

PSC/IR 106: Basic Models of Conflict and Cooperation

William Spaniel

williamspaniel.com/ps-0500-2017

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

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

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

Outline for the Unit

- 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?

Outline for the Unit

- 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?

Outline for the Unit

- 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

IR Applications

- “The Cult of the Offensive” and the origins of World War I
- Tariffs and free trade policy

IR Applications

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

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

Outline

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

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

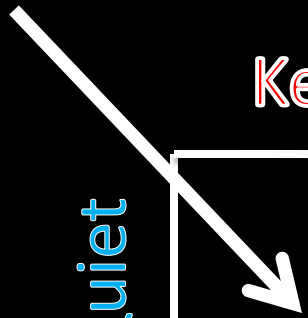
Confess

-1, -1

-12, 0

0, -12

-8, -8



Conflictual Outcomes

Player 2

Player 1

Keep Quiet

Confess

Keep Quiet

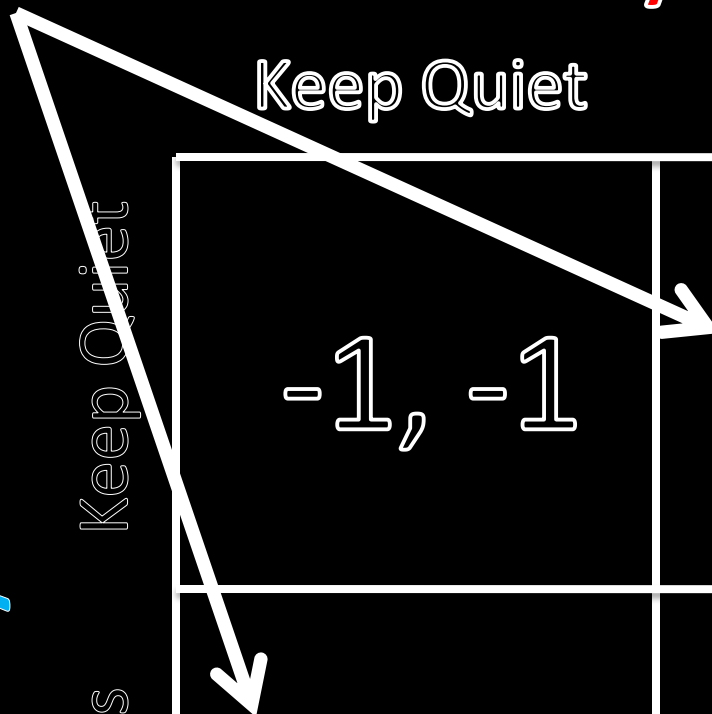
Confess

-1, -1

-12, 0

0, -12

-8, -8



The "Bad" Outcome

Player 2

Keep Quiet

Confess

Player 1

Keep Quiet

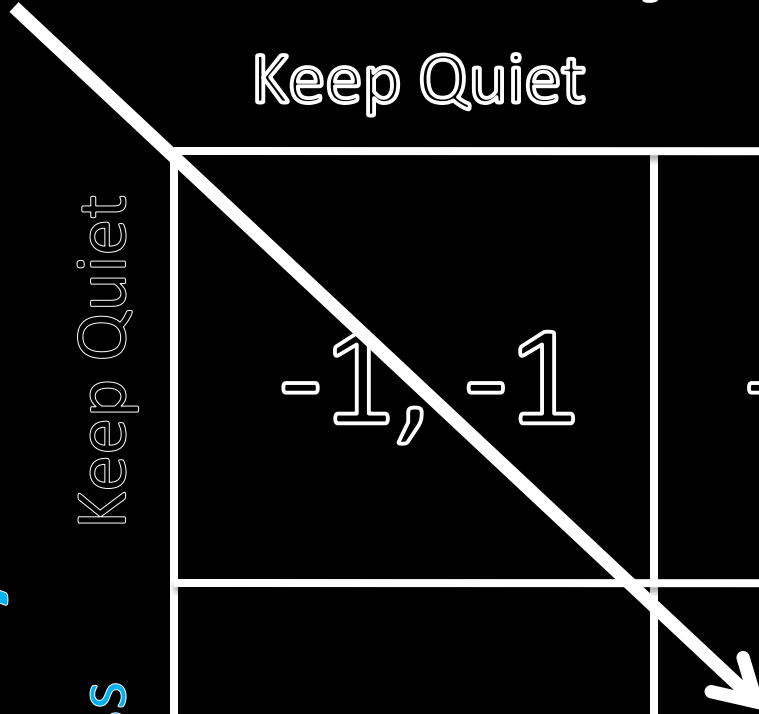
Confess

-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

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

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

-8, -8

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

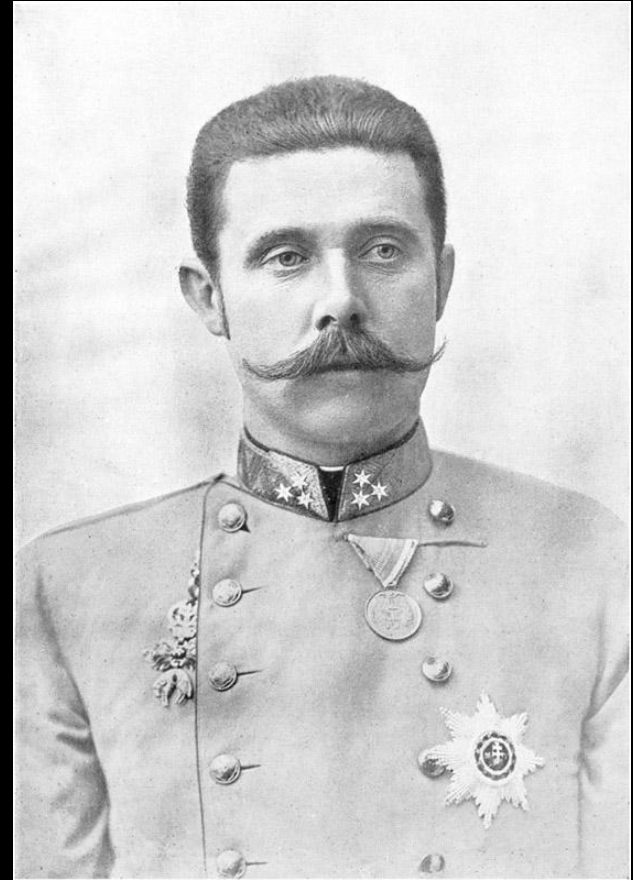
Outline

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

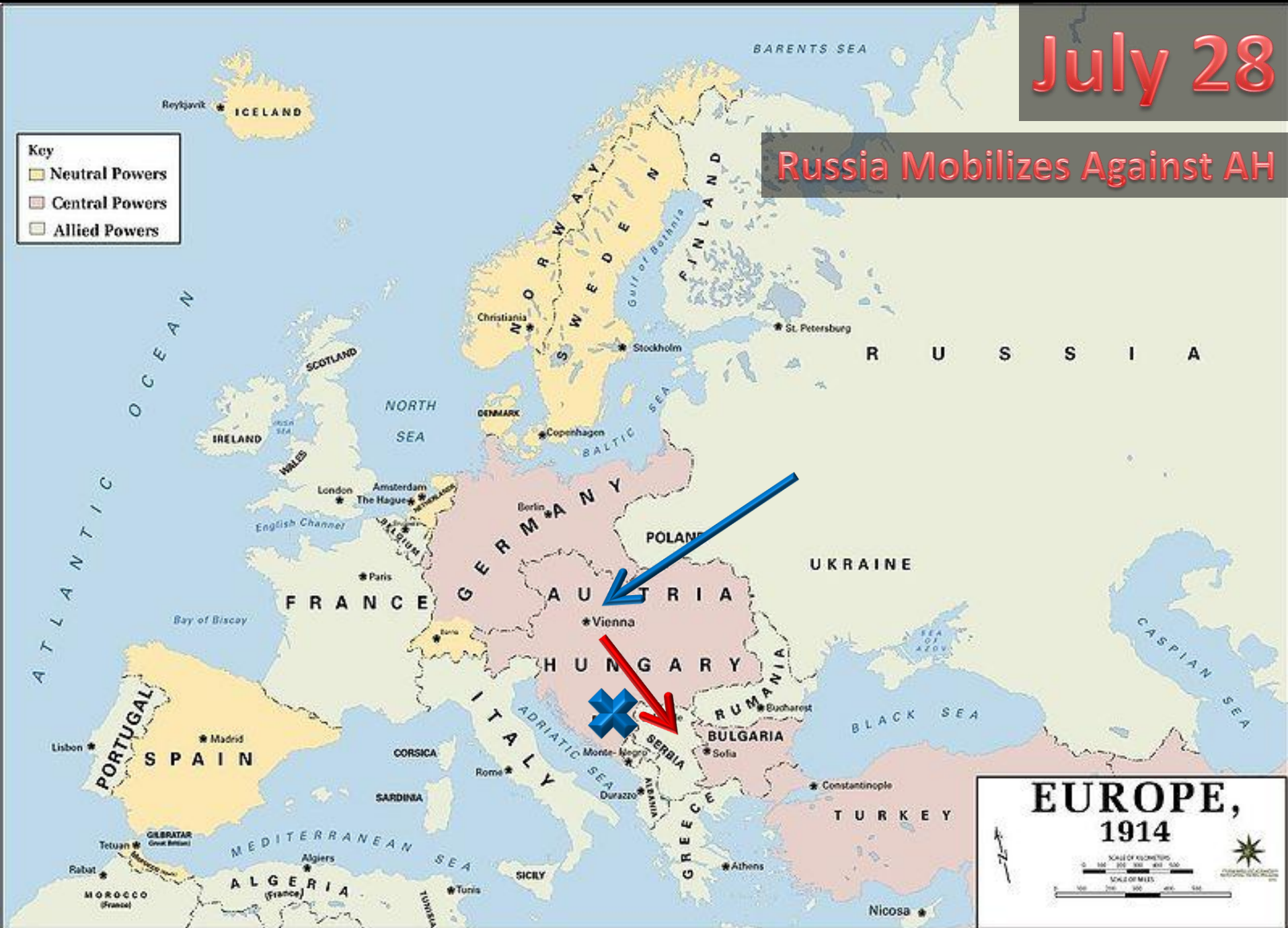


July 28

Russia Mobilizes Against AH

Key

- Neutral Powers
- Central Powers
- Allied Powers



August 1

Germany Declares War on Russia

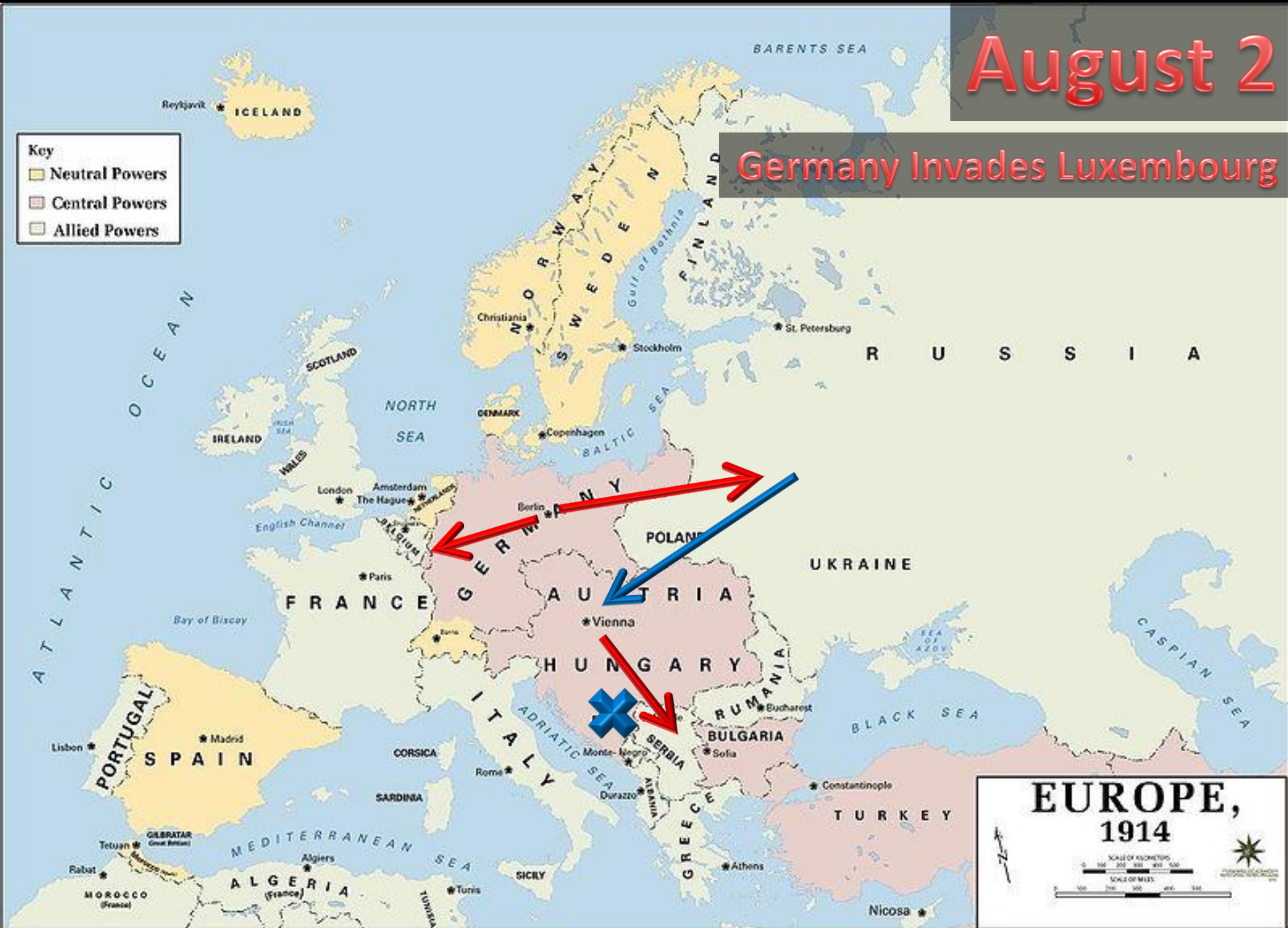
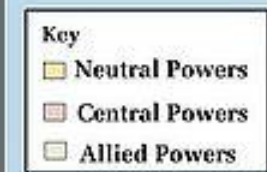
Key

