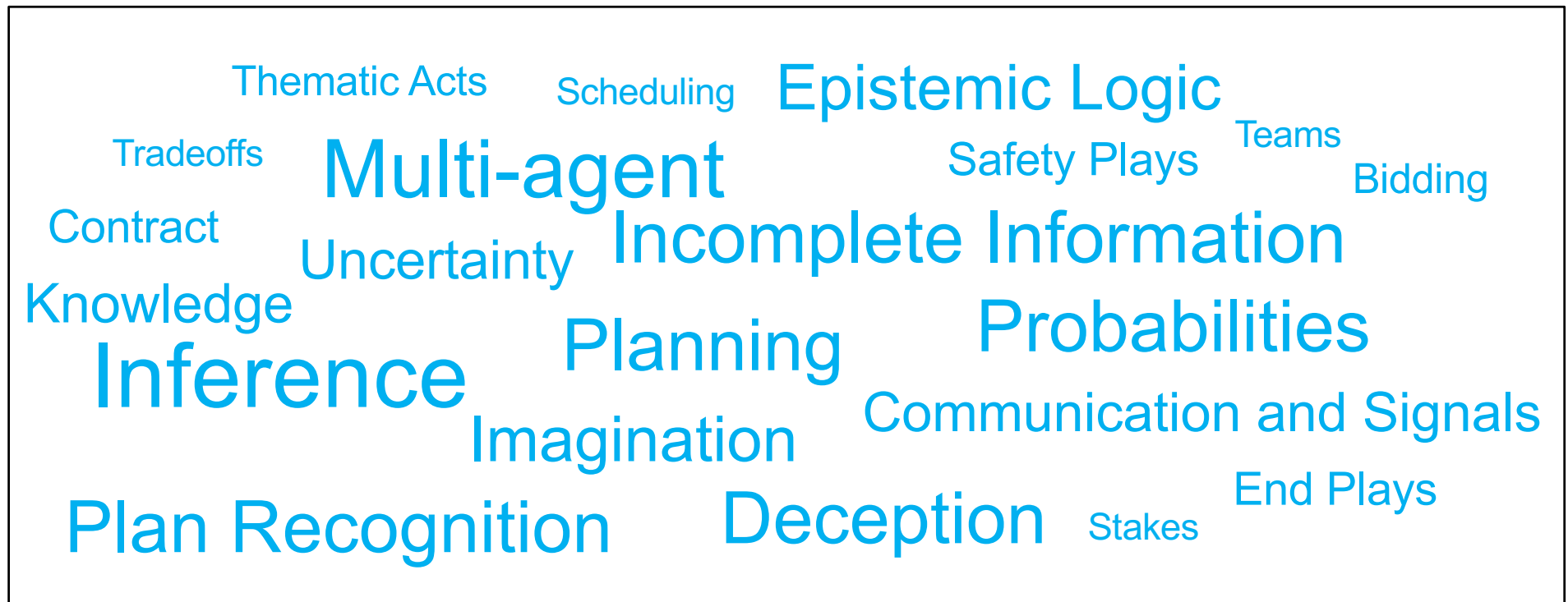


Contract Bridge: Par and Beyond

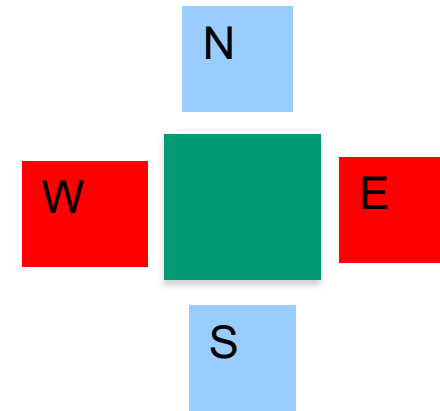
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A Bridge Foursome

