PS 0500: Basic Models of Conflict and Cooperation

William Spaniel

williamspaniel.com/IR22

Outline

- Background
- The Prisoner's Dilemma
- The Cult of the Offensive
- Tariffs and Free Trade
- Arms Races
- Repeated Interaction
- Coordination Problems

Under what conditions can two parties play nice with one another?

The Temptation

- In many circumstances, people have incentive to be mean to one another
  - Example: Your roommate leaves $20 sitting out

The Temptation

- In many circumstances, people have incentive to be mean to one another
  - Example: Your roommate leaves $20 sitting out
- Laws make it simple to resist the temptation
  - If you steal the $20, you go to jail

Anarchy, Again

- No world police exists
- We cannot just make laws to force two states to be nice to one another
- Is cooperation impossible under these circumstances?
  - If it is possible, how can we structure interactions to achieve cooperation?

Outline for the Unit

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- How can individually rational behavior lead to collectively bad outcomes?
- Can the shadow of future interaction induce two states to play nice with one another?
- What if the future is never ending?
- Can two cooperative people nevertheless fail to cooperate?

IR Applications

- “The Cult of the Offensive” and the origins of World War I

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- Tariffs and free trade policy

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IR Applications

- “The Cult of the Offensive” and the origins of World War I
- Tariffs and free trade policy
- Arms races and arms treaties
- “The Evolution of Cooperation” and trench warfare

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How can individually rational behavior lead to collectively bad outcomes?

The Situation

- Two suspects are arrested
- Police think that they wanted to rob a store
  - But only proof that the suspects were trespassing
- Thus, police need one of criminals to rat out the other

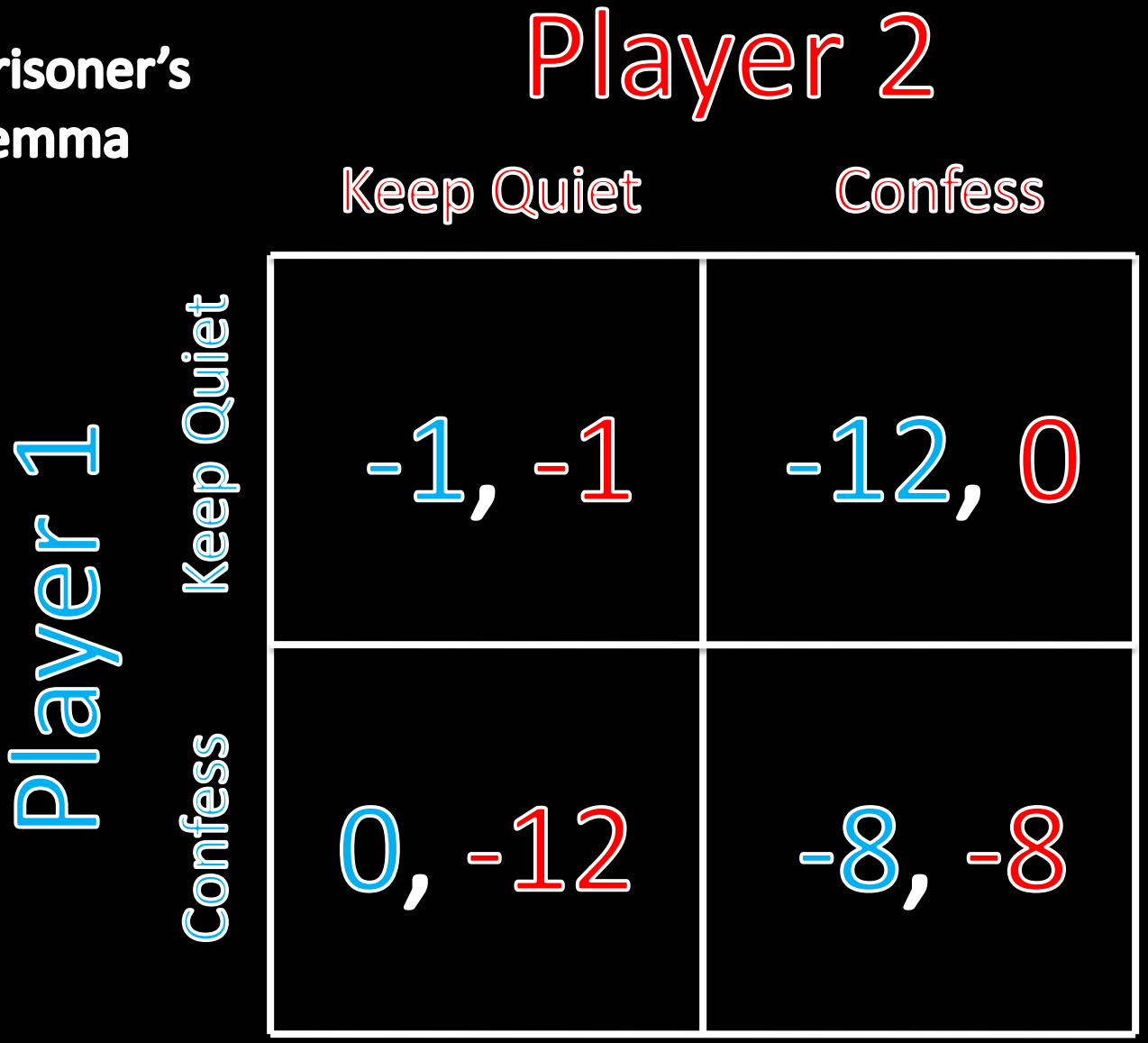
The Potential Deal

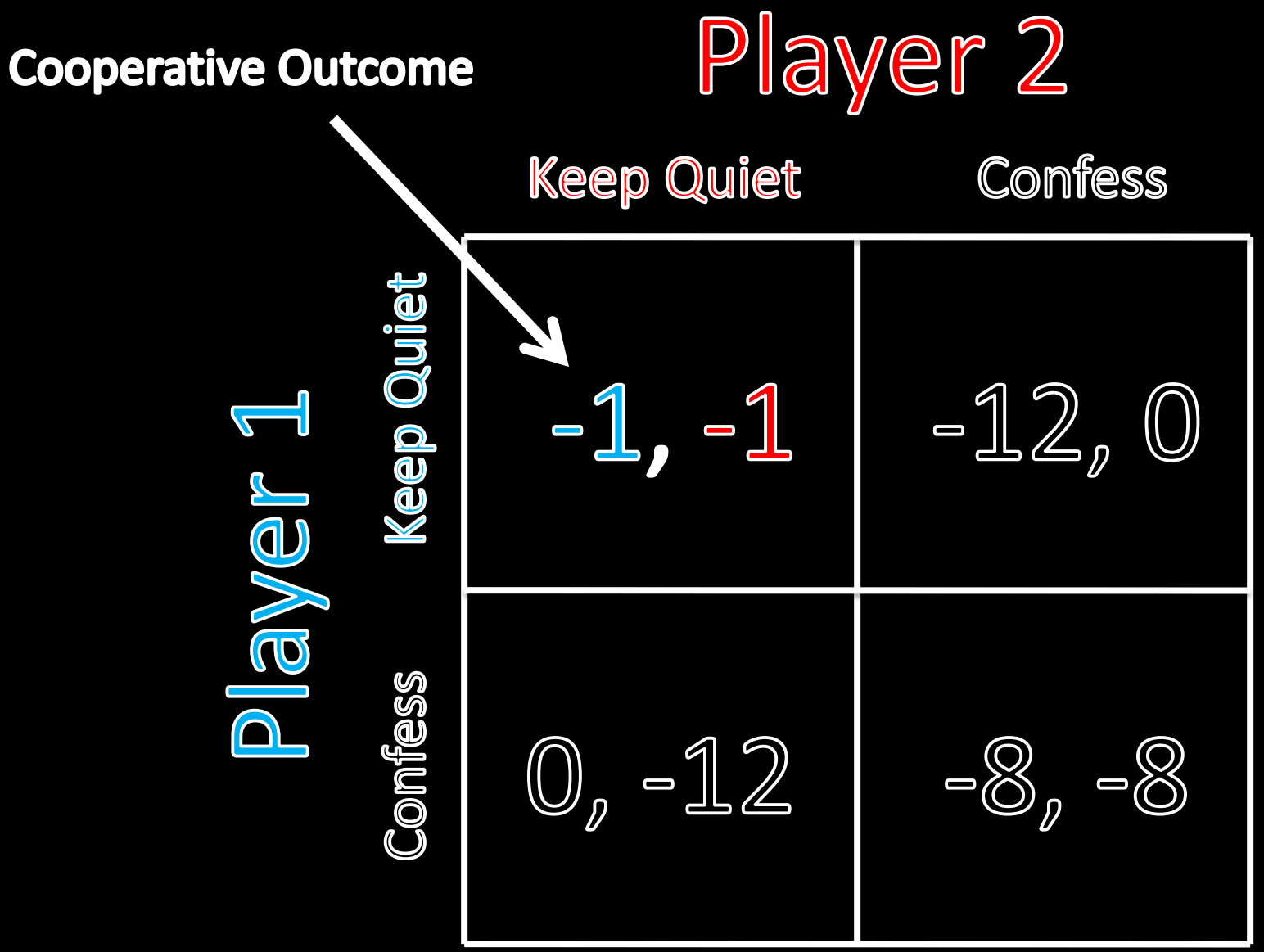
- If no one confesses to robbery, police can only charge the prisoners for trespassing
  - Punishment: 1 month in jail each
- If one confesses and the other doesn't, police will be lenient on the rat and severely punish the quiet one:
  - Punishment: 12 months in jail for the quiet one; 0 months for the rat
- If both confess, police punish both equally
  - Punishment: 8 months in jail each

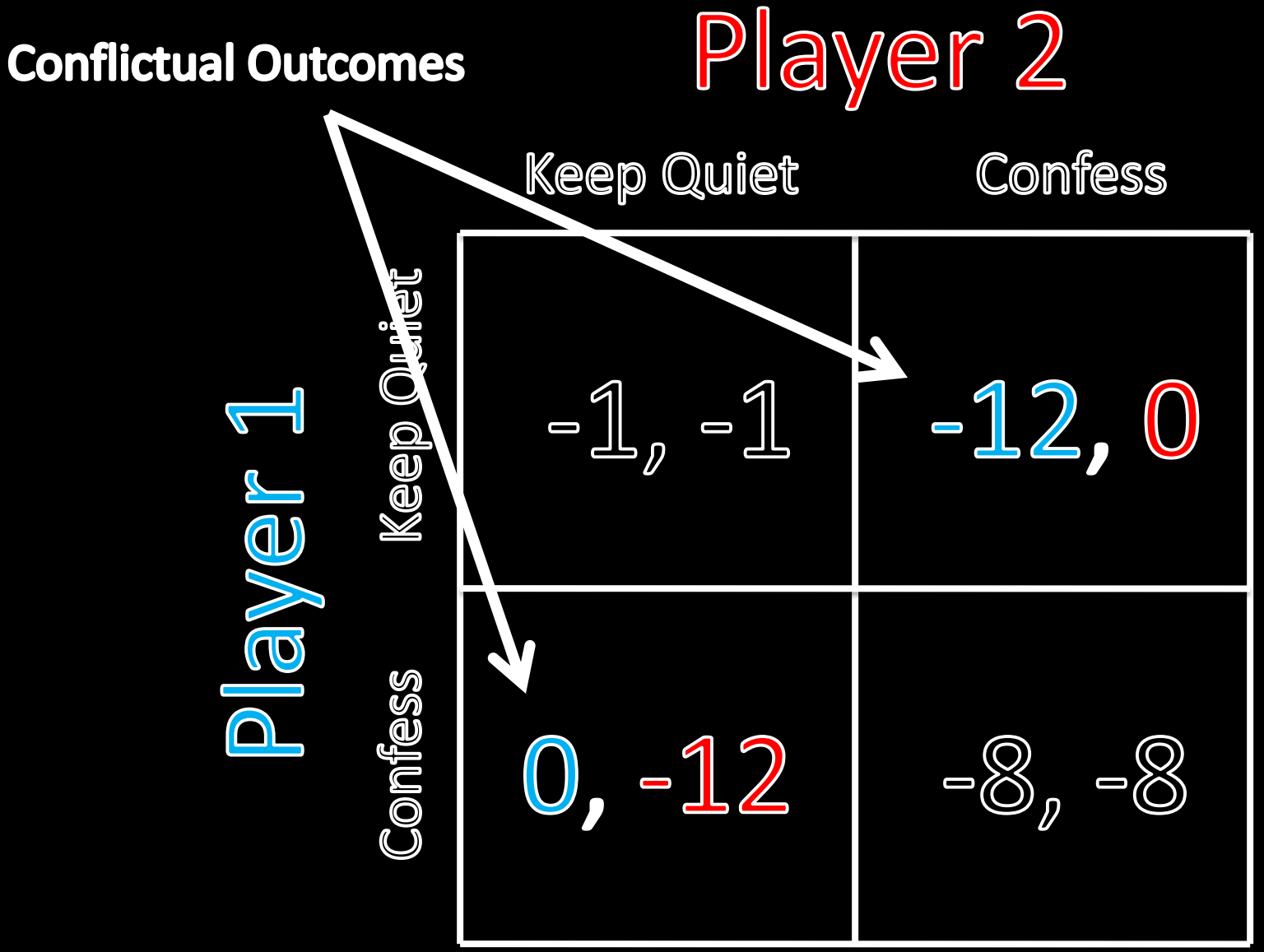
The Question

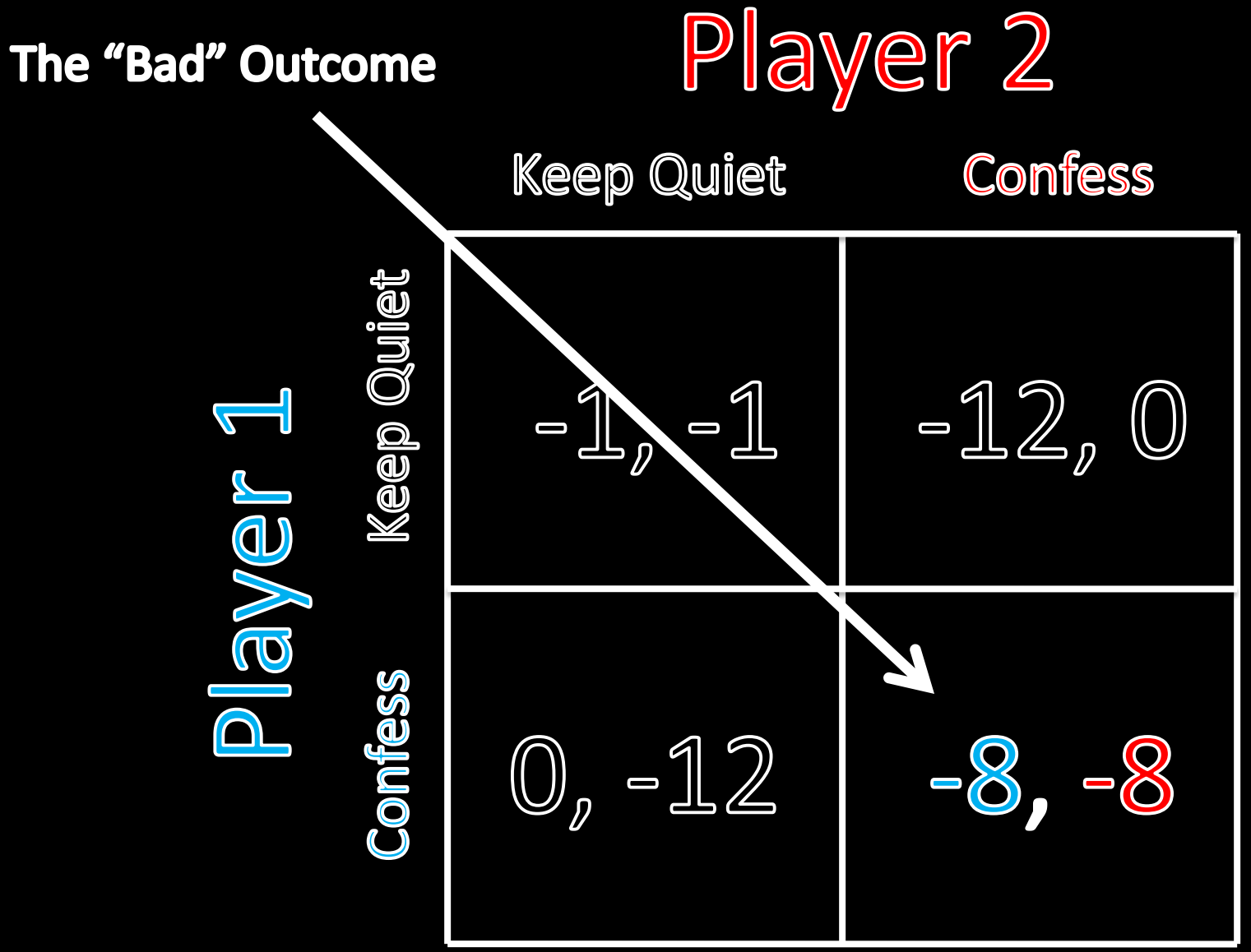
- *No Honor Among Thieves*
  - Suppose each thief only wants to minimize the number of months he spends in jail
- Should they confess to the police?

The Prisoner's Dilemma




Cooperative Outcome
Player 2
Keep Quiet
Confess
Player 1
Keep Quiet
Confess
-1, -1
-12, 0
0, -12
-8, -8


Conflictual Outcomes
Player 2
Keep Quiet
Confess
Player 1
Keep Quiet
Confess
-1, -1
-12, 0
0, -12
-8, -8


The "Bad" Outcome
Player 2
Keep Quiet
Confess
Player 1
Keep Quiet
Confess
-1, -1
-12, 0
0, -12
-8, -8

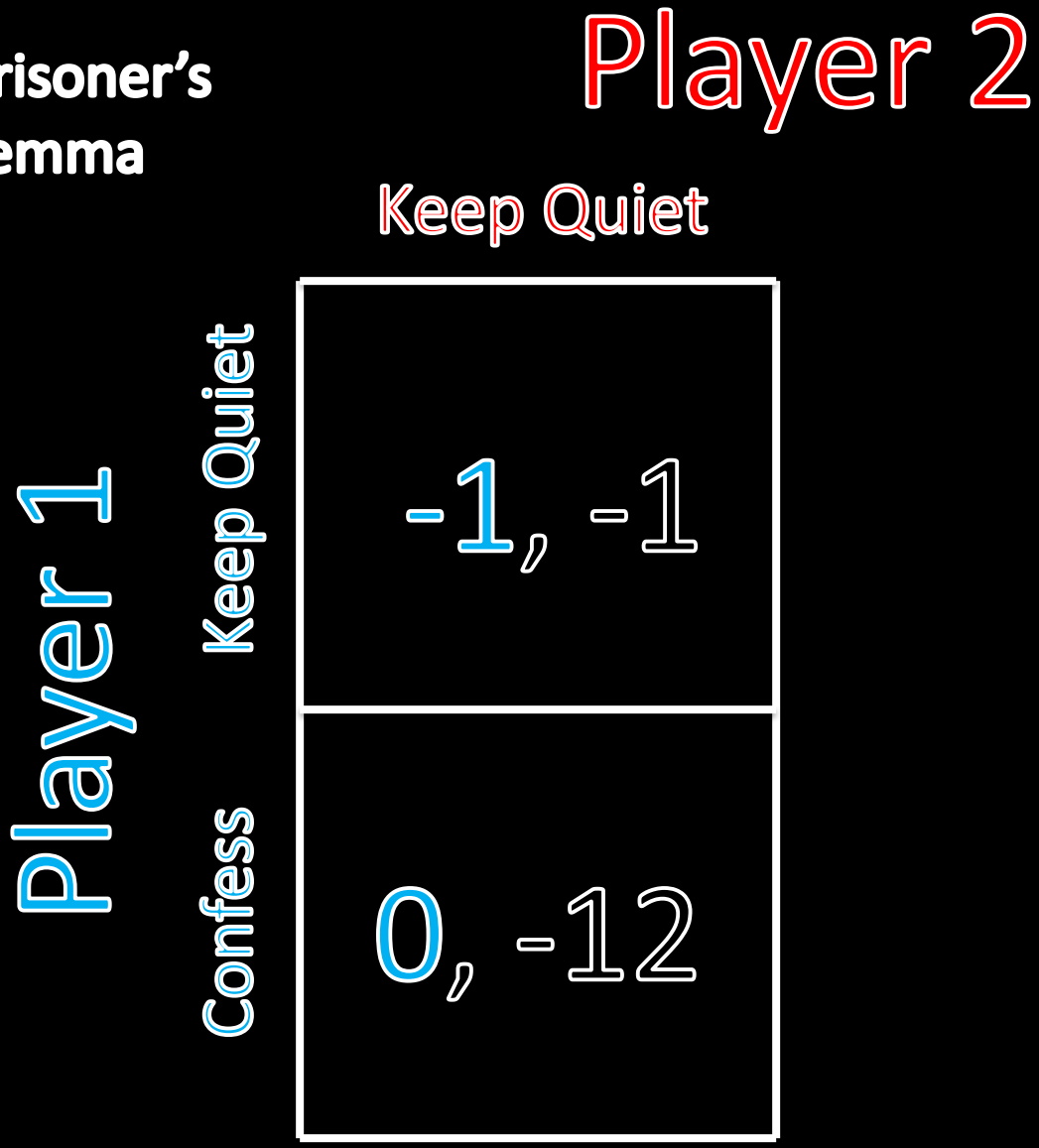
Neat Result

- The only reasonable outcome for this game is for both players to confess, even though the <keep quiet, keep quiet> outcome is mutually preferable

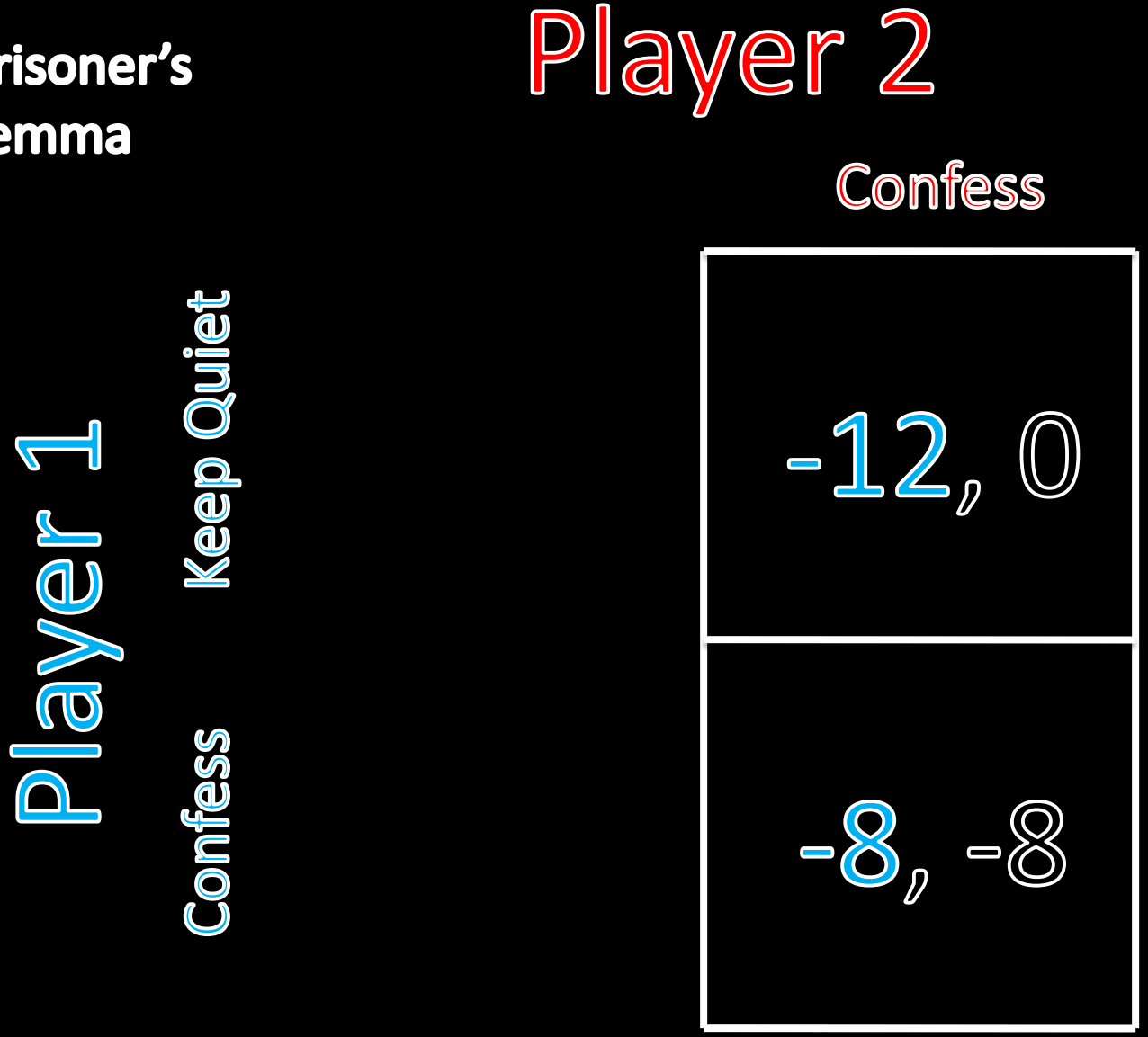
Neat Result

- The only reasonable outcome for this game is for both players to confess, even though the <keep quiet, keep quiet> outcome is mutually preferable
- Individual incentives explain why