- Neutral Powers
- Central Powers
- Allied Powers



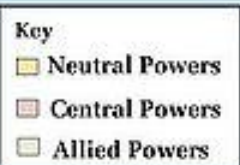
August 2

Germany Invades Luxembourg



August 3

Germany Declares War on France and Belgium

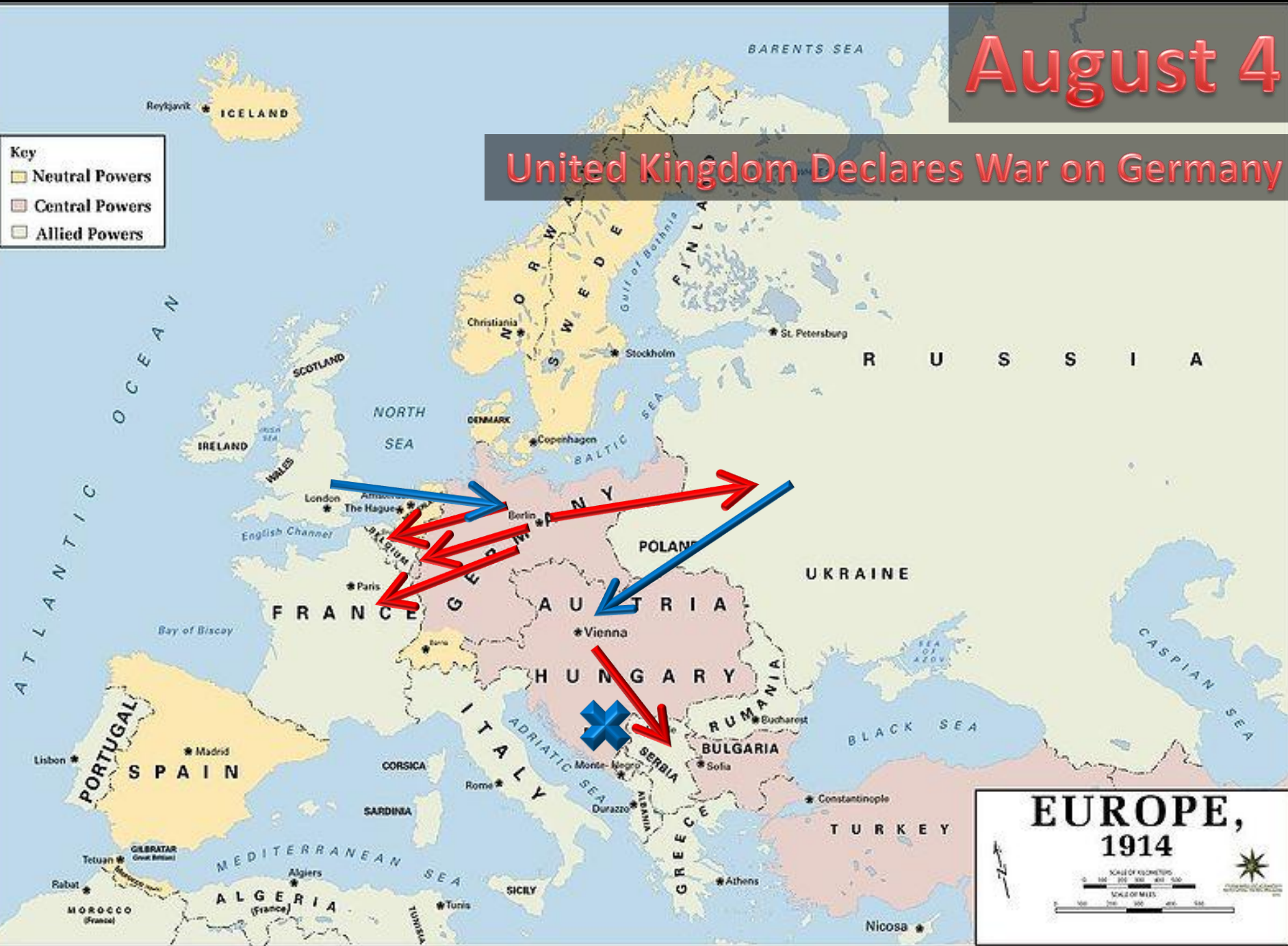


August 4