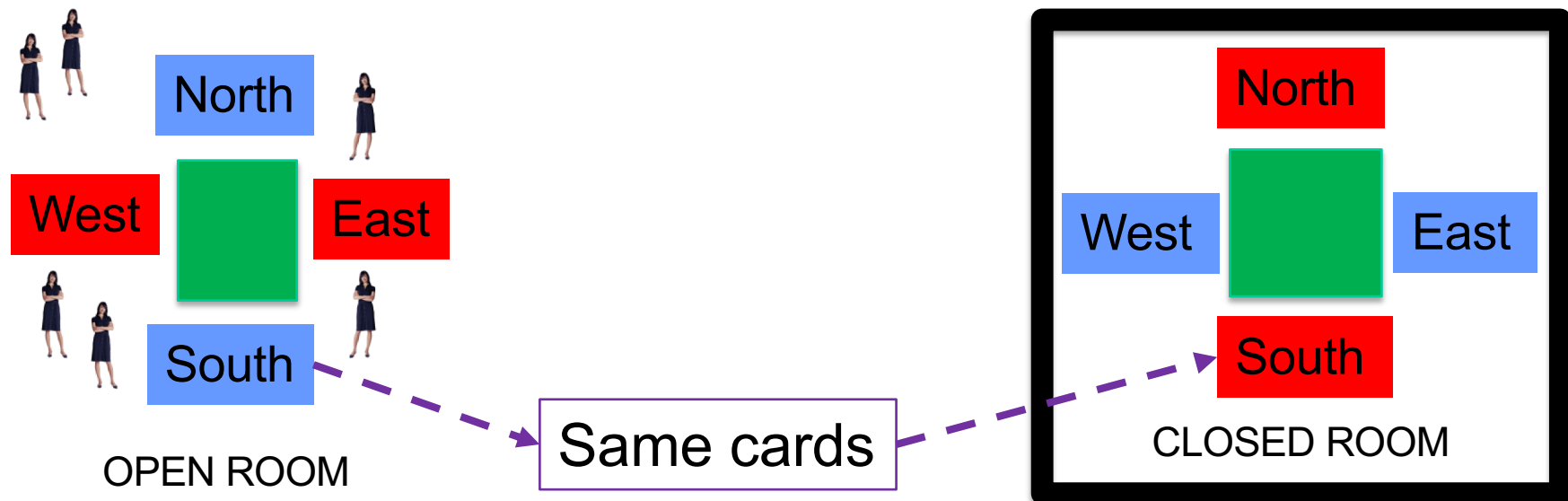
- On the table there are four players
- Traditionally called North (N), South (S), East (E) and West (W)
- N-S are partners and so are E-W
- All 52 cards are shuffled and dealt clockwise, each player getting 13
- The game has 2 phases
 1. Bidding (for the contract)
 - How many of the 13 'tricks' you bid for?
 2. Play of cards (fulfilling the contract)



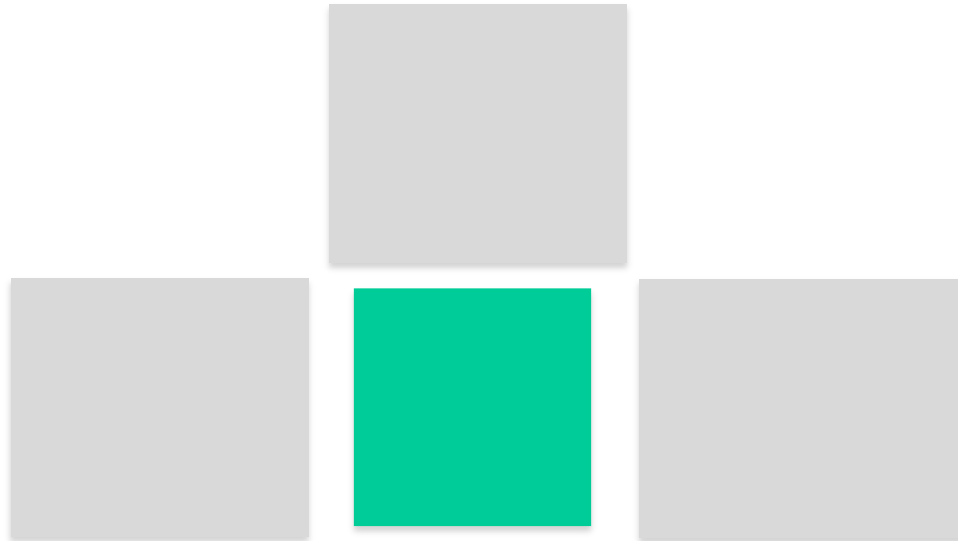
Bridge vs. Chess

- The number of different deals or starting positions is
 $5,364,659,935,864,916,575,237,440,000 = 5 \times 10^{27}$
 - Practically every deal is a new deal
 - The game tree for *each deal* has about 10^{21} leaf nodes
- Chess always has the same starting position, and the same goal
- Chess is played between two players
 - There is no communication, not deception, and no hidden information

