The Natural Numbers

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

If x is a set, then S(x) is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

If x is a set, then S(x) is a set. Here is why:

• Assume that *x* is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

If x is a set, then S(x) is a set. Here is why:

• Assume that *x* is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S(\{A,B\}) = \{A,B\} \cup \{\{A,B\}\} = \{A,B,\{A,B\}\}.$$

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set. (Pair x with itself.)

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set. (Pair x with itself.)
- **1** By the Axiom of Pairing, $\{x, \{x\}\}$ is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set. (Pair x with itself.)
- **1** By the Axiom of Pairing, $\{x, \{x\}\}$ is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set. (Pair x with itself.)
- **3** By the Axiom of Pairing, $\{x, \{x\}\}$ is a set.
- **1** By the Axiom of Union, $\bigcup \{x, \{x\}\} = x \cup \{x\}$ is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set. (Pair x with itself.)
- **3** By the Axiom of Pairing, $\{x, \{x\}\}$ is a set.
- **3** By the Axiom of Union, $\bigcup \{x, \{x\}\} = x \cup \{x\}$ is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set. (Pair x with itself.)
- **3** By the Axiom of Pairing, $\{x, \{x\}\}$ is a set.
- **3** By the Axiom of Union, $\bigcup \{x, \{x\}\} = x \cup \{x\}$ is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set. (Pair x with itself.)
- **3** By the Axiom of Pairing, $\{x, \{x\}\}$ is a set.
- **3** By the Axiom of Union, $\bigcup \{x, \{x\}\} = x \cup \{x\}$ is a set.

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

If x is a set, then S(x) is a set. Here is why:

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set. (Pair x with itself.)
- **3** By the Axiom of Pairing, $\{x, \{x\}\}$ is a set.
- **1** By the Axiom of Union, $\bigcup \{x, \{x\}\} = x \cup \{x\}$ is a set.

We call the successor function a "class function" because it can be described by a formula:

Recall that the successor function is the function $S(x) = x \cup \{x\}$.

Example.
$$S({A,B}) = {A,B} \cup {\{A,B\}\}} = {A,B,\{A,B\}\}}.$$

If x is a set, then S(x) is a set. Here is why:

- Assume that *x* is a set.
- ② By the Axiom of Pairing, $\{x\}$ is a set. (Pair x with itself.)
- **3** By the Axiom of Pairing, $\{x, \{x\}\}$ is a set.
- **3** By the Axiom of Union, $\bigcup \{x, \{x\}\} = x \cup \{x\}$ is a set.

We call the successor function a "class function" because it can be described by a formula:

$$\varphi_{y=S(x)}(x,y): (\forall z)((z \in y) \leftrightarrow ((z \in x) \lor (z = x))).$$

The Natural Numbers

A set *I* is called "inductive" if

 $0 \in I$, and

A set *I* is called "inductive" if

 $0 \in I$, and

- $0 \in I$, and
- ② *I* is closed under successor.

- $0 \in I$, and
- ② *I* is closed under successor.

- $0 \in I$, and
- ② *I* is closed under successor. This means

- $0 \in I$, and
- 2 I is closed under successor. This means

$$x \in I$$
 implies $S(x) \in I$.

A set *I* is called "inductive" if

- $0 \in I$, and
- ② *I* is closed under successor. This means

$$x \in I$$
 implies $S(x) \in I$.

By the first property of this definition, $0 \in I$.

A set *I* is called "inductive" if

- $0 \in I$, and
- ② *I* is closed under successor. This means

$$x \in I$$
 implies $S(x) \in I$.

By the first property of this definition, $0 \in I$. By the second property, $1 \in I$.

A set I is called "inductive" if

- $0 \in I$, and
- ② *I* is closed under successor. This means

$$x \in I$$
 implies $S(x) \in I$.

By the first property of this definition, $0 \in I$.

By the second property, $1 \in I$. $(((0 \in I) \to (S(0) \in I)))$

A set I is called "inductive" if

- $0 \in I$, and
- 2 *I* is closed under successor. This means

$$x \in I$$
 implies $S(x) \in I$.