United Kingdom Declares War on Germany

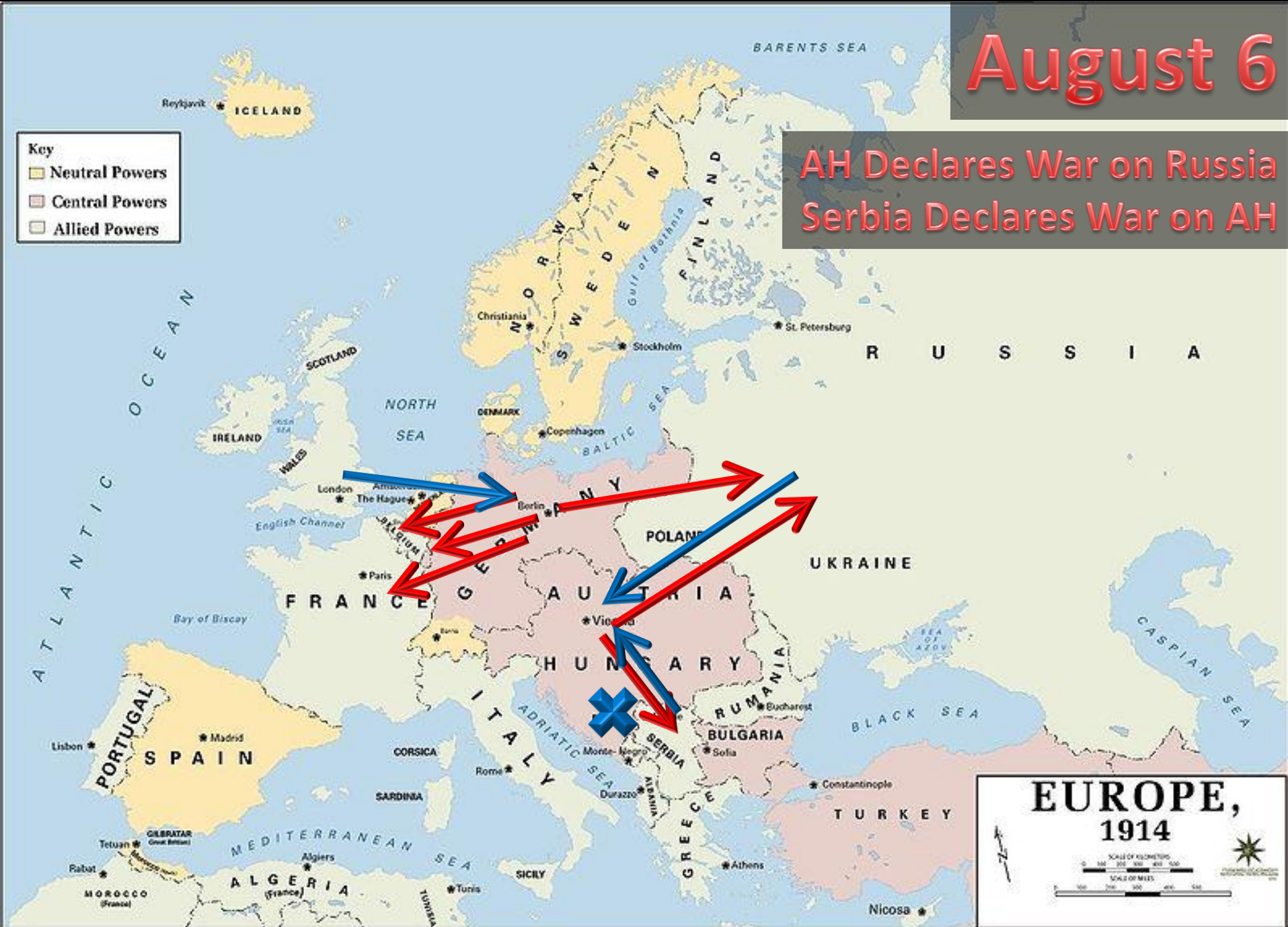
Key

- Neutral Powers
- Central Powers
- Allied Powers



August 6

AH Declares War on Russia Serbia Declares War on AH

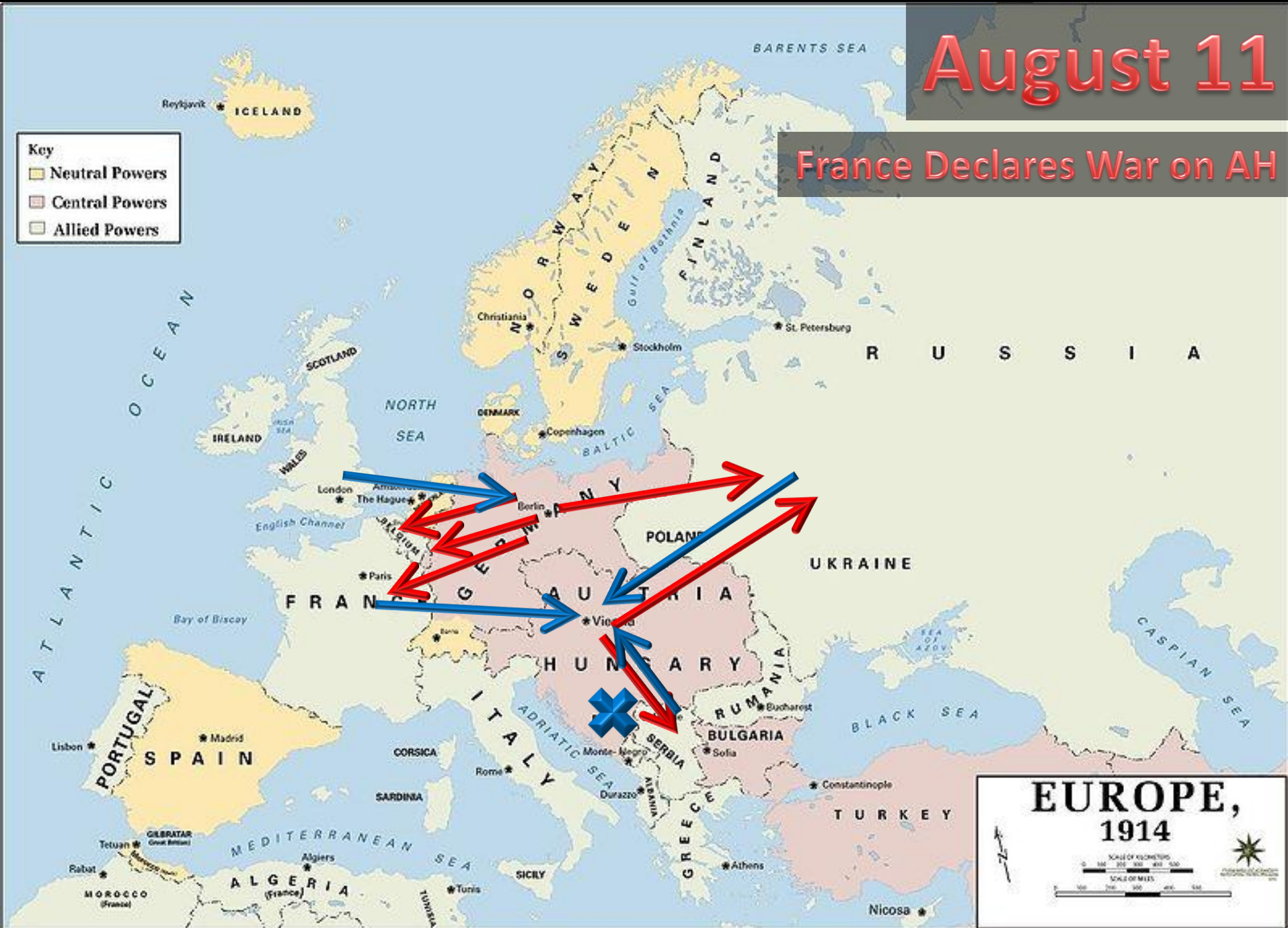


August 11

