

# PSC/IR 106: Basic Models of Conflict and Cooperation

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# Outline

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

Big question: 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.

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- 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

- How can individually rational behavior lead to collectively bad outcomes?

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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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- “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

Player 1

Keep Quiet  
Confess

Player 2

Keep Quiet

Confess

-1, -1

-12, 0

0, -12

-8, -8

Cooperative Outcome

Player 2

Player 1

Keep Quiet

Confess

Keep Quiet

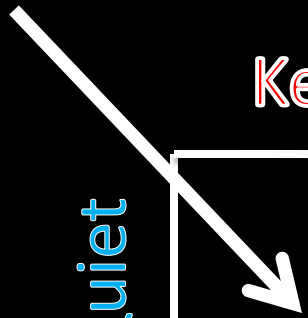
Confess

-1, -1

-12, 0

0, -12

-8, -8



Conflictual Outcomes

Player 2

Player 1

Keep Quiet

Confess

Keep Quiet

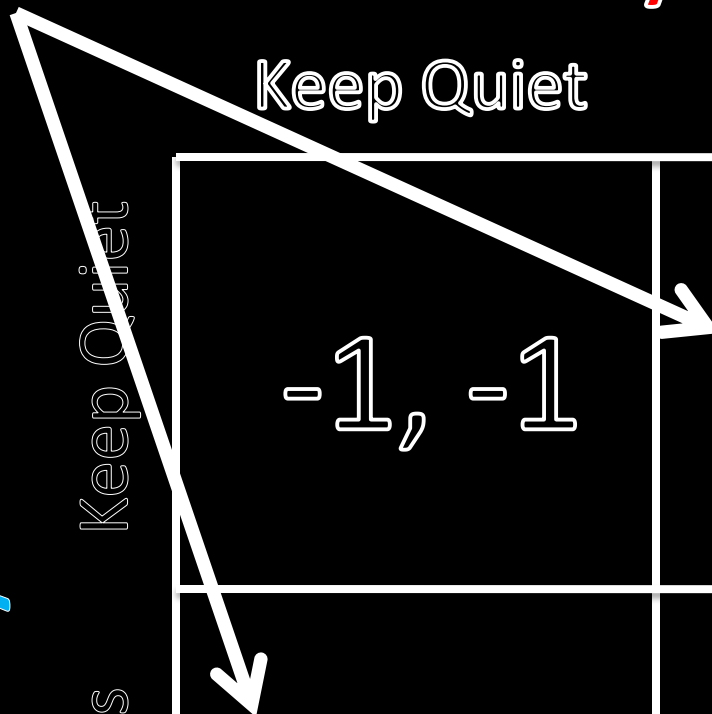
Confess

-1, -1

-12, 0

0, -12

-8, -8



The "Bad" Outcome

Player 2

Keep Quiet

Confess

Player 1

Keep Quiet

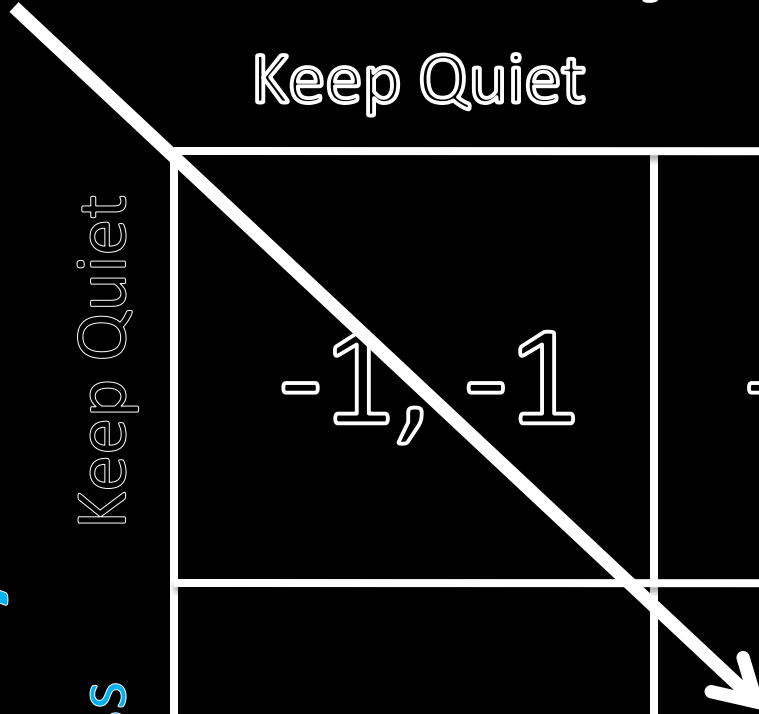
Confess

-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

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- 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