The Prisoner's Dilemma



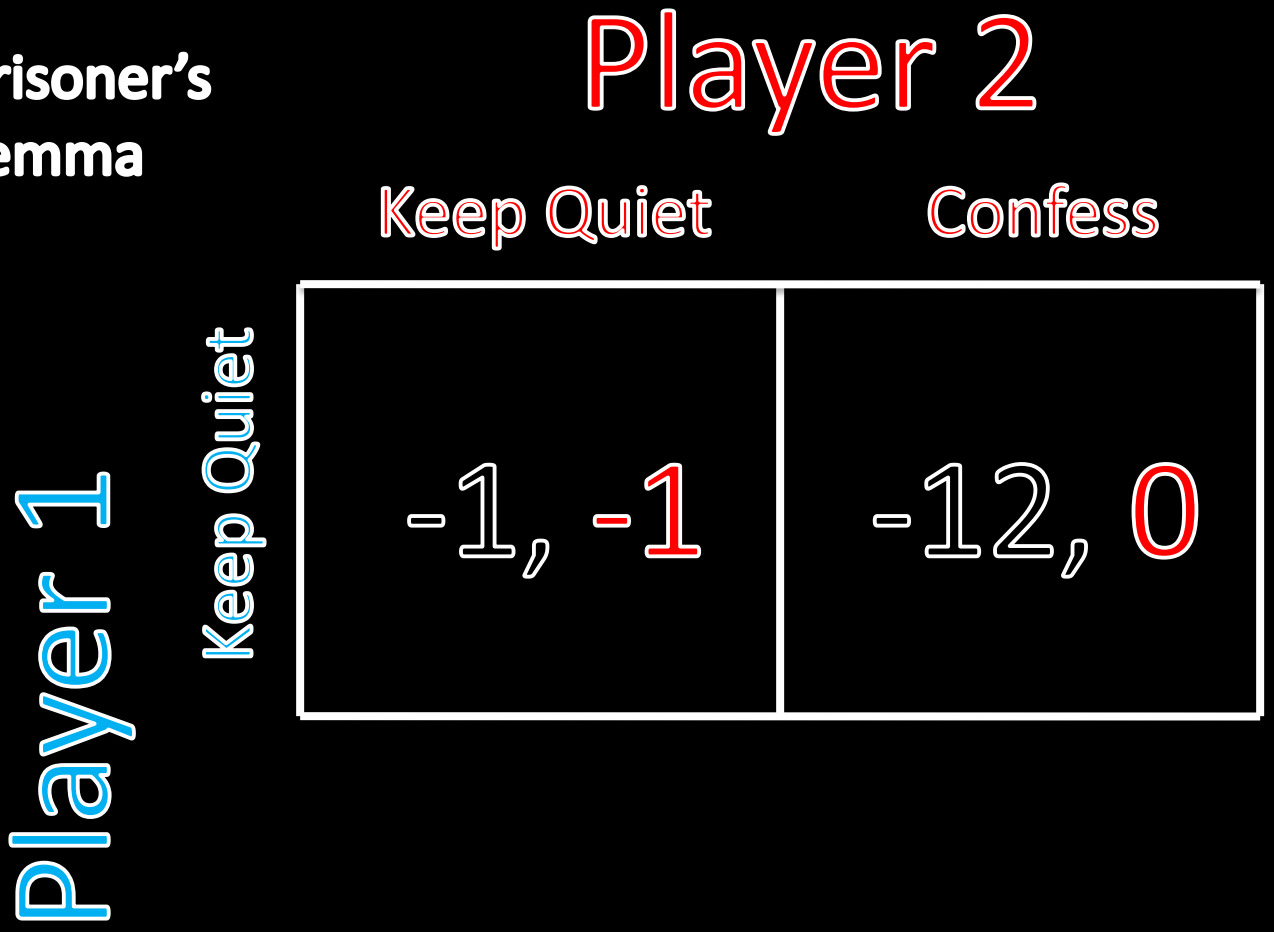
The Prisoner's Dilemma



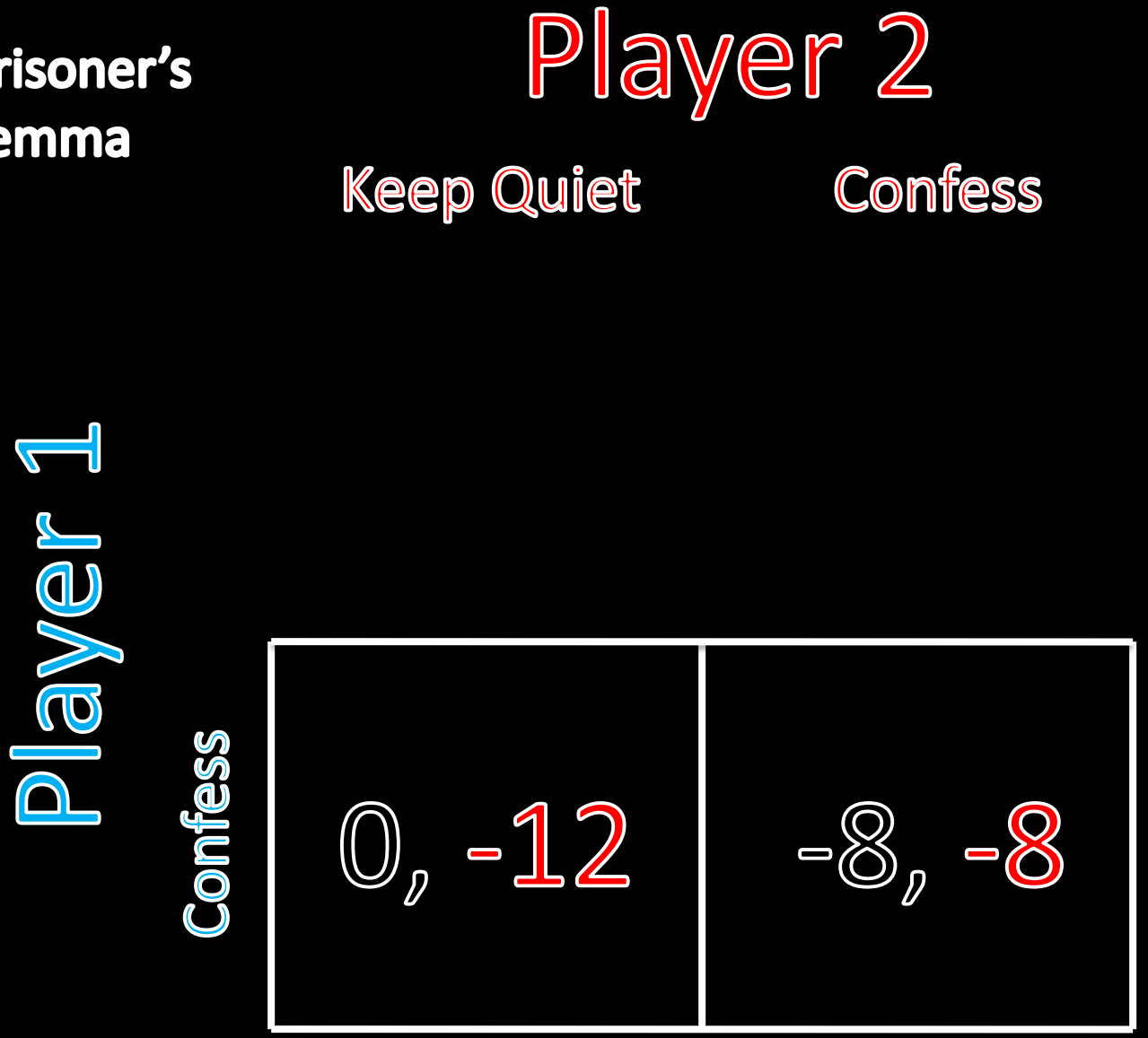
Player 1's Optimal Strategy

- Regardless of player 2's choice, player 1 is better off confessing
- Therefore, player 1 confesses

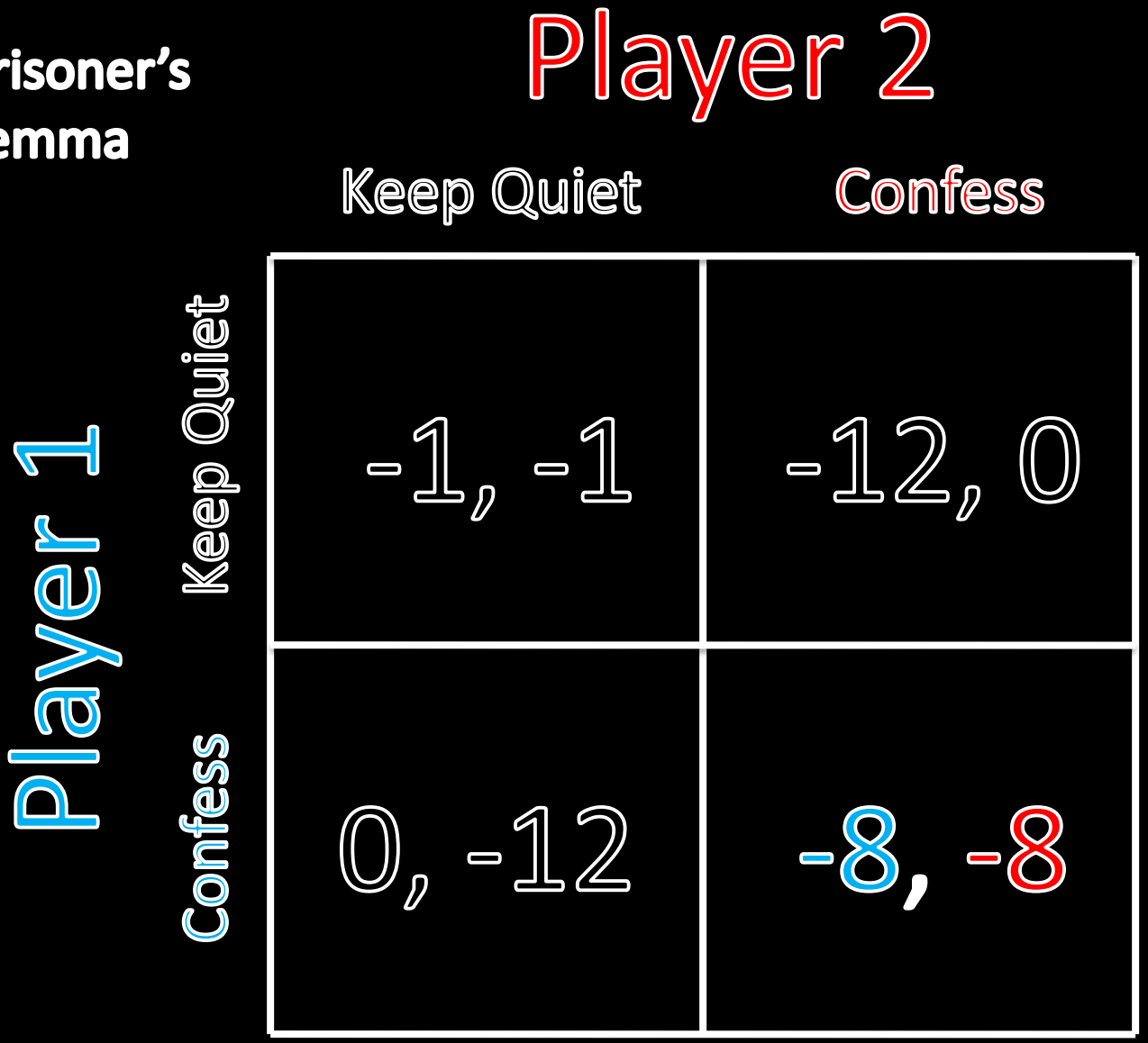
The Prisoner's Dilemma



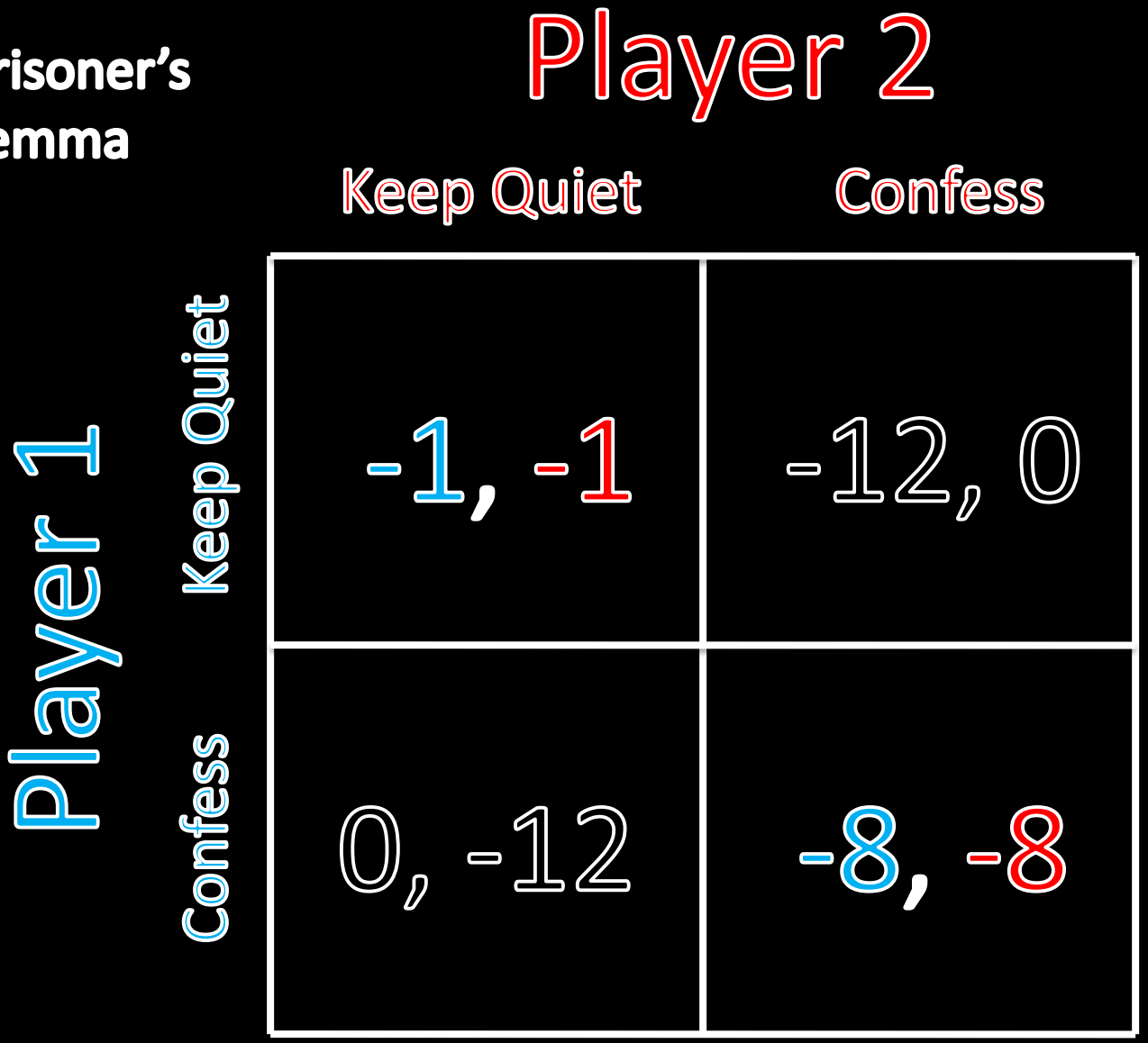
The Prisoner's Dilemma



The Prisoner's Dilemma



The Prisoner's Dilemma



Pareto Efficiency

- The mutual confession outcome is not *Pareto efficient*
  - Another outcome exists that is better for at least one party without leaving anyone worse off
    - In fact, it leaves both parties better off
- Major goal in IR: explain why states reach inefficient outcomes

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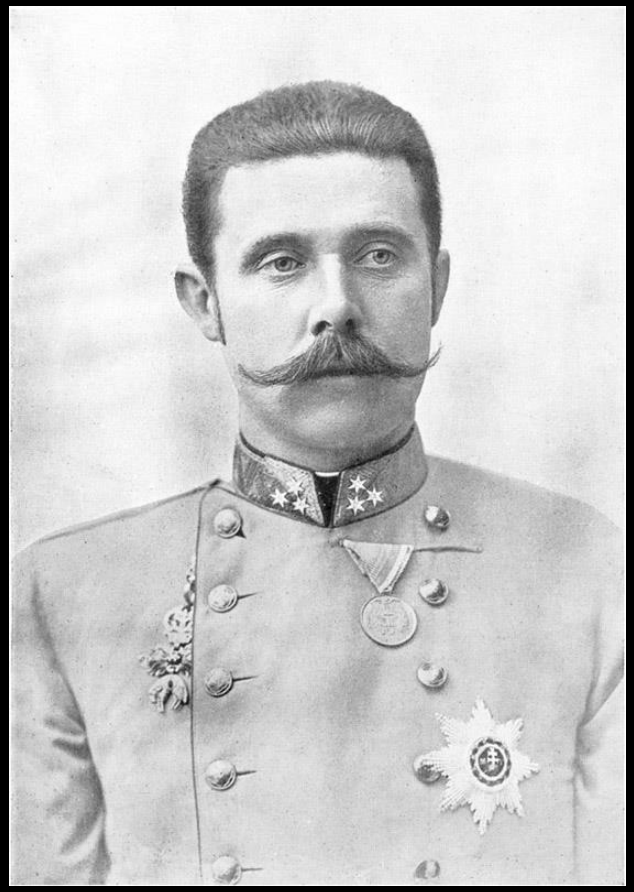
Why did World War I start?

The Trivial Explanation

- Franz Ferdinand was assassinated by Serbian nationalists on June 28, 1914



June 28

Franz Ferdinand Assassinated


July 28
AH Demands Not Met;
AU Declares War on Serbia
Key
Neutral Powers
Central Powers
Allied Powers
BARENTS SEA
Reykjavik
ICELAND
NORWAY
SWEDEN
FINLAND
Gulf of Bothnia
WHITE SEA
Christiania
Stockholm
St. Petersburg
RUSSIA
ATLANTIC OCEAN
SCOTLAND
NORTH SEA
DENMARK
Copenhagen
BALTIC SEA
IRELAND
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Amsterdam
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SEA OF AZOV
CASPIAN SEA
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Bucharest
BLACK SEA
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Tunis
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Athens
Nicosa
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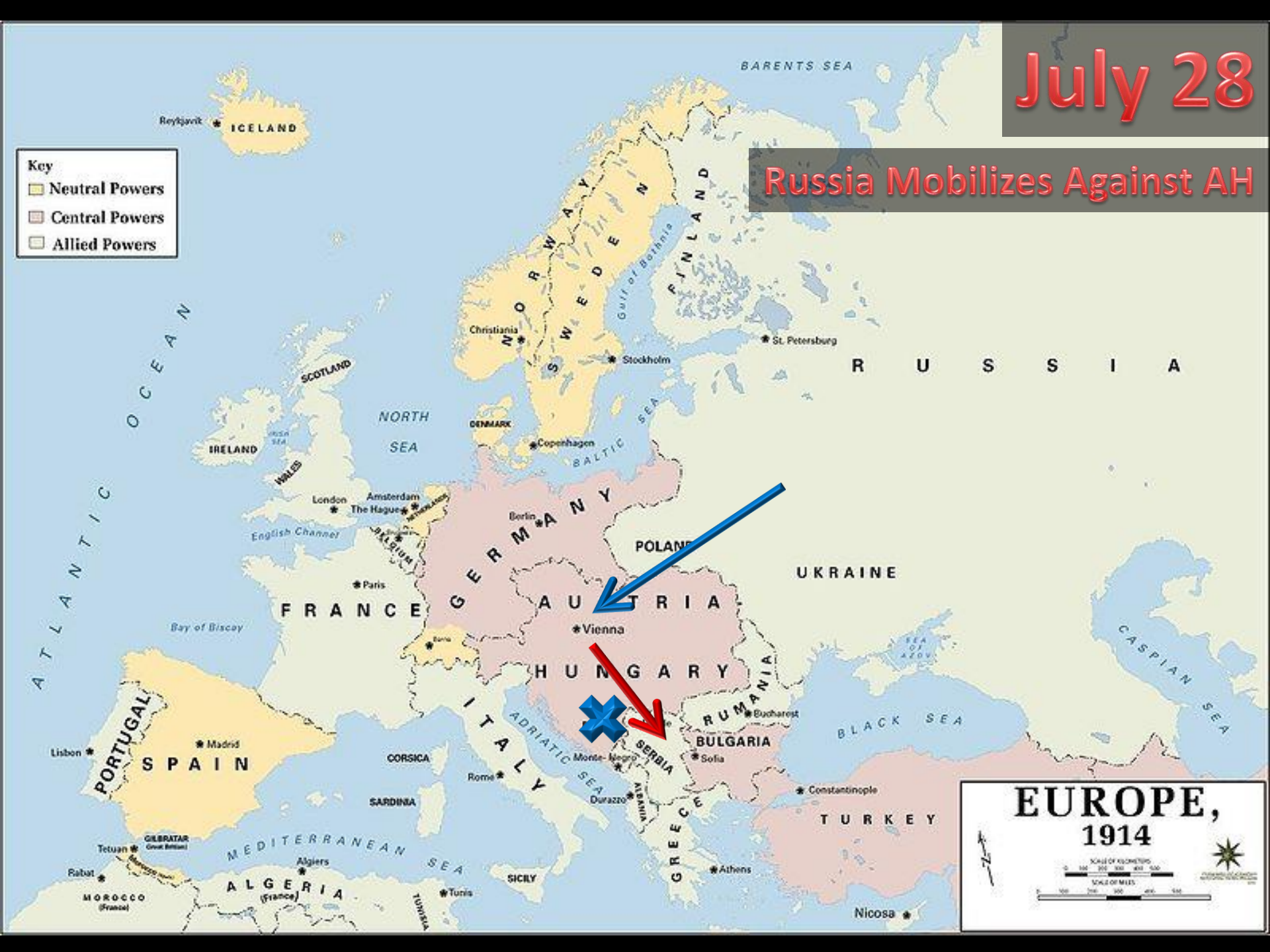
1914


July 28
Russia Mobilizes Against AH
Key
Neutral Powers
Central Powers
Allied Powers
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Nicosa
EUROPE,
1914


August 1
Germany Declares War on Russia
Key
Neutral Powers
Central Powers
Allied Powers
BARENTS SEA
Reykjavik
ICELAND
NORWAY
SWEDEN
FINLAND
Gulf of Bothnia
Christiania
Stockholm
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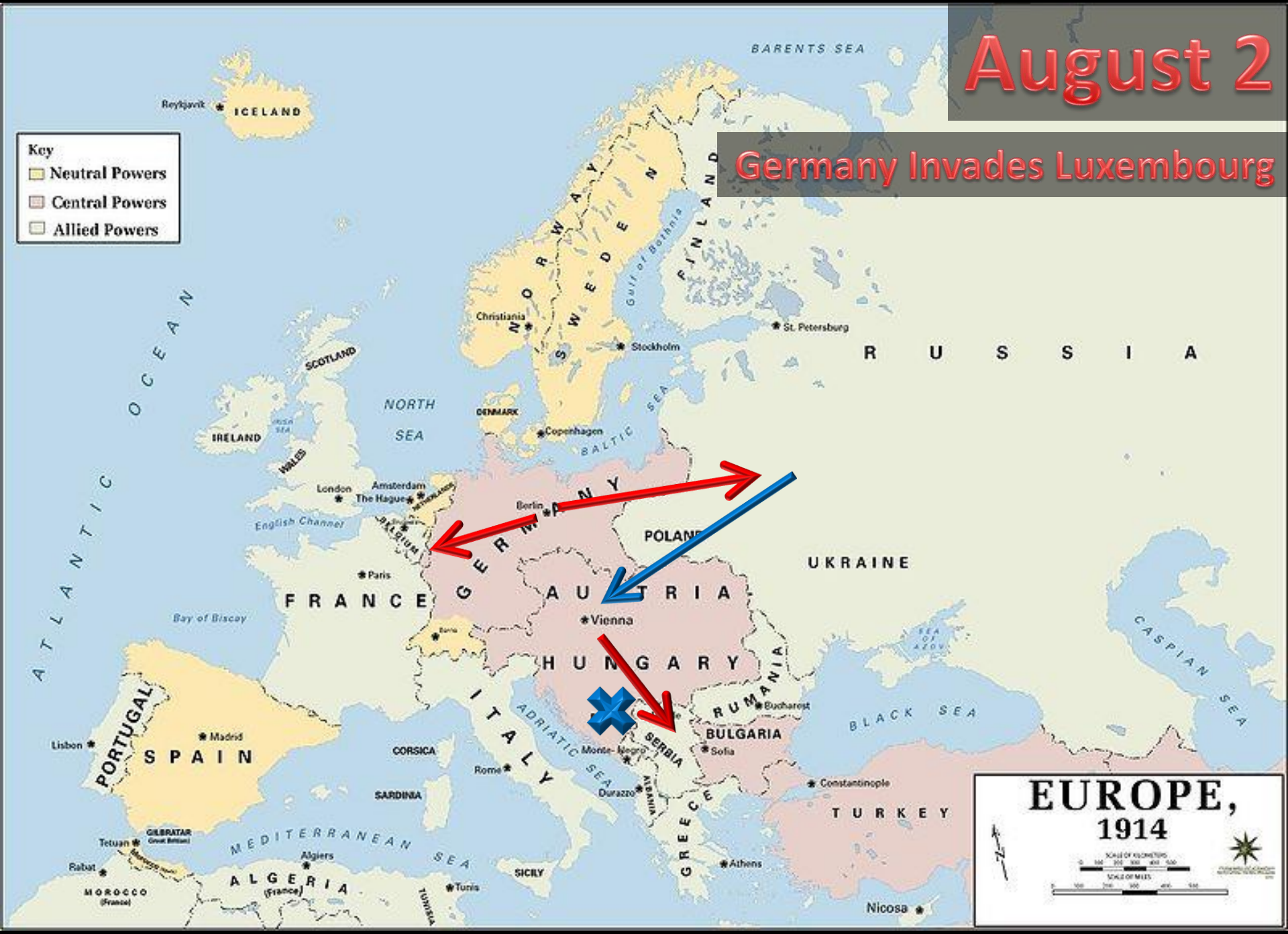
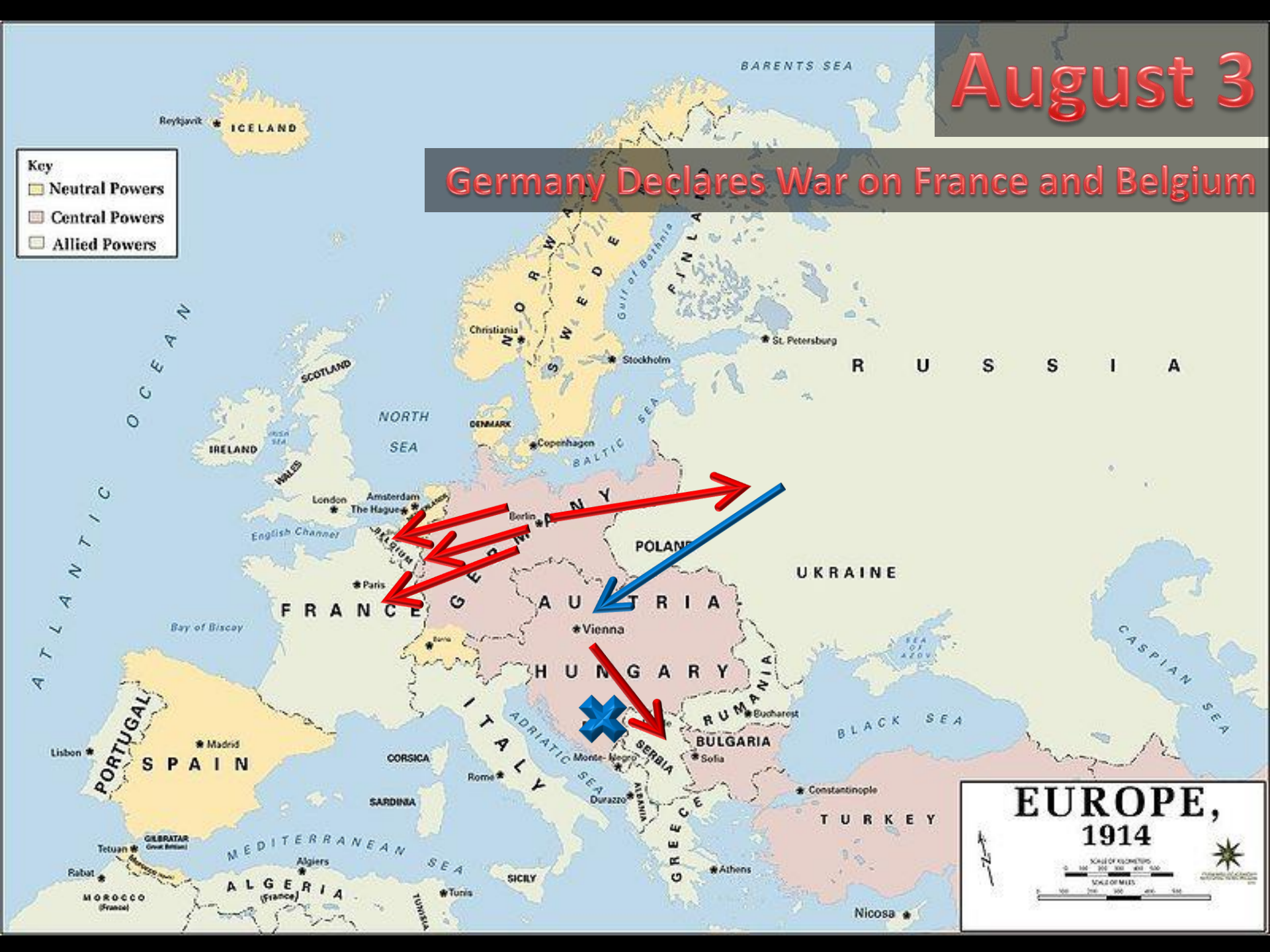
August 2

