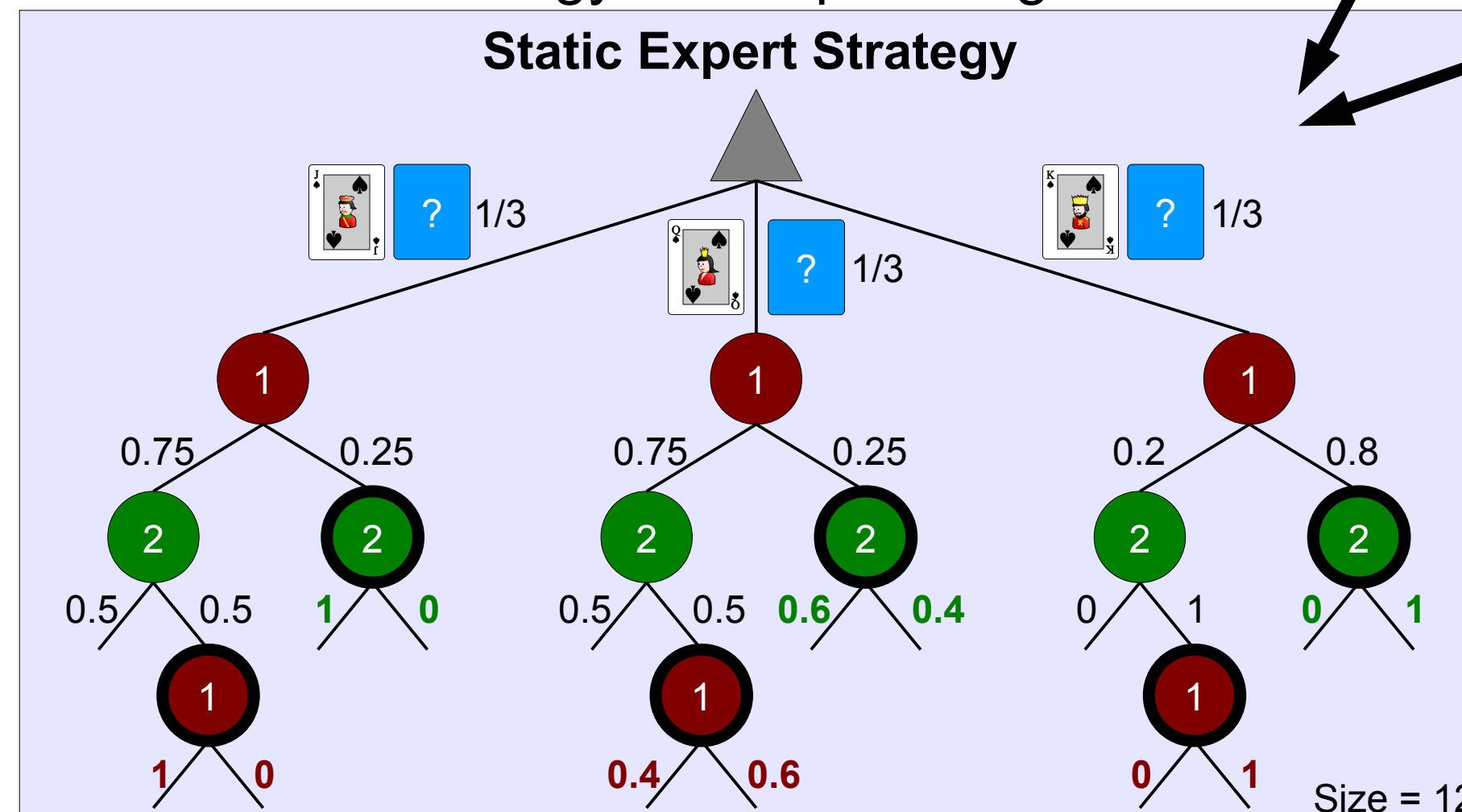
STATIC EXPERTS



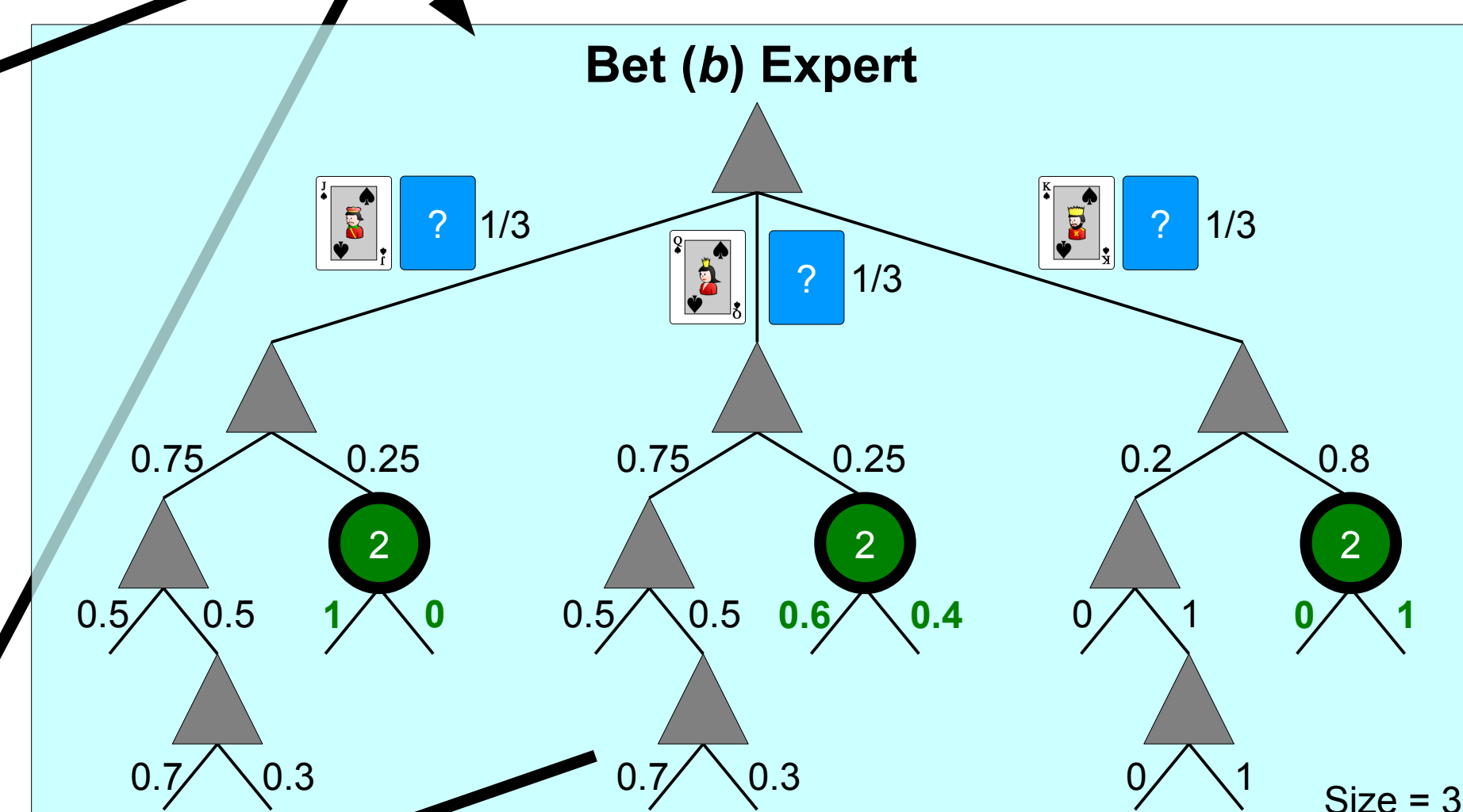
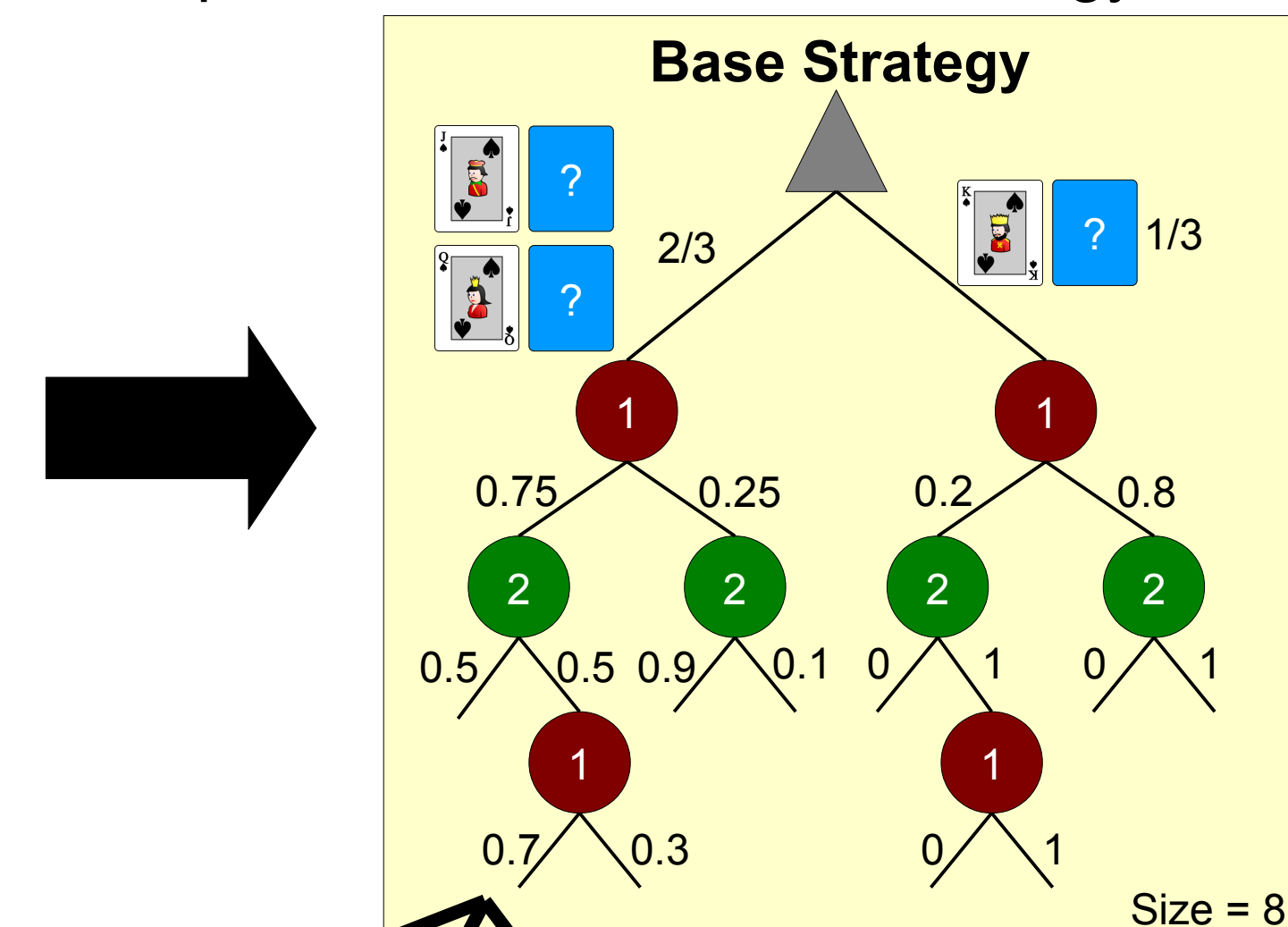
3. Create "sub-games" and compute "expert" strategies