A bridge match: Blue Team vs. Red Team



A Multi-agent Incomplete Information Game



♠ A 10 7
♥ A Q
♦ 9 8 2
♣ A Q 9 7 4

The number of possible worlds for a player during bidding is

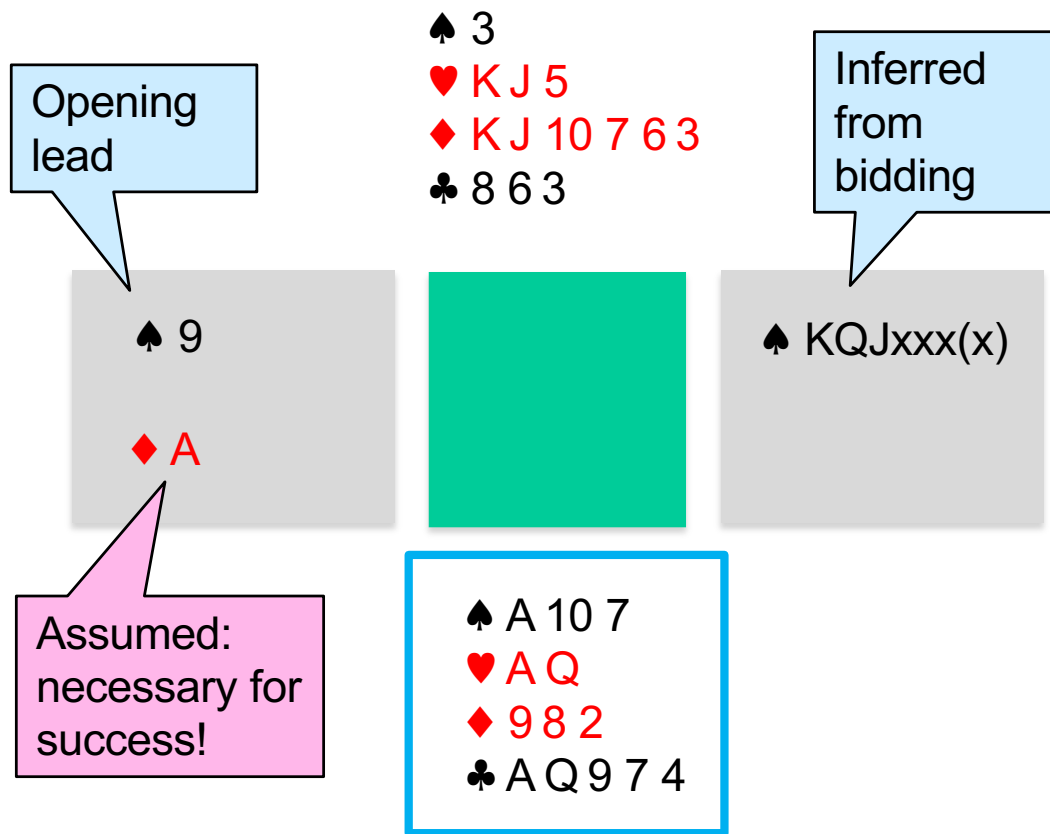
$$\begin{aligned} & {}^{39}C_{13} \times {}^{26}C_{13} \\ &= 8,122,425,444 \times 10,400,600 \\ &= 84,478,098,072,866,400 \\ &= 8.4 \times 10^{16} \end{aligned}$$

As bidding proceeds players gets additional information, which reduces the uncertainty.

This additional information is in the form of *features* like suit lengths or high card points.

Representing this additional information is a challenge.

Play: The Possible Worlds for Declarer



	Bidding			
West	North	East	South	
Pass	1 ♦	3 ♠	1 ♣	
Pass	Pass	Pass	3 NT	

The number of possible worlds for declarer after the opening lead is ${}^{25}C_{12} = 5,200,300$

Additional information received during bidding reduces this uncertainty.

As play proceeds more information accrues -

- the cards played
- inferences from the signals exchanged

In addition the declarer may make some *teleological assumptions*

Payoffs: Par

IF all four hands are visible* to each player
then the deal has a par score (Nash equilibrium)

The score may come from

- the declarer bidding and fulfilling an optimum contract C with a value say V
- the opponents bidding higher than the optimum contract C, not fulfilling it, but conceding a penalty $P < V$
 - it would not be possible for the declarer to bid a contract higher than C
 - that would result in a negative payoff instead of a gain

* Most current playing programs do Monte Carlo simulation on the hidden hands

Payoffs: Beyond Par

IF all four hands are NOT visible to each player then the deal may result in a non-par contract or non-par payoff

Let V be the par score with contract C bid by Team Red.

The deviation from par score may come if,

- Team Blue makes some **preemptive bids** thus consuming space needed by Team Red for exchanging information and **reaching** the par contract
- Team Blue employs **deception** during Bidding
- Team Blue employs **deception** during Play to defeat the par contract.

Card Play Techniques: Finesse

Works when East has the missing card

North: ♠ 9 2 ♠K
South: ♠ A Q

Play the ♠2 from the North hand.
IF East plays a small card
 play the ♠Q
ELSE (if East plays ♠K)
 play the ♠A

North: ♠ Q J ♠K
South: ♠ A 2

Play the ♠Q from the North hand.
IF East plays a small card
 play the ♠2
ELSE (if East plays ♠K)
 play the ♠A

North: ♠ 9 3 2 ♠Q
South: ♠ A K J

Play the ♠2 from the North hand.
IF East plays a small card
 play the ♠J
ELSE (if East plays ♠Q)
 play the ♠A

North: ♠ J 10 4 ♠Q
South: ♠ A K 2

Play the ♠J from the North hand.
IF East plays a small card
 play the ♠2
ELSE (if East plays ♠Q)
 play the ♠A

Planning in (Declarer) Play

- The declarer devises a set of plans
 - employing different card-play techniques.
- Each plan is based on a set of assumptions
 - the location of specific hidden cards
 - the distribution of cards in a given suit
- The probability of success = probability (assumptions are true)
 - for example, *a priori* the probability of a finesse working is 50%

- The declarer selects the plan with the highest probability and monitors the plan as play proceeds
 - do the assumptions still hold?
 - has a new opportunity arisen?
 - does one to re-plan?

Public Announcements

All actions are public announcements. Actions are of two types.