France Declares War on AH

Key

- Neutral Powers
- Central Powers
- Allied Powers

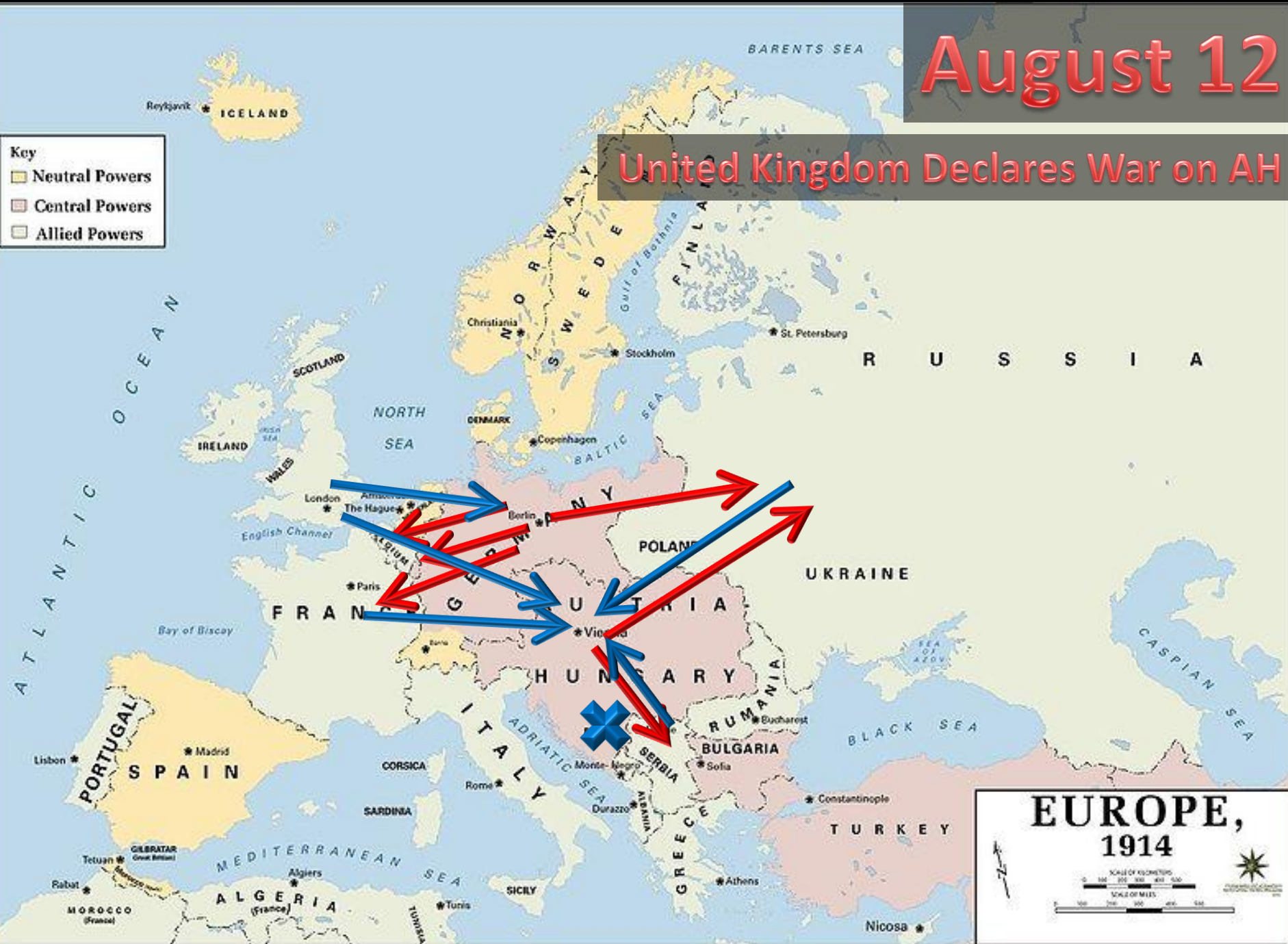


August 12

United Kingdom Declares War on AH

Key

- Neutral Powers
- Central Powers
- Allied Powers

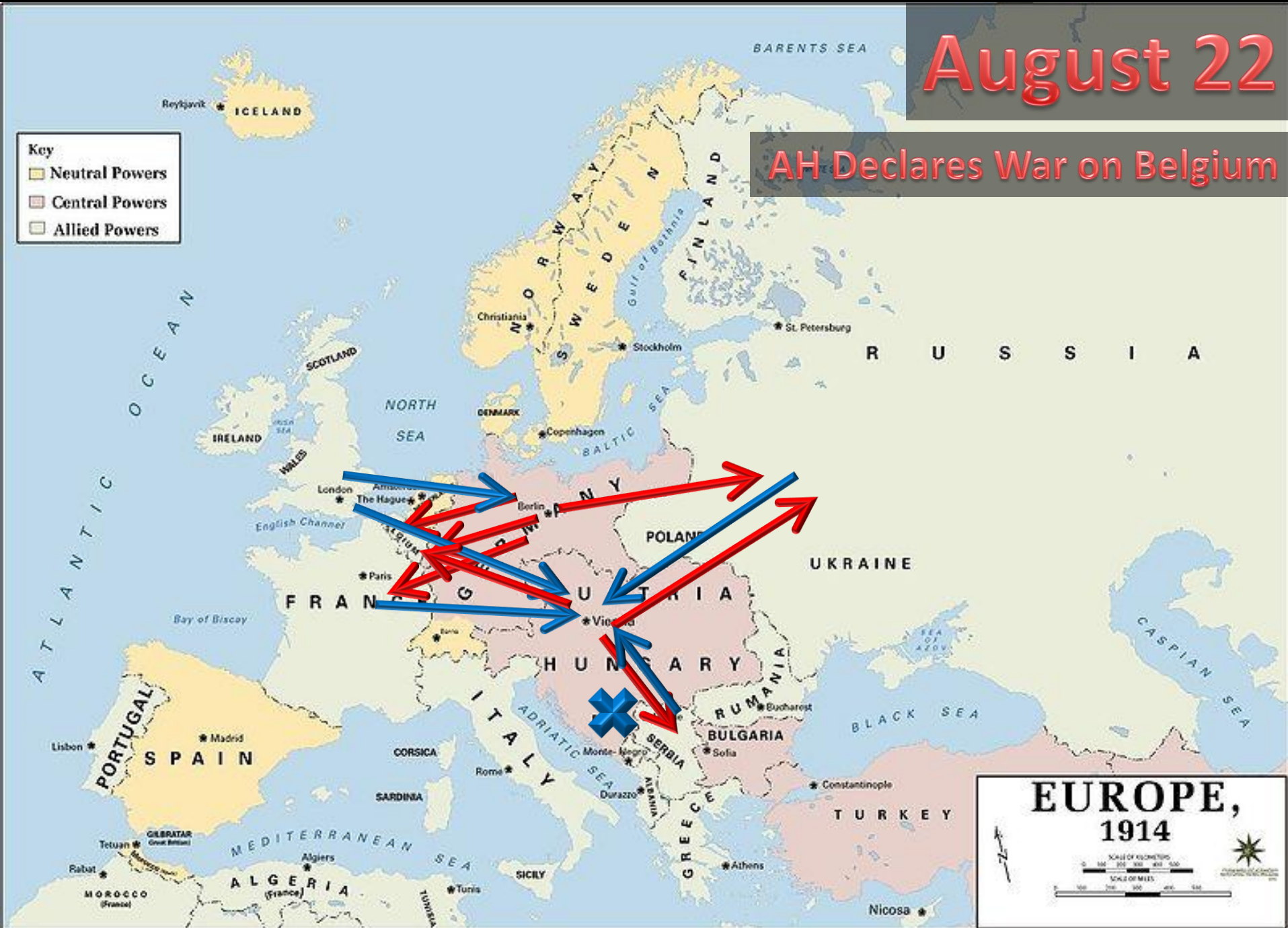