Germany Invades Luxembourg




August 3
Germany Declares War on France and Belgium
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Neutral Powers
Central Powers
Allied Powers
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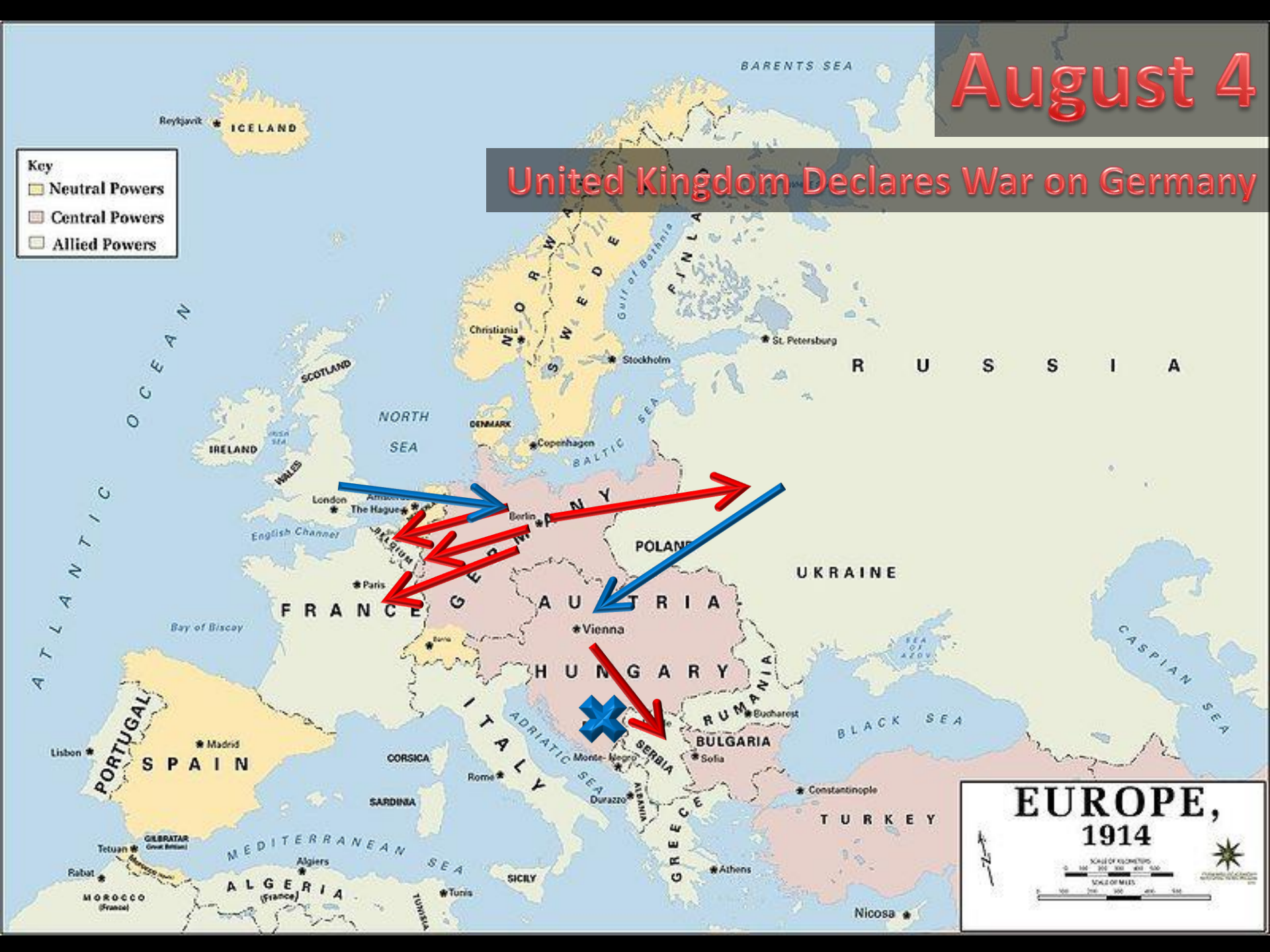
August 4
United Kingdom Declares War on Germany
Key
Neutral Powers
Central Powers
Allied Powers
BARENTS SEA
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August 6
AH Declares War on Russia
Serbia Declares War on AH
Key
Neutral Powers
Central Powers
Allied Powers
BARENTS SEA
Reykjavik
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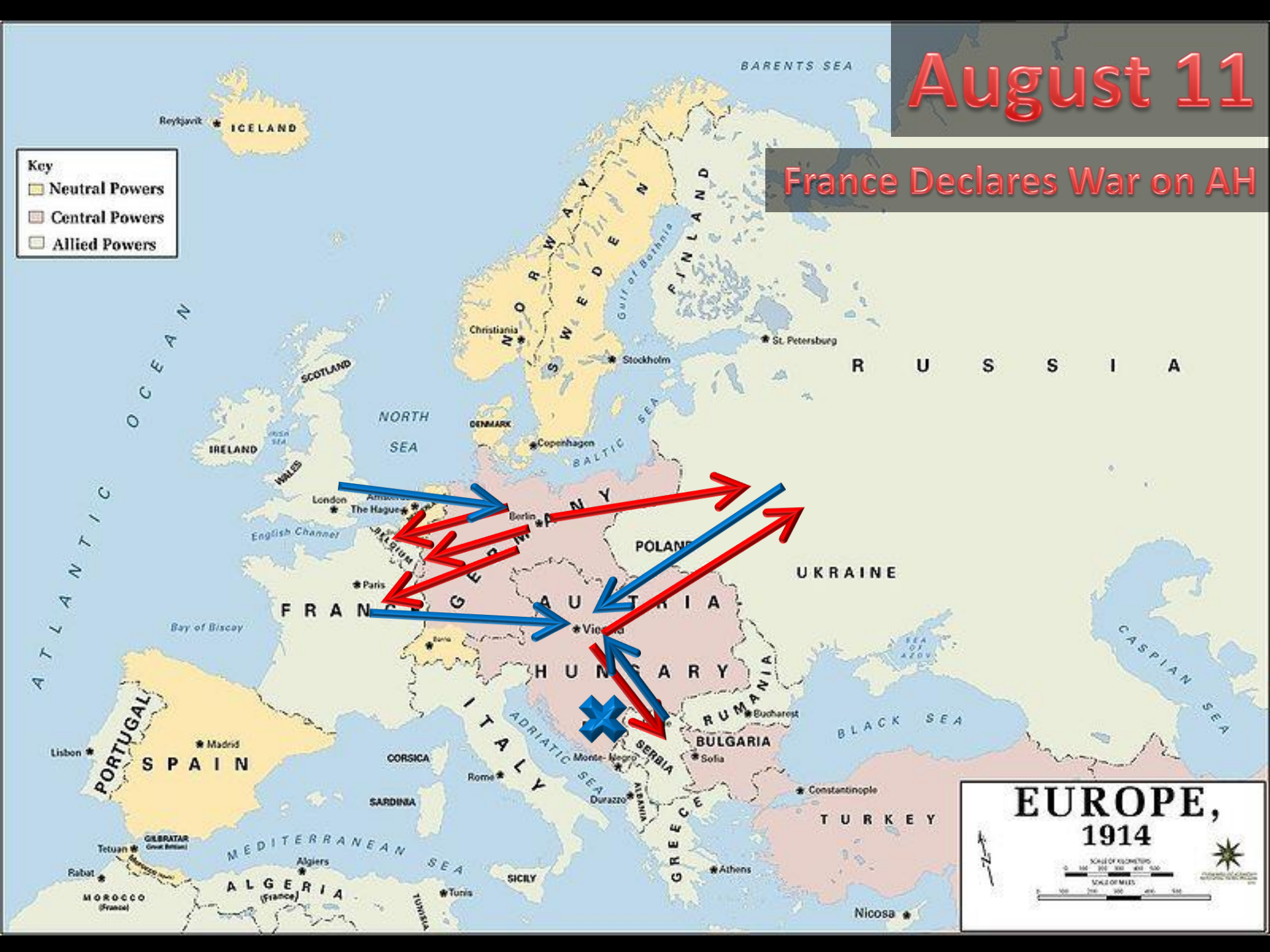
August 11
France Declares War on AH
Key
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Allied Powers
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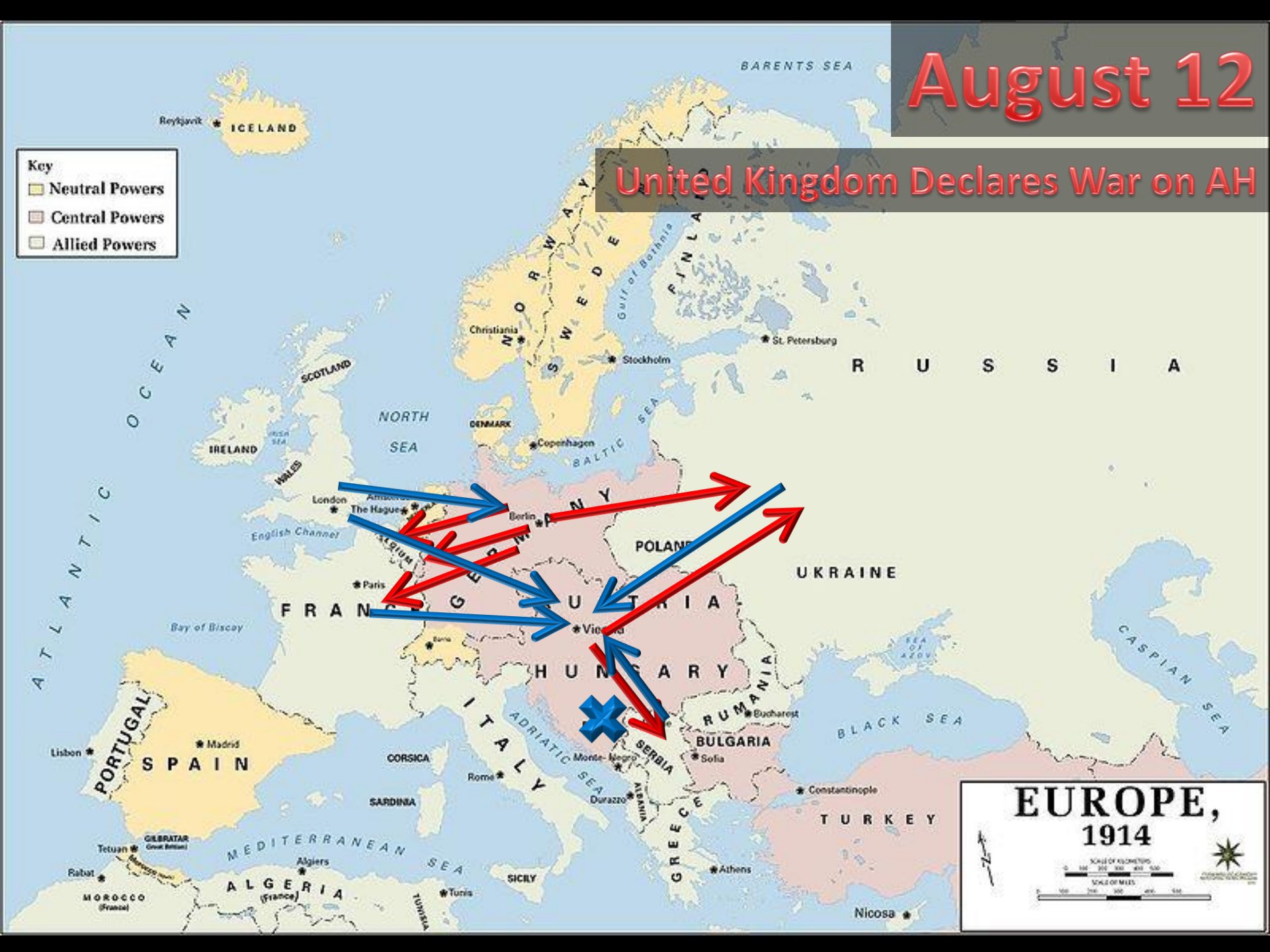
August 12
United Kingdom Declares War on AH
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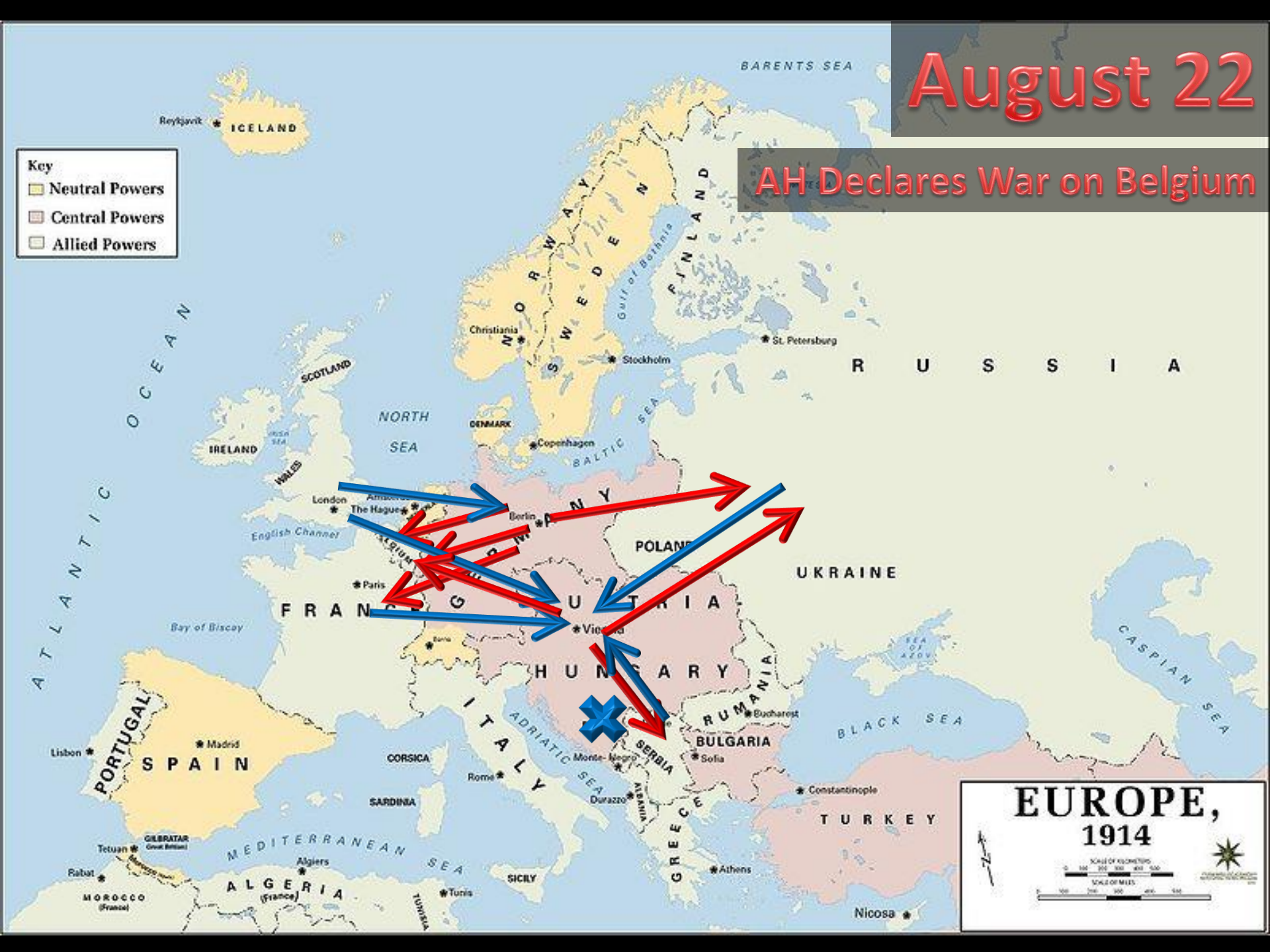
August 22
AH Declares War on Belgium
Key
Neutral Powers
Central Powers
Allied Powers
BARENTS SEA
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Christiania
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St. Petersburg
RUSSIA
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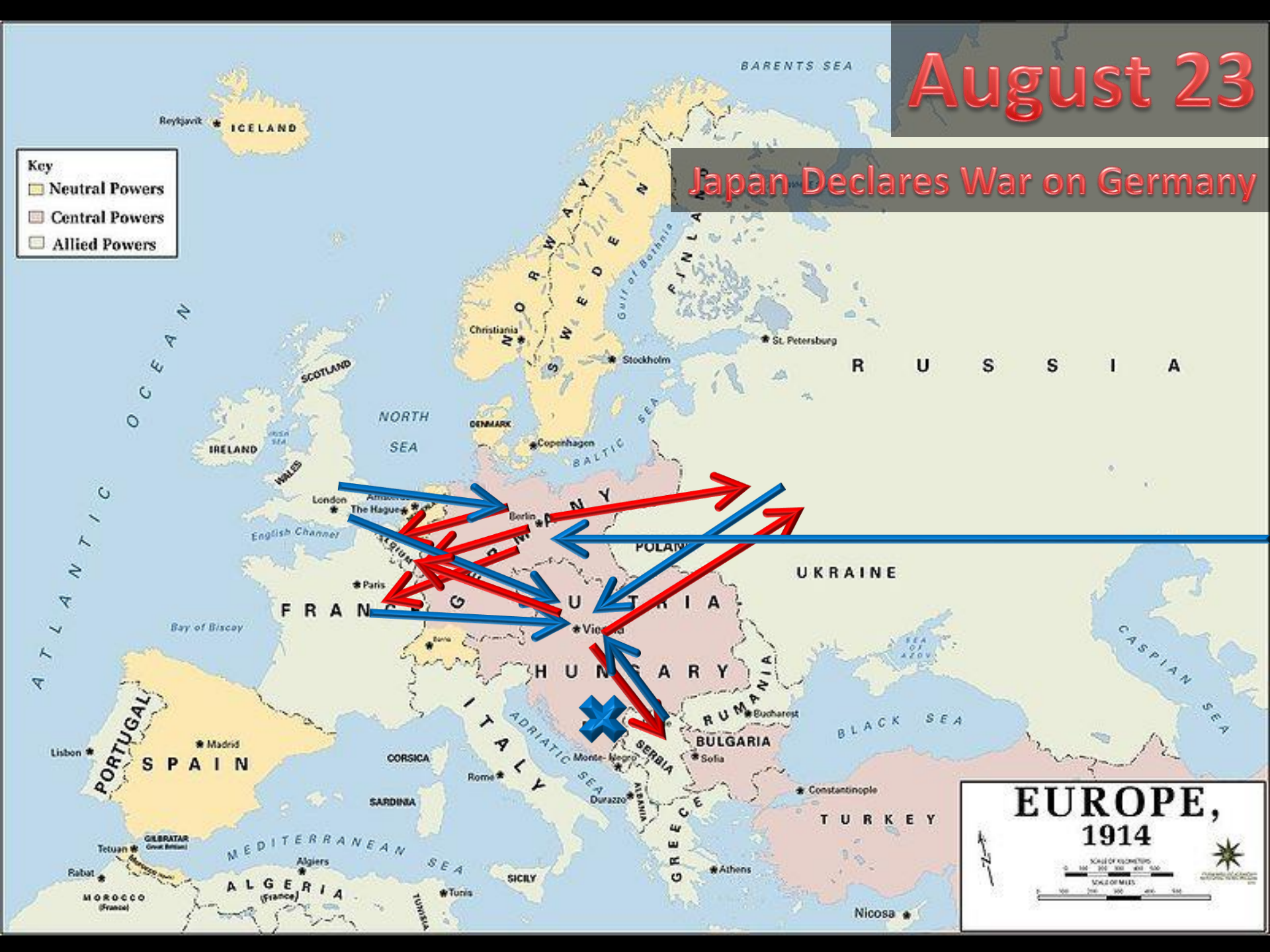
EUROPE, 1914


August 23
Japan Declares War on Germany
Key
Neutral Powers
Central Powers
Allied Powers
BARENTS SEA
Reykjavik
ICELAND
NORWAY
SWEDEN
FINLAND
Gulf of Bothnia
Christiania
Stockholm
St. Petersburg
RUSSIA
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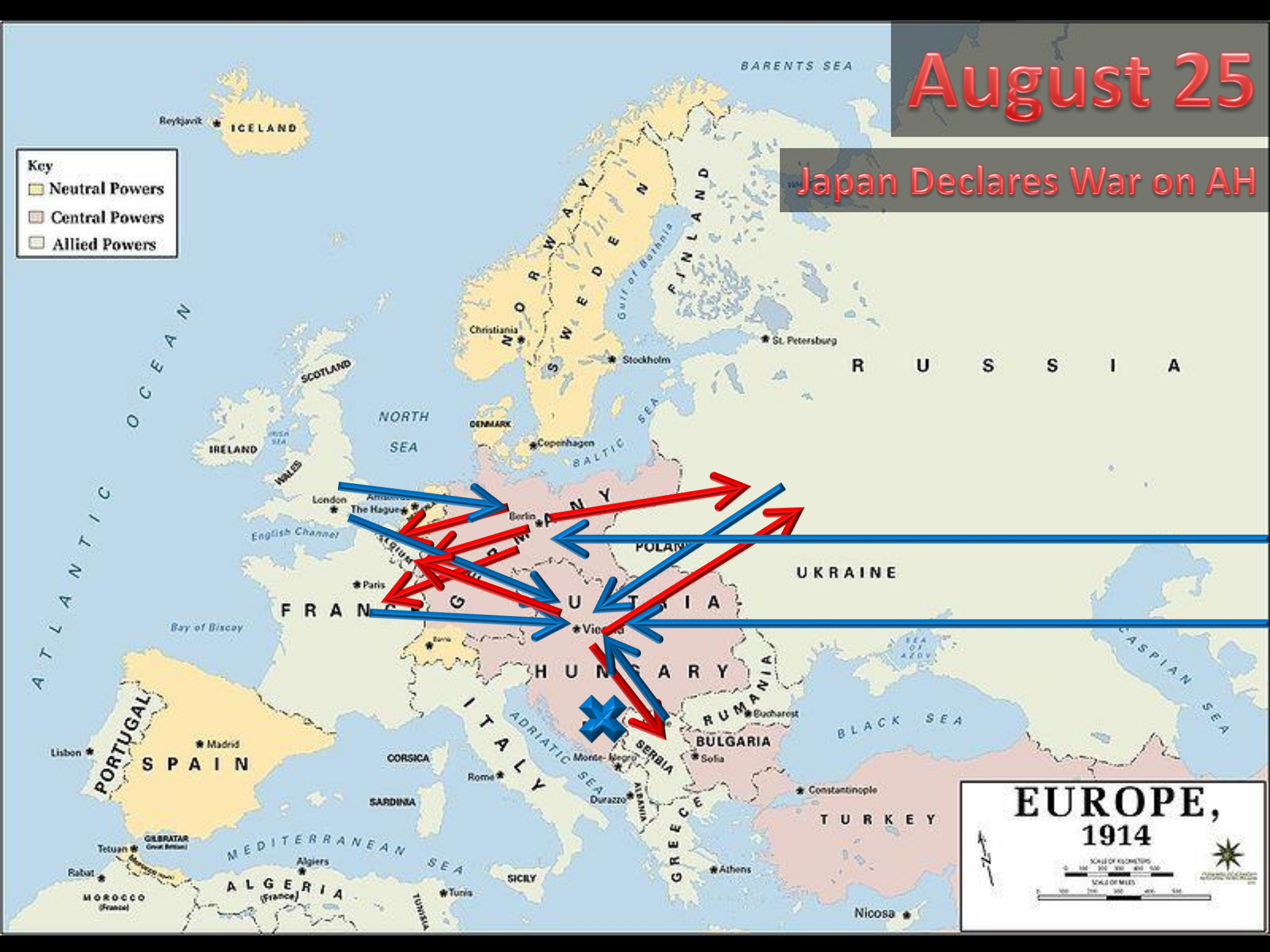
August 25
Japan Declares War on AH
Key
Neutral Powers
Central Powers
Allied Powers
EUROPE,
1914
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RUSSIA
ATLANTIC OCEAN
SCOTLAND
NORTH SEA
DENMARK
Copenhagen
BALTIC SEA
IRELAND
WALES
London
The Hague
Berlin
GERMANY
English Channel
POLAND
UKRAINE
Paris
FRANCE
AUSTRIA
Bay of Biscay
Vienna
HUNGARY
ROMANIA
Bucharest
BLACK SEA
CASPIAN SEA
PORTUGAL
Lisbon
Madrid
SPAIN
CORSICA
ITALY
Rome
ADRIATIC SEA
SERBIA
Monte-Negro
BULGARIA
Sofia
SARDINIA
Durazzo
ALBANIA
GREECE
Constantinople
TURKEY
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Tetuan
Rabat
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Tunis
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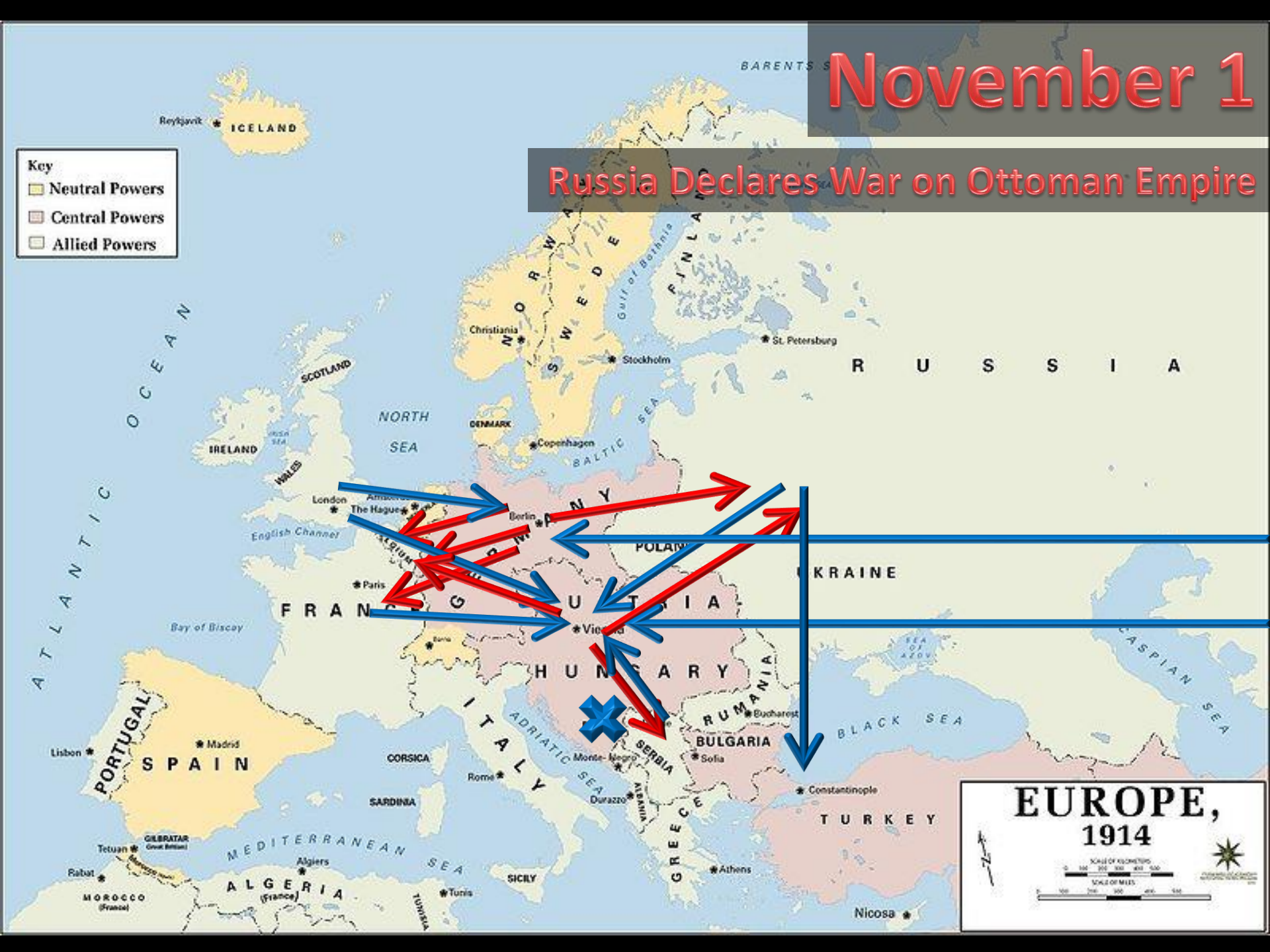
SICILY
Athens
Nicosa


November 1
Russia Declares War on Ottoman Empire
Key
Neutral Powers
Central Powers
Allied Powers
EUROPE,
1914
ATLANTIC OCEAN
BARENTS SEA
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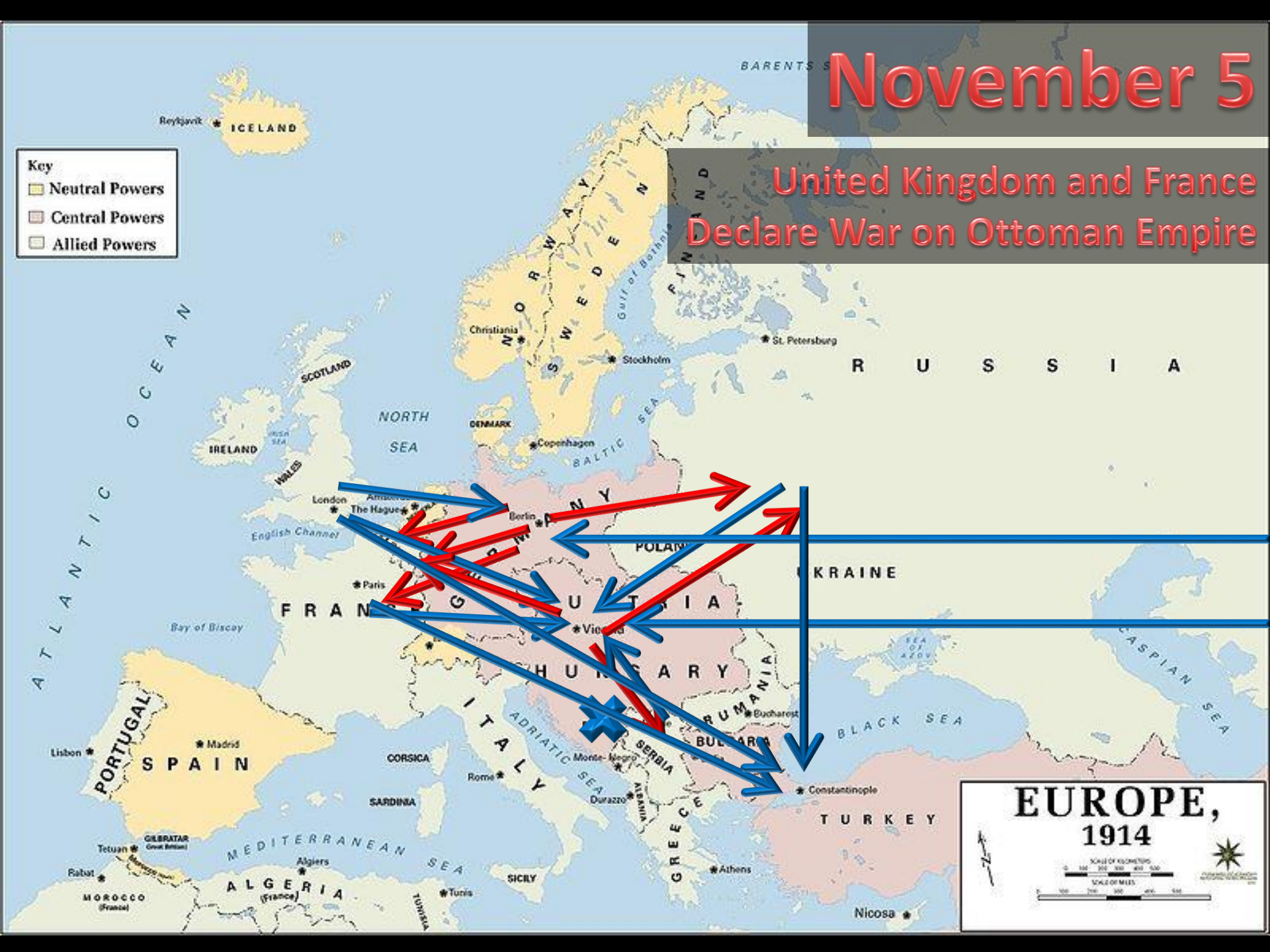
November 5
United Kingdom and France Declare War on Ottoman Empire
Key
Neutral Powers
Central Powers
Allied Powers
EUROPE, 1914
ATLANTIC OCEAN
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SWEDEN
FINLAND
Christiania
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St. Petersburg
RUSSIA
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TURKEY
CASPIAN SEA
EUROPE,
1914

The Trivial Explanation

- Franz Ferdinand was assassinated by Serbian nationalists on June 28, 1914
  - The war started because a dude with a funny mustache died

The Trivial Explanation

- Franz Ferdinand was assassinated by Serbian nationalists on June 28, 1914
  - The war started because a dude with a funny mustache died
- But why are states preemptively declaring war on each other?