- Ontic: Play of a card.
 - Everyone can see what card is played.
 - The possible worlds are then pruned by each player.
- Epistemic: Bidding
 - A bid during the auction is a public announcement
 - For example, “*I hold five or more cards in the spade suit*”
- Epistemic: Play
 - A card, or a sequence of cards, may encode some information
 - For example, playing a king in the first position promises the queen
 - A “hi-lo” is a signal is encouraging partner to play the suit again

Information Gathering

- All players try to unearth information about the hidden cards
 - remember all actions are public announcements
 - both during bidding and play

In addition intent may be inferred

- Plans are synthesized using card play techniques
 - which are (generally) common knowledge
- Abduction or Plan Recognition can be employed

Deception

Public announcements do not have to be true

DECEPTION: Maurice H Gray: dispatch rider in World War I

South in 3 NT

♠ 3
 ♥ K J 5
 ♦ K J 10 7 6 3
 ♣ 8 6 3

♠ 9 2	♠ K Q J 8 6 5 4
♥ 9 8 7 3	♥ 10 6 4 2
♦ A Q 4	♦ 5
♣ K J 5 2	♣ 10

♠ A 10 7
 ♥ A Q
 ♦ 9 8 2
 ♣ A Q 9 7 4

Lead: ♠9

Bidding			
West	North	East	South
(Gray)			1 ♣
Pass	1 ♦	3 ♠	3 NT
Pass	Pass	Pass	

3♠ showed a long spade suit

The final contract 3 NT

South has to make 9 tricks

There is no trump suit

Gray sitting West led 9♠

Clearly East was a dangerous opponent and had to be kept at bay.

The cards as seen by the declarer

South in 3 NT

♠ 3
 ♥ K J 5
 ♦ K J 10 7 6 3
 ♣ 8 6 3

♠ 9

♠ K Q J x x x x
 inferred from bidding

♠ A 10 7
♥ A Q
♦ 9 8 2
♣ A Q 9 7 4

Lead: ♠9

Bidding			
West	North	East	South
(Gray)			1 ♣
Pass	1 ♦	3 ♠	3 NT
Pass	Pass	Pass	

3♠ showed a long spade suit

The final contract 3 NT
 South has to make 9 tricks
 There is no trump suit

Gray sitting West led 9♠

The cards as seen by West

South in 3 NT

♠ 3
 ♥ K J 5
 ♦ K J 10 7 6 3
 ♣ 8 6 3

♠ 9 2
 ♥ 9 8 7 3
 ♦ A Q 4
 ♣ K J 5 2

♠ K Q J x x x x
 inferred from bidding

Good club suit
 Good points
 inferred from bidding

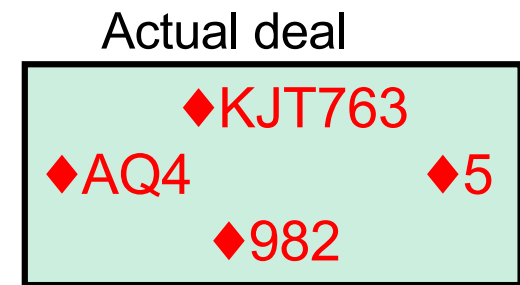
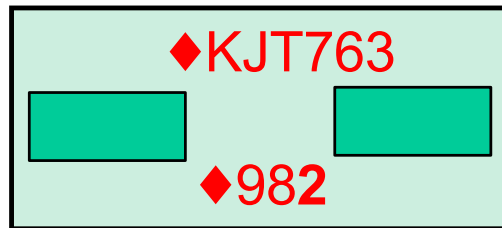
Bidding			
West	North	East	South
(Gray)			1 ♣
Pass	1 ♦	3 ♠	3 NT
Pass	Pass	Pass	

Maurice Gray sitting West led 9♠

The moment he saw the dummy he knew that the declarer will go after diamonds, and what is more, will succeed.

He thought up a devious counterplan....

How should declarer play diamonds?

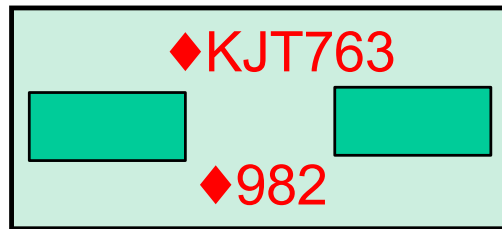


Goal: Set up diamond tricks without giving a trick to East
 The ♦A HAS to be with West. Else the contract can never make..
 PLAN: Play small diamond to King ..

