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# Principles of AI Planning

## Exercise Sheet 2

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### Exercise 2.1 - Effect Normal Form

a) Transform the operator into ENF

$$\langle \neg e \vee f, (a \triangleright (b \triangleright c)) \wedge (\neg d \triangleright c) \wedge (\neg(\neg c \wedge \neg a) \triangleright (d \wedge \neg e)) \wedge (d \triangleright \neg e) \rangle$$

De Morgan's Law

$$\langle \neg e \vee f, (a \triangleright (b \triangleright c)) \wedge (\neg d \triangleright c) \wedge ((c \vee a) \triangleright (d \wedge \neg e)) \wedge (d \triangleright \neg e) \rangle$$

(7)

$$\langle \neg e \vee f, ((a \wedge b) \triangleright c) \wedge (\neg d \triangleright c) \wedge ((c \vee a) \triangleright (d \wedge \neg e)) \wedge (d \triangleright \neg e) \rangle$$

(9)

$$\langle \neg e \vee f, ((a \wedge b \vee \neg d) \triangleright c) \wedge ((c \vee a) \triangleright (d \wedge \neg e)) \wedge (d \triangleright \neg e) \rangle$$

(8)

$$\langle \neg e \vee f, ((a \wedge b \vee \neg d) \triangleright c) \wedge ((c \vee a) \triangleright d) \wedge ((c \vee a) \triangleright \neg e) \wedge (d \triangleright \neg e) \rangle$$

(9)

$$\langle \neg e \vee f, ((a \wedge b \vee \neg d) \triangleright c) \wedge ((c \vee a) \triangleright d) \wedge ((c \vee a \vee d) \triangleright \neg e) \rangle$$

b) Transform the operator into positive normal form

$$\langle \neg e \vee f, ((a \wedge b \vee \neg d) \triangleright c) \wedge ((c \vee a) \triangleright d) \wedge ((c \vee a \vee d) \triangleright \neg e) \rangle$$

We identify the negative atom  $\neg e$  and we change it for  $\hat{e}$  in preconditions and effects as it is not used in any other condition.

$$\langle \hat{e} \vee f, ((a \wedge b \vee \neg d) \triangleright c) \wedge ((c \vee a) \triangleright d) \wedge ((c \vee a \vee d) \triangleright \hat{e}) \rangle$$

We identify the negative atom  $\neg d$  and we change it for  $\hat{d}$  in preconditions.

$$\langle \hat{e} \vee f, ((a \wedge b \vee \hat{d}) \triangleright c) \wedge ((c \vee a) \triangleright d) \wedge ((c \vee a \vee d) \triangleright \hat{e}) \rangle$$

We change effect  $d$  for  $d \wedge \neg \hat{d}$

$$\langle \hat{e} \vee f, ((a \wedge b \vee \hat{d}) \triangleright c) \wedge ((c \vee a) \triangleright (d \wedge \neg \hat{d})) \wedge ((c \vee a \vee d) \triangleright \hat{e}) \rangle$$

(8)

$$\langle \hat{e} \vee f, ((a \wedge b \vee \hat{d}) \triangleright c) \wedge ((c \vee a) \triangleright d) \wedge ((c \vee a) \triangleright \neg \hat{d}) \wedge ((c \vee a \vee d) \triangleright \hat{e}) \rangle$$