The Cult of the Offensive

- Military and political leaders at the time believed the offense had an enormous advantage
  - New military technology: machine guns, chemical gas, railroads

Strategies and Outcomes

- Consider a world with two states
- Two strategies: preempt and defend
- Ranking the outcomes:
  1) I preempt, you defend (Surprise!)
  2) We both defend (Peace)
  3) We both preempt (War)
  4) I defend, you preempt (I'm a sucker)

Strategies and Outcomes

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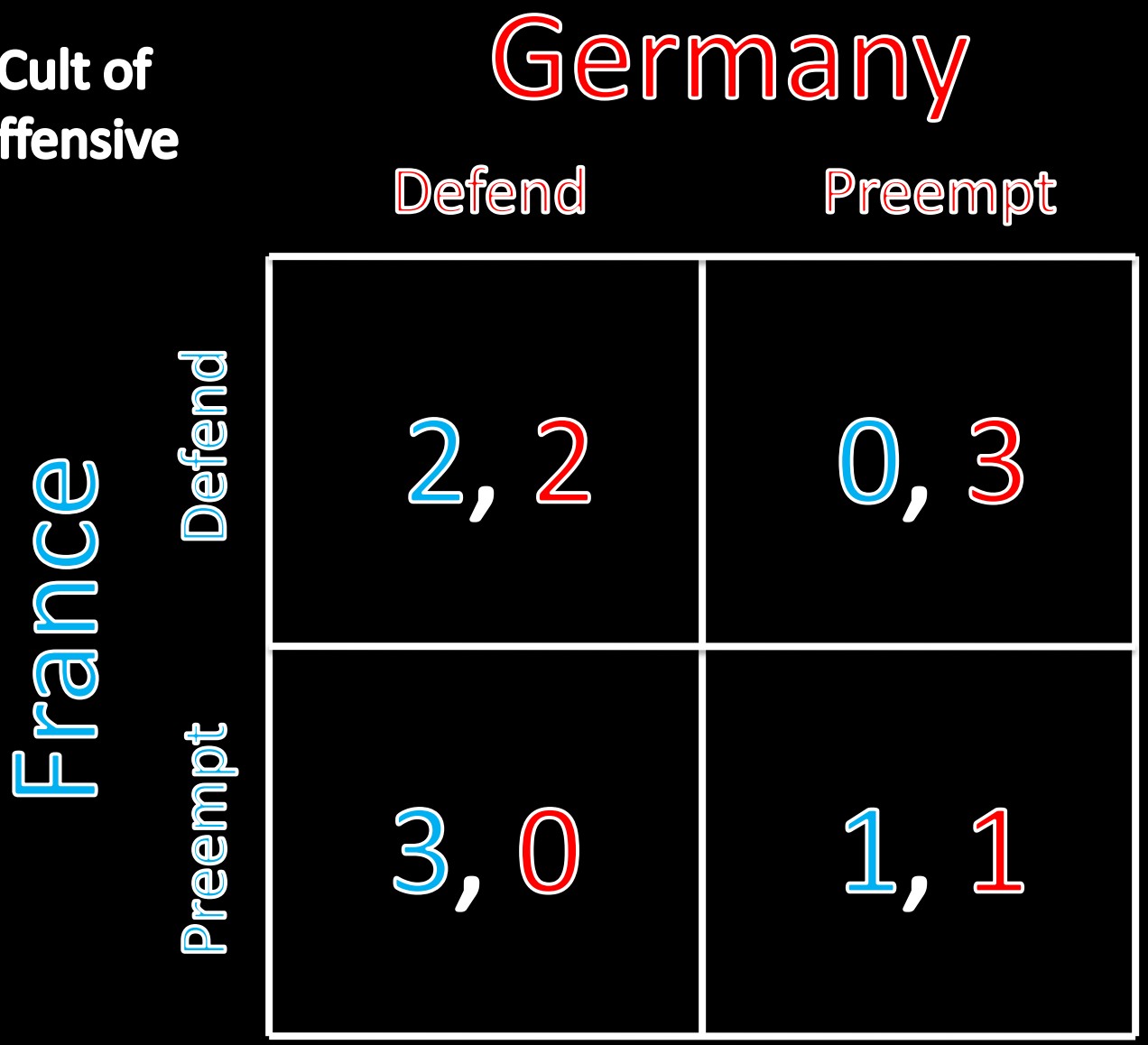
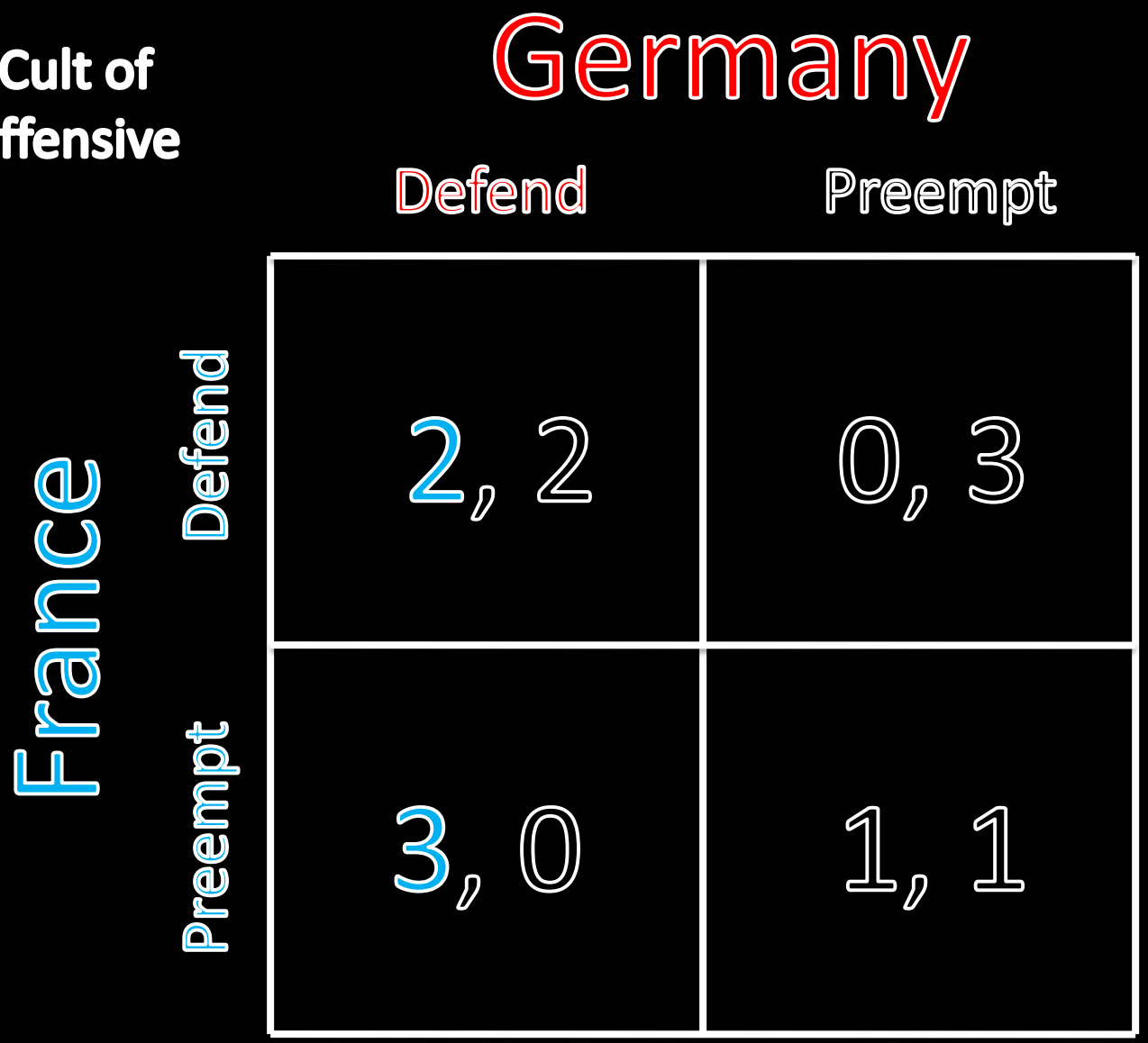
- Two strategies: preempt and defend
- Ranking the outcomes:
  1) I preempt, you defend (Surprise!)
  2) We both defend (Peace)
  3) We both preempt (War)
  4) I defend, you preempt (I'm a sucker)
- What have our assumptions bought us?

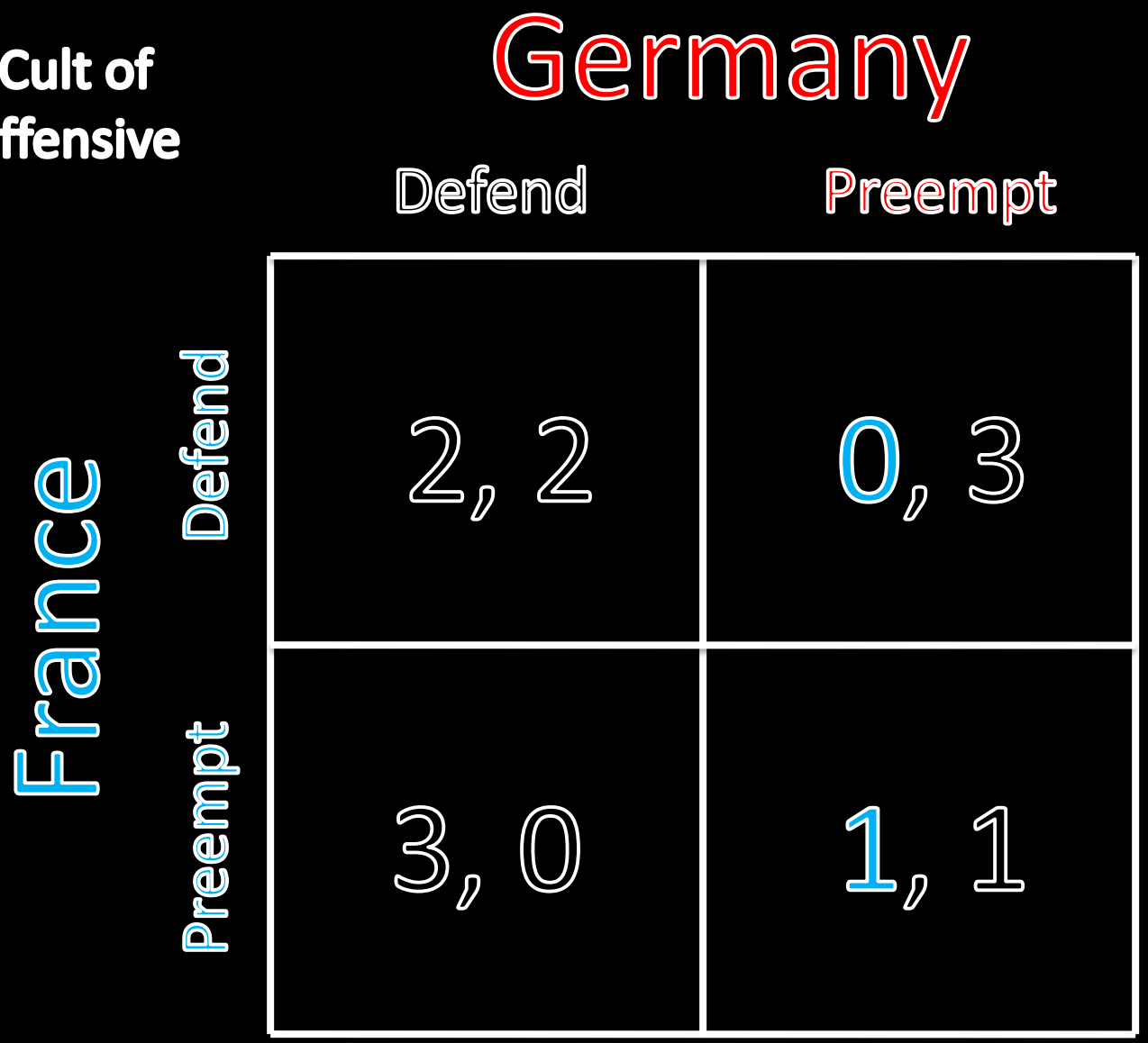
The Cult of the Offensive



The Cult of the Offensive



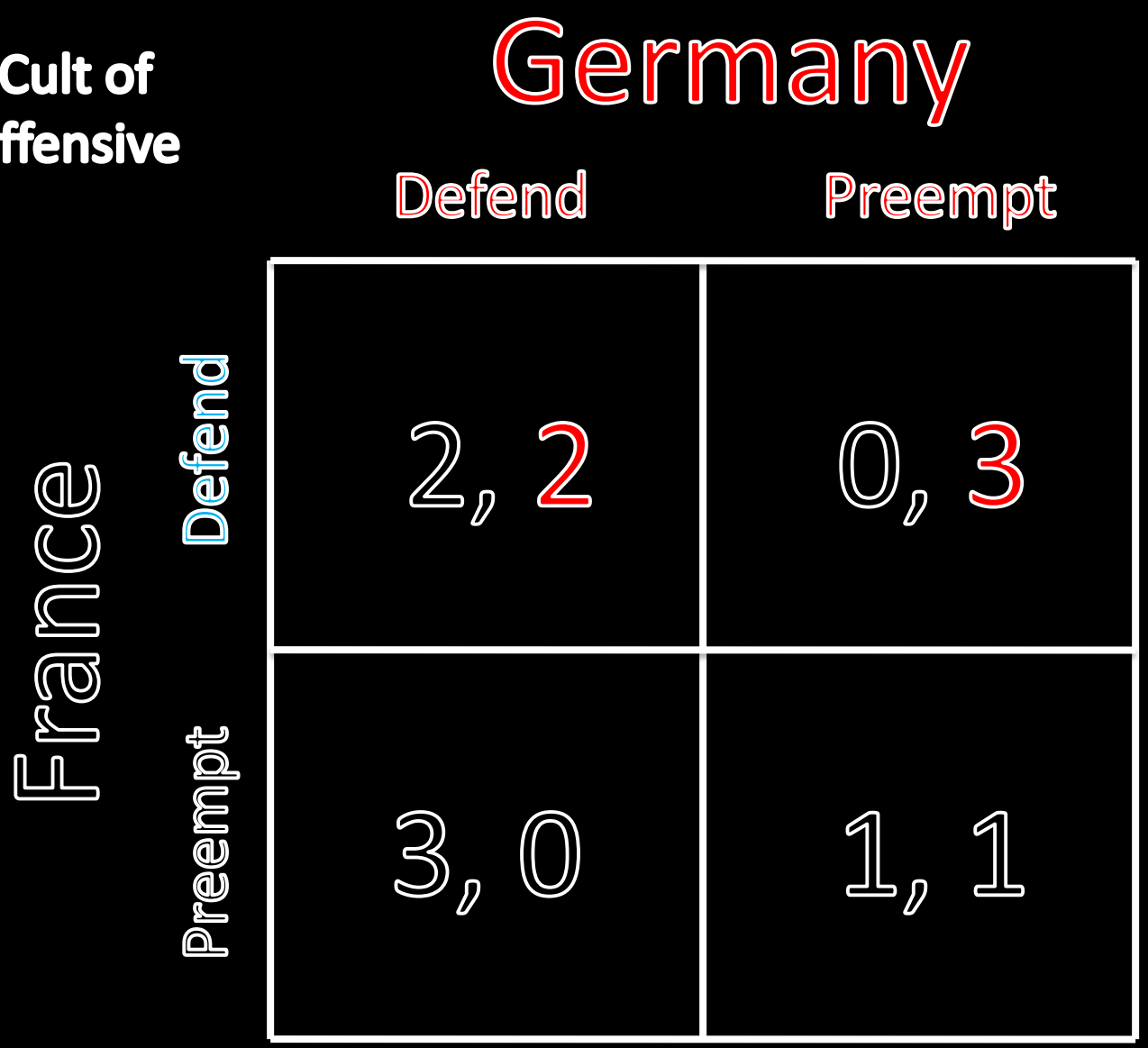
The Cult of the Offensive



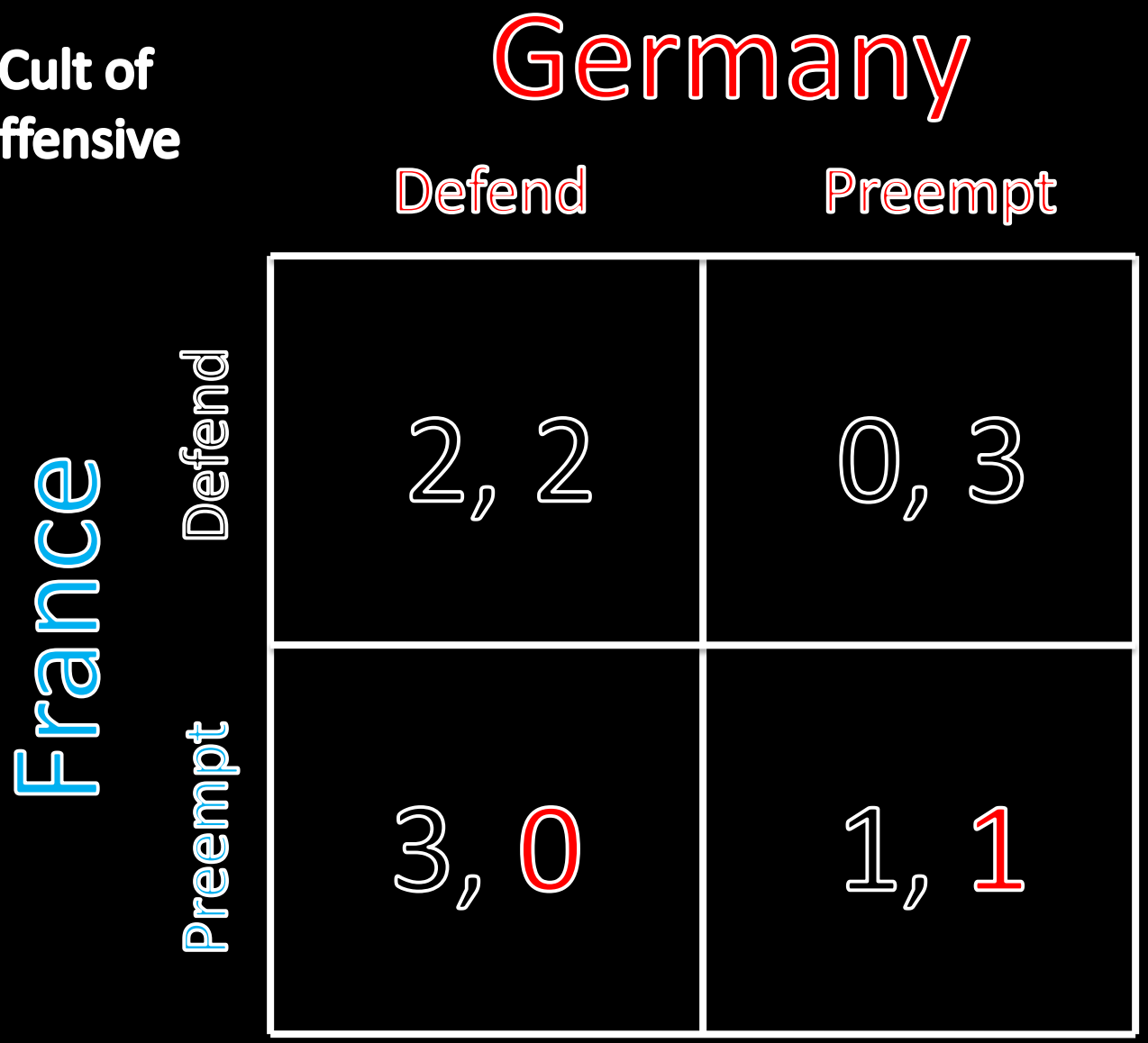
France's Strategy

- Regardless of Germany's move, France is always better off preempting
  - Therefore, France preempts

The Cult of the Offensive



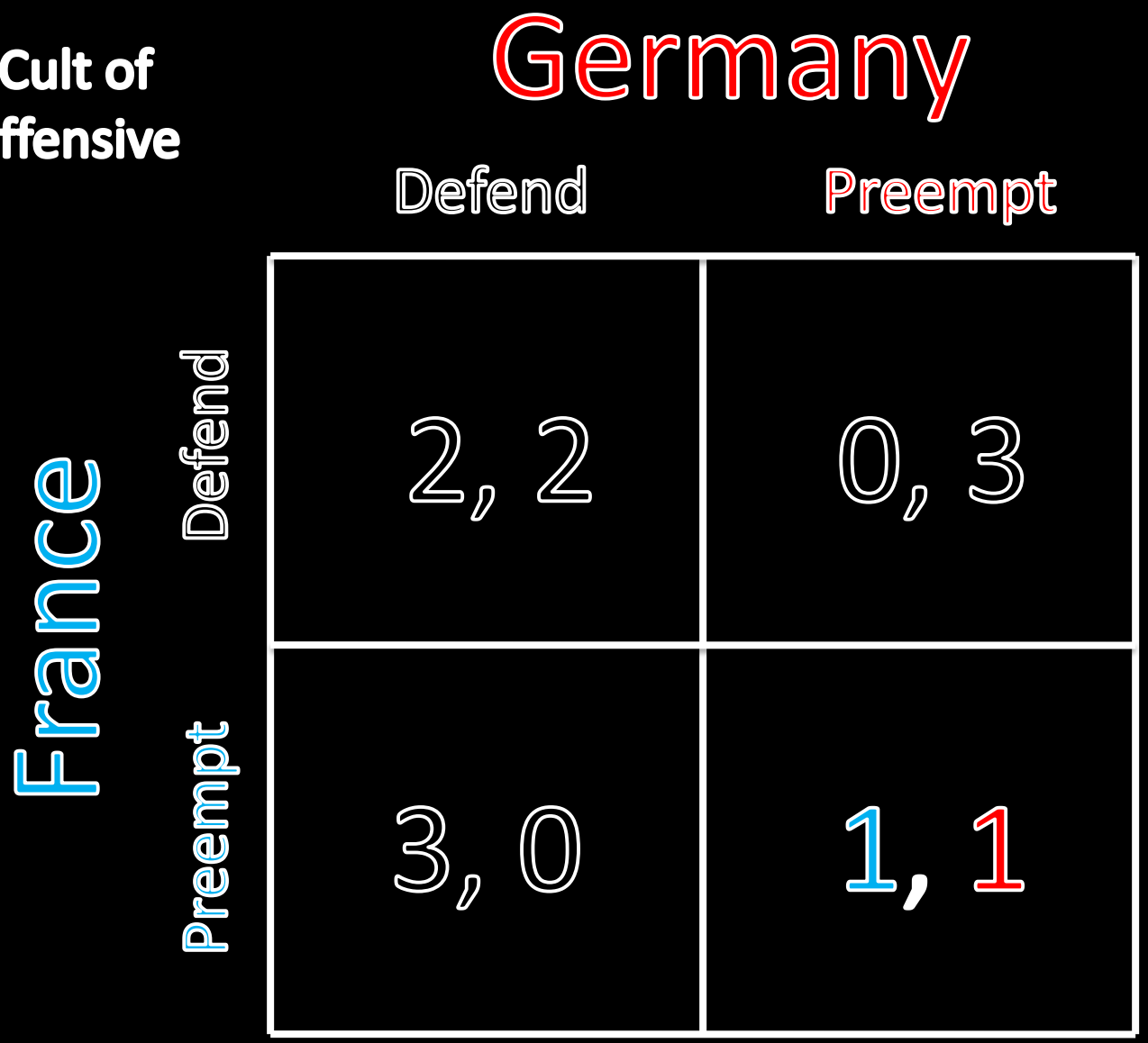
The Cult of the Offensive



Germany's Strategy

- Regardless of France's move, Germany is always better off preempting
  - Therefore, Germany preempts
- This is a prisoner's dilemma
  - Order of the payoffs is identical to before

The Cult of the Offensive



Conclusion

- First strike advantages provide a reasonable explanation for the initiation of World War I

Outline

- Background
- The Prisoner's Dilemma
- The Cult of the Offensive
- Tariffs and Free Trade
- Arms Races
- Repeated Interaction
- Coordination Problems

Why was it so hard to establish free trade?