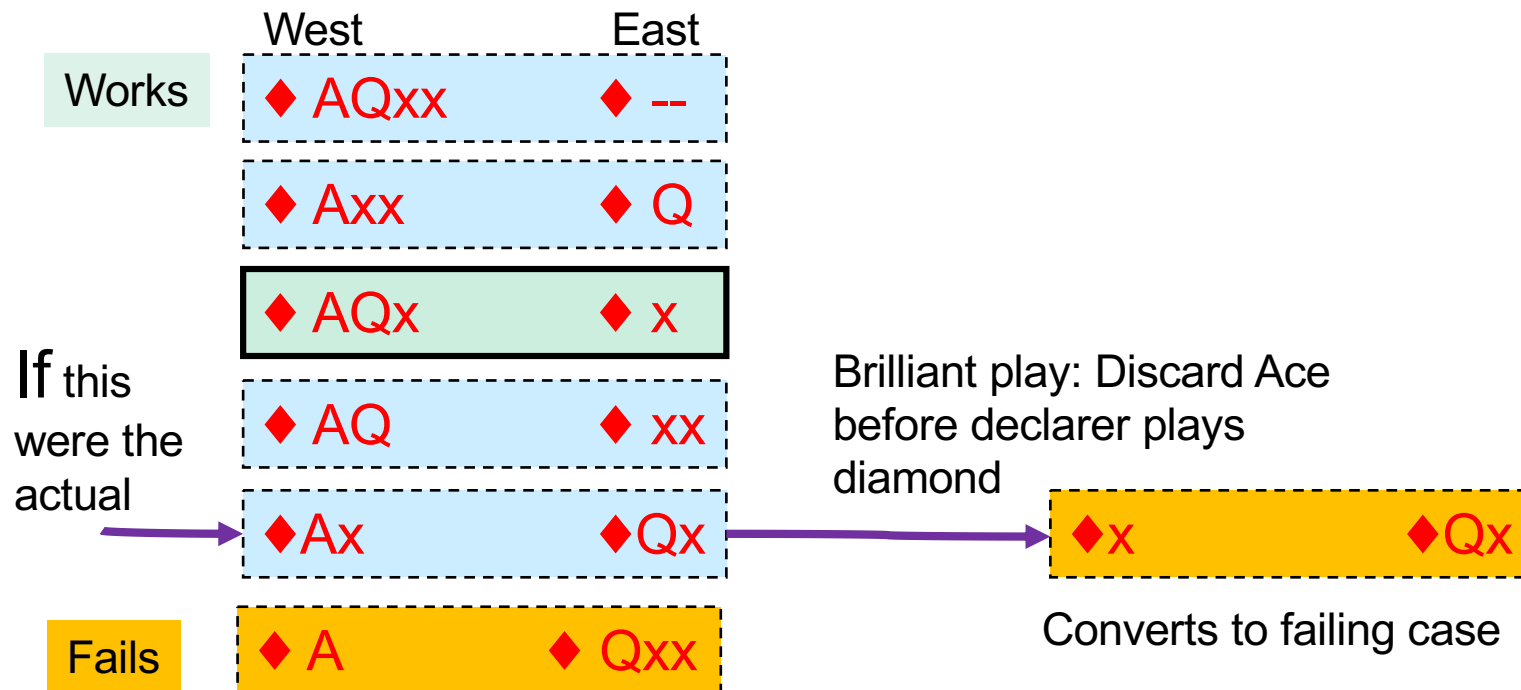
	West	East	
Works	♦ AQxx	♦ --	
	♦ Axx	♦ Q	
Actual	♦ AQx	♦ x	2
	♦ AQ	♦ xx	
	♦ Ax	♦ Qx	2
Fails	♦ A	♦ Qxx	

Different possible worlds for the diamond suit

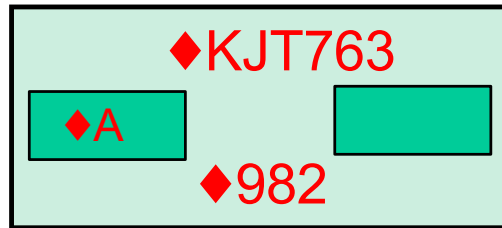
DECEPTION: Maurice H Gray: dispatch rider in World War I



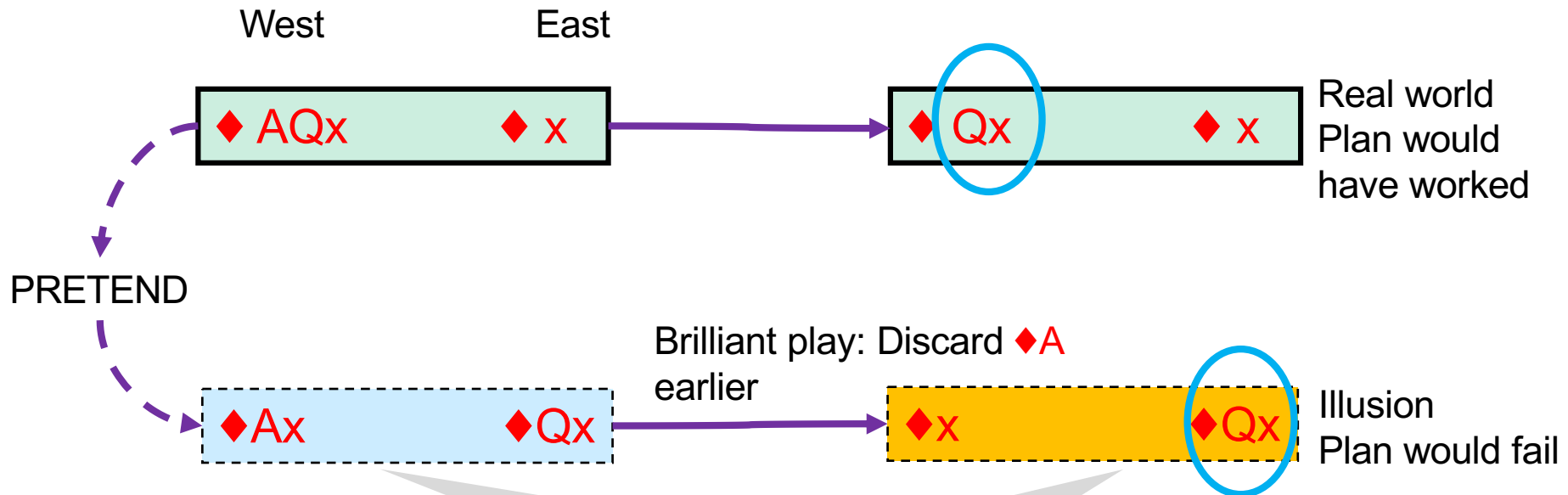
PLAN: Play small diamond to King ..