August 22

AH Declares War on Belgium

Key

- Neutral Powers
- Central Powers
- Allied Powers



EUROPE, 1914

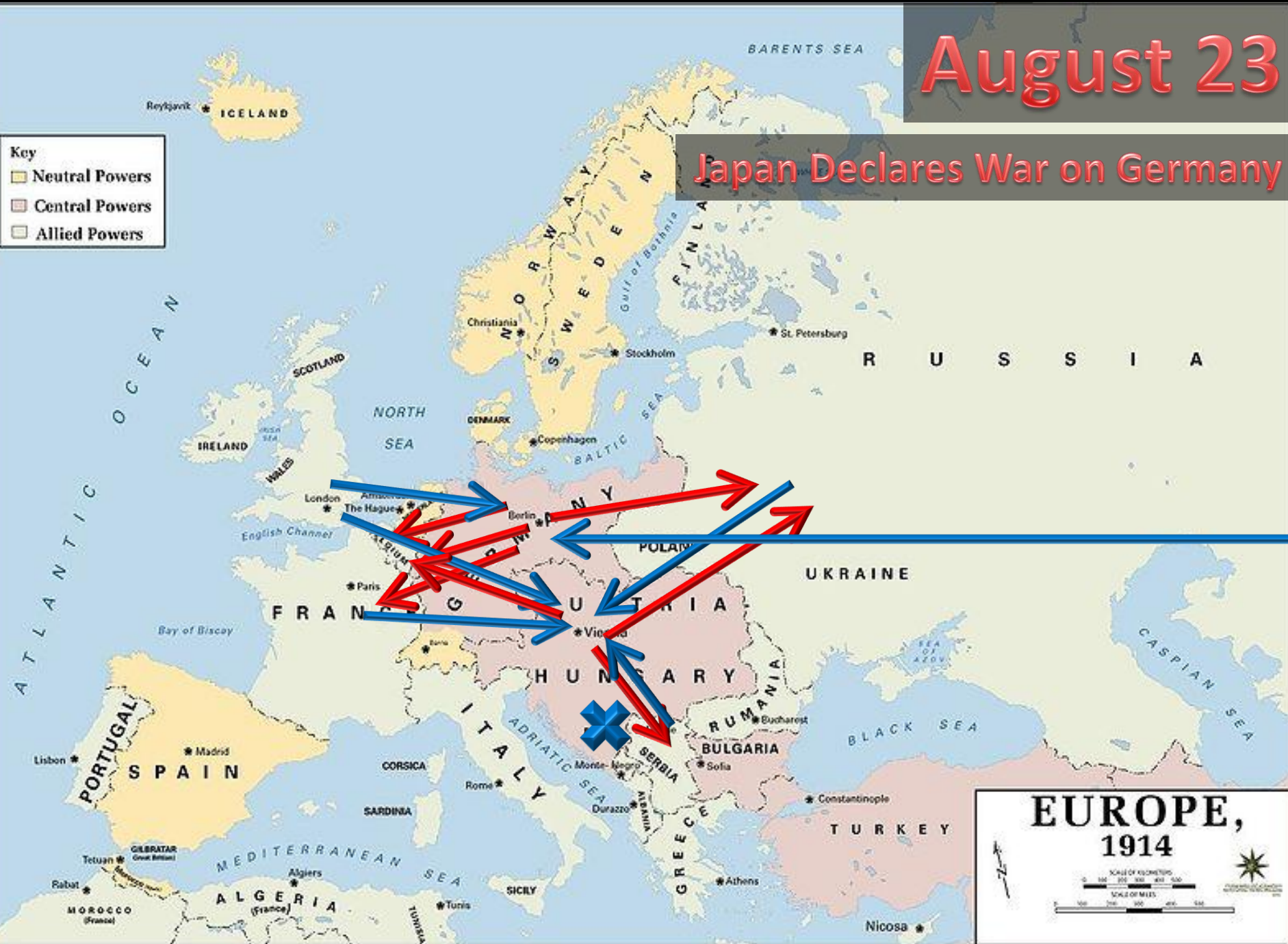
SCALE OF KILOMETERS
0 100 200 300 400 500
SCALE OF MILES
0 100 200 300 400 500