Fun Fact

- Free trade is a historically new phenomenon
- In the past, states set up tariffs (import taxes) on imported goods

Taxes Aren’t Fun

- Tariffs are good for bolstering domestic companies
- Econ 101: Taxes raise consumer prices, and that’s generally a bad thing

The Plight of the Mexican Winery

- Mexico doesn't have the best grape-producing climate
  - Thus, *El Vino Nacional* must spend more money to produce quality grapes
  - The company must pass this additional cost onto consumers or go out of business

The Predatory California Winery

- California has a great climate for grapes and makes wine with ease
  - California companies can flood the Mexican market with wine and put *El Vino Nacional* out of business
  - But this funnels Mexican money out of Mexico and into California

Solution: Tariffs

- If Mexico taxes imported wine, prices of *Vino Nacional* will be competitive
  - Money stays within Mexico

Tequila in California

- California doesn't have the best agave-producing climate
  - Californian tequila companies must spend more money to produce quality tequila
  - The company must pass additional cost onto consumers or go out of business

Predatory Mexican Tequila

- Mexico has a great climate for agave and makes wonderful tequila
  - Mexican companies can flood the Californian market with tequila and put the Californian companies out of business
  - But this funnels American money out of California and into Mexico

Solution: Tariffs

- If the United States taxes imported tequila, the prices of Californian tequila will be competitive
  - The money stays within California

Outcome

- Tariffs everywhere!
- Mexico taxes imports from California
- California taxes imports from Mexico

Outcome

- Tariffs everywhere!
- Mexico taxes imports from California
- California taxes imports from Mexico
- Everyone loses (except for the protected businesses)

Free Trade Game

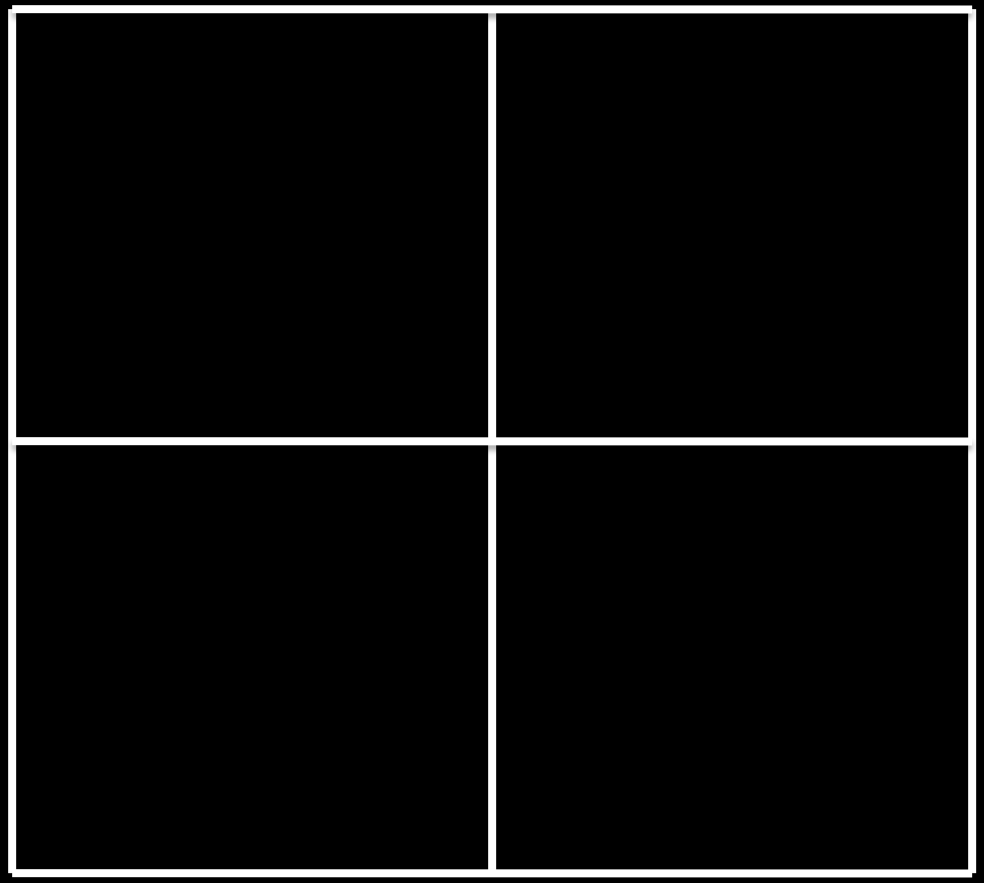
California

Freedom | Taxation

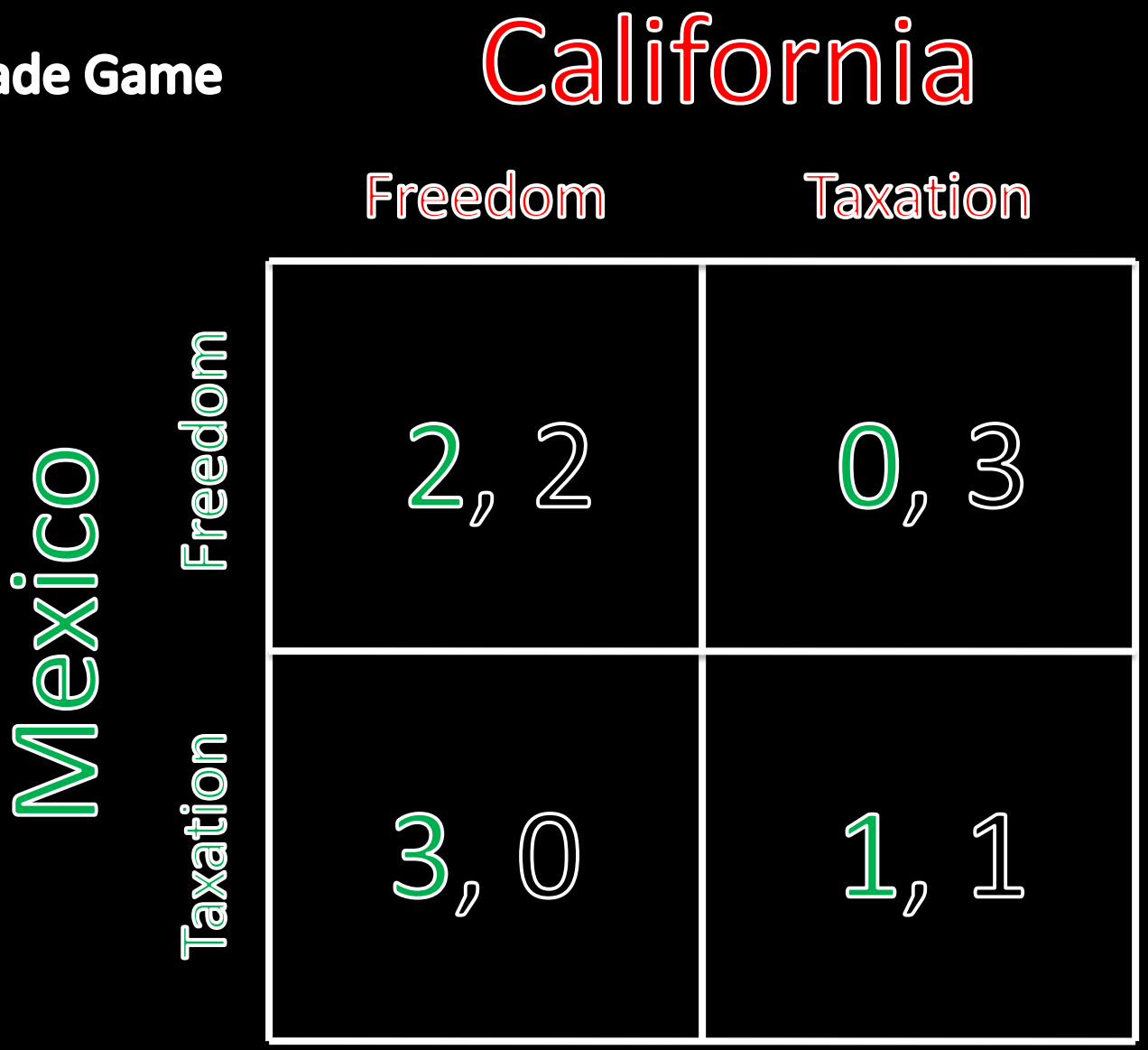
Mexico

Freedom

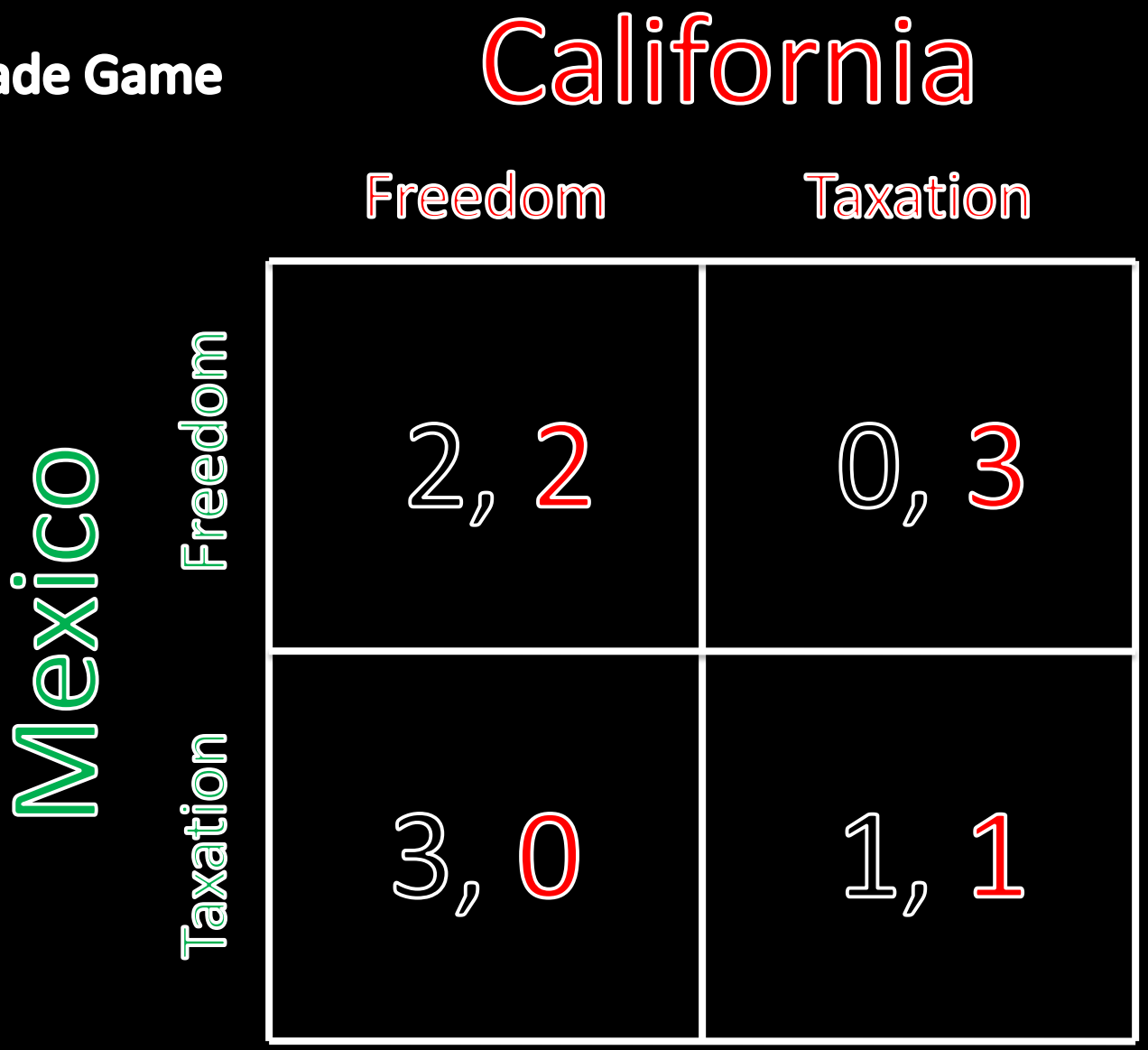
Taxation



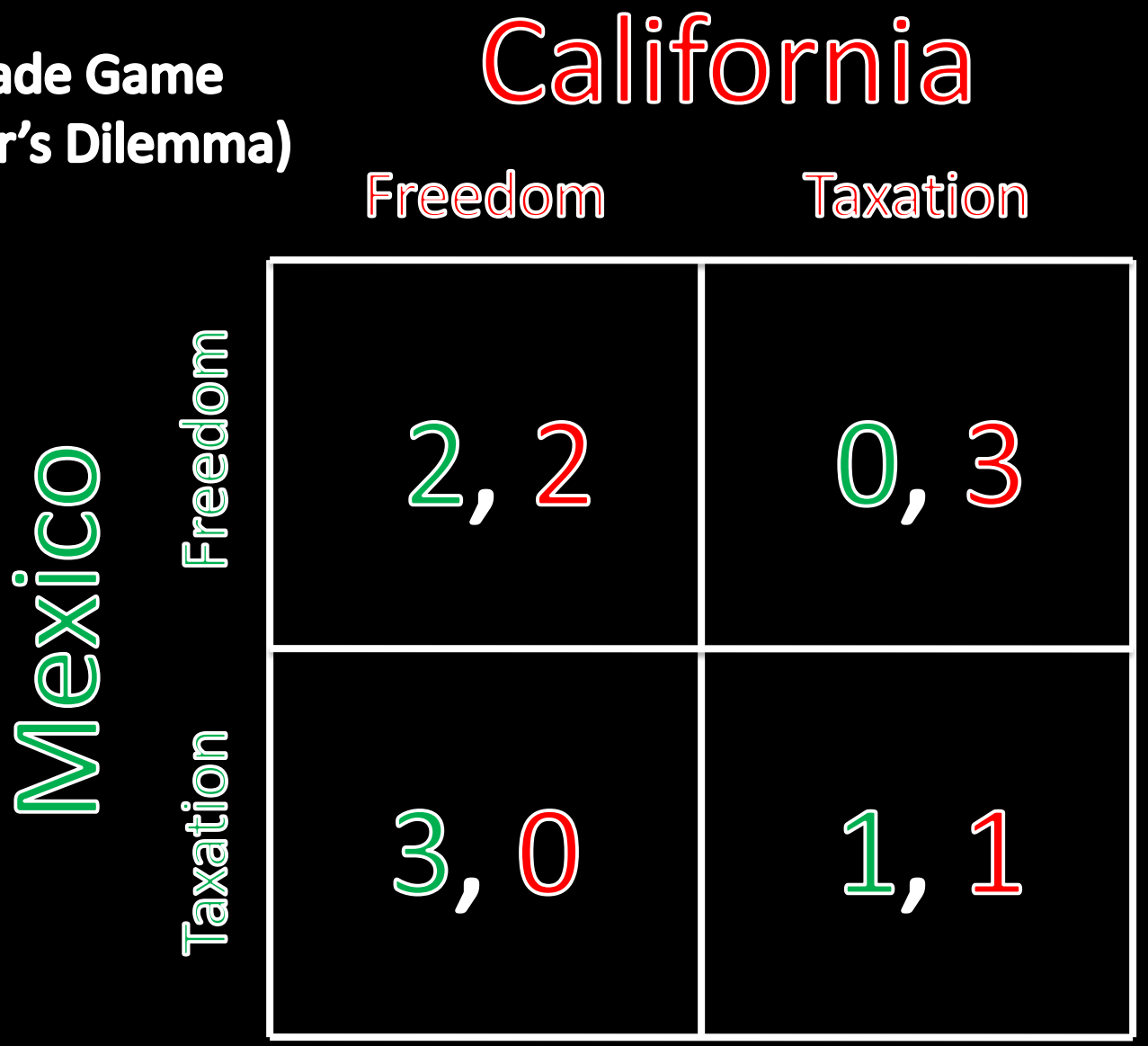
Free Trade Game



Free Trade Game



Free Trade Game
(A Prisoner's Dilemma)



Free Trade Game
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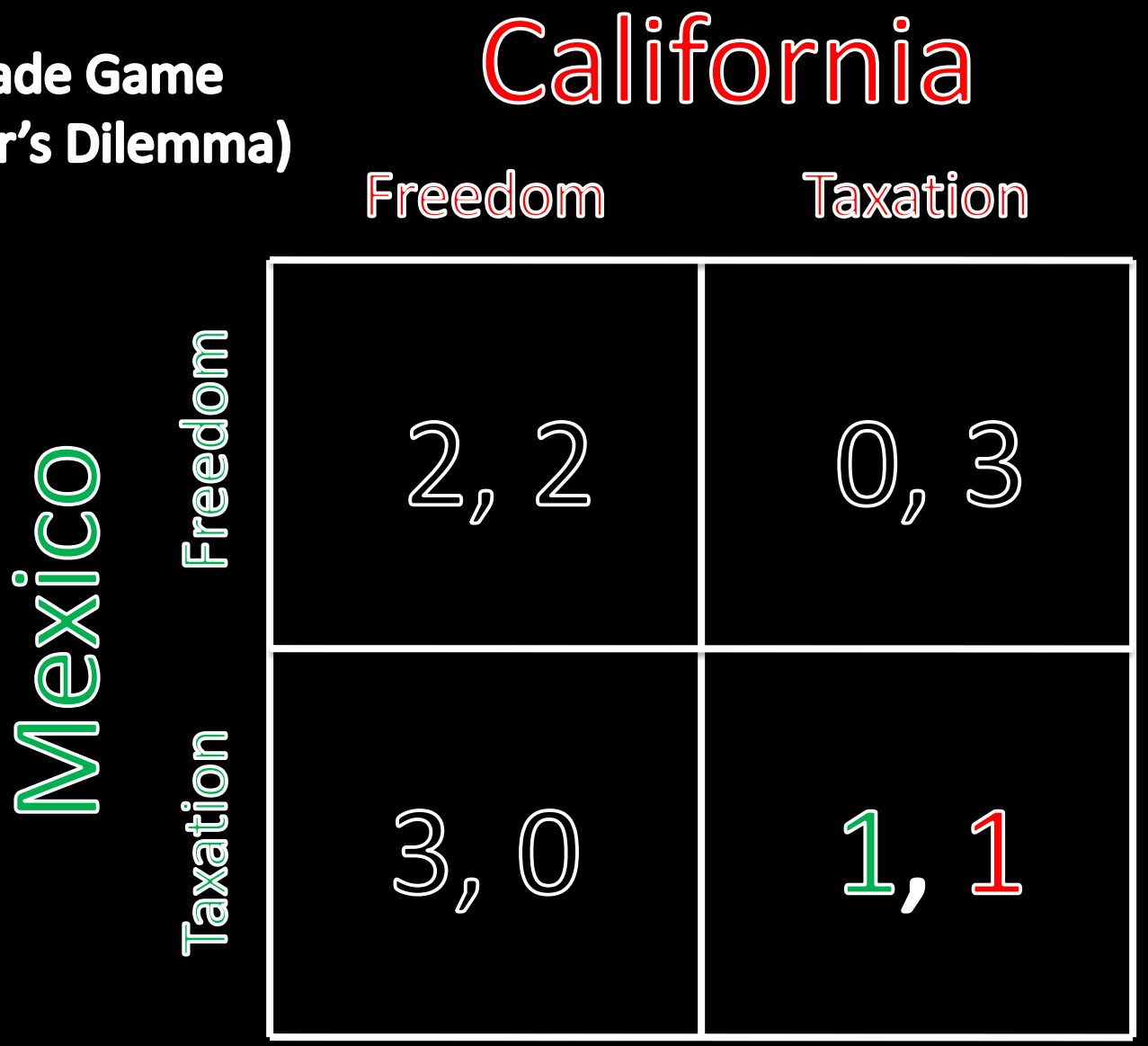

New Puzzle

- The prisoner's dilemma predicts that we would see high levels of tariffs
- This was true before World War II but not the case anymore
  - How have states maintained free trade agreements recently (in the not-so-recent past)?

Outline

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Why do states engage in arms races?

The Arms Dilemma

- In a world of anarchy, having military power allows you to get your way

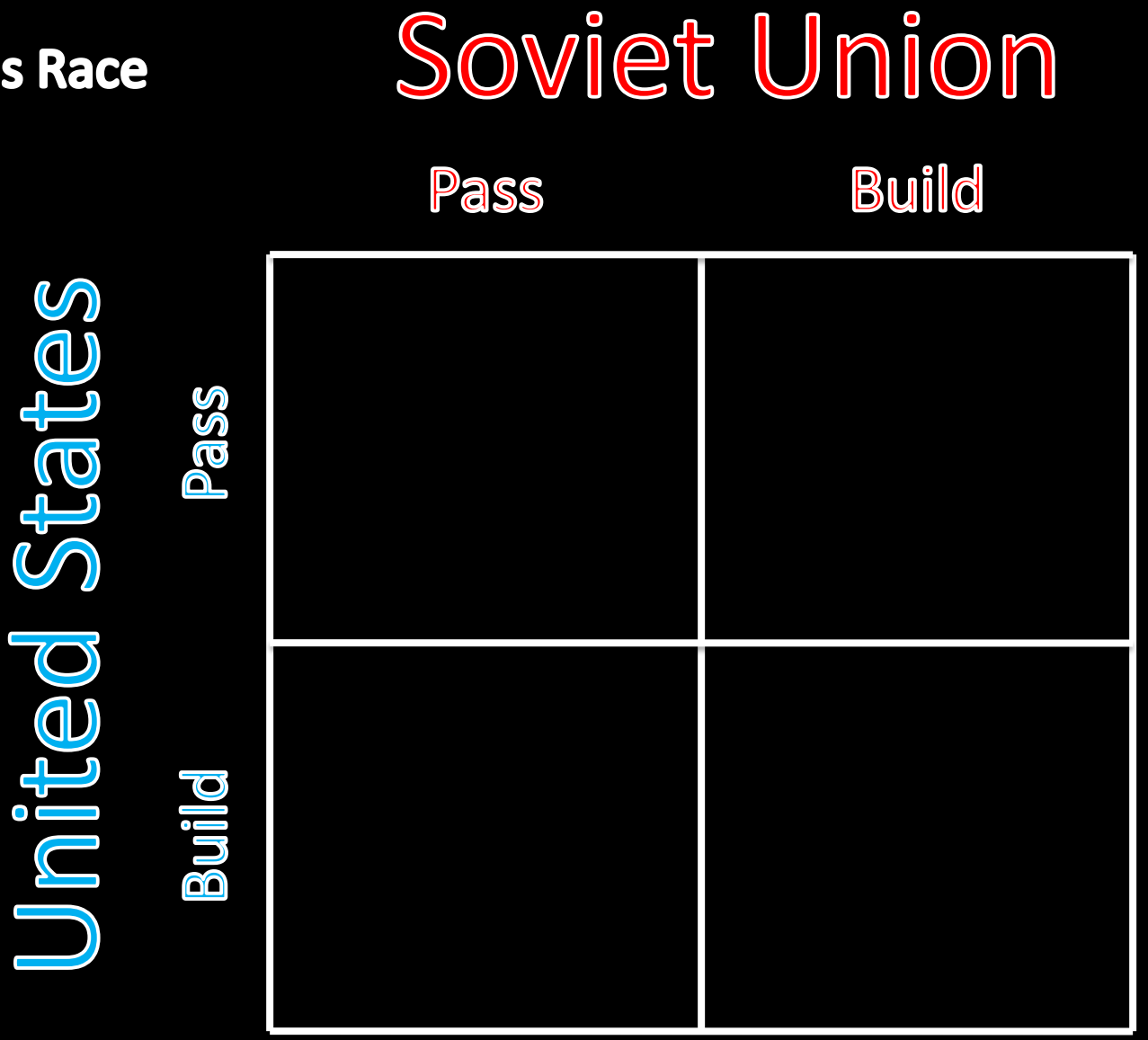
The Arms Dilemma

- In a world of anarchy, having military power allows you to get your way
- But military power is *relative*
  - The Roman Empire was more powerful than Italy is today
  - So a state only makes a relative gain against a rival if it builds and the rival does not

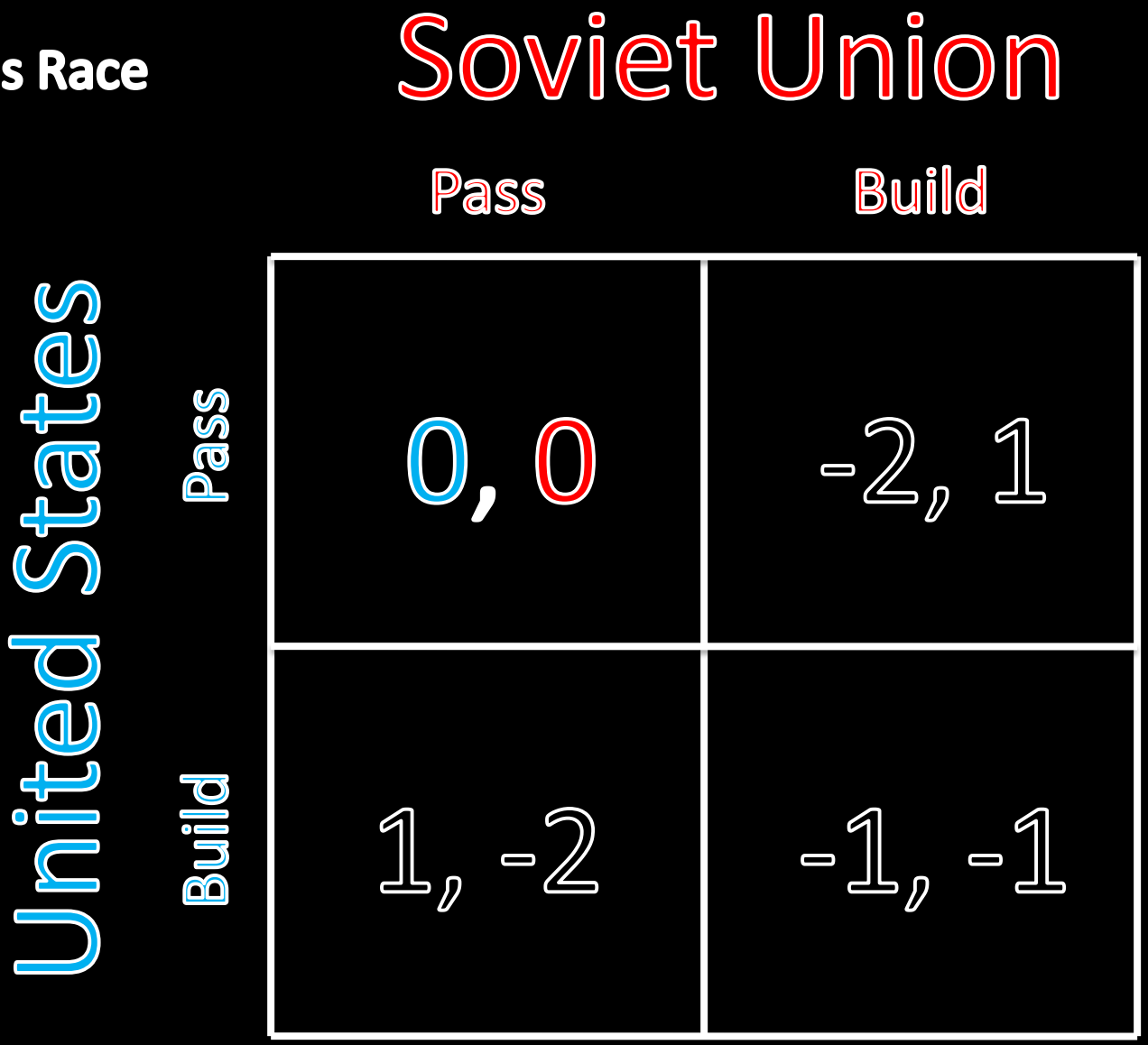
The Arms Dilemma

- In a world of anarchy, having military power allows you to get your way
- But military power is *relative*
  - The Roman Empire was more powerful than Italy is today
  - So a state only makes a relative gain against a rival if it builds and the rival does not
- Arms are costly to build

