

Assignment Project Exam Help

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CSE, UNSW (and Data6
29 July 2020)

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What is Intuitionistic Logic?

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What is Intuitionistic Logic?

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- Classical lo

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What is Intuitionistic Logic?

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- Classical lo
- Intuitionis
equivalent

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$p \vee \neg p$ or

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What is Intuitionistic Logic?

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- Classical lo
- Intuitionis
- equivalent

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- In classical logic more can be proven but less can be expressed

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What is Intuitionistic Logic?

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- Classical logic
- Intuitionistic logic is not equivalent to classical logic
- In classical logic more can be proven but less can be expressed
- Intuitionistic proof of an existence statement gives a witness

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Example of Existence in the Classical Sense

- Let \mathbb{Q} be the set of rational numbers and \mathbb{I} be the set of irrational numbers.
- Consider the set $S = \{x \in \mathbb{I} \mid x^2 = 2\}$.

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Example of Existence in the Classical Sense

- Let \mathbb{Q} be the set of rational numbers and \mathbb{I} be the set of irrational numbers.
- Consider the function $f: \mathbb{R} \rightarrow \mathbb{I}$ defined by $f(x) = x\sqrt{2}$.
- Proof:

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Example of Existence in the Classical Sense

- Let \mathbb{Q} be the set of rational numbers and \mathbb{I} be the set of irrational numbers.
- Consider the statement $\exists x (x \in \mathbb{Q} \wedge x^2 = 2)$.
- Proof:
 - Consider the set $S = \{x \in \mathbb{Q} \mid x^2 < 2\}$.

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Example of Existence in the Classical Sense

- Let \mathbb{Q} be the set of rational numbers and \mathbb{I} be the set of irrational numbers.
- Consider the statement $\exists x (x \in \mathbb{Q} \wedge x^2 = 2)$.
- Proof:

- Consider the statement $\exists x (x \in \mathbb{Q} \wedge x^2 = 2)$.

① If $\sqrt{2} \in \mathbb{Q}$,

- then $\sqrt{2} \in \mathbb{Q}$.

- then $\sqrt{2} \in \mathbb{Q}$.

② Otherwise, if $\sqrt{2} \notin \mathbb{Q}$, then $\sqrt{2} \in \mathbb{I}$.

- then $\sqrt{2} \in \mathbb{I}$.

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Example of Existence in the Classical Sense

- Let \mathbb{Q} be the set of rational numbers and \mathbb{I} be the set of irrational numbers.
- Consider the statement $\exists x, y \in \mathbb{R} \text{ such that } x^y \in \mathbb{Q}$.
- Proof:

- Consider two cases:
- 1 If $\sqrt{2} \in \mathbb{Q}$
 - Pick $x = \sqrt{2}$ and $y = \sqrt{2}$
 - Then $x^y = (\sqrt{2})^{\sqrt{2}}$. So $x^y \in \mathbb{Q}$.
- 2 Otherwise if $\sqrt{2} \in \mathbb{I}$
 - Consider $x = \sqrt{2}$ and $y = \sqrt{2}$.
 - If $x^y \in \mathbb{Q}$, then we are done.
 - If $x^y \in \mathbb{I}$, then consider $(x^y)^x$. This is a rational number.

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Example of Existence in the Classical Sense

- Let \mathbb{Q} be the set of rational numbers and \mathbb{I} be the set of irrational numbers.
- Consider the statement $\exists x \in \mathbb{I} \exists y \in \mathbb{I} \text{ such that } x^y \in \mathbb{Q}$.
- Proof:

- Consider two cases:

1 If $\sqrt{2} \in \mathbb{I}$

- Pick $x = \sqrt{2}$ and $y = \sqrt{2}$
- Then $x^y = \sqrt{2}^{\sqrt{2}}$ so $x^y \in \mathbb{Q}$

2 Otherwise if $\sqrt{2}^{\sqrt{2}} \in \mathbb{I}$

- Pick $x = \sqrt{2}^{\sqrt{2}}$ and $y = \sqrt{2}$
- Then $x^y = (\sqrt{2}^{\sqrt{2}})^{\sqrt{2}} = \sqrt{2}^2 = 2$ so $x^y \in \mathbb{Q}$

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Recall: The Curry-Howard Isomorphism

This correspondence goes by many names, but is usually attributed to Haskell Curry and William Howard.