August 23

Japan Declares War on Germany

Key

- Neutral Powers
- Central Powers
- Allied Powers

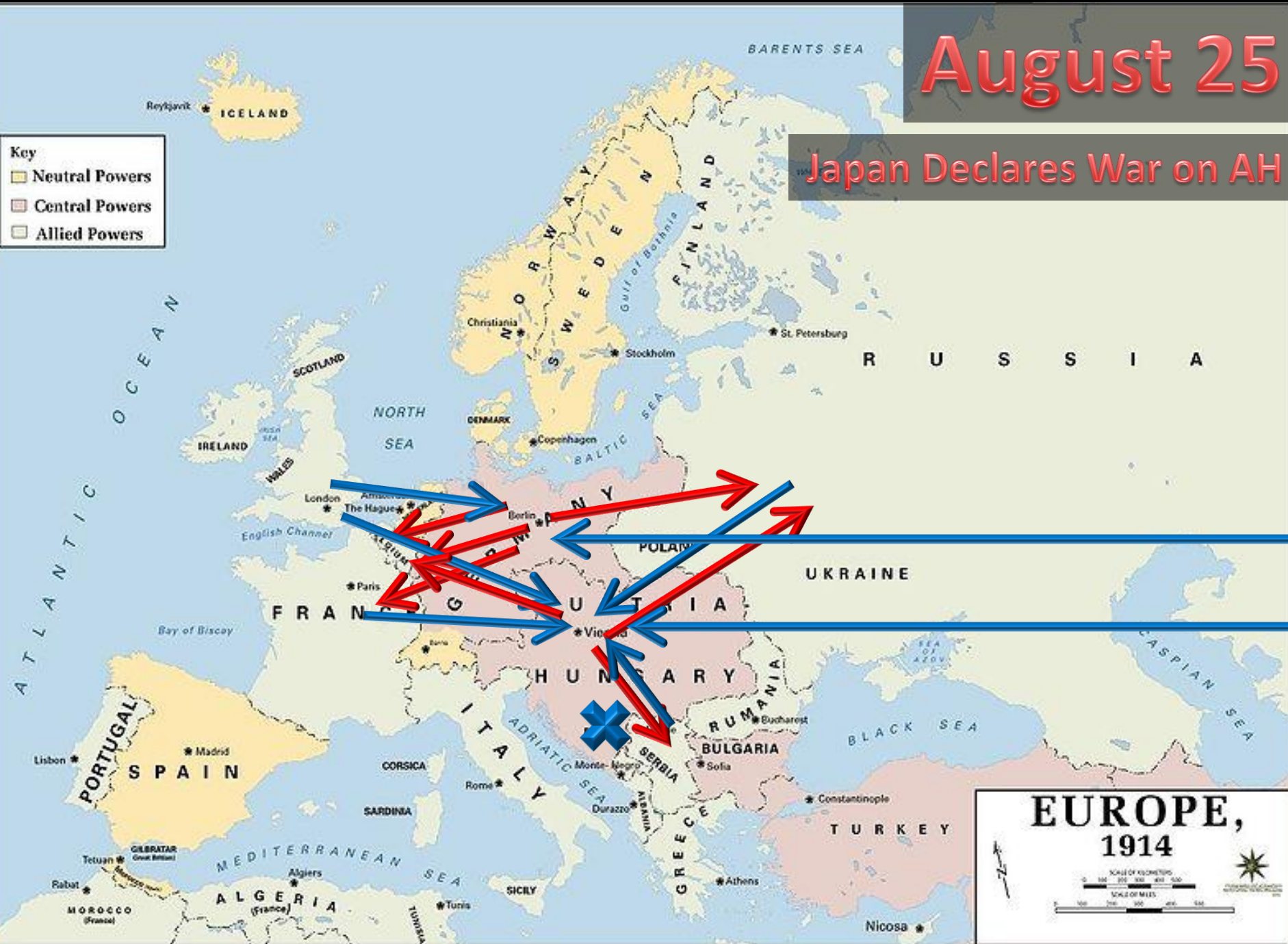


August 25

Japan Declares War on AH

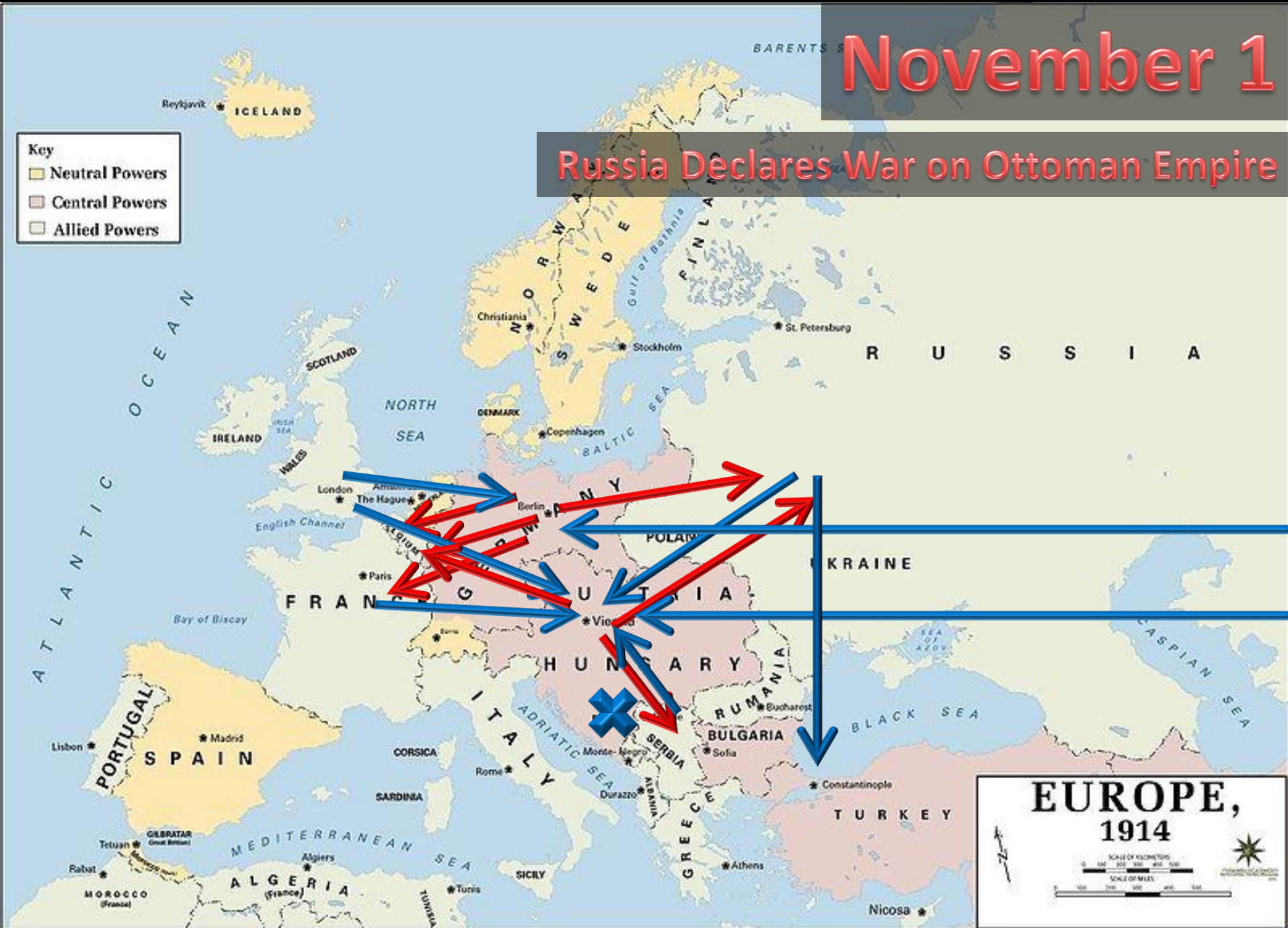
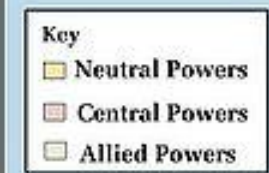
Key