4. Stitch base strategy and experts together

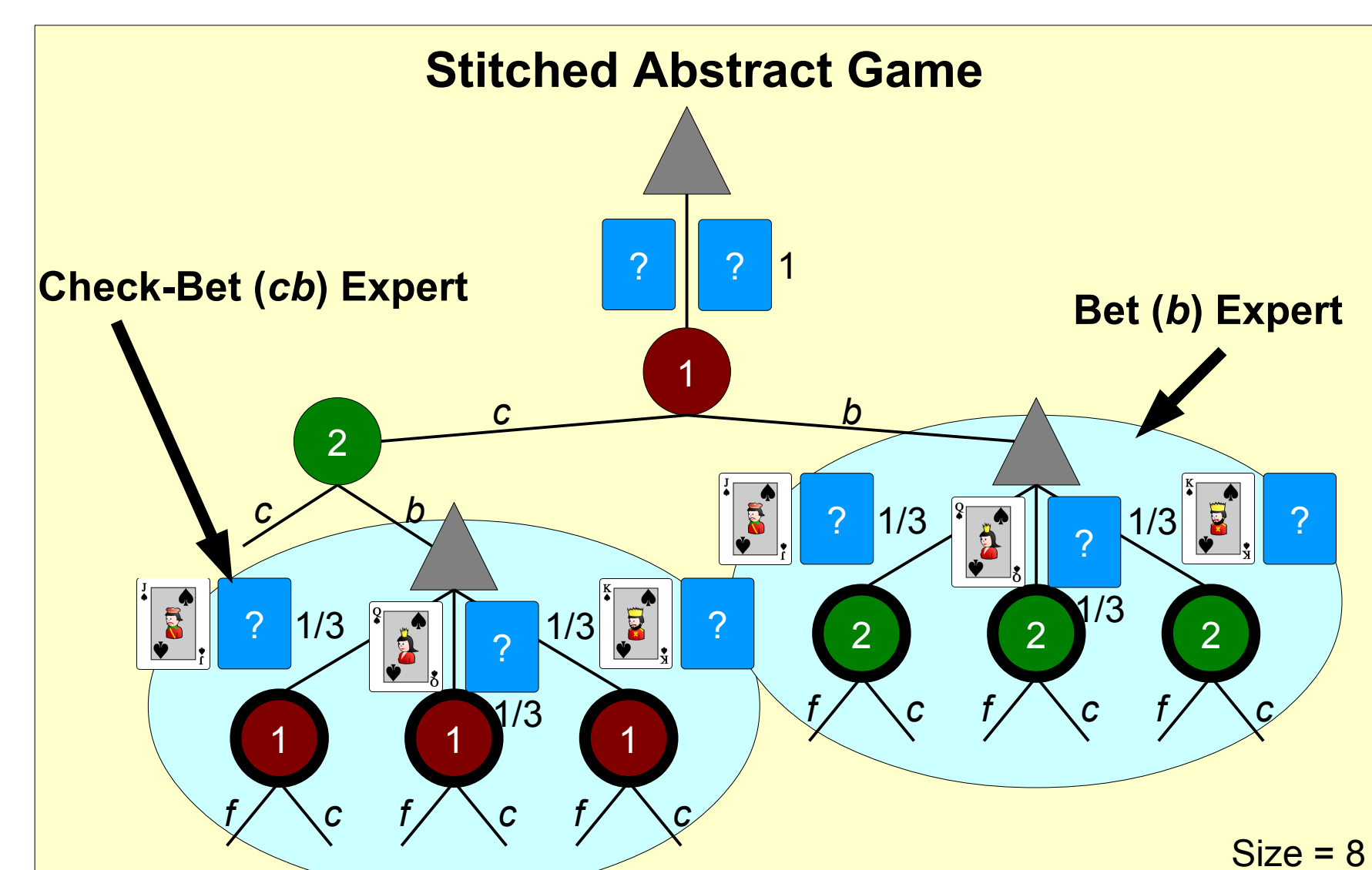
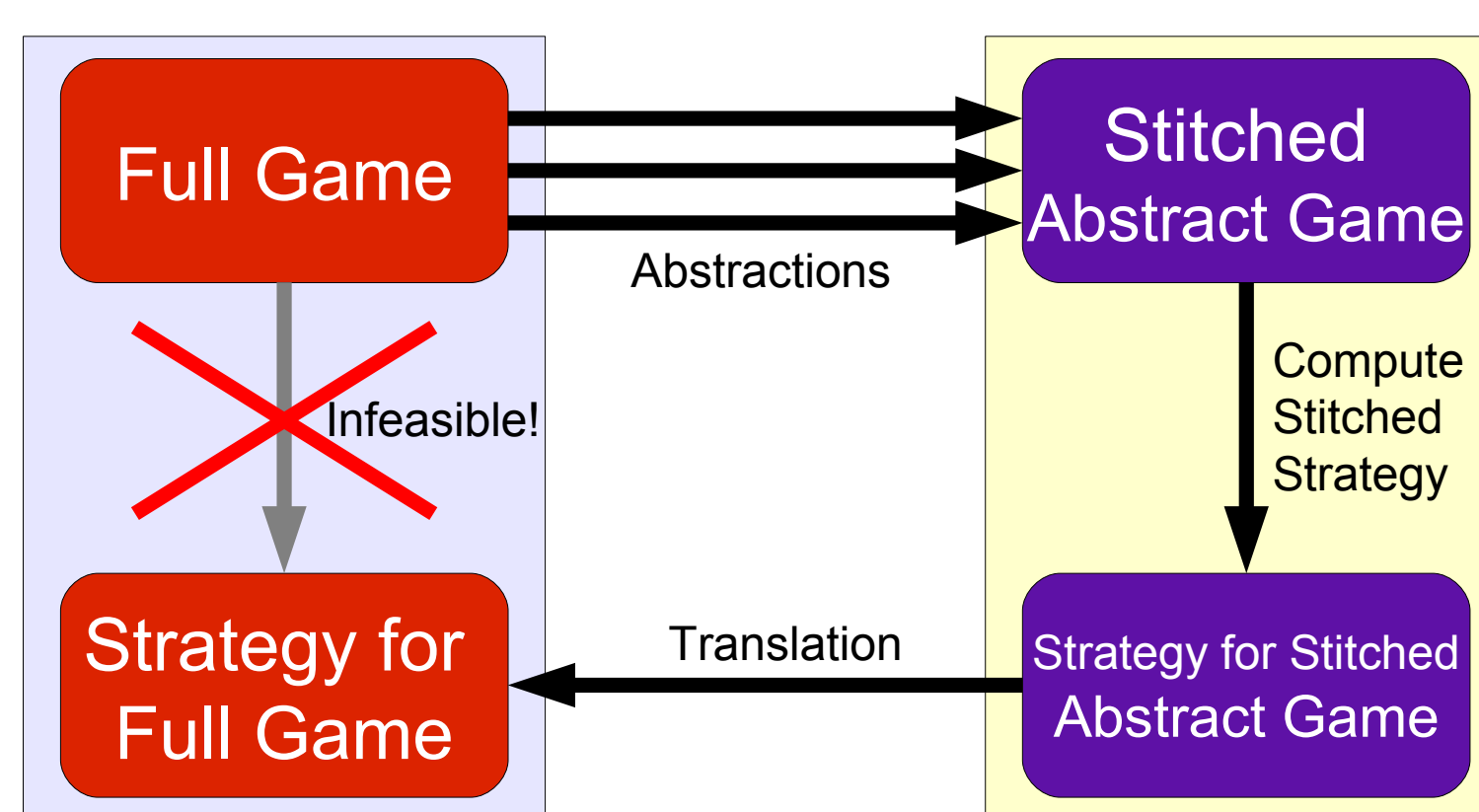


1. Pick a subset S of players. Ex. $S = \{1, 2\}$
2. Compute an abstract "base" strategy for every player in S



- Generalizes strategy grafting [Vaughn et al., NIPS 2009] and two poker specific adaptations [Billings et al., IJCAI 2003; Abou Risk and Szafron, AAMAS 2010] under a single framework
- Static experts increase abstraction granularity within the expert's subtree, allowing for more diverse abstract strategies to be created.
- **Independent of strategy computation** and abstraction techniques.
- Any base strategy could be used to "seed" the experts (example: human expert knowledge).
