# A whopper of a number 

Lee A. Butler

Department of Mathematics
University of Bristol lee.butler@bris.ac.uk

November 24, 2009

## Models and theories

- Model theory $=$ Models + Theories.


## Models and theories

- Model theory $=$ Models + Theories.
- A theory:


## Models and theories

- Model theory $=$ Models + Theories.
- A theory:
- $\forall x \forall y \forall z(x \cdot y) \cdot z=x \cdot(y \cdot z)$
- $\forall x x \cdot e=e \cdot x=x$
- $\forall x \exists y x \cdot y=e$.


## Models and theories

- Model theory $=$ Models + Theories.
- A theory:
- $\forall x \forall y \forall z(x \cdot y) \cdot z=x \cdot(y \cdot z)$
- $\forall x x \cdot e=e \cdot x=x$
- $\forall x \exists y x \cdot y=e$.
- Models:


## Models and theories

- Model theory $=$ Models + Theories.
- A theory:
- $\forall x \forall y \forall z(x \cdot y) \cdot z=x \cdot(y \cdot z)$
- $\forall x x \cdot e=e \cdot x=x$
- $\forall x \exists y x \cdot y=e$.
- Models:
- $(\mathbb{Z},+, 0)$
- $\left(\mathbb{R}^{\times}, \times, 1\right)$.


## Compactness

Theorem (Gödel's compactness theorem)
A theory $T$ is satisfiable if and only if every finite subset of $T$ is satisfiable.

Proof.

## Compactness

Theorem (Gödel's compactness theorem)
A theory $T$ is satisfiable if and only if every finite subset of $T$ is satisfiable.

Proof.
Ask Dave.

## Unnaturally large

## Unnaturally large

- $\mathrm{PA} \models \mathbb{N}$


## Unnaturally large

- $\mathrm{PA} \vDash \mathbb{N}$
- PA tell you about "=", "1", and "+1".


## Unnaturally large

- $\mathrm{PA} \vDash \mathbb{N}$
- PA tell you about "=", "1", and "+1".
- 1. $1<\omega$

2. $1+1<\omega$
3. $1+1+1<\omega \ldots$

## Unnaturally large

- $\mathrm{PA} \vDash \mathbb{N}$
- PA tell you about "=", "1", and "+1".
- 1. $1<\omega$

2. $1+1<\omega$
3. $1+1+1<\omega \ldots$

- $\omega=$ big.


## Unnaturally large

- $\mathrm{PA} \vDash \mathbb{N}$
- PA tell you about "=", "1", and "+1".
- 1. $1<\omega$

2. $1+1<\omega$
3. $1+1+1<\omega \ldots$

- $\omega=$ big.
- Exists thing that looks like $\mathbb{N}$


## Unnaturally large

- $\mathrm{PA} \models \mathbb{N}$
- PA tell you about "=", " 1 ", and " +1 ".
- 1. $1<\omega$

2. $1+1<\omega$
3. $1+1+1<\omega \ldots$

- $\omega=$ big.
- Exists thing that looks like $\mathbb{N}$, but has a really big number in it.