- Neutral Powers
- Central Powers
- Allied Powers



November 1

Russia Declares War on Ottoman Empire

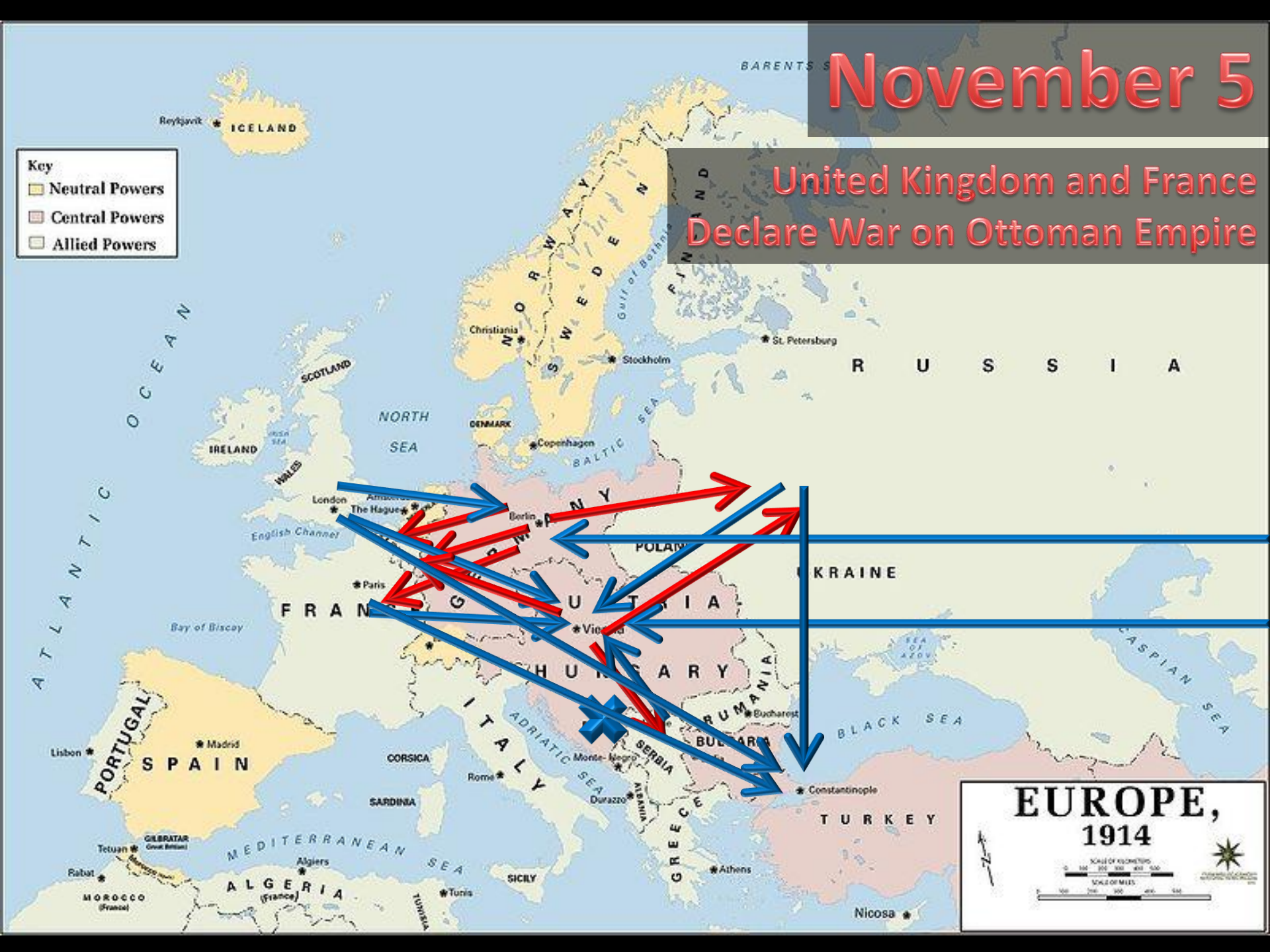


November 5

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.

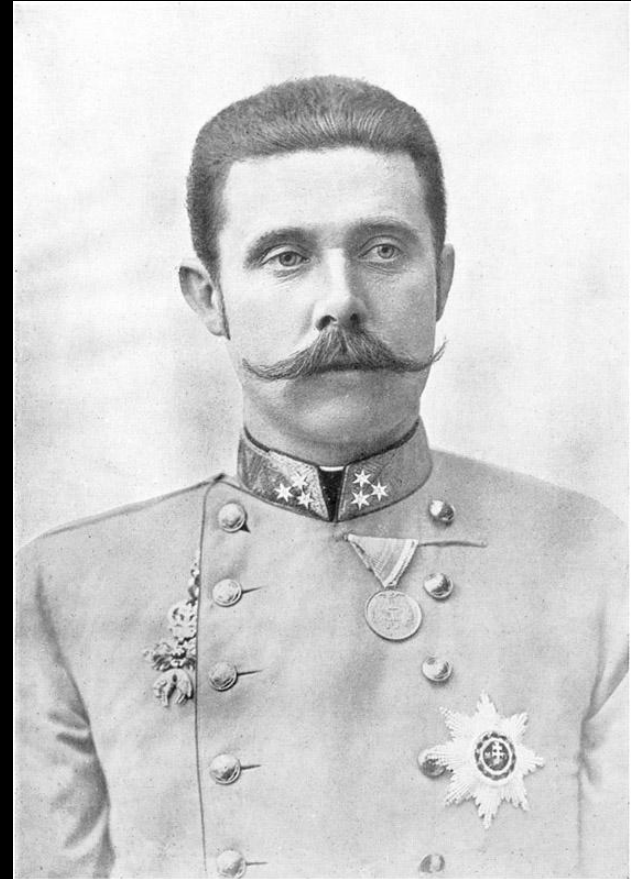
The Trivial Explanation

- 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

3, 0

1, 1

Defend	Preempt
2, 2	0, 3
3, 0	1, 1

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

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

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

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

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, 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

	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

		Freedom	Taxation
Mexico	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

	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

		Freedom	Taxation
Mexico	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

	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

	Freedom	Taxation
Freedom	2, 2	0, 3
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

	Freedom	Taxation
Freedom	2, 2	0, 3
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?

Outline

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

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

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

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

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

		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: 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



Robert Axelrod



Robert Axelrod



Next Topic

- “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

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 institutions