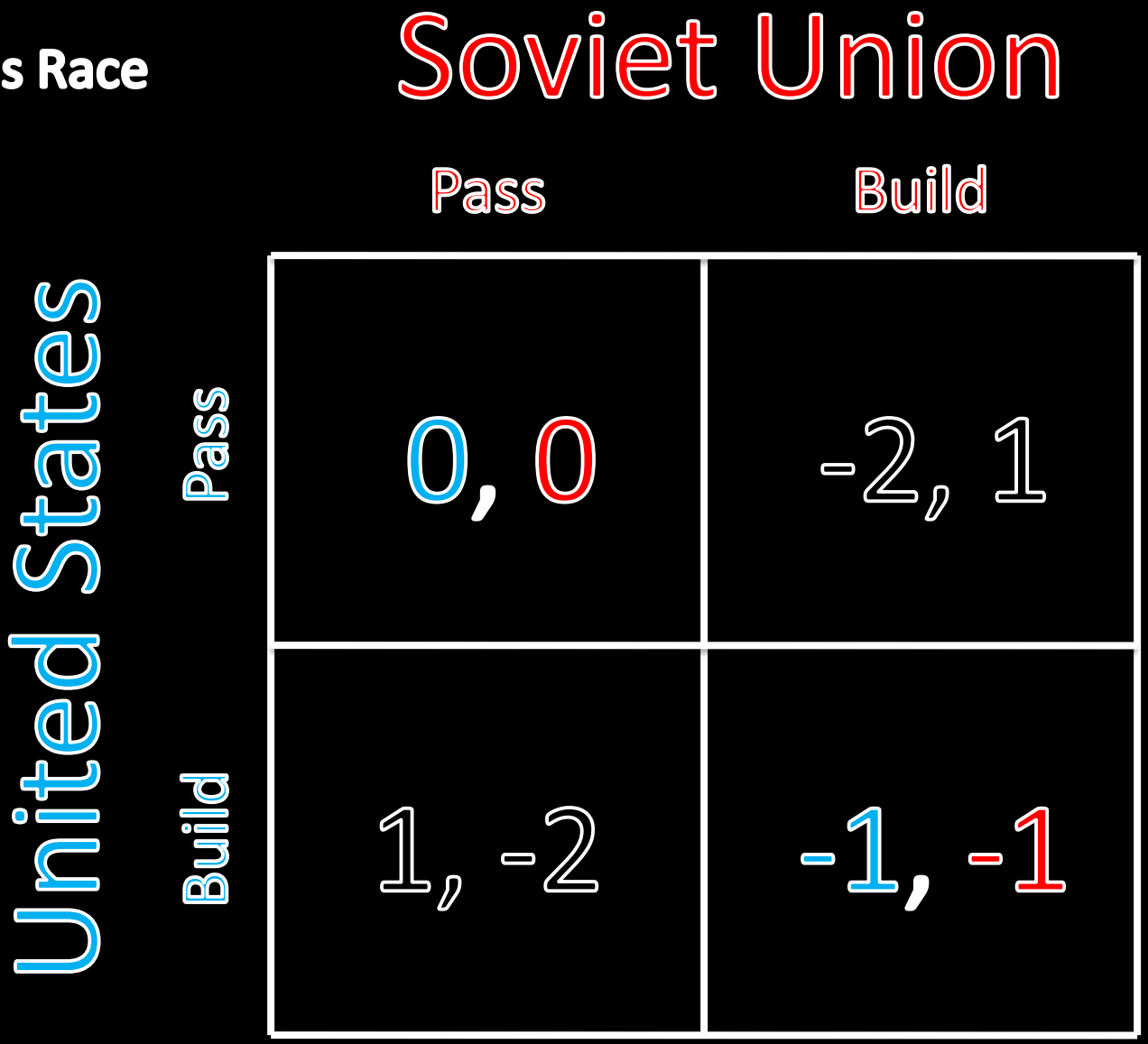
Arms Race



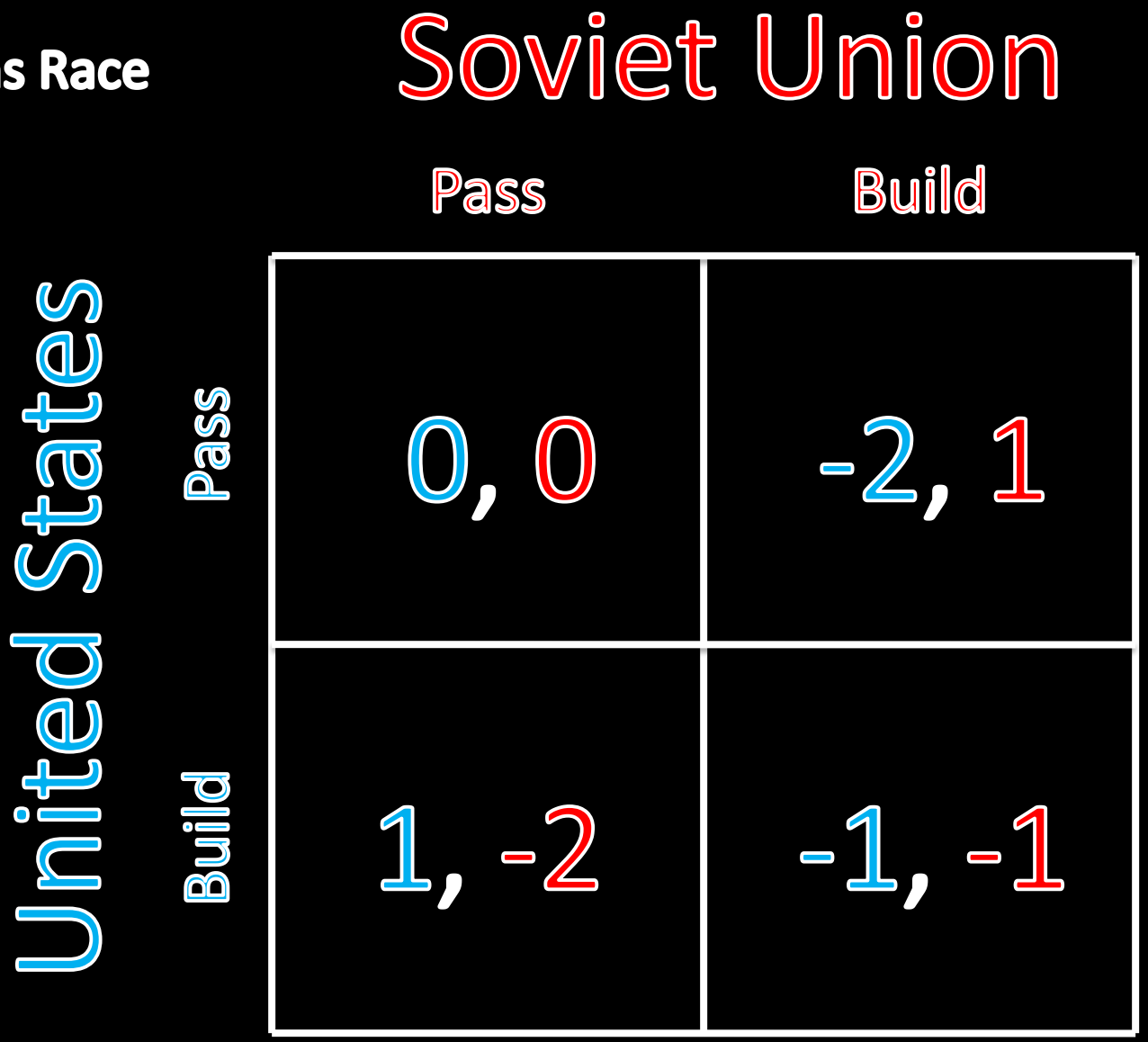
Arms Race



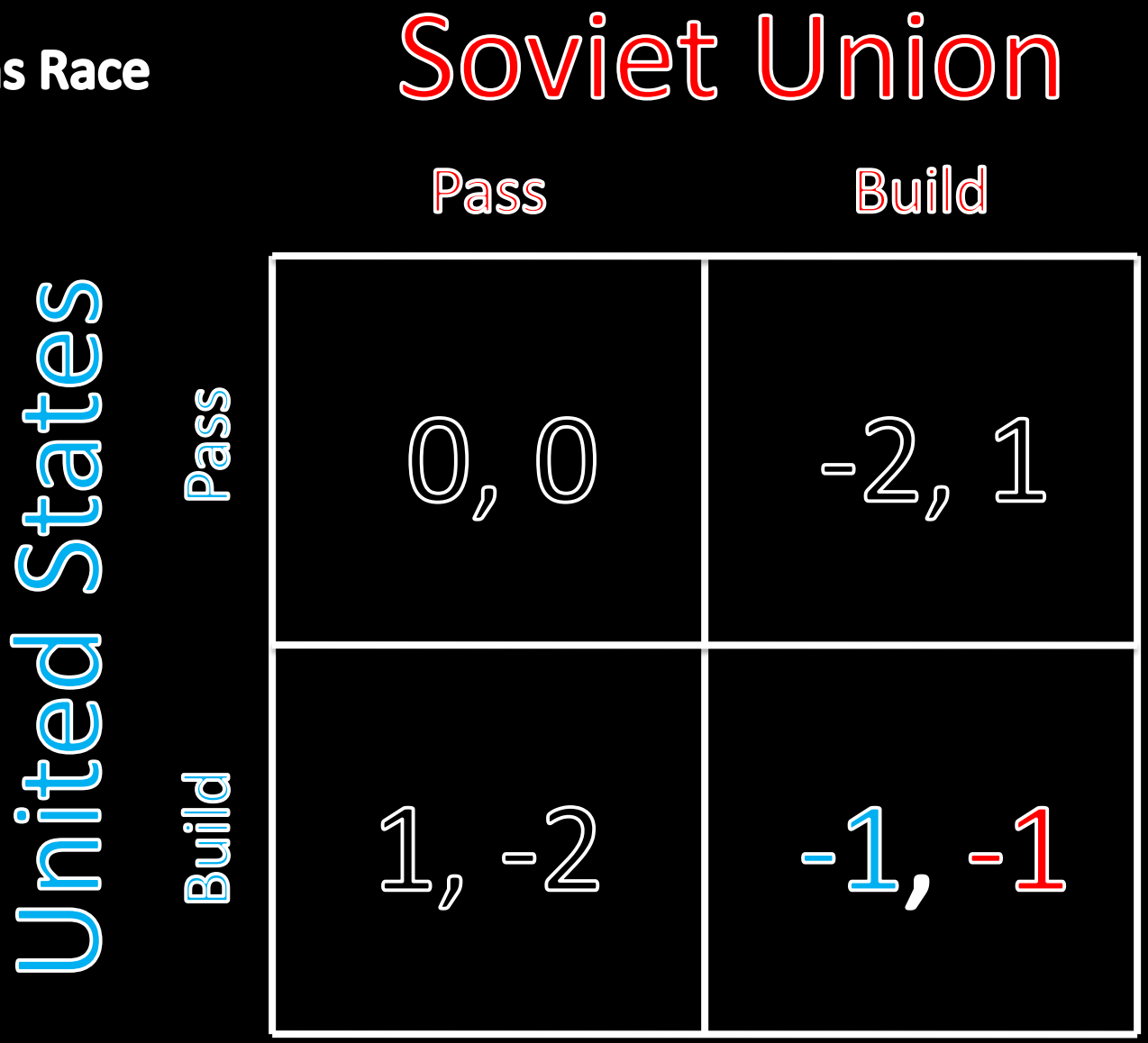
Arms Race



Arms Race



Arms Race



New Puzzle

- The prisoner's dilemma predicts that arms races should be prevalent
- Yet states sign arms treaties
  - Why are these arms treaties sustainable?
- Majority of nuclear-capable countries do not have nuclear weapons
  - Why doesn't everyone pull a North Korea?

Outline

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Can future interaction inspire cooperation today?

The Prisoner's Dilemma

- In a one-shot interaction, the players cannot cooperate because they individually prefer to act aggressively

The Prisoner's Dilemma

- In a one-shot interaction, the players cannot cooperate because they individually prefer to act aggressively
  - Some interactions are truly one-shot (preemptive war)
  - Others are repetitive (trade, arms races)

The Prisoner's Dilemma

- In a one-shot interaction, the players cannot cooperate because they individually prefer to act aggressively
  - Some interactions are truly one-shot (preemptive war)
  - Others are repetitive (trade, arms races)
- Can states cooperate with each other by threatening punishment in the future?

Repeated Play

- The simplest model:
  - States play the prisoner's dilemma twice
  - Moves from the first round are publicly known in the second round

Repeated Play

- Can the players cooperate in the first round under threat of punishment in the second round?
  - Is “I will cooperate today and, if you cooperate today as well, I will cooperate tomorrow” a viable strategy?

Solving the Game

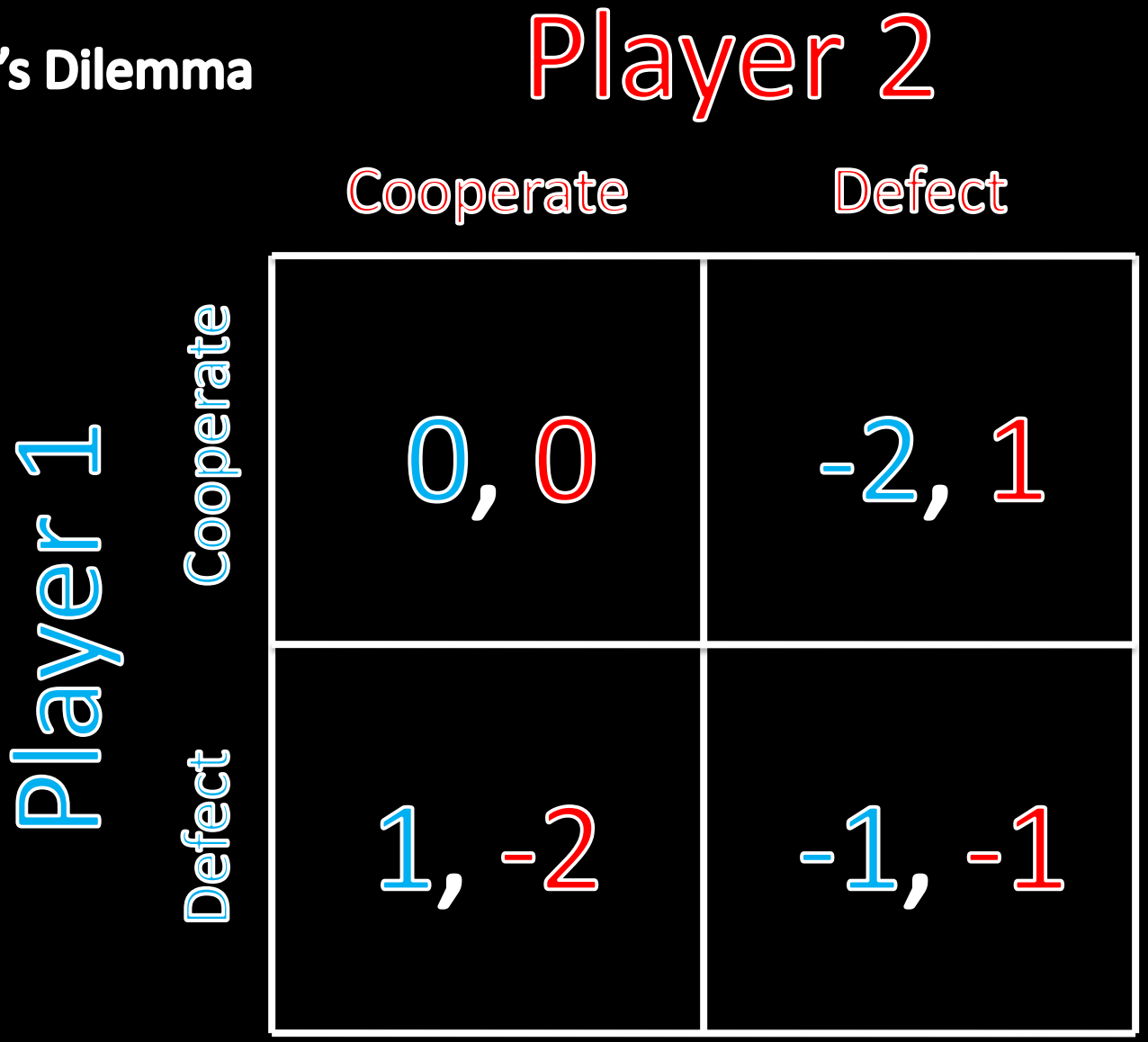
- Two possible ways to solve:
  1. Start by thinking about the first stage and then figure out the second stage
  2. Start by thinking about the second stage and then figure out the first stage
- Which is preferable?

Optimal Strategies

- Stage 1: Something happens

- Stage 2: Something already happened, but the states cannot alter their previous payoffs. Therefore, they must optimize their second stage payoffs.

Prisoner's Dilemma



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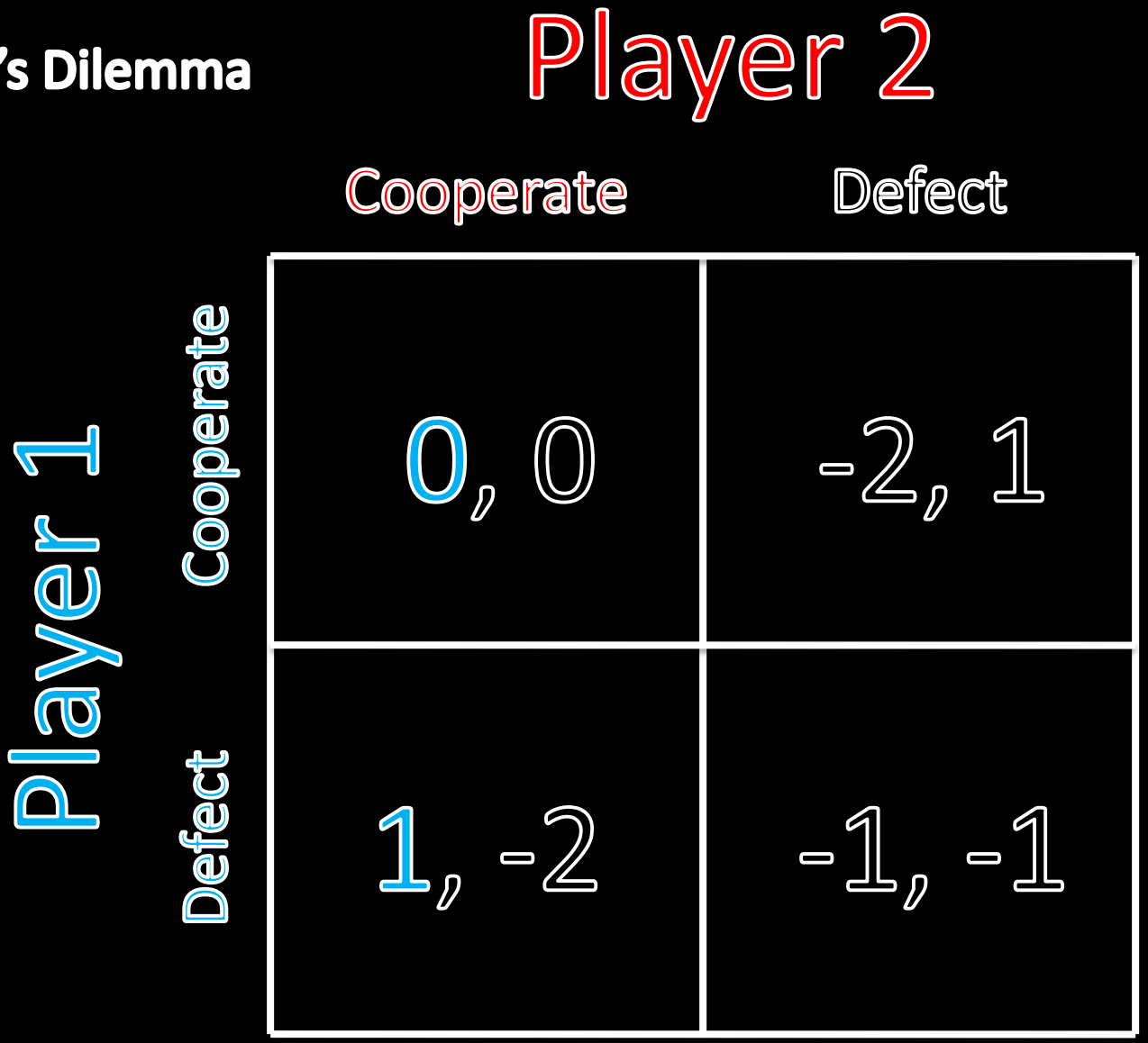
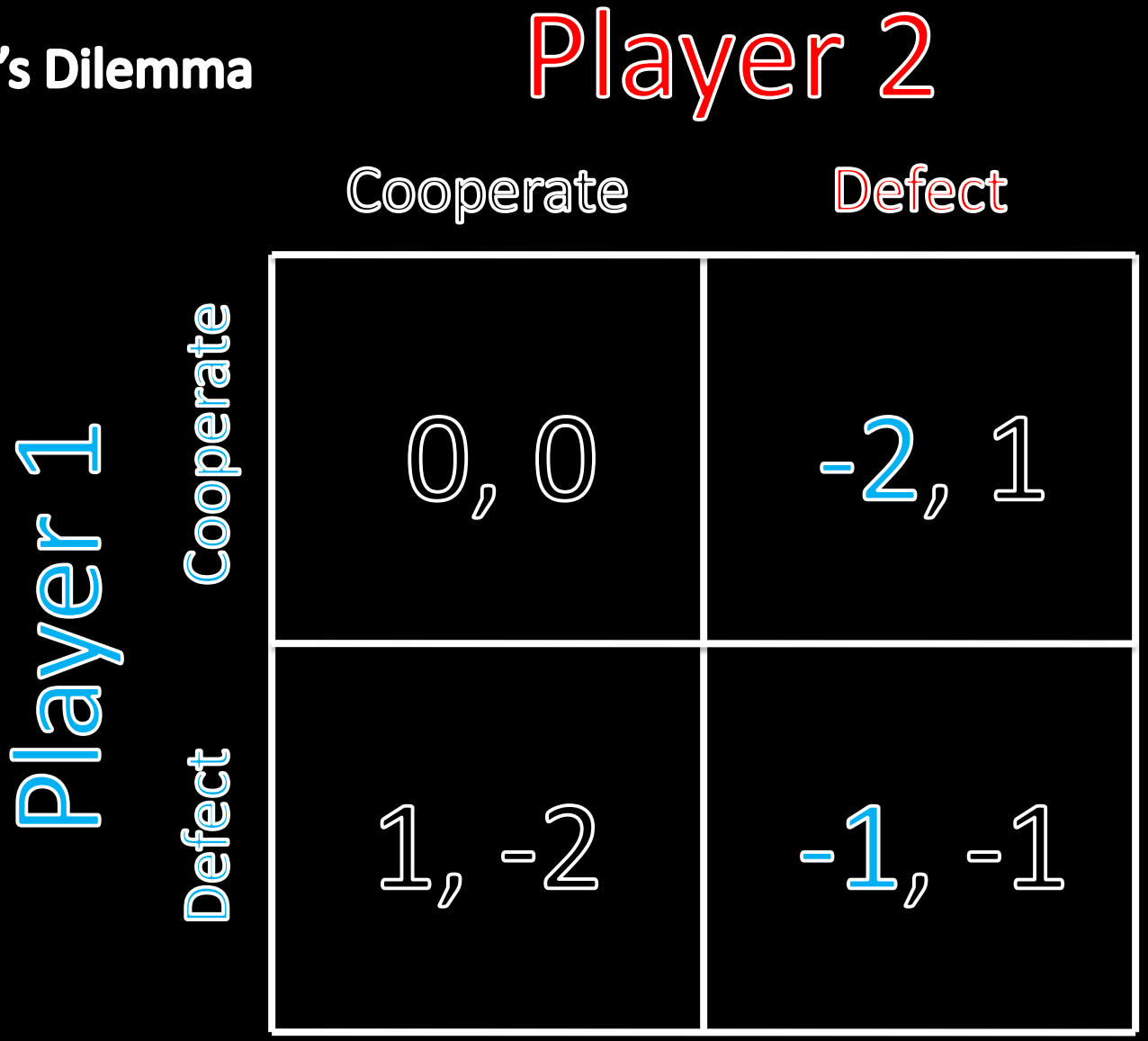


Prisoner's Dilemma



Optimal Strategies

- Stage 1: Something happens

- Stage 2: Both players defect

Repeated Play

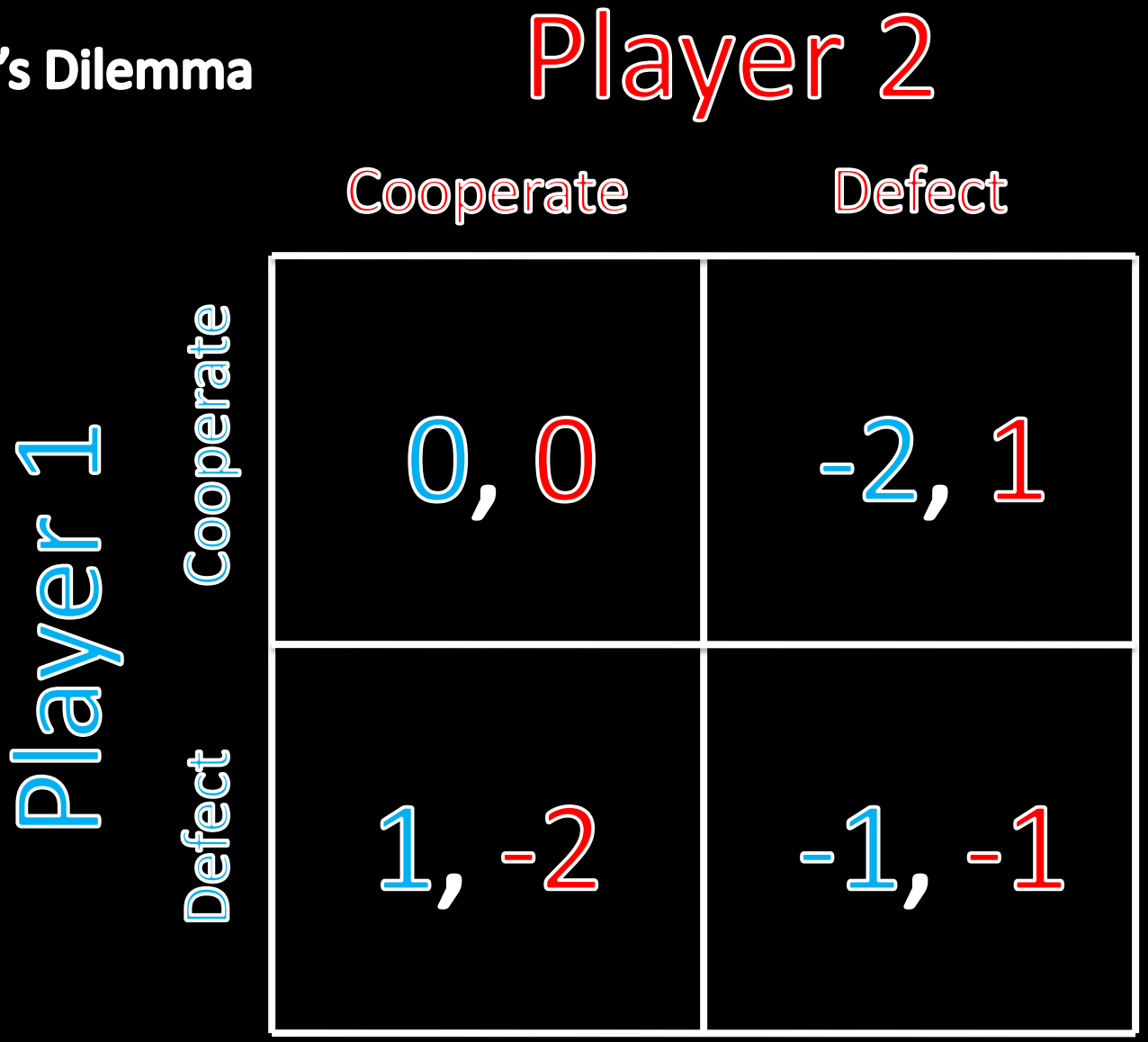
- “I will cooperate today and, if you cooperate today as well, I will cooperate tomorrow”