Player 2

Keep Quiet

Player 1

Keep Quiet

-1, -1

Confess

0, -12

# The Prisoner's Dilemma

Player 1

Confess      Keep Quiet

Player 2

Confess

-12, 0

-8, -8

# 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

Player 1

Keep Quiet

Player 2

Keep Quiet

Confess

-1, -1

-12, 0

# The Prisoner's Dilemma

Player 2

Keep Quiet

Confess

Player 1

Confess

0, -12

-8, -8

# The Prisoner's Dilemma

Player 2

Keep Quiet

Confess

Player 1

Keep Quiet

Confess

-1, -1

-12, 0

0, -12

-8, -8

# The Prisoner's Dilemma

Player 2

Keep Quiet

Confess

Player 1

Keep Quiet

Confess

-1, -1

-12, 0

0, -12

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# The Prisoner's Dilemma

Player 2

Keep Quiet

Confess

Player 1

Keep Quiet

Confess

-1, -1

-12, 0

0, -12

-8, -8

# 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

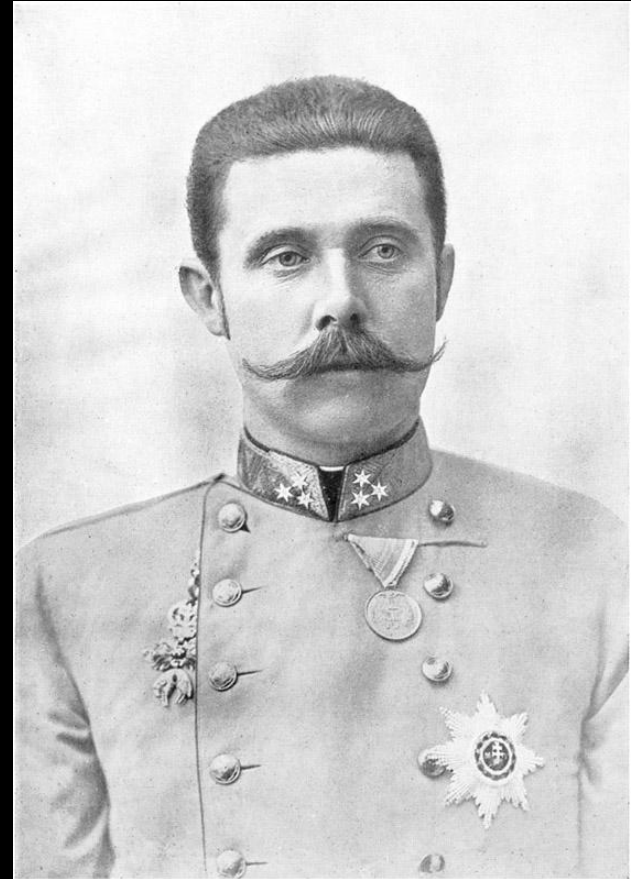
# Outline

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- Coordination Problems

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

Key

- Neutral Powers
- Central Powers
- Allied Powers



# July 28

AH Demands Not Met;  
AU Declares War on Serbia

Key

- Neutral Powers
- Central Powers
- Allied Powers

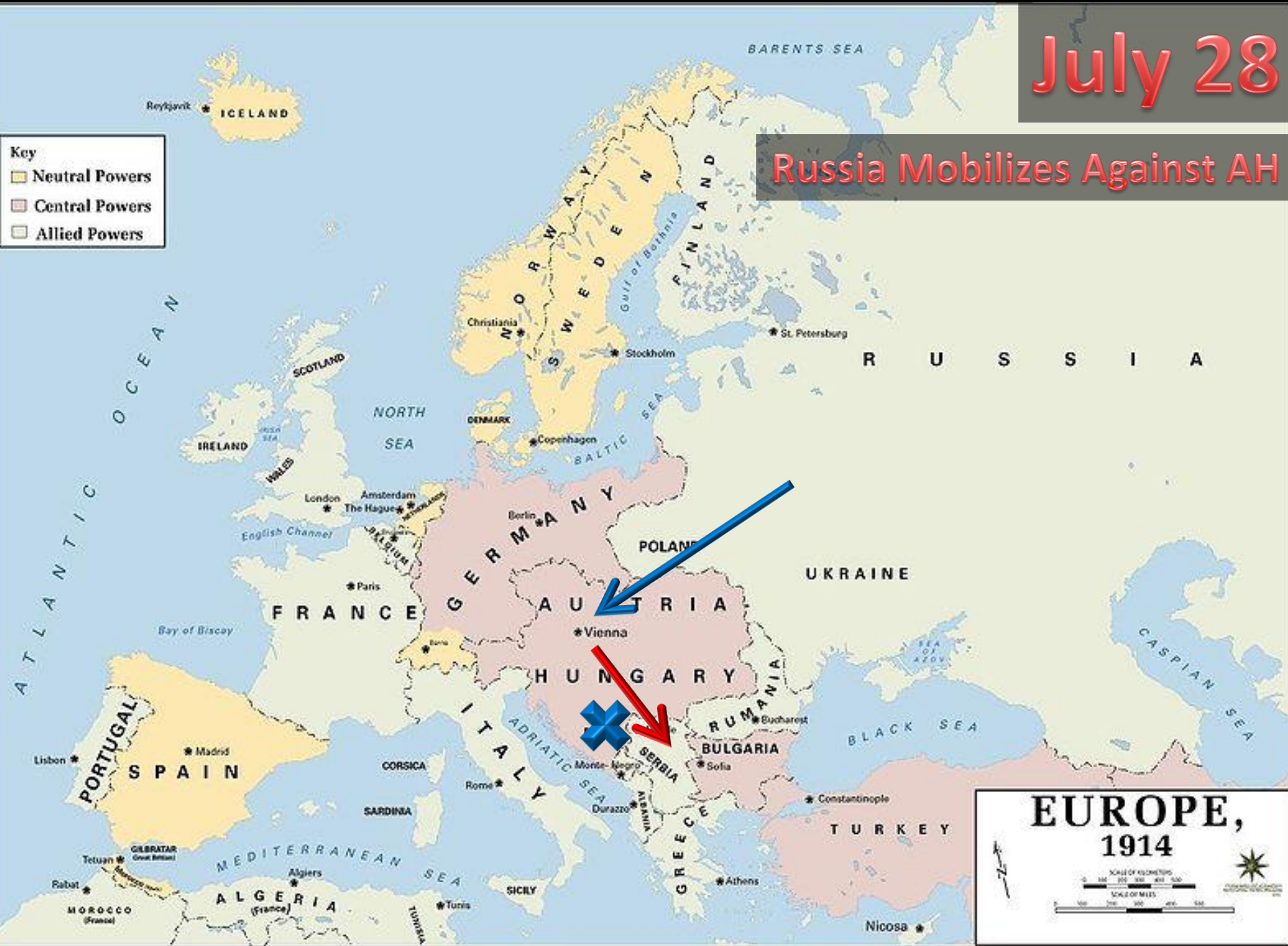


July 28

Russia Mobilizes Against AH

Key

- Neutral Powers
- Central Powers
- Allied Powers



# August 1

## Germany Declares War on Russia

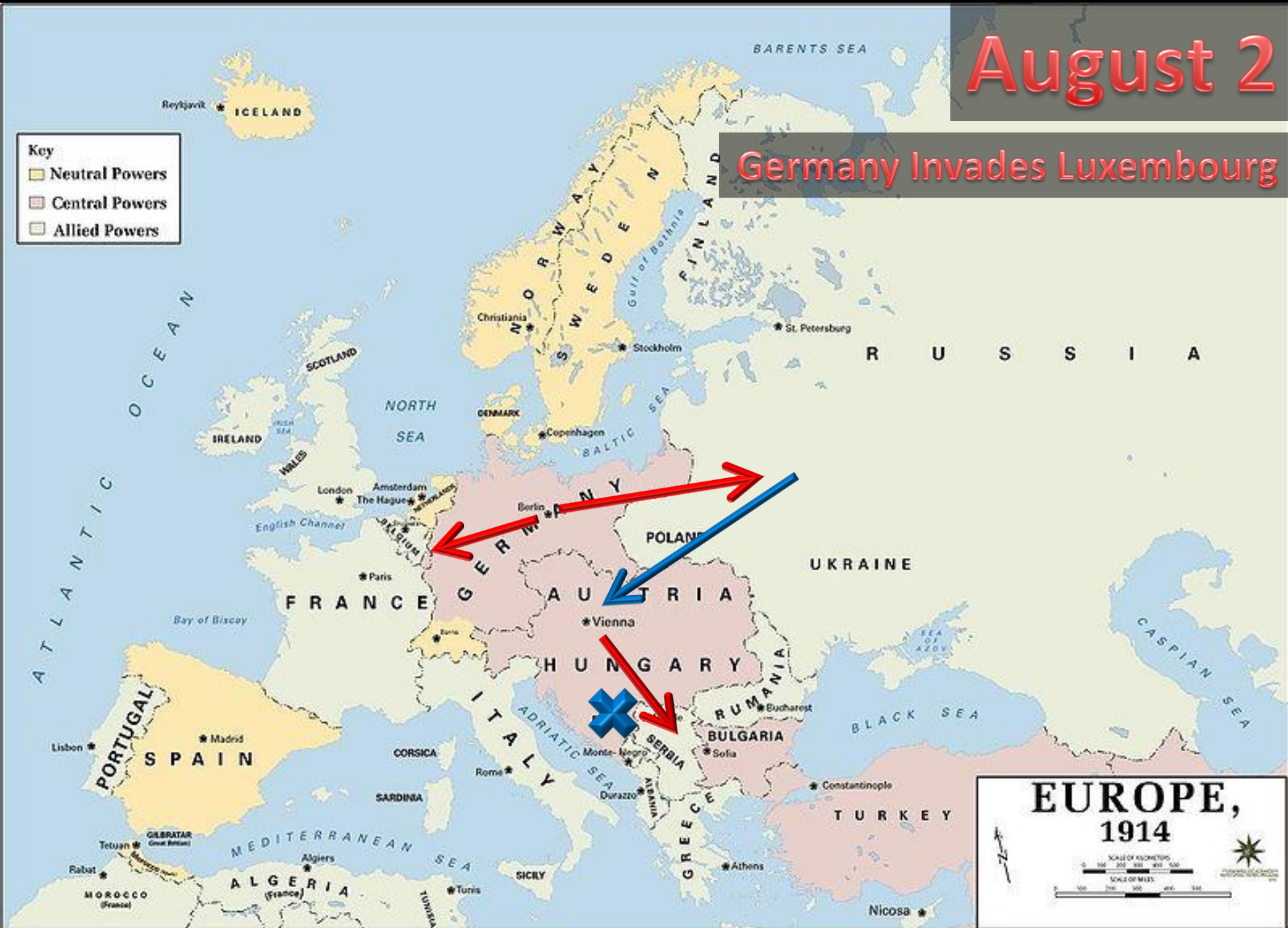
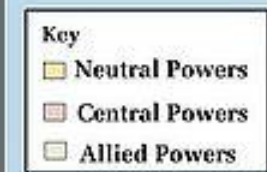
Key