By the first property of this definition, $0 \in I$. By the second property, $1 \in I$. $(((0 \in I) \to (S(0) \in I)))$ By the second property, $2 \in I$,

A set I is called "inductive" if

- $0 \in I$, and
- ② *I* is closed under successor. This means

$$x \in I$$
 implies $S(x) \in I$.

By the first property of this definition, $0 \in I$. By the second property, $1 \in I$. $(((0 \in I) \to (S(0) \in I)))$ By the second property, $2 \in I$, and so on.

A set I is called "inductive" if

- $0 \in I$, and
- ② *I* is closed under successor. This means

$$x \in I$$
 implies $S(x) \in I$.

By the first property of this definition, $0 \in I$.

By the second property, $1 \in I$. $(((0 \in I) \to (S(0) \in I)))$

By the second property, $2 \in I$, and so on.

So a typical inductive set looks like

A set I is called "inductive" if

- $0 \in I$, and
- ② *I* is closed under successor. This means

$$x \in I$$
 implies $S(x) \in I$.

By the first property of this definition, $0 \in I$.

By the second property, $1 \in I$. $(((0 \in I) \to (S(0) \in I)))$

By the second property, $2 \in I$, and so on.

So a typical inductive set looks like $I = \{0, 1, 2, \dots, (extra stuff)\}.$

A set I is called "inductive" if

- $0 \in I$, and
- 2 *I* is closed under successor. This means

$$x \in I$$
 implies $S(x) \in I$.

By the first property of this definition, $0 \in I$.

By the second property, $1 \in I$. $(((0 \in I) \to (S(0) \in I)))$

By the second property, $2 \in I$, and so on.

So a typical inductive set looks like $I = \{0, 1, 2, \dots, (\text{extra stuff})\}$. More concretely,

Inductive sets

A set I is called "inductive" if

- $0 \in I$, and
- ② *I* is closed under successor. This means

$$x \in I$$
 implies $S(x) \in I$.

By the first property of this definition, $0 \in I$.

By the second property, $1 \in I$. $(((0 \in I) \to (S(0) \in I)))$

By the second property, $2 \in I$, and so on.

So a typical inductive set looks like $I = \{0, 1, 2, \dots, (\text{extra stuff})\}$. More concretely,

$$I = \{0, 1, 2, \dots, u, S(u), SS(u), \dots, v, S(v), SS(v), SSS(v), \dots\}.$$

There is a formula $\varphi_{\text{inductive}}(x)$ that holds if x is inductive and fails if x is not inductive.

There is a formula $\varphi_{\text{inductive}}(x)$ that holds if x is inductive and fails if x is not inductive.

$$\varphi_{\text{inductive}}(x): \quad (0 \in x) \land (\forall y)((y \in x) \rightarrow (S(y) \in x)).$$

There is a formula $\varphi_{\text{inductive}}(x)$ that holds if x is inductive and fails if x is not inductive.

$$\varphi_{\text{inductive}}(x): \quad (0 \in x) \land (\forall y)((y \in x) \rightarrow (S(y) \in x)).$$

We want to define \mathbb{N} to be the intersection of all inductive sets.

There is a formula $\varphi_{\text{inductive}}(x)$ that holds if x is inductive and fails if x is not inductive.

$$\varphi_{\text{inductive}}(x): \quad (0 \in x) \land (\forall y)((y \in x) \rightarrow (S(y) \in x)).$$

We want to define \mathbb{N} to be the intersection of all inductive sets. This is the set of elements common to all inductive sets.

There is a formula $\varphi_{\text{inductive}}(x)$ that holds if x is inductive and fails if x is not inductive.

$$\varphi_{\text{inductive}}(x): \quad (0 \in x) \land (\forall y)((y \in x) \rightarrow (S(y) \in x)).$$

We want to define \mathbb{N} to be the intersection of all inductive sets. This is the set of elements common to all inductive sets. This is the intersection of all sets that satisfy the formula $\varphi_{\text{inductive}}(x)$:

There is a formula $\varphi_{\text{inductive}}(x)$ that holds if x is inductive and fails if x is not inductive.

$$\varphi_{\text{inductive}}(x): \quad (0 \in x) \land (\forall y)((y \in x) \rightarrow (S(y) \in x)).$$