DECEPTION: Maurice H Gray: dispatch rider in World War I

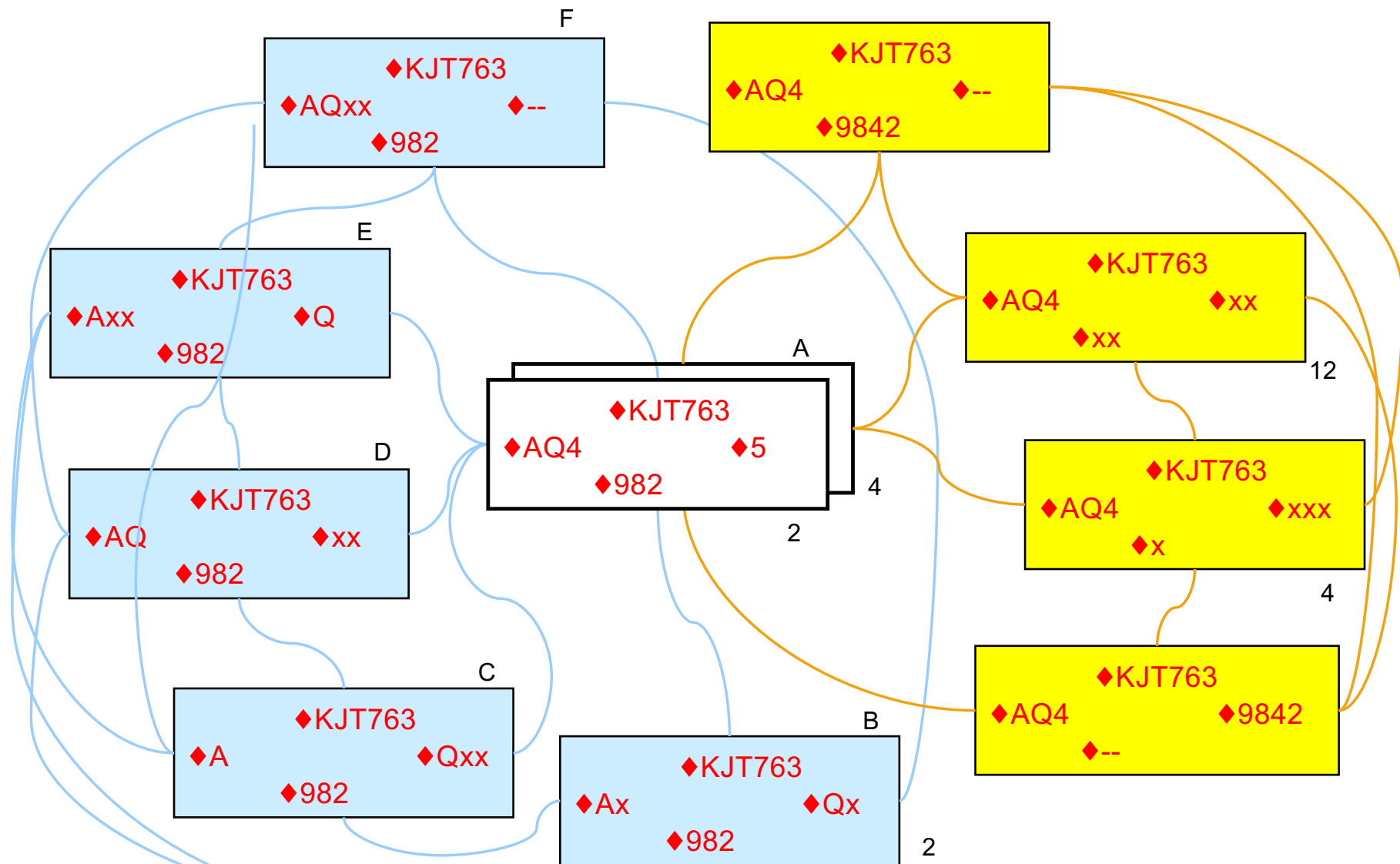


PLAN: Play small diamond to King ..
COUNTERPLAN: Deception: Discard ♦A



Declarer BELIEVED this is actual hand, because the diamond ace discard makes sense here, and abandoned the winning line of play