- Neutral Powers
- Central Powers
- Allied Powers



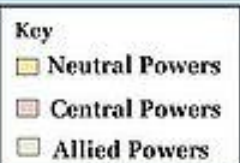
# August 2

## Germany Invades Luxembourg



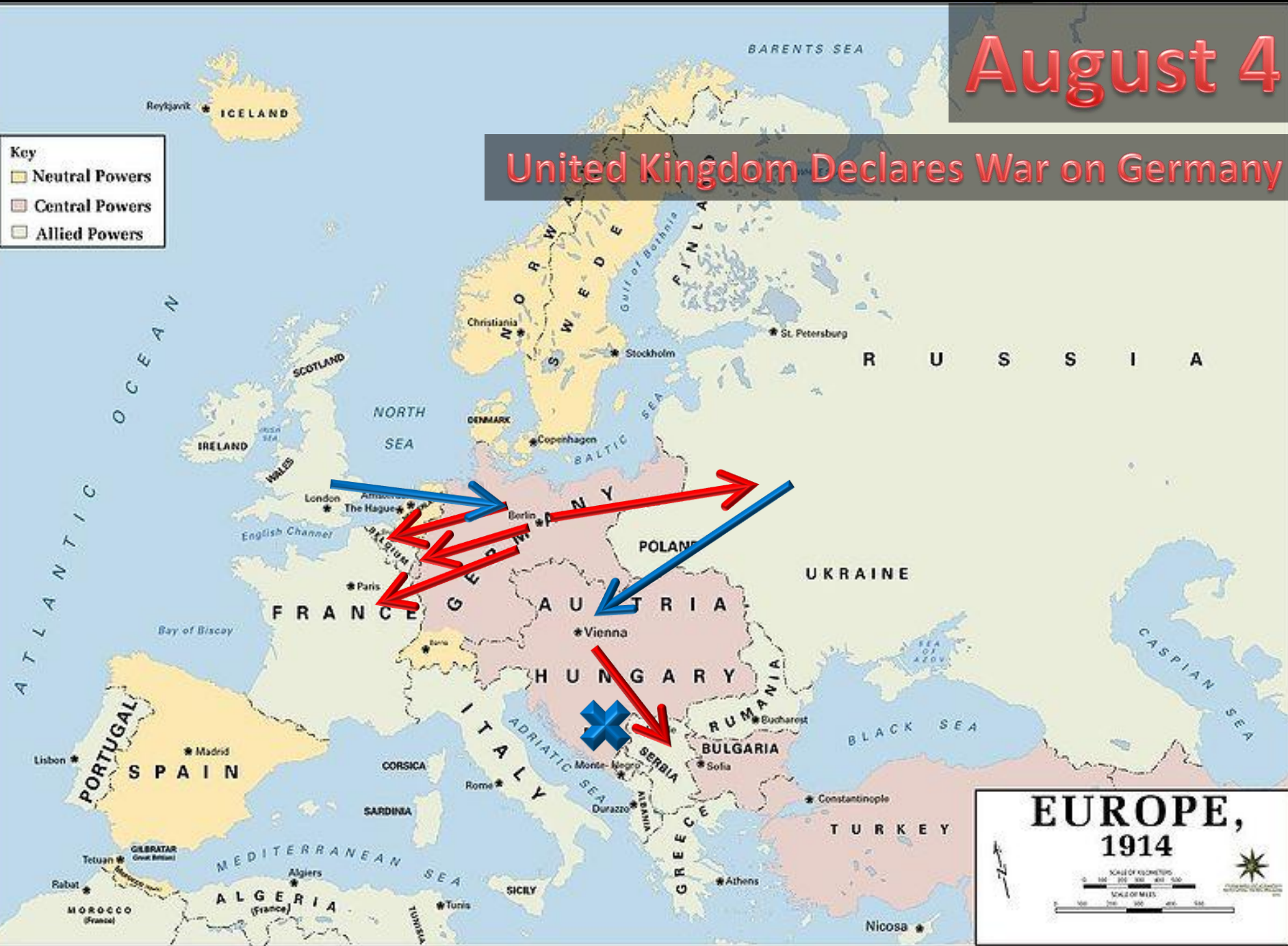
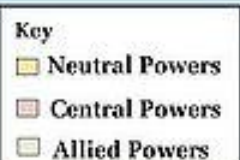
# August 3