Optimal Strategies

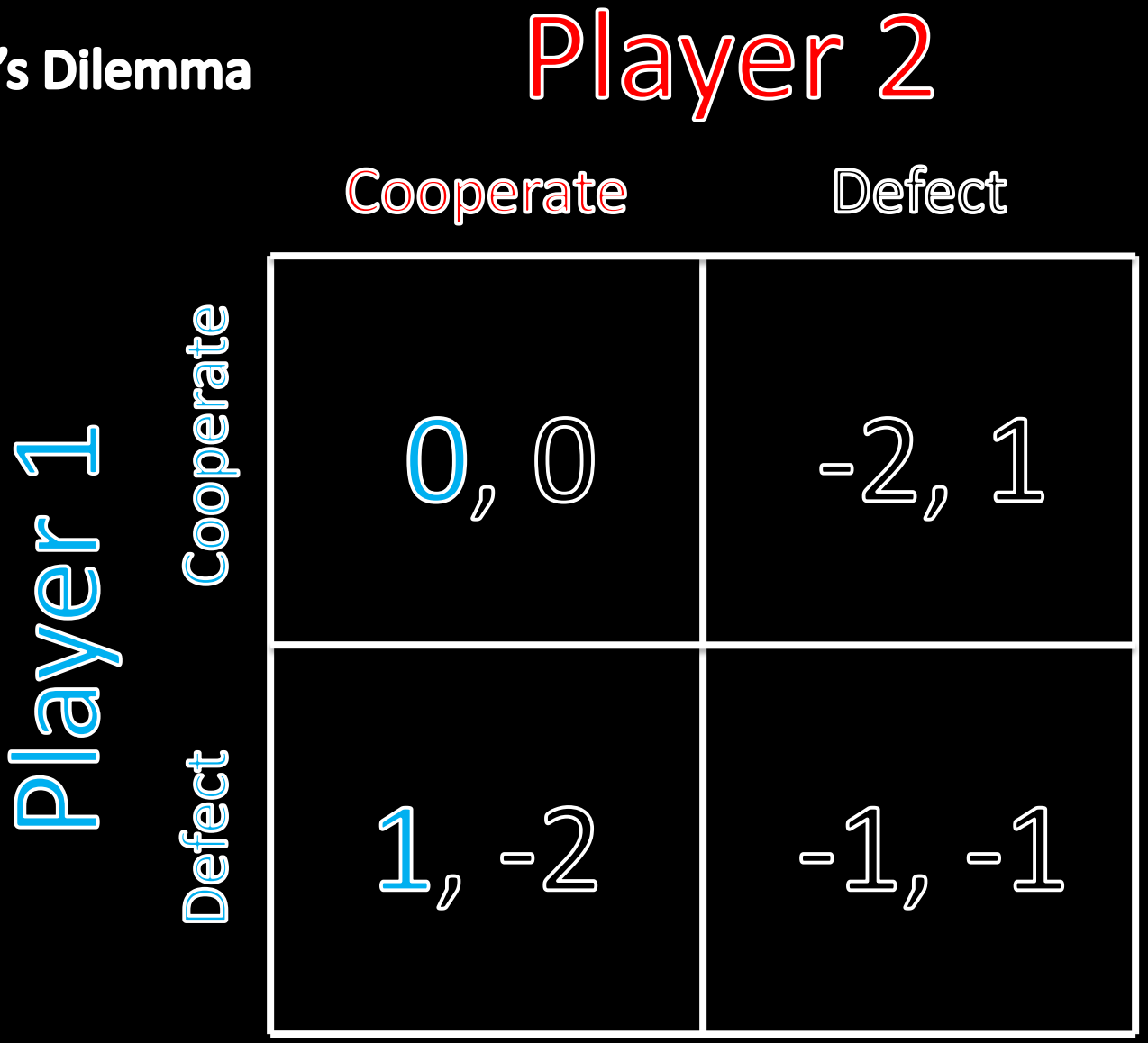
- Stage 1: Regardless of what happens in stage 1, the rival will defect in stage 2
  - Therefore, the states must optimize for today only

- Stage 2: Both players defect

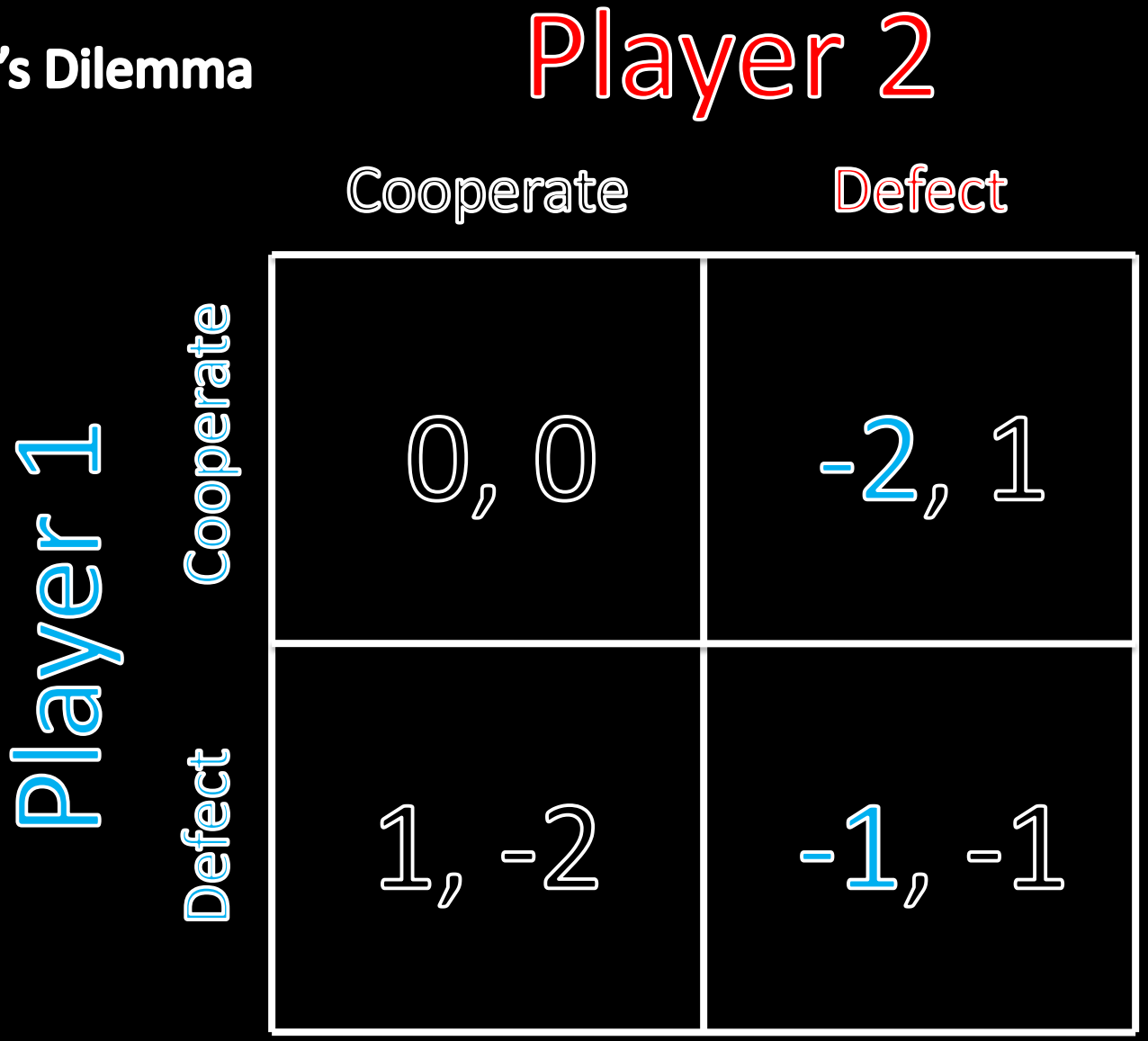
Prisoner's Dilemma



Prisoner's Dilemma



Prisoner's Dilemma



Optimal Strategies

- Stage 1: Both players defect

- Stage 2: Both players defect

Result

- Cooperation is not possible with just two interactions
- Can more interactions help? What if there were n stages?

Optimal Strategies

- Stage 1: ?
- Stage 2: ?
- Stage 3: ?
- …
- Stage n – 2: ?
- Stage n – 1: ?
- Stage n: ?

Optimal Strategies

- Stage 1: ?
- Stage 2: ?
- Stage 3: ?
- …
- Stage n – 2: ?
- Stage n – 1: ?
- Stage n: Whatever’s happened happened

Optimal Strategies

- Stage 1: ?
- Stage 2: ?
- Stage 3: ?
- …
- Stage n – 2: ?
- Stage n – 1: ?
- Stage n: ?

Optimal Strategies

- Stage 1: ?
- Stage 2: ?
- Stage 3: ?
- …
- Stage n – 2: ?
- Stage n – 1: ?
- Stage n: Everyone defects

Optimal Strategies

- Stage 1: ?
- Stage 2: ?
- Stage 3: ?
- …
- Stage n – 2: ?
- Stage n – 1: ?
- Stage n: Everyone defects

Optimal Strategies

- Stage 1: ?
- Stage 2: ?
- Stage 3: ?
- …
- Stage n – 2: ?
- Stage n – 1: WHH/future defection certain
- Stage n: Everyone defects

Optimal Strategies

- Stage 1: ?
- Stage 2: ?
- Stage 3: ?
- …
- Stage n – 2: ?
- Stage n – 1: Everyone defects
- Stage n: Everyone defects

Optimal Strategies

- Stage 1: ?
- Stage 2: ?
- Stage 3: ?
- …
- Stage n – 2: ?
- Stage n – 1: Everyone defects
- Stage n: Everyone defects

Optimal Strategies

- Stage 1: ?
- Stage 2: ?
- Stage 3: ?
- …
- Stage n – 2: WHH/FDC
- Stage n – 1: Everyone defects
- Stage n: Everyone defects

Optimal Strategies

- Stage 1: ?
- Stage 2: ?
- Stage 3: ?
- …
- Stage n – 2: Everyone defects
- Stage n – 1: Everyone defects
- Stage n: Everyone defects

Optimal Strategies

- Stage 1: Everyone defects
- Stage 2: Everyone defects
- Stage 3: Everyone defects
- …
- Stage n – 2: Everyone defects
- Stage n – 1: Everyone defects
- Stage n: Everyone defects

Outcome

- Regardless of the length of the interaction, states never cooperate
- The endgame sabotages cooperation in the earlier stages

New Puzzle

- What if the shadow of the future is indefinite?
  - We might not know when the interaction will end

Infinite Horizon Model

- Two states play the prisoner's dilemma repeatedly
  - After every period, they play another period with probability p
  - With probability 1 – p, a meteor smashes into the Earth (or something similar) and the game ends

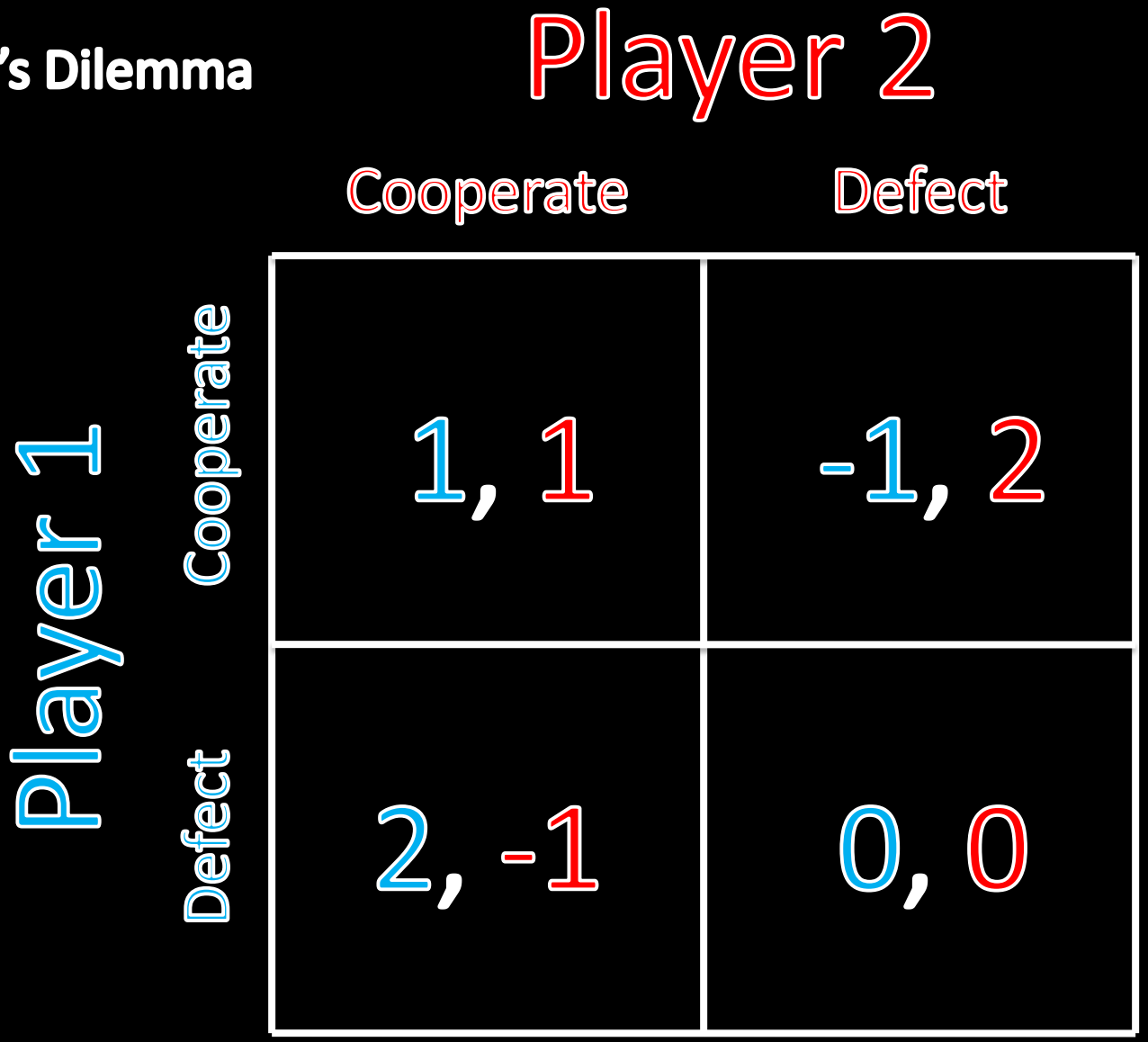
Infinite Horizon Model

- Two states play the prisoner's dilemma repeatedly
  - After every period, they play another period with probability p
  - With probability 1 – p, a meteor smashes into the Earth (or something similar) and the game ends
    - Also, present values > future values
    - We imagine p to be fairly large

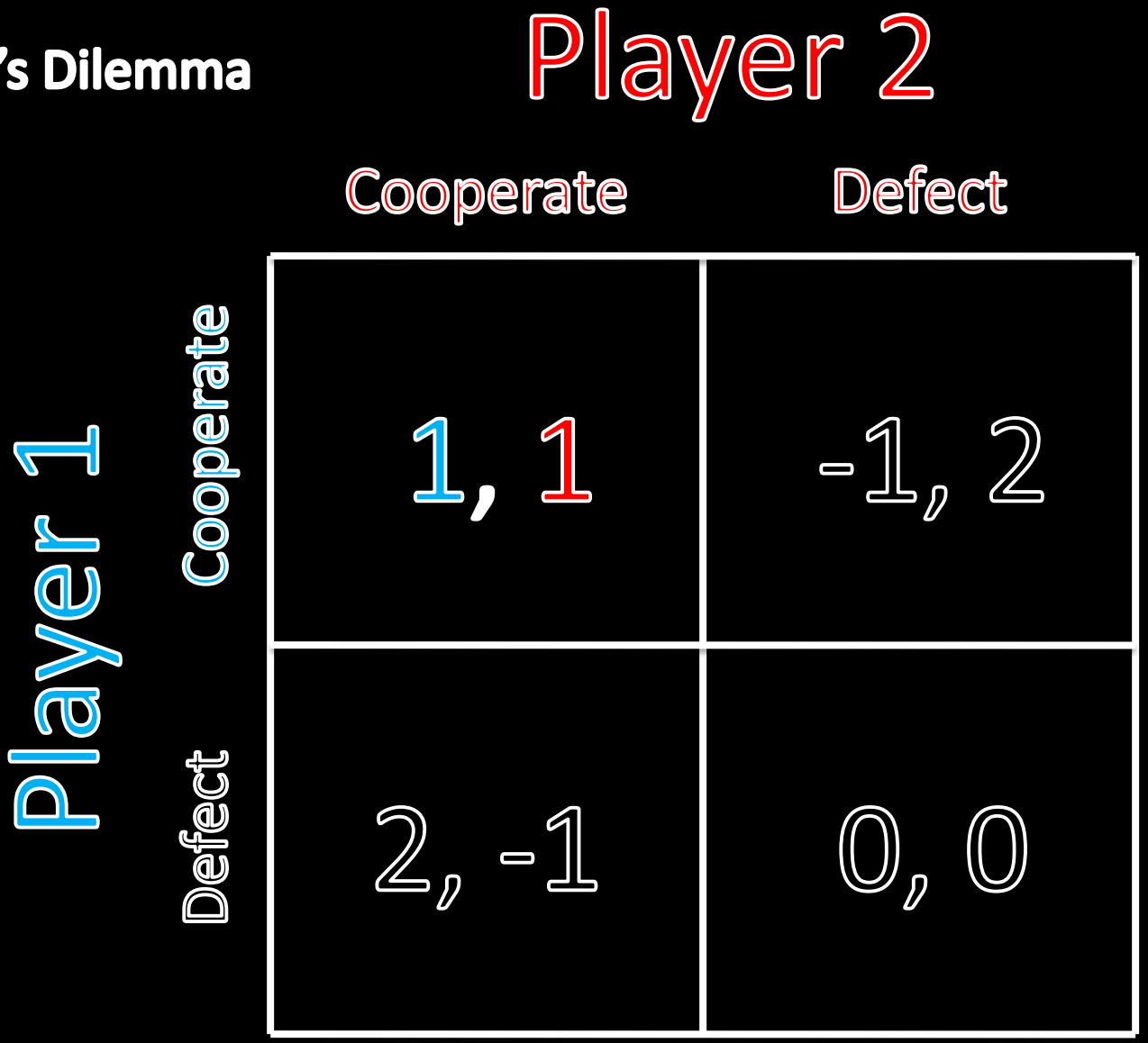
Grim Trigger

- A “tough love” strategy
  - Begin by cooperating
  - If at any point in the game a player has defected, defect for the rest of time
- Would two grim trigger players ever have incentive to defect on one another?

Prisoner's Dilemma



Prisoner's Dilemma



Payoffs for Cooperating Forever

- Today’s payoff: 1

Payoffs for Cooperating Forever

- Today's payoff: 1
- Tomorrow's payoff: (p)(1)

Payoffs for Cooperating Forever

- Today's payoff: 1
- Tomorrow's payoff: (p)(1)
- Day after tomorrow's payoff: $(p^2)(1)$

Payoffs for Cooperating Forever

- Today's payoff: 1
- Tomorrow's payoff: $(p)(1)$
- Day after tomorrow's payoff: $(p^2)(1)$
- Fourth day's payoff: $(p^3)(1)$
- Fifth day's payoff: $(p^4)(1)$
- Sixth day's payoff: $(p^5)(1)$
- Seventh day's payoff: $(p^6)(1)$

Payoffs for Cooperating Forever

- $1 + (p)(1) + (p^2)(1) + (p^3)(1) + (p^4)(1) + (p^5)(1) + (p^6)(1) + (p^7)(1) + (p^8)(1) + (p^9)(1) + (p^{10})(1) + (p^{11})(1) + (p^{12})(1) + (p^{13})(1) + (p^{14})(1) + (p^{15})(1) + (p^{16})(1) + (p^{17})(1) + (p^{18})(1) + (p^{19})(1) + \ldots$
  - This goes on forever

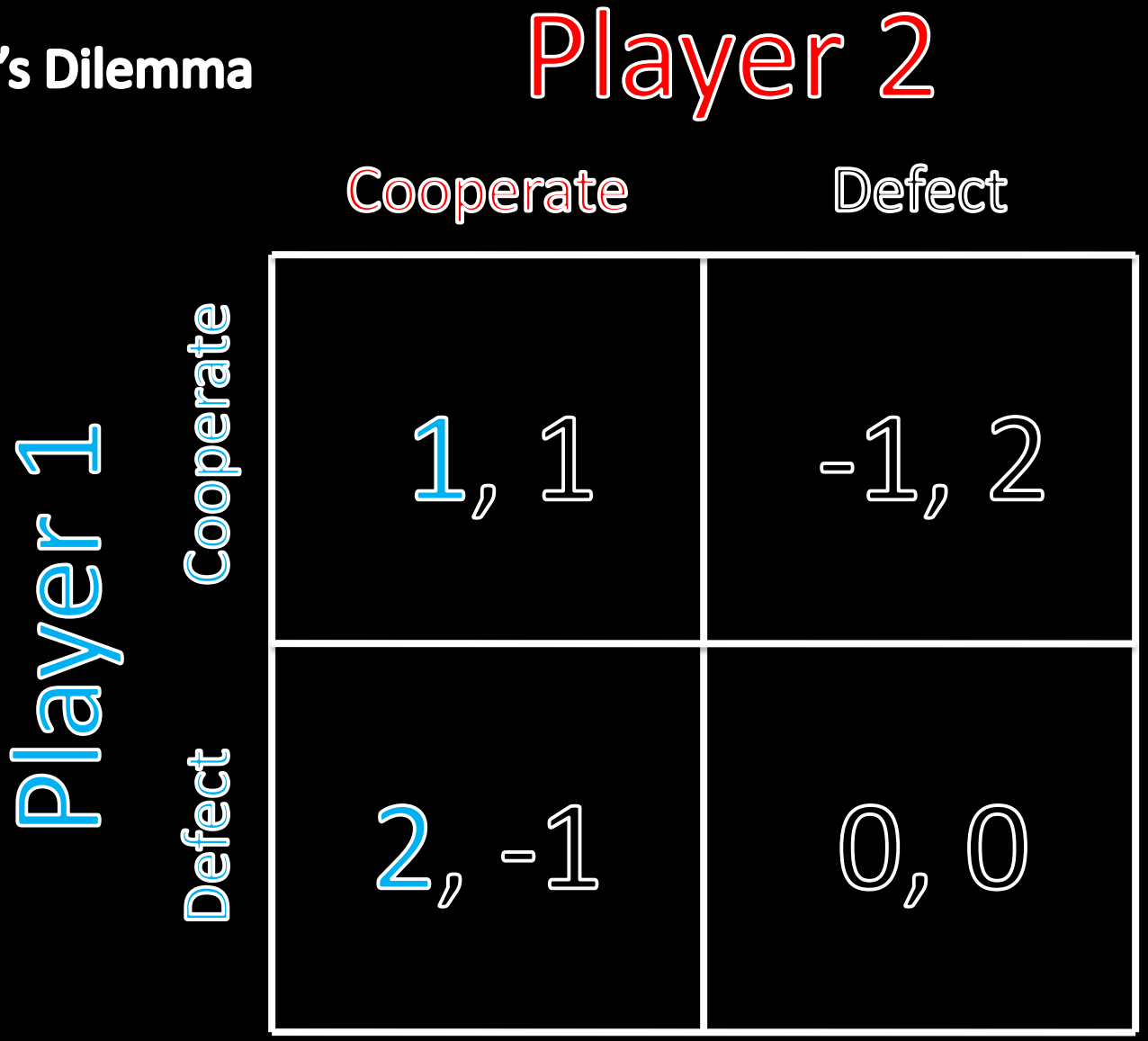
Payoffs for Cooperating Forever

- $1 + (p)(1) + (p^2)(1) + (p^3)(1) + (p^4)(1) + (p^5)(1) + (p^6)(1) + (p^7)(1) + (p^8)(1) + (p^9)(1) + (p^{10})(1) + (p^{11})(1) + (p^{12})(1) + (p^{13})(1) + (p^{14})(1) + (p^{15})(1) + (p^{16})(1) + (p^{17})(1) + (p^{18})(1) + (p^{19})(1) + \ldots$
  - This goes on forever
- Neat math trick: this is finite!
- Equal to $1/(1 - p)$

Payoffs for Betrayal

- If I defect against a grim trigger player, I do slightly better during the first period

Prisoner's Dilemma



Payoffs for Betrayal

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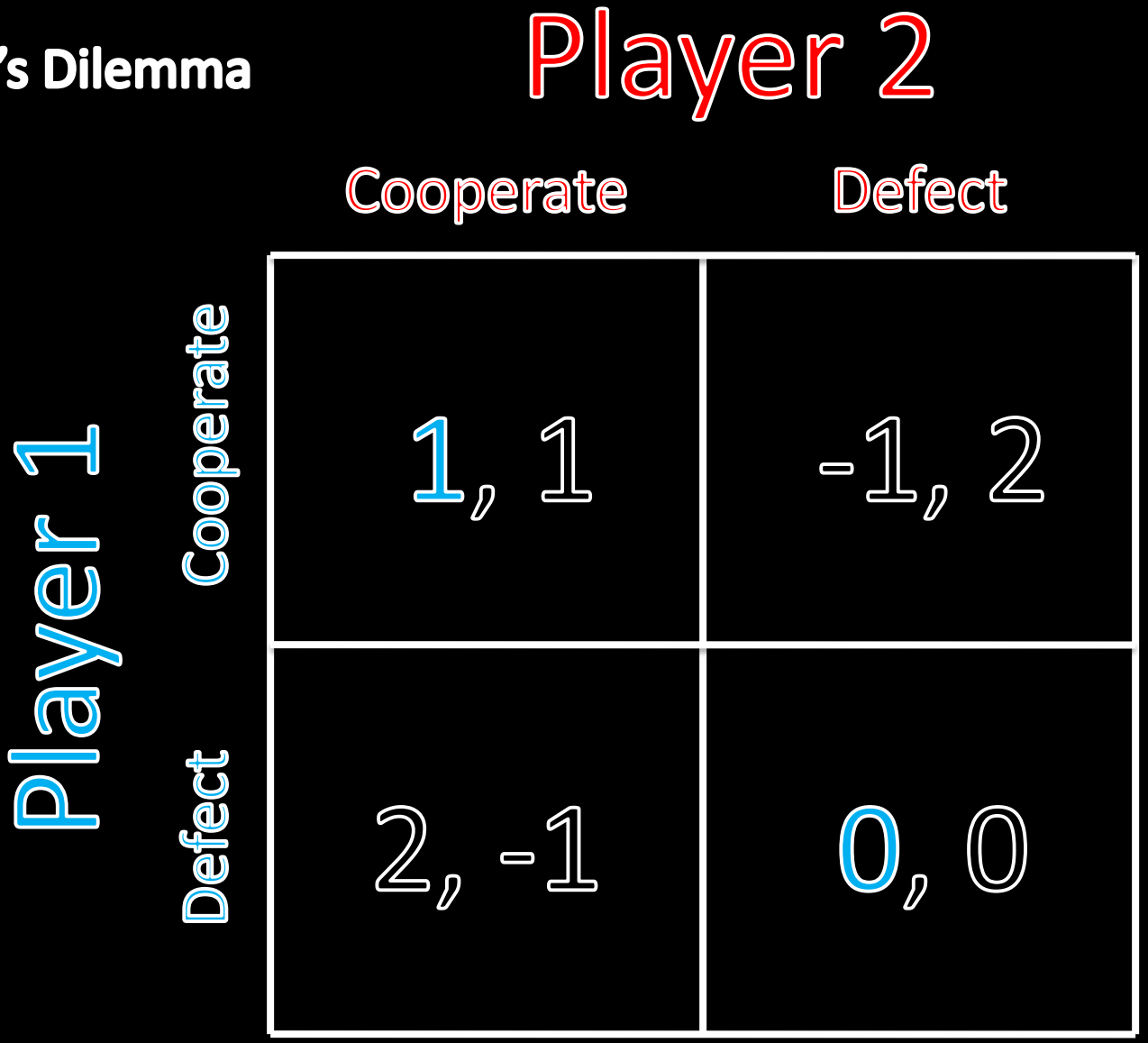
  - I get 2 instead of 1
- However, I do worse for the rest of time

Prisoner's Dilemma



Payoffs for Betrayal

- If I defect against a grim trigger player, I do slightly better during the first period
  - I get 2 instead of 1
- However, I do worse for the rest of time
  - Instead of earning 1 every period, I earn 0 instead
- The most I can earn from betrayal is 2

Comparing My Choices

- Payoff for sticking to grim trigger: $1/(1 - p)$
- Payoff for betrayal of my opponent: 2

Comparing My Choices

- Payoff for sticking to grim trigger: $1/(1 - p)$
- Payoff for betrayal of my opponent: 2
- Therefore, playing cooperatively is in my best interest if:
  - $1/(1 - p) \geq 2$
  - $1 \geq 2(1 - p)$
  - $1 \geq 2 - 2p$
  - $p \geq ½$

Important Result

- As long as we are likely to keep interacting in the future, cooperation is possible!