The possible worlds according to South and West

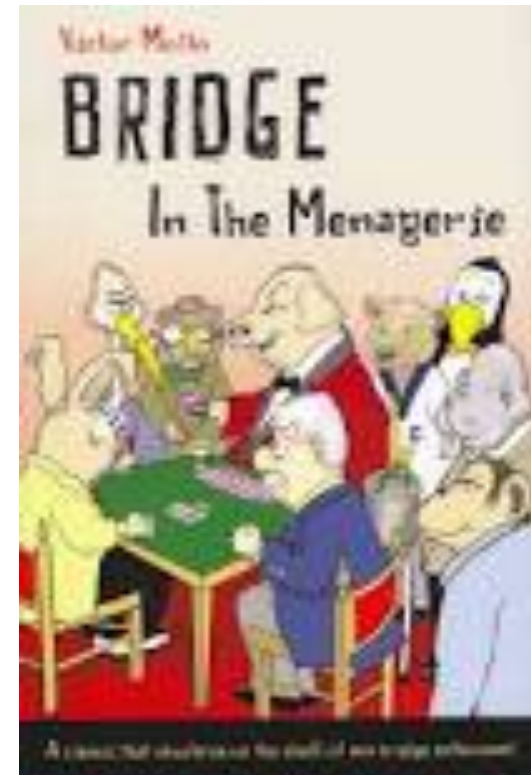


Gray imagined South's uncertainty and played AS IF this was the real world!

Cloak & Dagger (from this book by Victor Mollo)

“Papa made his plan and looked round at the kibitzers. He was not ‘a rose full born to blush unseen and waste its fragrance on the desert air.’ As he led a diamond to dummy’s ten, he waited to be noticed.

Alas, unsuspected by the Greek, the Hog had not only the knave of diamonds, but also a well-camouflaged heart, which he had been nursing secretly from the start. He now took it from its hiding place and the unbreakable contract was quickly broken.”