## Germany Declares War on France and Belgium



# August 4

## United Kingdom Declares War on Germany

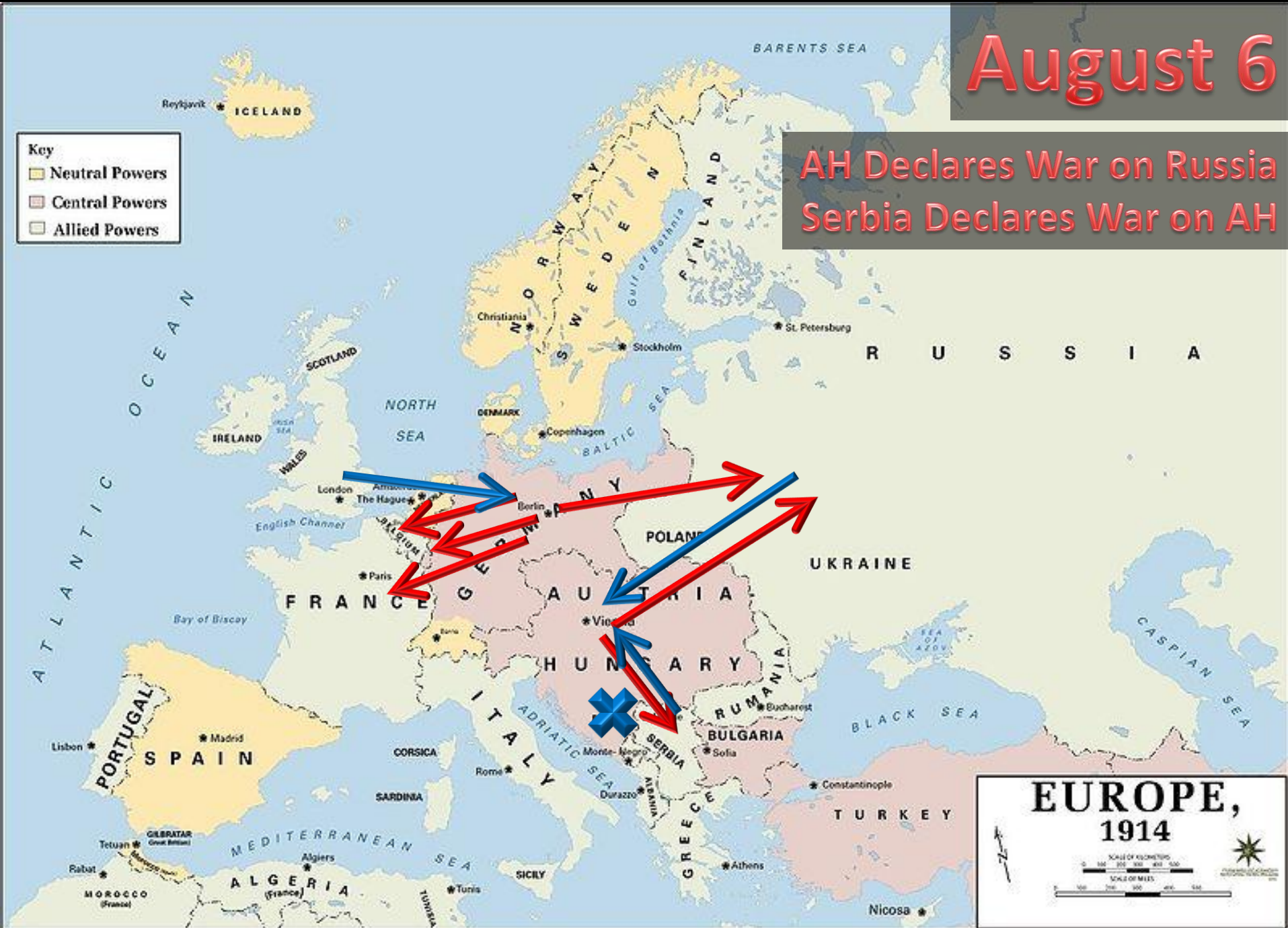


# August 6

AH Declares War on Russia  
Serbia Declares War on AH

Key

- Neutral Powers
- Central Powers
- Allied Powers



# August 11

## France Declares War on AH

Key

- Neutral Powers
- Central Powers
- Allied Powers