- However, experts make assumptions about opponent action probabilities: Example: Player 2 b -expert assumes player 1 will bet the K with prob 0.8.
- Our 3-player Texas Hold'em programs are built using static experts and won the 2010 and 2011 instant-runoff events of the Annual Computer Poker Competition.

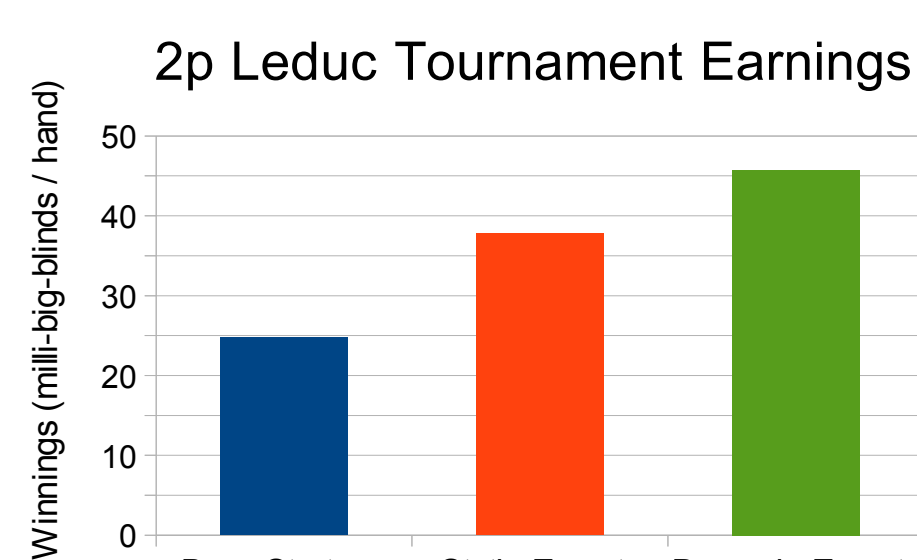
DYNAMIC EXPERTS



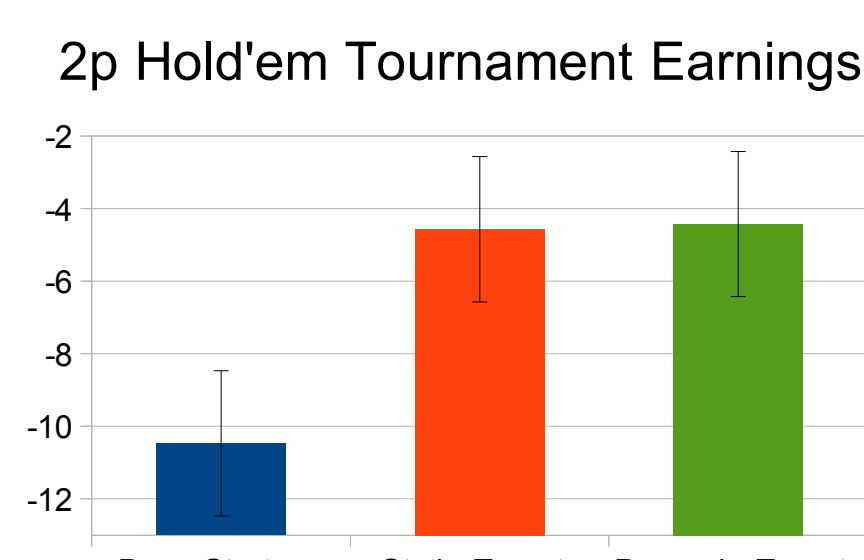
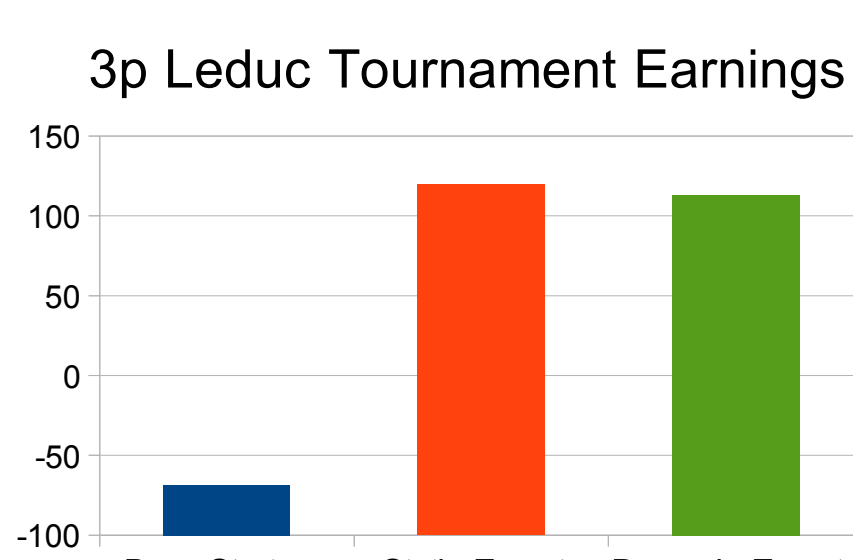
- Dynamic experts increase abstraction granularity at "more important" parts of the tree, but must sacrifice granularity elsewhere.
- We obtain one cohesive strategy that avoids fixing opponent action probabilities.

RESULTS

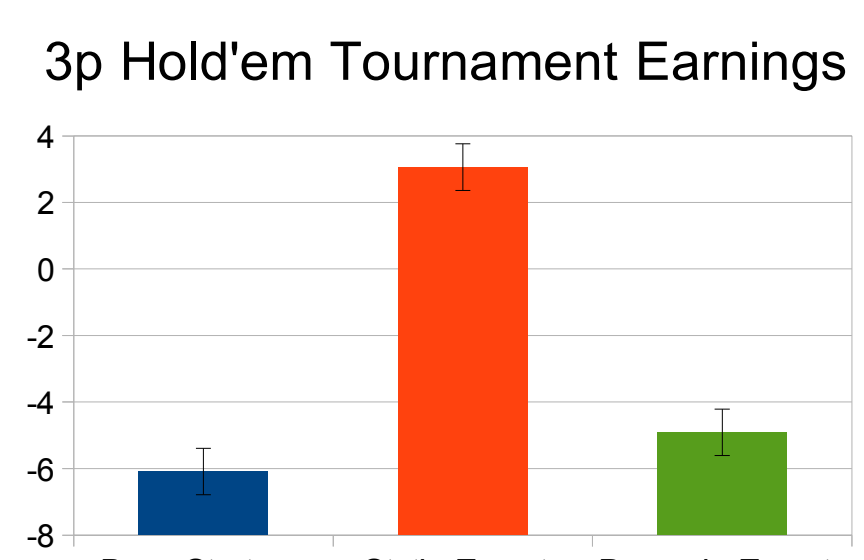
Leduc Strategy	Max Size (2p)	Max Size (3p)	Exploitability (2p)
Base	132	1890	496
Static	186	2145	433
Dynamic	444	6903	160



- Leduc poker is similar to Kuhn: 6 card deck, 2 betting rounds, max 1 raise per round.
- Built experts after the first bet occurs (Leduc and 2p Hold'em) and after the first fold occurs (3p Hold'em).
- All strategies generated using Counterfactual Regret Minimization [Zinkevich et al., NIPS 2008].
- Leduc used JQ-K (2p) and J-QK (3p) base abstractions, no abstraction for experts.
- Hold'em used percentile hand strength bucketing abstractions [Johanson, M.Sc. Thesis 2007], utilizing as many buckets as possible under an information set limitation (Max Size).
- Leduc tournaments consist of round robin play against fixed stable of players.
- Hold'em tournaments consist of round robin play amongst themselves and ACPC competitors.



Hold'em Strategy	Max Size (2p)	Max Size (3p)	Exploitability (2p)
Base	~24m	~162m	310
Static	~24m	~162m	289
Dynamic	~24m	~162m	308



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