We want to define \mathbb{N} to be the intersection of all inductive sets. This is the set of elements common to all inductive sets. This is the intersection of all sets that satisfy the formula $\varphi_{\text{inductive}}(x)$:

$$\varphi_{\mathbb{N}}(x): (\forall y)((y \in x) \leftrightarrow (\forall z)(\varphi_{\text{inductive}}(z) \rightarrow (y \in z)))$$

This is a fancy way to say

There is a formula $\varphi_{\text{inductive}}(x)$ that holds if x is inductive and fails if x is not inductive.

$$\varphi_{\text{inductive}}(x): \quad (0 \in x) \land (\forall y)((y \in x) \rightarrow (S(y) \in x)).$$

We want to define \mathbb{N} to be the intersection of all inductive sets. This is the set of elements common to all inductive sets. This is the intersection of all sets that satisfy the formula $\varphi_{\text{inductive}}(x)$:

$$\varphi_{\mathbb{N}}(x): (\forall y)((y \in x) \leftrightarrow (\forall z)(\varphi_{\text{inductive}}(z) \rightarrow (y \in z)))$$

This is a fancy way to say

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I.$$

There is a formula $\varphi_{\text{inductive}}(x)$ that holds if x is inductive and fails if x is not inductive.

$$\varphi_{\text{inductive}}(x): \quad (0 \in x) \land (\forall y)((y \in x) \rightarrow (S(y) \in x)).$$

We want to define \mathbb{N} to be the intersection of all inductive sets. This is the set of elements common to all inductive sets. This is the intersection of all sets that satisfy the formula $\varphi_{\text{inductive}}(x)$:

$$\varphi_{\mathbb{N}}(x): (\forall y)((y \in x) \leftrightarrow (\forall z)(\varphi_{\text{inductive}}(z) \rightarrow (y \in z)))$$

This is a fancy way to say

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I.$$

This is a "legal intersection" provided there is at least one inductive set.

There is a formula $\varphi_{\text{inductive}}(x)$ that holds if x is inductive and fails if x is not inductive.

$$\varphi_{\text{inductive}}(x): (0 \in x) \land (\forall y)((y \in x) \rightarrow (S(y) \in x)).$$

We want to define \mathbb{N} to be the intersection of all inductive sets. This is the set of elements common to all inductive sets. This is the intersection of all sets that satisfy the formula $\varphi_{\text{inductive}}(x)$:

$$\varphi_{\mathbb{N}}(x): (\forall y)((y \in x) \leftrightarrow (\forall z)(\varphi_{\text{inductive}}(z) \rightarrow (y \in z)))$$

This is a fancy way to say

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I.$$

This is a "legal intersection" provided there is at least one inductive set. (We can only intersect nonempty collections.)

The Axiom of Infinity

The Axiom of Infinity

There is an inductive set.

The Axiom of Infinity

There is an inductive set.

This axiom guarantees that \mathbb{N} exists.

There are different inductive sets, like

There are different inductive sets, like

$$\{0, 1, 2, \dots, u, S(u), SS(u), \dots\}$$

There are different inductive sets, like

$$\{0, 1, 2, \dots, u, S(u), SS(u), \dots\}$$

and

There are different inductive sets, like

$$\{0, 1, 2, \dots, u, S(u), SS(u), \dots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

There are different inductive sets, like

$$\{0, 1, 2, \dots, u, S(u), SS(u), \dots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

There are different inductive sets, like

$$\{0, 1, 2, \dots, u, S(u), SS(u), \dots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

There are different inductive sets, like

$$\{0, 1, 2, \dots, u, S(u), SS(u), \dots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

(no mysterious "extra stuff" at the end).

There are different inductive sets, like

$$\{0, 1, 2, \dots, u, S(u), SS(u), \dots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

(no mysterious "extra stuff" at the end).

Question:

There are different inductive sets, like

$$\{0, 1, 2, \dots, u, S(u), SS(u), \dots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

(no mysterious "extra stuff" at the end).

There are different inductive sets, like

$$\{0, 1, 2, \ldots, u, S(u), SS(u), \ldots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

(no mysterious "extra stuff" at the end).