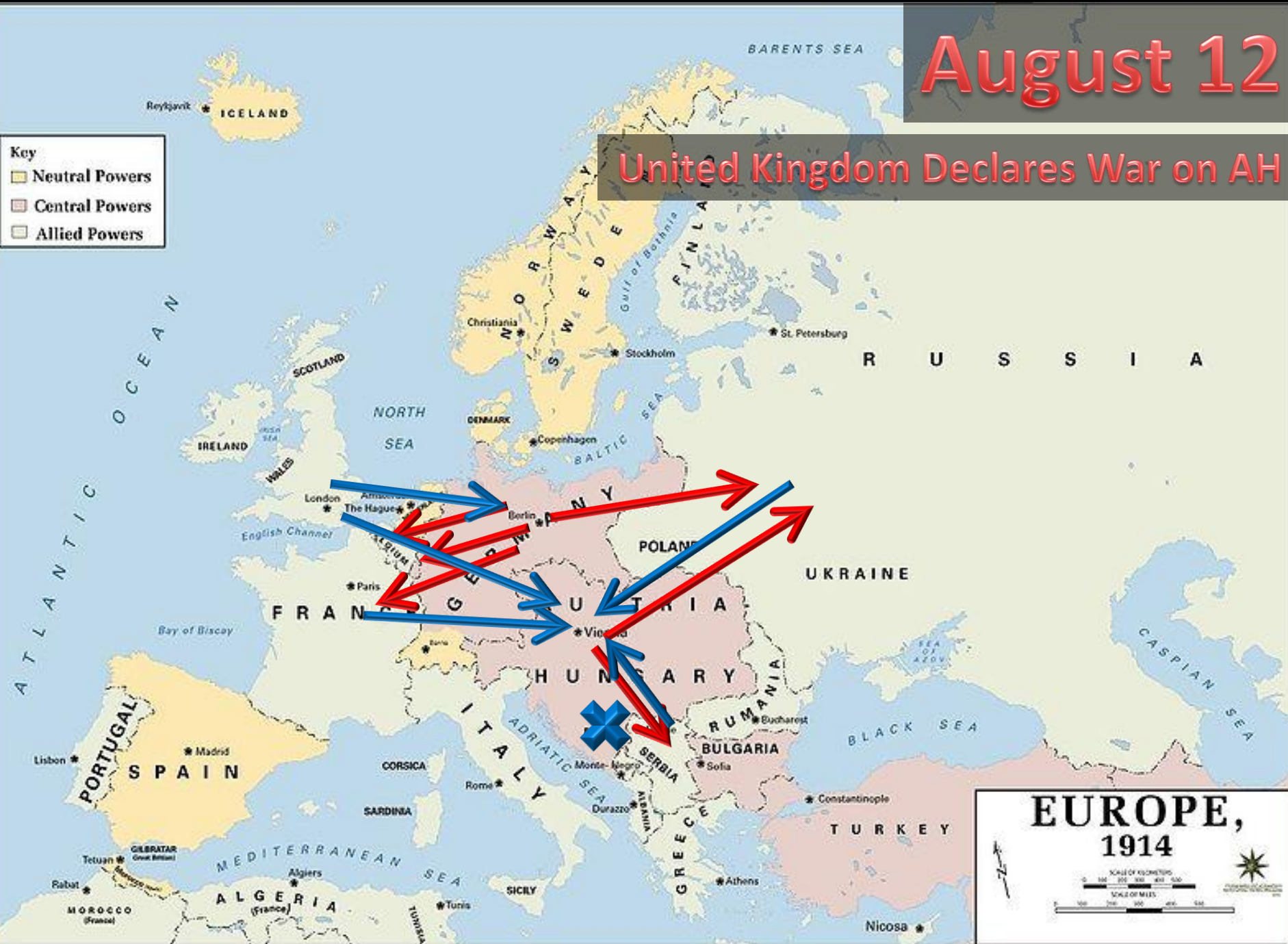


# August 12

## United Kingdom Declares War on AH

Key

- Neutral Powers
- Central Powers
- Allied Powers

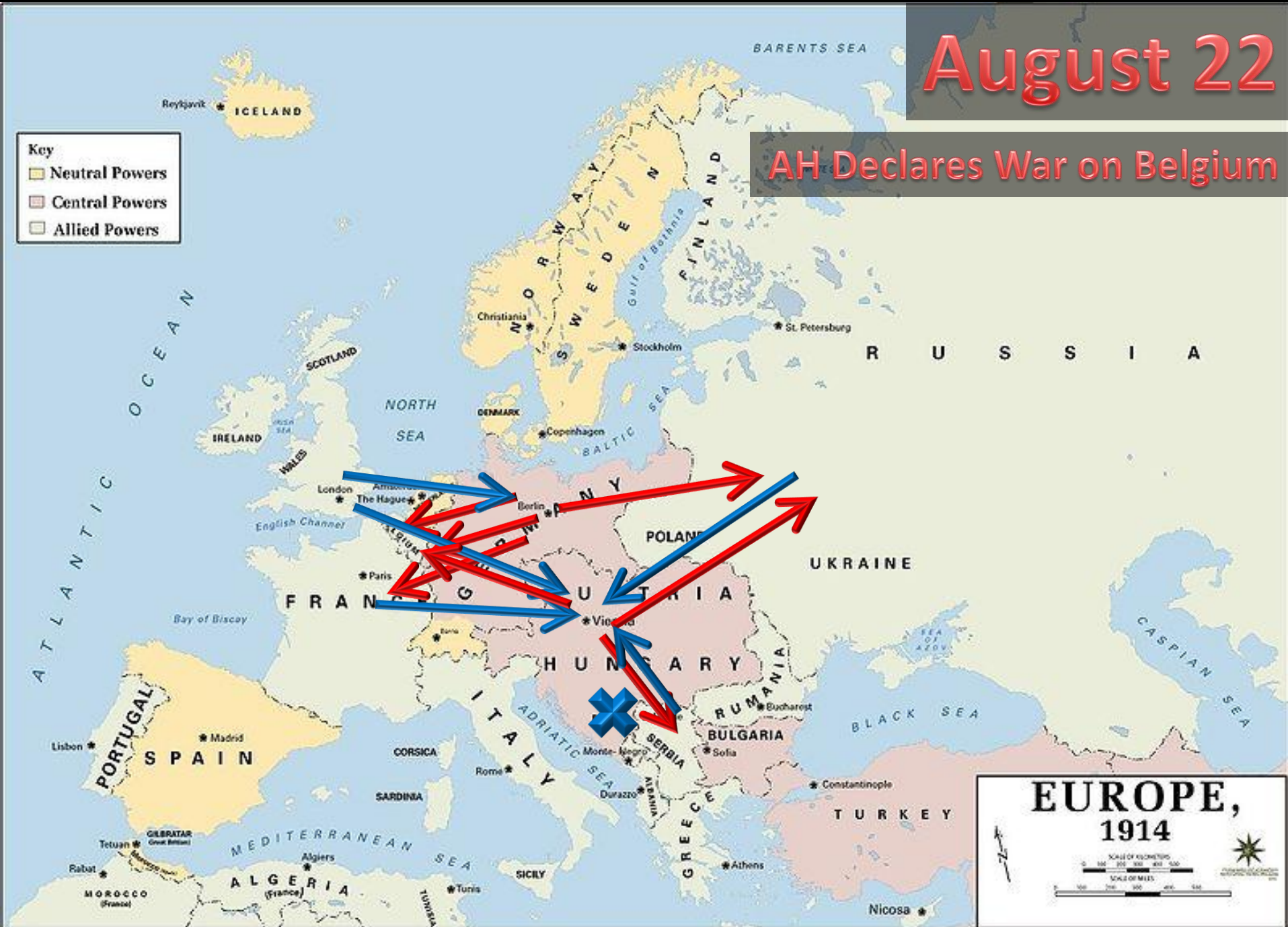


# August 22

## AH Declares War on Belgium

Key

- Neutral Powers
- Central Powers
- Allied Powers

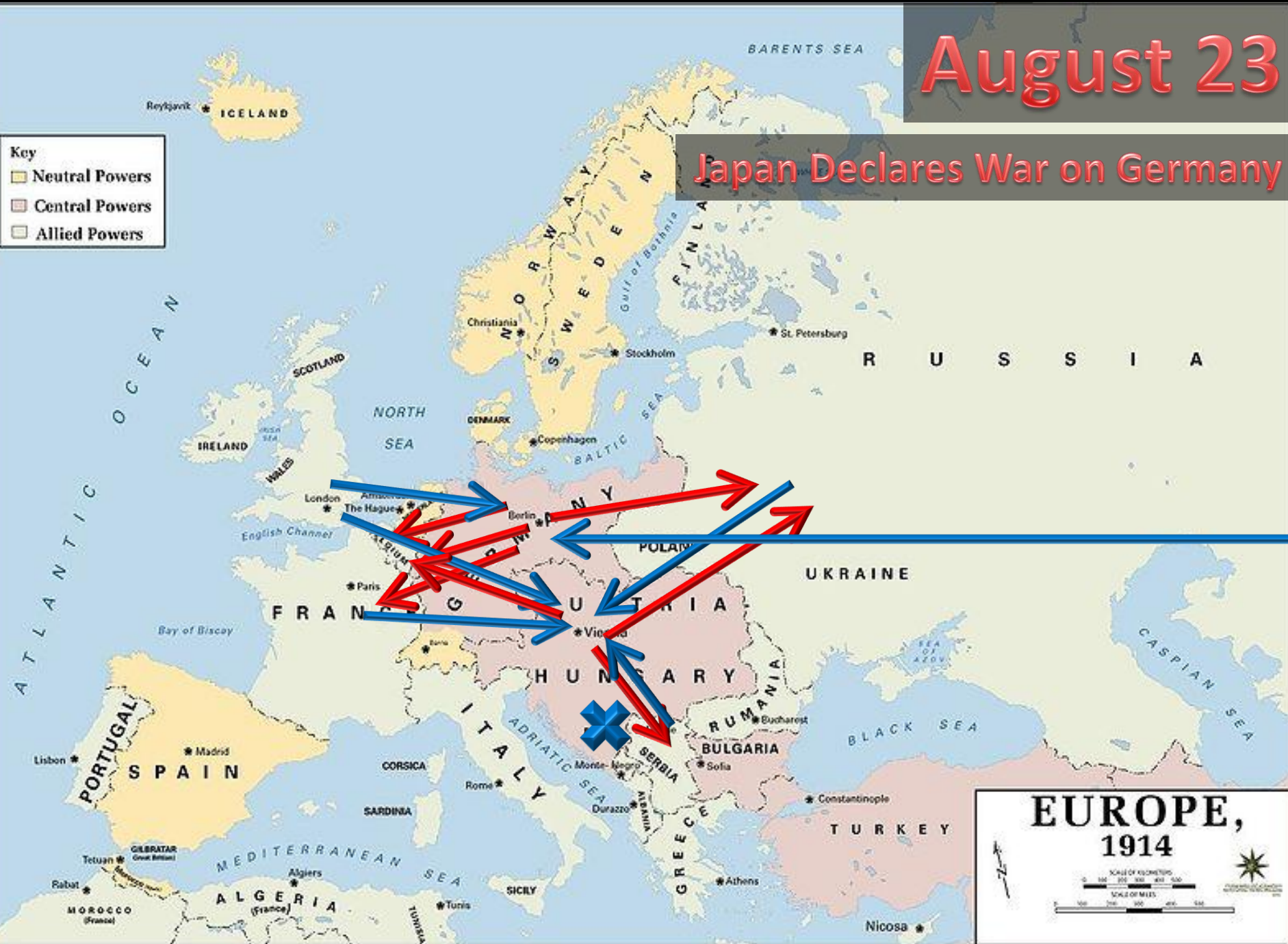


# August 23

## Japan Declares War on Germany

Key