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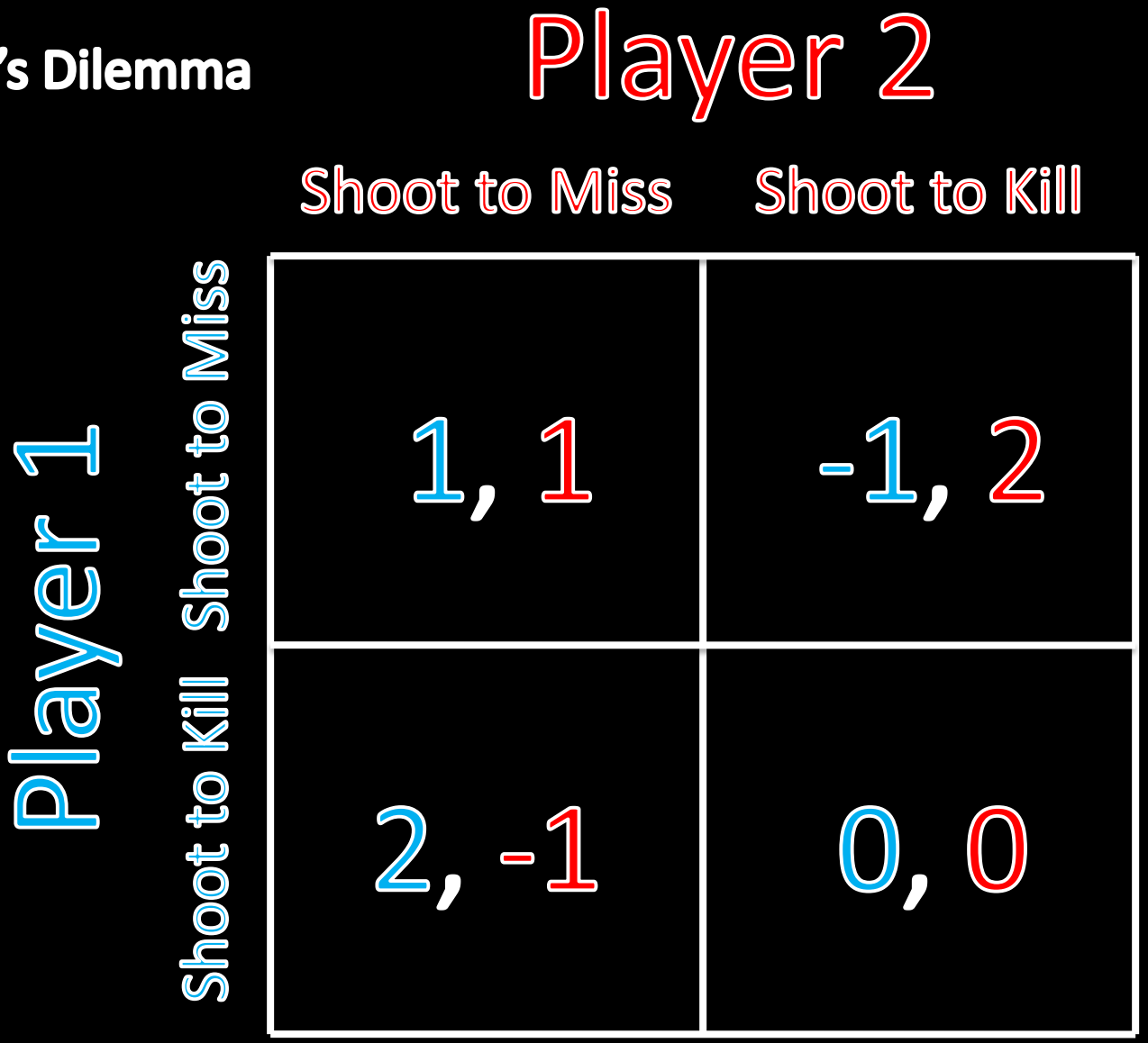
- As long as we are likely to keep interacting in the future, cooperation is possible!
  - Threat of future punishment keeps states in line even without a world police
  - States must not know when the interaction will end ahead of time

Life in WWI Trenches

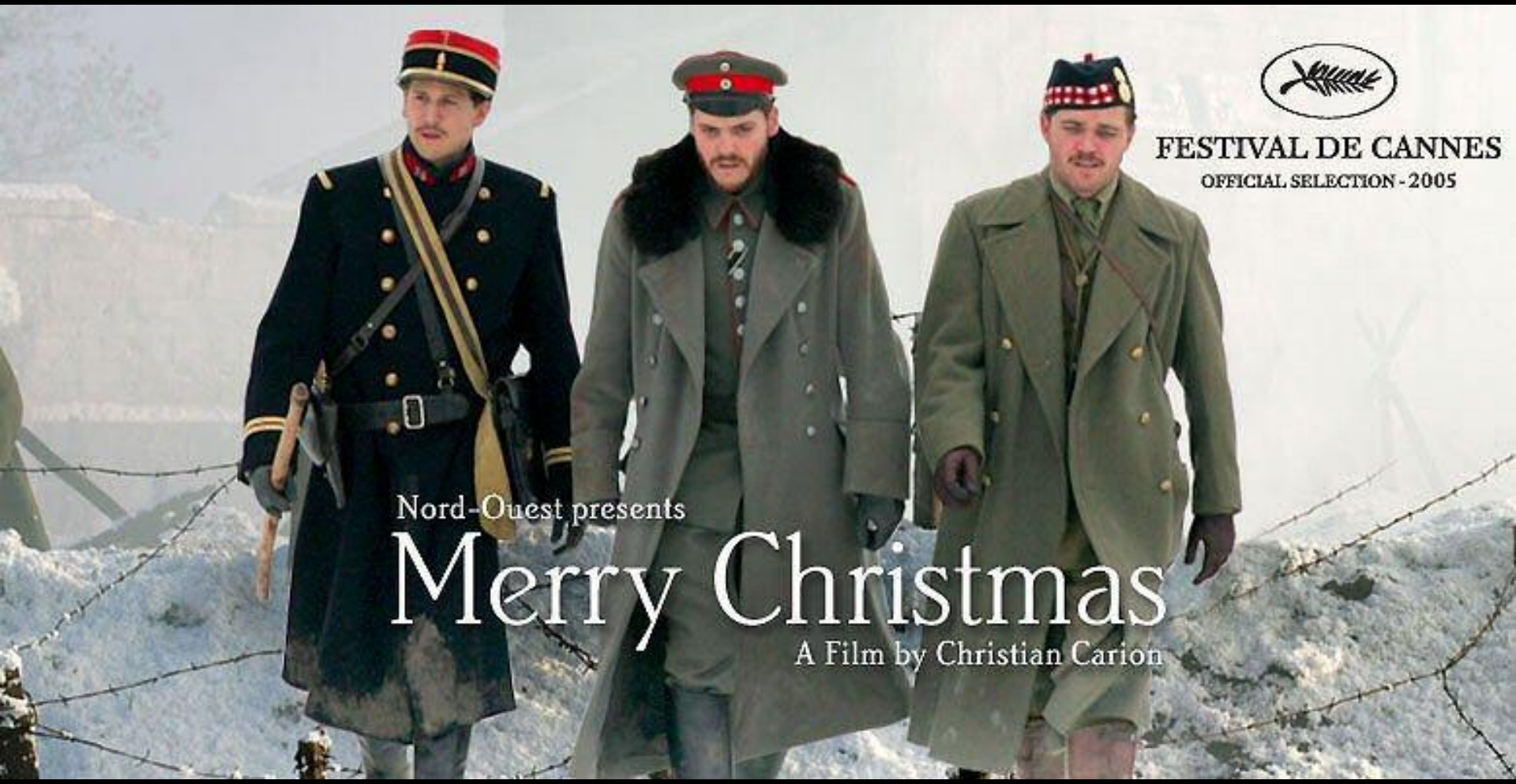
- Remember those first strike advantages?
  - Machine guns: good at mowing down oncoming soldiers, bad at overtaking positions
  - Chemical weapons: much harder to use
  - Railroads: great for resupplying troops at the front lines, bad for advancing into enemy territory

Prisoner's Dilemma



Life in WWI Trenches

- One-shot interaction: they kill each other
- But trench warfare was different!
  - Sides stayed stationary
  - Enemy troops “interacted” repeatedly
- Troops often intentionally shot to miss!


FESTIVAL DE CANNES
OFFICIAL SELECTION - 2005
Nord-Ouest presents
Merry Christmas
A Film by Christian Carion

Government Reaction

- Governments faced compliance problem
  - Incentives of those executing the action were not aligned with those giving the orders
- Began requiring troops to attempt “over the top” raids
  - Two possible outcomes
    - Overtake opposing trench
    - Have a lot of dead bodies
  - Verifiable evidence of fighting either way

Robert Axelrod

In Later Lectures…

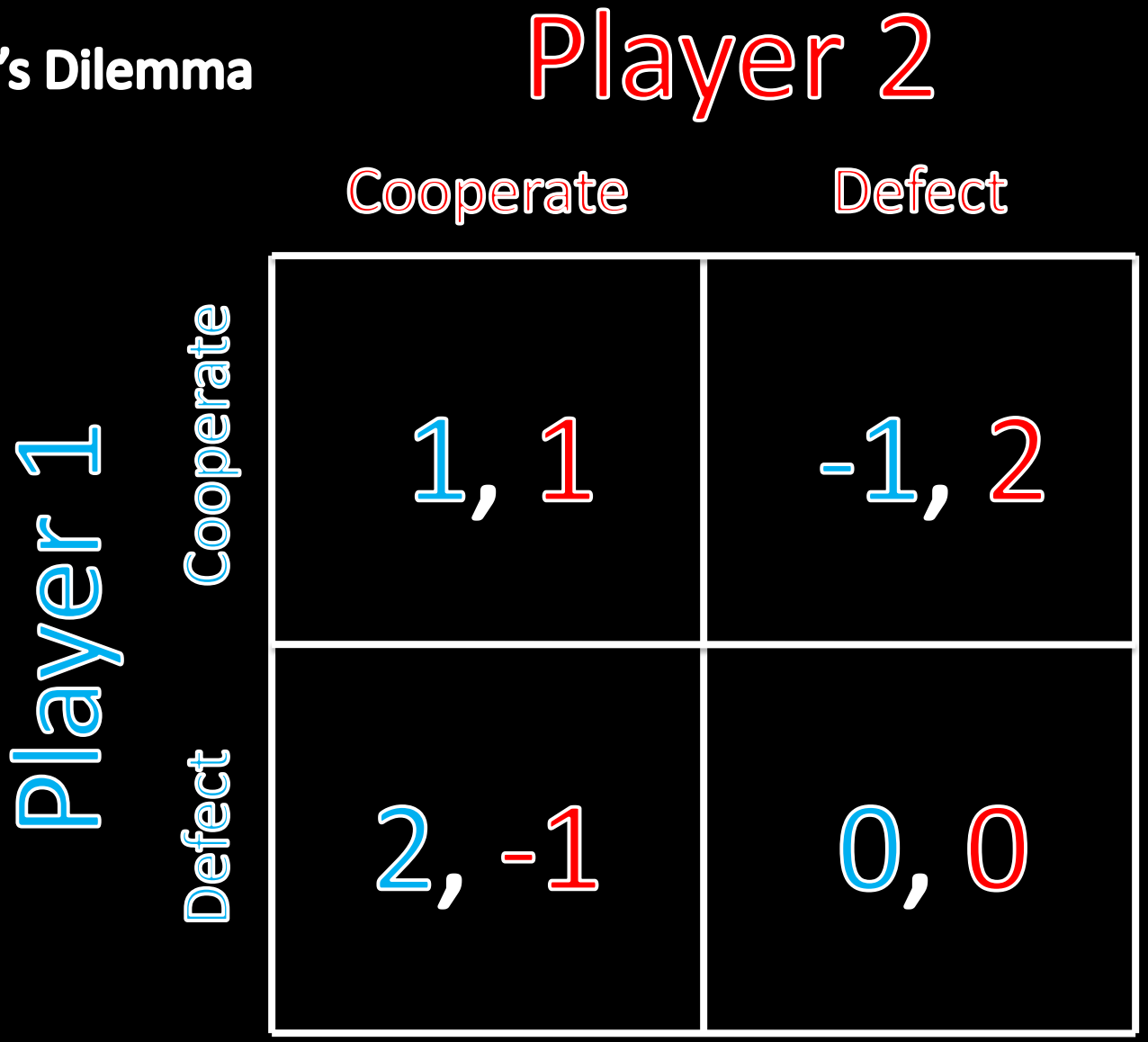
- “Cooperate” and “defect” are very restrictive strategies
  - We need to allow states to bargain with one another

Outline

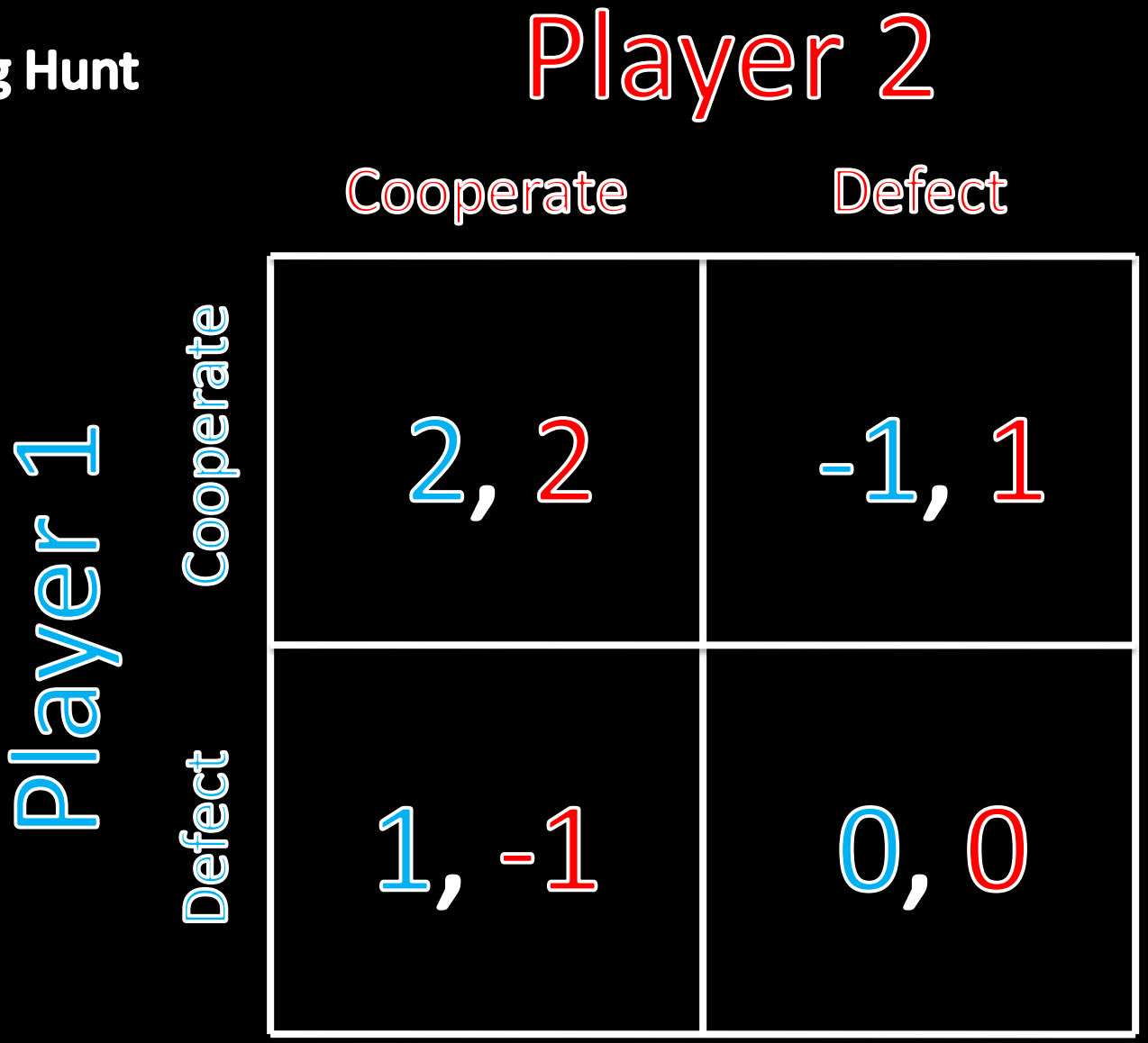
- Background
- The Prisoner's Dilemma
- The Cult of the Offensive
- Tariffs and Free Trade
- Arms Races
- Repeated Interaction
- Coordination Problems

What happens if states have nice preferences?

Prisoner's Dilemma



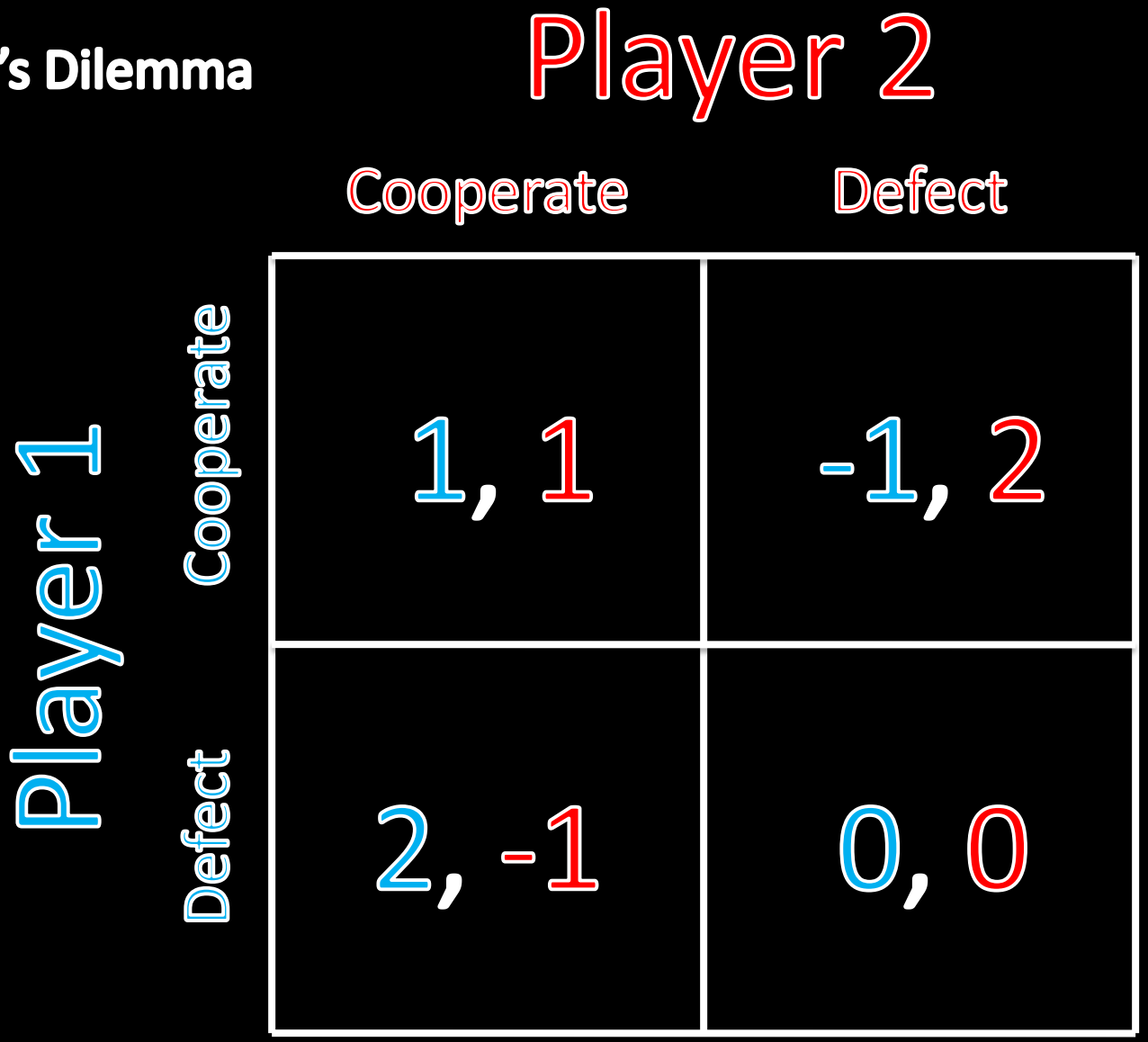
Stag Hunt


Player 2
Cooperate
Defect
Player 1
Cooperate
Defect
2, 2
-1, 1
1, -1
0, 0

Key Results

- Players can credibly commit to cooperation in a one-shot game
  - Not possible in a prisoner's dilemma
    - Players have no incentive to follow through on a commitment that says "I will cooperate when we play"

Prisoner's Dilemma



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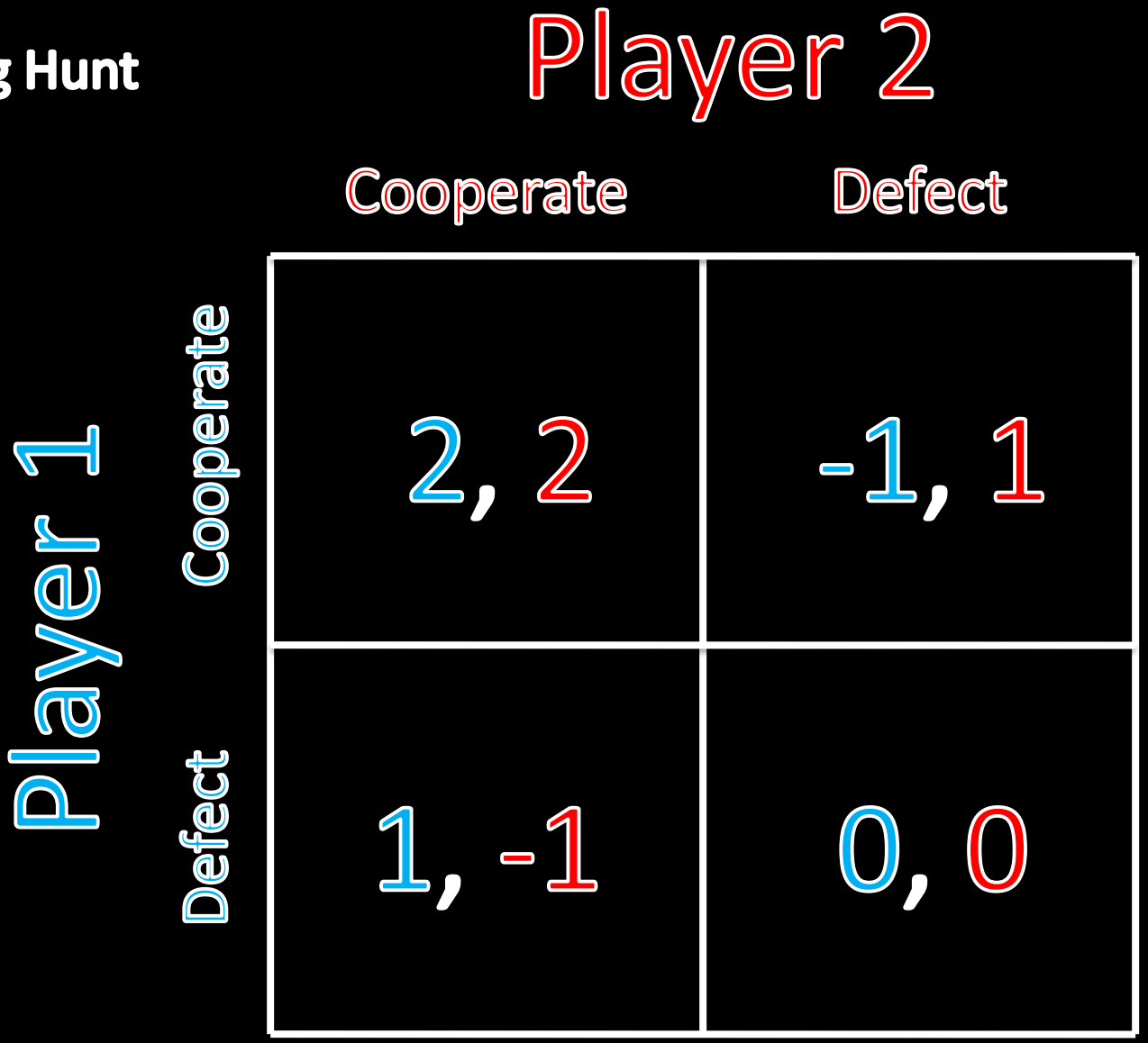
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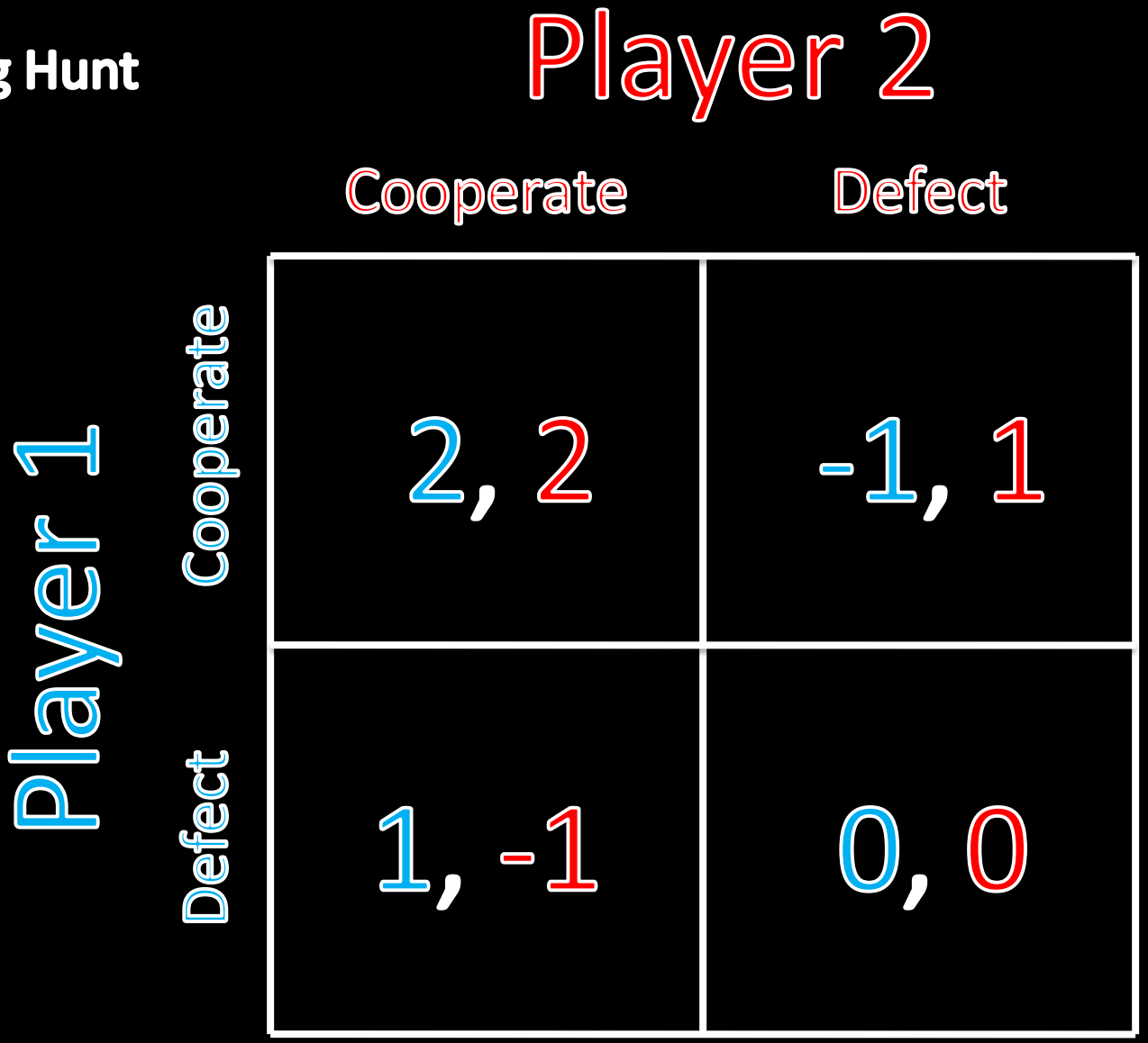
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Key Results

- Players can credibly commit to cooperation in a one-shot game
  - Not possible in a prisoner's dilemma
- Inefficient uncooperative outcome is still possible
  - Stag hunt is a "coordination" game
  - A primary motivation for international institutions