There are different inductive sets, like

$$\{0, 1, 2, \ldots, u, S(u), SS(u), \ldots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

(no mysterious "extra stuff" at the end).

There are different inductive sets, like

$$\{0, 1, 2, \ldots, u, S(u), SS(u), \ldots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

(no mysterious "extra stuff" at the end).

There are different inductive sets, like

$$\{0, 1, 2, \ldots, u, S(u), SS(u), \ldots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

(no mysterious "extra stuff" at the end).

There are different inductive sets, like

$$\{0, 1, 2, \ldots, u, S(u), SS(u), \ldots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

(no mysterious "extra stuff" at the end).

There are different inductive sets, like

$$\{0, 1, 2, \ldots, u, S(u), SS(u), \ldots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

(no mysterious "extra stuff" at the end).

There are different inductive sets, like

$$\{0, 1, 2, \ldots, u, S(u), SS(u), \ldots\}$$

and

$$\{0, 1, 2, \dots, v, S(v), SS(v), \dots, w, S(w), \dots\},\$$

and the hope is that if we intersect all of them we will be left with only

$$\mathbb{N} = \bigcap_{I \text{ inductive}} I = \{0, 1, 2, \ldots\}$$

(no mysterious "extra stuff" at the end).

\mathbb{N} is inductive

Theorem.

Theorem. \mathbb{N} is inductive.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set.

Theorem. \mathbb{N} is inductive. (So it is the "least" inductive set. This means that \mathbb{N} is an inductive set that is a subset of every other inductive set.)

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof.

Theorem. \mathbb{N} is inductive. (So it is the "least" inductive set. This means that \mathbb{N} is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive}} I$.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason:

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I,

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive }} I$

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Claim 2.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Claim 2. \mathbb{N} is closed under successor.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Claim 2. \mathbb{N} is closed under successor.

Reason:

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Claim 2. \mathbb{N} is closed under successor.

Reason: Choose $x \in \mathbb{N}$

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Claim 2. \mathbb{N} is closed under successor.

Reason: Choose $x \in \mathbb{N} = \bigcap_{I \text{ inductive }} I$.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Claim 2. \mathbb{N} is closed under successor.

Reason: Choose $x \in \mathbb{N} = \bigcap_{I \text{ inductive }} I$. Then $x \in I$ for every inductive I.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Claim 2. \mathbb{N} is closed under successor.

Reason: Choose $x \in \mathbb{N} = \bigcap_{I \text{ inductive }} I$. Then $x \in I$ for every inductive I. Hence $S(x) \in I$ for every inductive I.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Claim 2. \mathbb{N} is closed under successor.

Reason: Choose $x \in \mathbb{N} = \bigcap_{I \text{ inductive }} I$. Then $x \in I$ for every inductive I. Hence $S(x) \in I$ for every inductive I. Hence $S(x) \in \bigcap_{I \text{ inductive }} I$

The Natural Numbers

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Claim 2. \mathbb{N} is closed under successor.

Reason: Choose $x \in \mathbb{N} = \bigcap_{I \text{ inductive }} I$. Then $x \in I$ for every inductive I. Hence $S(x) \in I$ for every inductive I. Hence $S(x) \in \bigcap_{I \text{ inductive }} I = \mathbb{N}$.

Theorem. $\mathbb N$ is inductive. (So it is the "least" inductive set. This means that $\mathbb N$ is an inductive set that is a subset of every other inductive set.)

Proof. Recall that we have defined \mathbb{N} so that it is the intersection of all inductive sets, say $\mathbb{N} = \bigcap_{I \text{ inductive }} I$. To prove that \mathbb{N} is inductive, we must show that it contains 0 and it is closed under successor.

Claim 1. $0 \in \mathbb{N}$.

Reason: $0 \in I$ for every inductive I, so $0 \in \bigcap_{I \text{ inductive}} I = \mathbb{N}$.

Claim 2. \mathbb{N} is closed under successor.

Reason: Choose $x \in \mathbb{N} = \bigcap_{I \text{ inductive }} I$. Then $x \in I$ for every inductive I. Hence $S(x) \in I$ for every inductive I. Hence $S(x) \in \bigcap_{I \text{ inductive }} I = \mathbb{N}$. \square