- Neutral Powers
- Central Powers
- Allied Powers

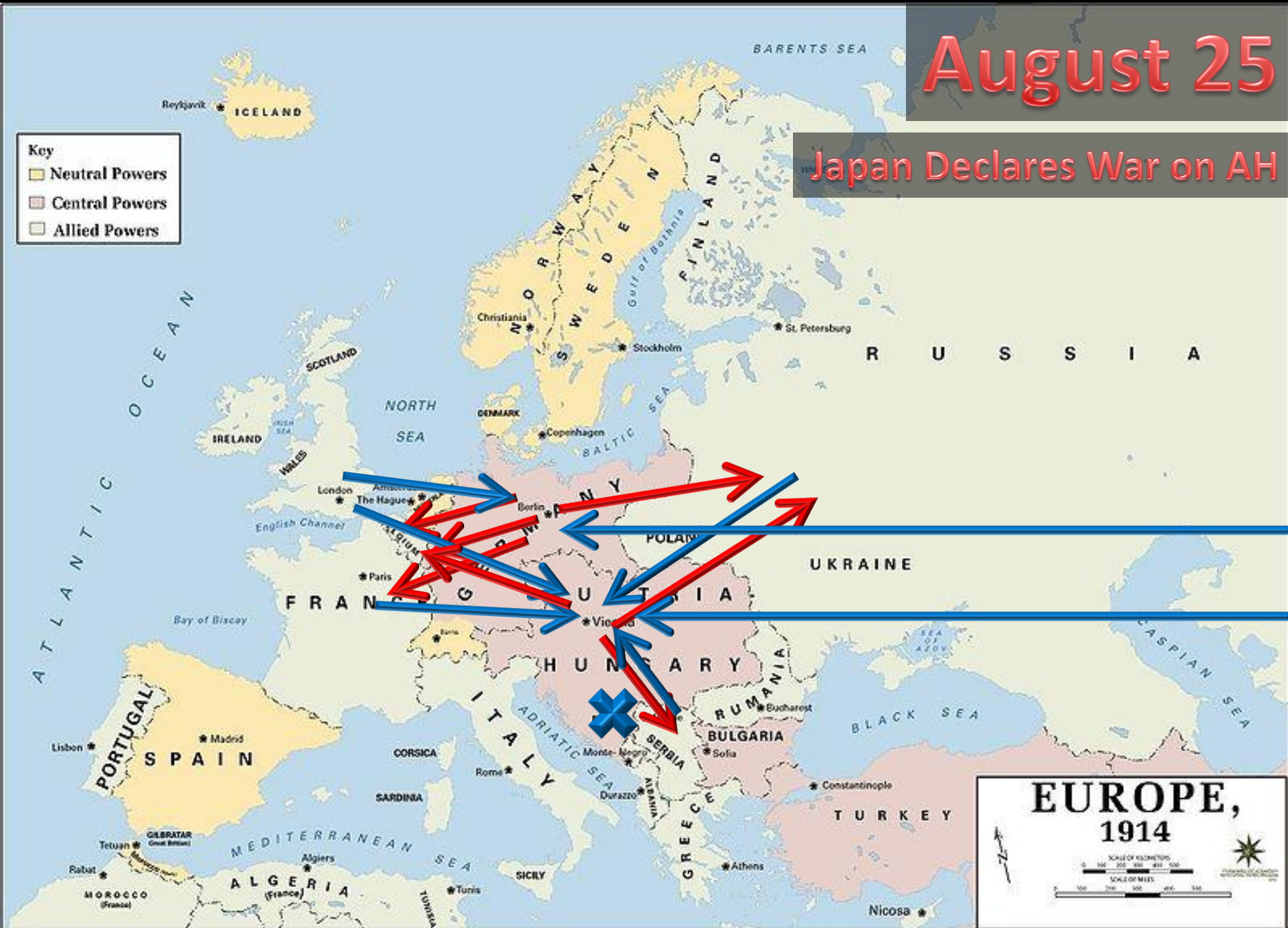


# August 25

## Japan Declares War on AH

Key

- Neutral Powers
- Central Powers
- Allied Powers

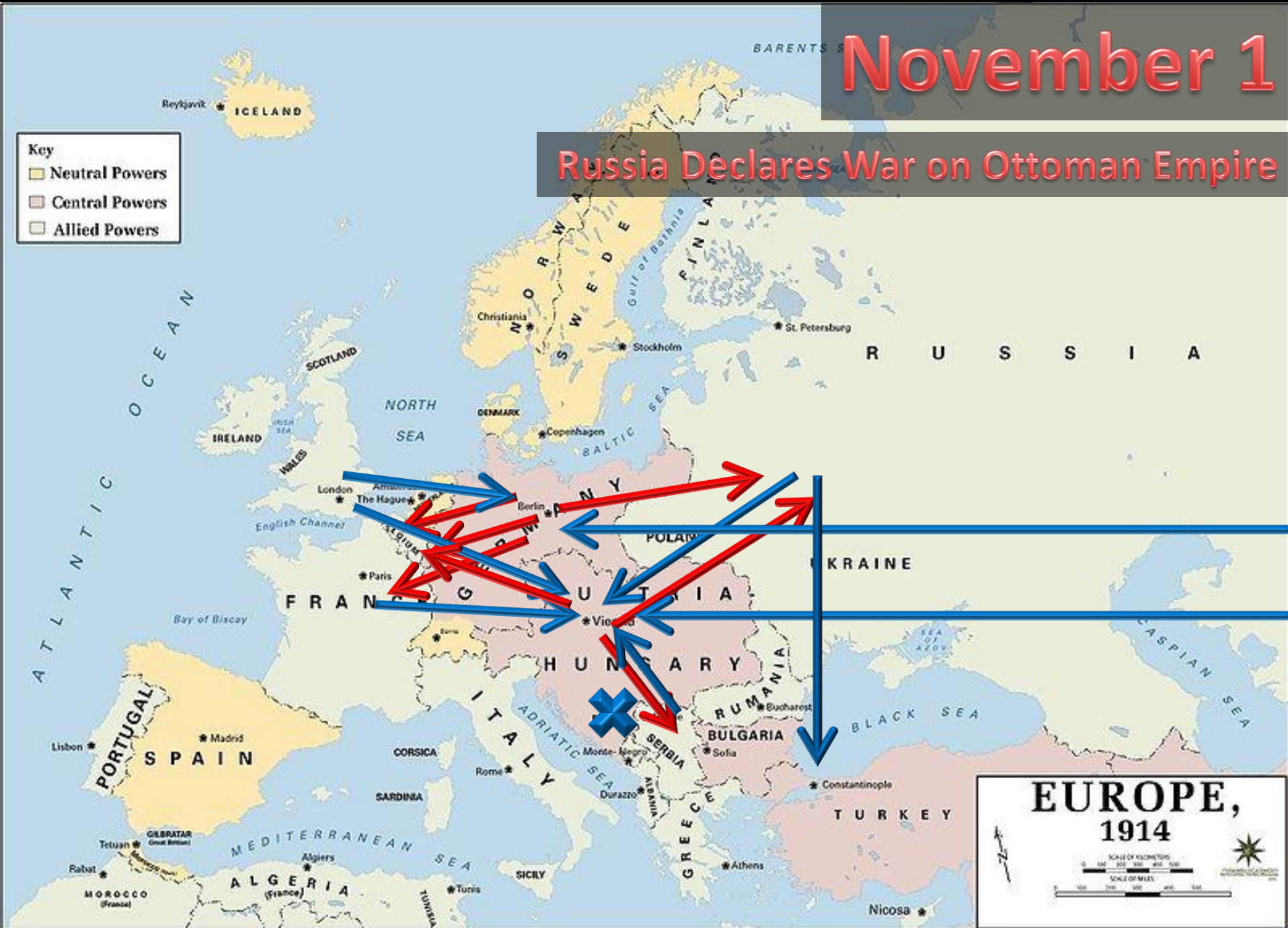


# November 1

## Russia Declares War on Ottoman Empire

Key

- Neutral Powers
- Central Powers
- Allied Powers

