Advanced Functional Programming

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Assignment 1-4 are *individual* assignments and Assignment 5 and 6 are group assignments, where a group consists of two students. You will receive the Assignment descriptions for Assignment 4-6 according to the schedule. We expect timely submission of the assignments, late assignments count as failed assignments. We expect genuine solutions and plagiarism will lead directly to fail. Please read the submission guide for each assignment.

1 Assignment

Perform β reduction of the following terms and write the β-contractum: *(Lambda calculus slides, p. 21.)*

1. $\lambda x.x$
2. $(\lambda x.x)y$
3. $(\lambda x.xx)y$
4. $(\lambda x.z)y$
5. $(\lambda x \lambda y.x)z$

2 Assignment

Does the following terms have a β Normalform? Please briefly explain why. β Normalforms are presented in *(Lambda calculus slides, p. 21.)*

1. $\mathbf{I} = \lambda x.x$
2. $\Omega = \omega\omega$ with $\omega = \lambda x.xx$
3. $\mathbf{KI}\Omega$ with $\mathbf{K} = \lambda x\ y.x$
4. $(\lambda x.\mathbf{KI}(x\ x)\lambda y.\mathbf{KI}(y\ y))$
5. $(\lambda x.z(xx))\lambda y.z(yy)$

3 Assignment

A reduction path of a λ term M is a finite or infinite sequence of the following form:

$$M \rightarrow_\beta M_1 \rightarrow_\beta M_2 \rightarrow_\beta \ldots$$

We call a term weak normalizing, if it has a Normalform. A term is called strong normalizing, if all of its reduction paths end in a Normalform.

1. Which of the previous five terms are weak normalizing and which of them are strong normalizing?
2. In which of these cases does the term end in different Normalforms?