It is a ~~very deep~~ result:

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Recall: The Curry-Howard Isomorphism

This correspondence goes by many names, but is usually attributed to Haskell Curry and William Howard.

It is a ~~very deep~~ result:

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It turns out, no matter what logic you want to define, there is always λ -calculus, and vice versa.

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Constructive Logic	Type Theory
Classical Logic	Continuations
Modal Logic	Monads
Linear Logic	Linear Types, Session Types
Separation Logic	Region Types

Translating

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We can translate logical connectives to types and back:

True	()
False	

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We can also translate our *equational reasoning* on proofs!

plification

Constructors and Elimimators for Sums

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`data TrafficLight = Red | Amber | Green`

Example (Tra

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Red \approx Left ()
Amber \approx Right (Le
Green \approx Right (Ri

Type Correctness

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$$\frac{}{\Gamma \vdash () :: ()} () \quad \frac{\Gamma \quad e :: A}{\text{Either } A \quad B} \quad \frac{\Gamma \quad e :: B}{\text{Either } A \quad B} S_R$$

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Type Correctness

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$$\frac{}{\Gamma \vdash () :: ()} () \quad \frac{\Gamma \quad e :: A}{\text{right } (Left ()) :: \text{Eit}} \quad \frac{\Gamma \quad e :: B}{\text{Either } A \ B} S_R$$

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???

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$$\frac{\frac{\text{Left } () :: ()}{\text{right } (Left ()) :: \text{Eit}}}{\text{Right } (Right (Left ())) :: \text{Either } () \ (\text{Either } () \ ())} S_R$$

Type Correctness

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$$\frac{}{\Gamma \vdash () :: ()} () \quad \frac{\Gamma \quad e :: A}{\text{Either } A \ B} S_R \quad \frac{\Gamma \quad e :: B}{\text{Either } A \ B} S_R$$

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$$\frac{\frac{\frac{}{\text{Right } () :: \text{Either } () \ (())} ()}{\text{Right } () :: \text{Either } () \ (())} ()}{\text{Right } (\text{Right } ()) :: \text{Either } () \ (\text{Either } () \ (()))} R$$

Examples

```
prop_or_false :: a -> (Either a Void)
```

```
prop_or_false a = Left a
```

```
prop_or_true :: a -> (Either a ())
```

```
prop_or_true
```

```
prop_and_tr
```

```
prop_and_true a = (a, ())
```

```
prop_double_neg_intro :: a -> (a -> Void) -> Void
```

```
prop_double_neg_intro a f = f a
```

```
prop_triple_neg_elim ::
```

```
((a -> Void) -> Void) -> a -> Void
```

```
prop_triple_neg_elim f a = f (\g -> g a)
```

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Wrap-up

- ① Assignment 2 is before my next lecture (5th August).
- # Exam Help

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Wrap-up

- 1 Assignment 2 is before my next lecture (5th August).
- 2 There is a quiz for this week, but no exercise.

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Wrap-up

1 Assignment 2 is before my next lecture (5th August).

2 There is a quiz for this week, but no exercise.

3 Next week's exercises and a revision lecture

4 There will be a specific questions

5 If you enjoyed the course and want to do more in this direction, taste of research projects, and consider attending COMP4161.

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Wrap-up

- 1 Assignment 2 is before my next lecture (5th August).
- 2 There is a quiz for this week, but no exercise.
- 3 Next week's exercises and a revision lecture
- 4 There will be a set of specific questions
- 5 If you enjoyed the course and want to do more in this direction, taste of research projects, and consider attending COMP4161.
- 6 Fill in the myExperience reports, it is important for us to receive your feedback.

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Consultations

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cs3141@c

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- Will be in the Thursday lecture slot, 9am to 11am on Blackb
- Make sure to join the queue on Hopper. Be ready to share your (`ghci` or `stack repl`) and editor set up.

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