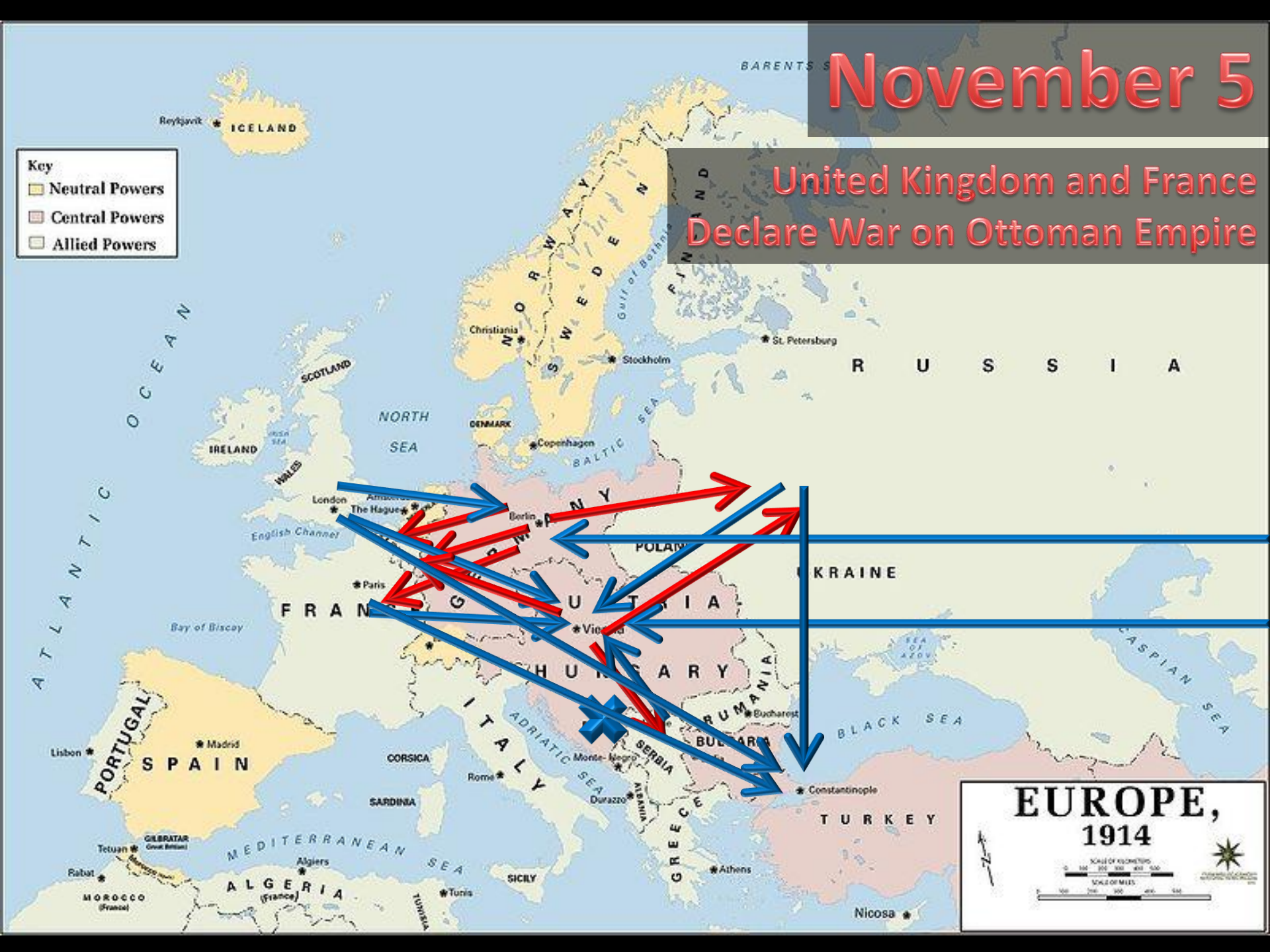


# November 5

## United Kingdom and France Declare War on Ottoman Empire

Key

- Neutral Powers
- Central Powers
- Allied Powers





Key

- Neutral Powers
- Central Powers
- Allied Powers

EUROPE, 1914

SCALE OF KILOMETERS  
0 100 200 300 400 500

SCALE OF MILES  
0 100 200 300 400 500

Compass rose and scale bar.