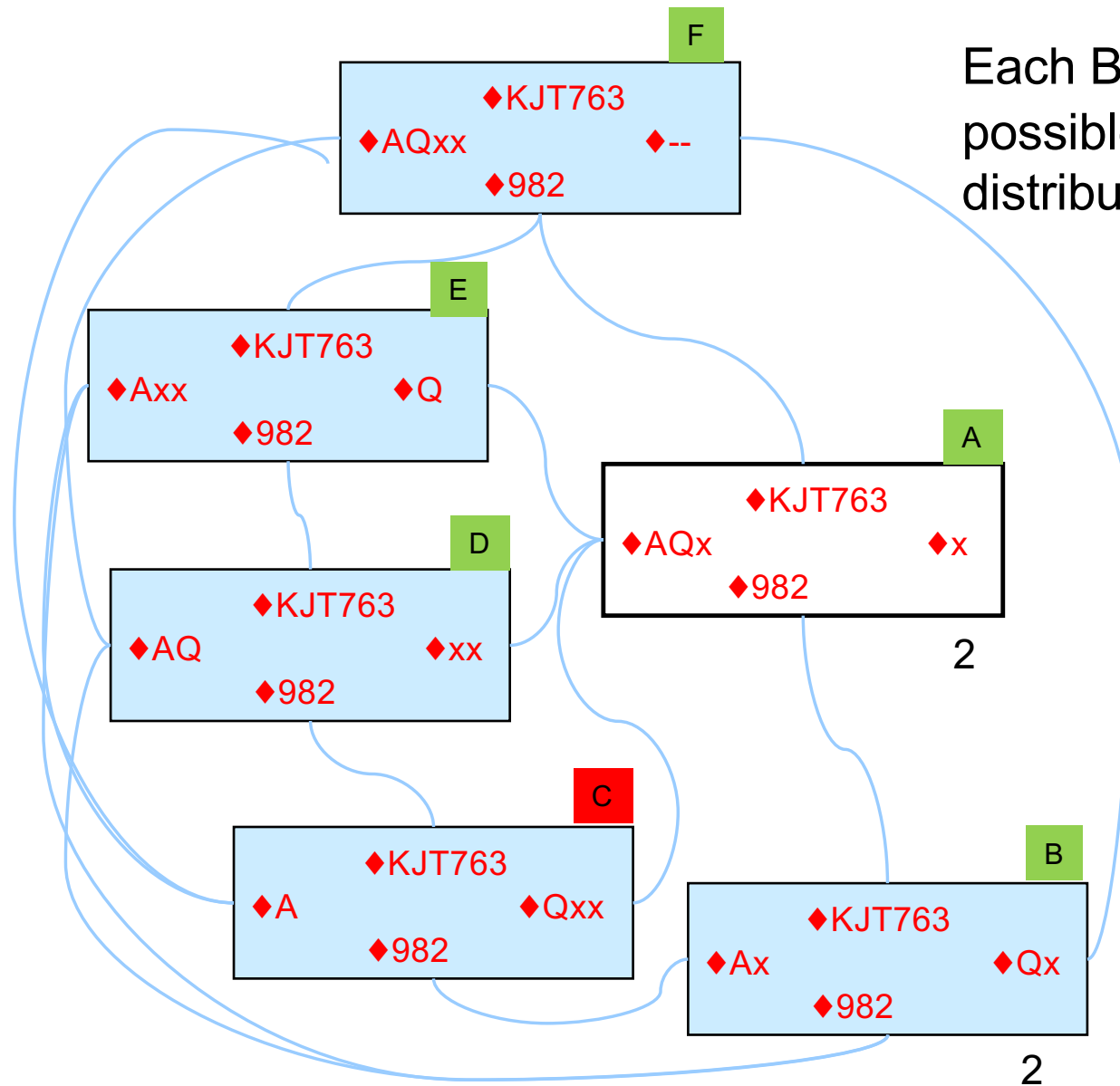


Further reading:

Fred Karpin, Psychological Strategy in Contract Bridge: The Techniques of Deception and Harrassment in Bidding and Play, Dover Publications Inc. 1978.

Thank you

South cannot distinguish between these diamond possibilities



Each Box stands for a **cluster** of possible worlds with different distribution of the other three suits.

The Avoidance play works in Worlds A, B, D, E and F, that is, in 7 out of 8 Worlds. – high probability

So South planned to duck two rounds of Spades and then use the Avoidance play.

On Trick 3 West discarded the A !!!

South in 3 NT

♠	3		
♥	K J 5		
♦	K J 10 7	6 3	
♣	8 6 3		
♠	9 2	♠	K Q J
♥		♥	
♦	A	♦	
♣		♣	
♠	A 10 7		
♥	A Q		
♦	9 8 2		
♣	A Q 9 7 4		

After 3 tricks

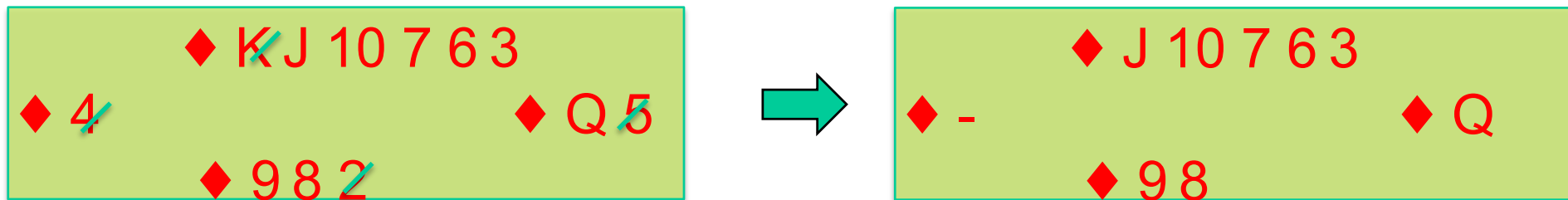
	W	N	E	S
Trick 1	♠9	♠3	♠J	♠7
Trick 2	♠2	♦3	♠K	♠10
South let East win first two tricks				

Trick 3	E	S	W	N
	♠Q	♠A	♦A	♦6
South wins with ♠A and Gray discarded the ♦A !!!				

What is happening here? Has West found the brilliant defense of throwing away the ♦A to make way for the ♦Q held by East?

The effect of sacrificing the ♦A in the *imagined* hand

The situation is depicted below AFTER West has made this brilliant discard.
The ♦A has been removed from the battlefield.

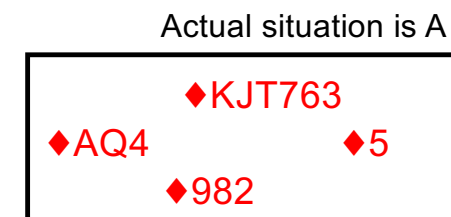
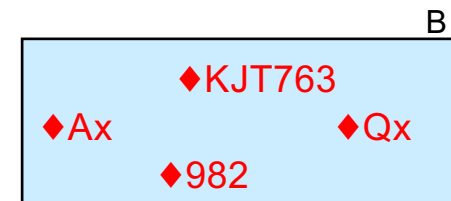


Now when South plays a small diamond card North wins with ♦K, but East has the ♦Q and can no longer be prevented from cashing all the spades in his hand.

On seeing the ♦A South

- wrongly infers that the situation is B
- “recognizes” West’s “counter plan”
- abandons his current Avoidance plan
- tries alternate plan which fails!

The deception has worked!



PLAY: Avoidance play

Let us say declarer wants to keep East at bay while playing the following suit

	♦ K J 10 7 6 3	
♦ A 5		♦ Q 4
	♦ 9 8 2	

	♦ K J 10 7 6 3	
♦ A 5 4		♦ Q
	♦ 9 8 2	

Play the ♦2 from the South hand

IF West plays small play the ♦K from the North hand.

IF West plays the ♦A then play ♦3 from the North hand.

Works when West has the Ace and East the Queen at most doubleton

♦ A 5	♦ Q 4
West will be forced to win with ♦A on the next round, and capture the ♦Q.	

♦ A 5 4	♦ Q
The ♦Q will fall when the ♦K is played.	