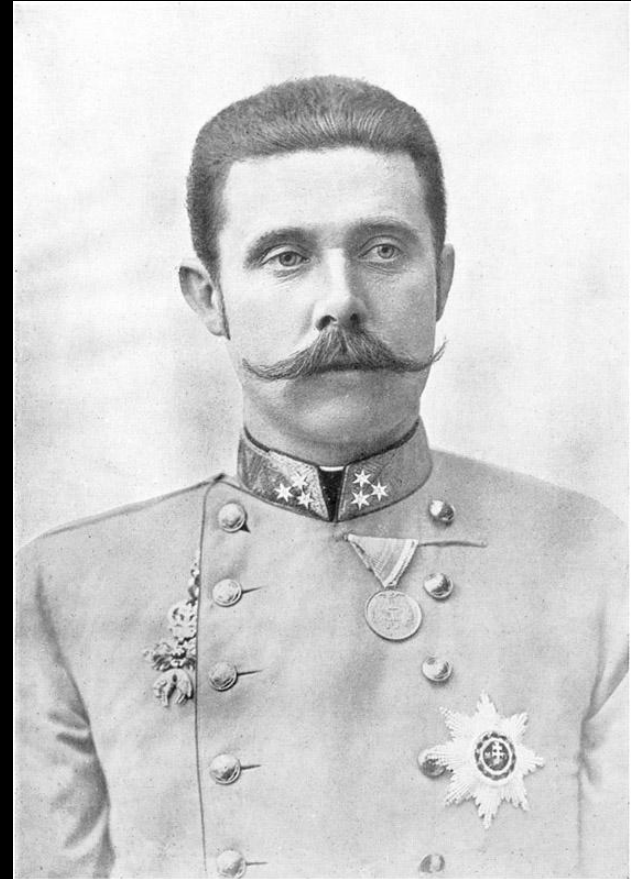
# The Trivial Explanation

- 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

- 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...)
- What have our assumptions bought us?

## The Cult of the Offensive

# Germany

Defend

Preempt

# France

Defend

Preempt

2, 2

0, 3

3, 0

1, 1

|        |         | Defend | Preempt |
|--------|---------|--------|---------|
|        |         |        |         |
| France | Defend  | 2, 2   | 0, 3    |
|        | Preempt | 3, 0   | 1, 1    |

## The Cult of the Offensive

# Germany

Defend

Preempt

# France

Defend

Preempt

2, 2

0, 3

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1, 1

|         |        |         |
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## The Cult of the Offensive

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|---------|--------|---------|
|         | Defend | Preempt |
| Defend  | 2, 2   | 0, 3    |
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# France's Strategy

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

## The Cult of the Offensive

# Germany

Defend

Preempt

France

Defend

Preempt

2, 2

0, 3

3, 0

1, 1

|         |        |         |
|---------|--------|---------|
|         | Defend | Preempt |
| Defend  | 2, 2   | 0, 3    |
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## The Cult of the Offensive

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Preempt

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2, 2

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|        | Preempt | 3, 0   | 1, 1    |

# 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

# Germany

Defend

Preempt

# France

Defend

Preempt

2, 2

0, 3

3, 0

1, 1

# Conclusion

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

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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, los precios del *Vino Nacional* will be competitive
  - El dinero 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

## Free Trade Game

# California

Freedom

Taxation

# Mexico

Freedom

Taxation

|  |  |
|--|--|
|  |  |
|  |  |

## Free Trade Game

# California

Freedom

Taxation

# Mexico

Freedom

Taxation

2, 2

0, 3

3, 0

1, 1

|          | Freedom | Taxation |
|----------|---------|----------|
| Freedom  | 2, 2    | 0, 3     |
| Taxation | 3, 0    | 1, 1     |

## Free Trade Game

California

Freedom

Taxation

Mexico

Freedom

Taxation

2, 2

0, 3

3, 0

1, 1

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|--------|----------|---------|----------|
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## Free Trade Game

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Mexico

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## Free Trade Game

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Taxation

# Mexico

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2, 2

0, 3

3, 0

1, 1

|          |         |          |
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|          | Freedom | Taxation |
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## Free Trade Game

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Freedom

Taxation

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Taxation

2, 2

0, 3

3, 0

1, 1

## Free Trade Game

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Freedom

Taxation

# Mexico

Freedom

Taxation

2, 2

0, 3

3, 0

1, 1

|          |         |          |
|----------|---------|----------|
|          | Freedom | Taxation |
| Freedom  | 2, 2    | 0, 3     |
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## Free Trade Game

# California

Freedom

Taxation

# Mexico

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Taxation

2, 2

0, 3

3, 0

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|----------|---------|----------|
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**Free Trade Game  
(A Prisoner's Dilemma)**

California

Freedom

Taxation

Mexico

Freedom

Taxation

2, 2

0, 3

3, 0

1, 1

|        |          | Freedom | Taxation |
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|        | Taxation | 3, 0    | 1, 1     |

Free Trade Game  
(A Prisoner's Dilemma)

California

Freedom

Taxation

Mexico

Freedom

Taxation

2, 2

0, 3

3, 0

1, 1

# 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?

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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

Soviet Union

Pass

Build

United States

Pass

Build

|  |  |
|--|--|
|  |  |
|  |  |

## Arms Race

# Soviet Union

Pass

Build

# United States

Pass

Build

0, 0

-2, 1

1, -2

-1, -1

## Arms Race

# Soviet Union

Pass

Build

# United States

Pass

Build

0, 0

-2, 1

1, -2

-1, -1

## Arms Race

# Soviet Union

Pass

Build

# United States

Pass

Build

0, 0

-2, 1

1, -2

-1, -1

| Pass  | Build  |
|-------|--------|
| 0, 0  | -2, 1  |
| 1, -2 | -1, -1 |

## Arms Race

# Soviet Union

Pass

Build

# United States

Pass

Build

0, 0

-2, 1

1, -2

-1, -1

# New Puzzle

- The prisoner's dilemma predicts that arms races should be prevalent
- Yet states sign arms treaties
  - Why are these arms treaties sustainable?

# 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

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

0, 0

-2, 1

1, -2

-1, -1

# Prisoner's Dilemma

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

0, 0

-2, 1

1, -2

-1, -1

# Prisoner's Dilemma

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

0, 0

-2, 1

1, -2

-1, -1

# 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

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

0, 0

-2, 1

1, -2

-1, -1

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

# Prisoner's Dilemma

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

0, 0

-2, 1

1, -2

-1, -1

# Prisoner's Dilemma

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

0, 0

-2, 1

1, -2

-1, -1

# 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

# 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

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

1, 1

-1, 2

2, -1

0, 0

# Prisoner's Dilemma

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

1, 1

-1, 2

2, -1

0, 0

# 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

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

# Payoffs for Cooperating Forever

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

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

1, 1

-1, 2

2, -1

0, 0

# 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

# Prisoner's Dilemma

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

1, 1

-1, 2

2, -1

0, 0

# 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:
  - $1/(1 - p) \geq 2$
  - $1 \geq 2(1 - p)$
  - $1 \geq 2 - 2p$
  - $p \geq \frac{1}{2}$

# Important Result

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

# Important Result

- 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

Player 2

Shoot to Miss

Shoot to Kill

Player 1

Shoot to Kill   Shoot to Miss

1, 1

-1, 2

2, -1

0, 0

# 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
- 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

# Next Chapter

- “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

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

1, 1

-1, 2

2, -1

0, 0

## Stag Hunt

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

2, 2

-1, 1

1, -1

0, 0

| 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

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

1, 1

-1, 2

2, -1

0, 0

## Stag Hunt

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

2, 2

-1, 1

1, -1

0, 0

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

# 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

Player 2

Cooperate

Defect

Player 1

Cooperate

Defect

2, 2

-1, 1

1, -1

0, 0

|           |  |           |        |
|-----------|--|-----------|--------|
|           |  | Cooperate | Defect |
| Cooperate |  | 2, 2      | -1, 1  |
| Defect    |  | 1, -1     | 0, 0   |

# 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 institution.