a) Context free generation

$$\geq (\_,\_) \quad = (\_,\_)$$
$$\exists(\lambda x_i : \_, \mathcal{X})$$
$$> (\_,\_) \quad \vee(\_,\_)$$
$$\forall(\lambda x_i : \_, \mathcal{X})$$
$$\wedge(\_,\_)$$
$$N^-(\lambda x_i : \_, \mathcal{X})$$
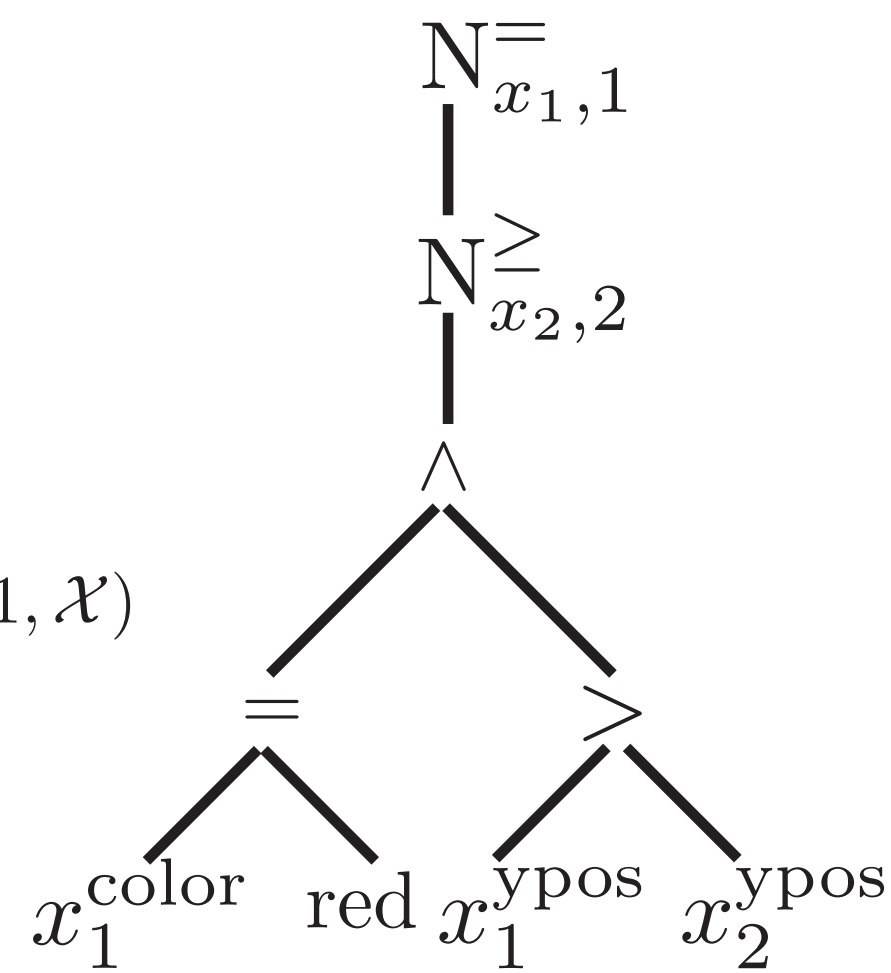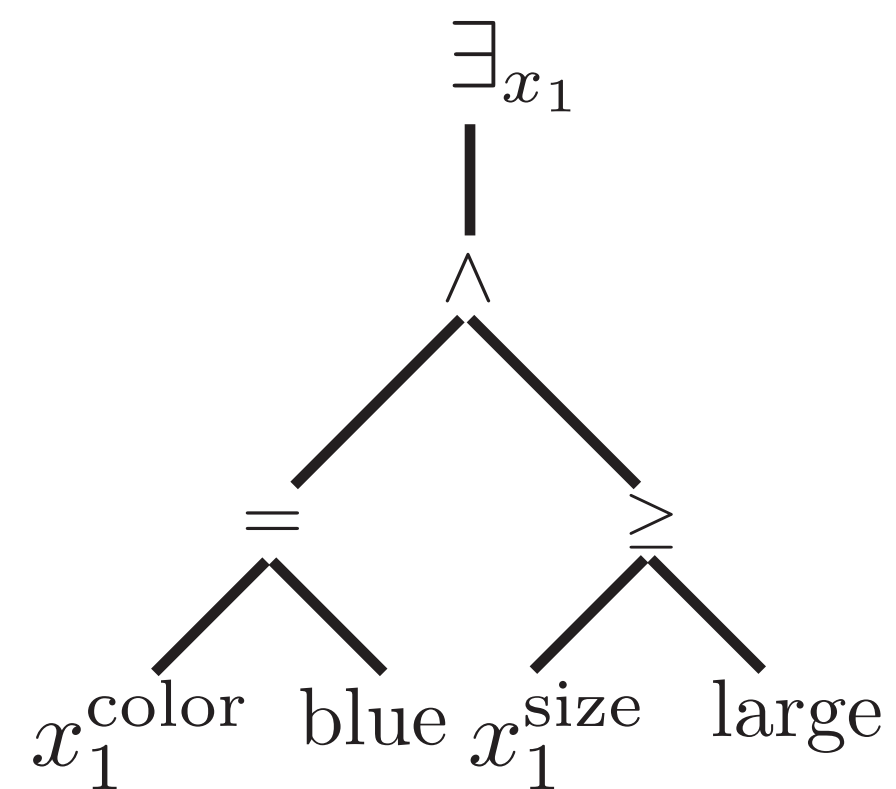
e.g.:

$$S \rightarrow$$
$$\exists(\lambda x_1 : A, \mathcal{X}) \rightarrow$$
$$\exists(\lambda x_1 : B, \mathcal{X}) \rightarrow$$
$$\exists(\lambda x_1 : H(B, B), \mathcal{X}) \rightarrow$$
$$\exists(\lambda x_1 : \wedge(= (x_1, D1), I(x_1, D2)), \mathcal{X}) \rightarrow$$
$$\exists(\lambda x_1 : \wedge(= (x_1, \text{blue}, \text{colour}), \geq (x_1, \text{medium}, \text{size})), \mathcal{X})$$
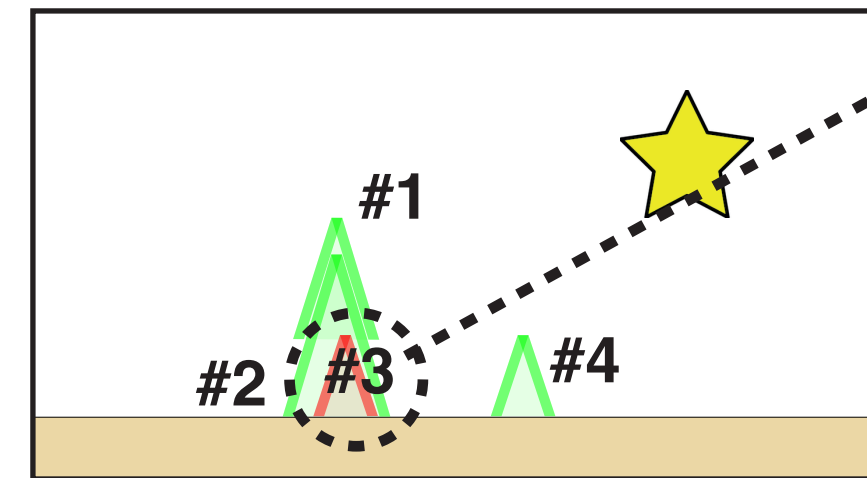
There is a blue cone that is at least medium sized

$$S \rightarrow$$
$$N^=(\lambda x_1 : A, 1, \mathcal{X})$$
$$N^=(\lambda x_1 : S, 1, \mathcal{X})$$
$$N^=(\lambda x_1 : N^{\geq}(\lambda x_2, A, 2, \mathcal{X}), 1, \mathcal{X}):$$
$$N^=(\lambda x_1 : N^{\geq}(\lambda x_2, B, 2, \mathcal{X}), 1, \mathcal{X}):$$
$$N^=(\lambda x_1 : N^{\geq}(\lambda x_2, \wedge(B, B), 2, \mathcal{X}), 1, \mathcal{X}):$$
$$N^=(\lambda x_1 : N^{\geq}(\lambda x_2 : \wedge(= (x_1, D1), I(x_1, x_2, E2)), 2, \mathcal{X}), 1, \mathcal{X})$$
$$N^=(\lambda x_1 : N^{\geq}(\lambda x_2 : \wedge(= (x_1, \text{red}, \text{colour}), > (x_1, x_2, \text{ypos})), 2, \mathcal{X}), 1, \mathcal{X})$$
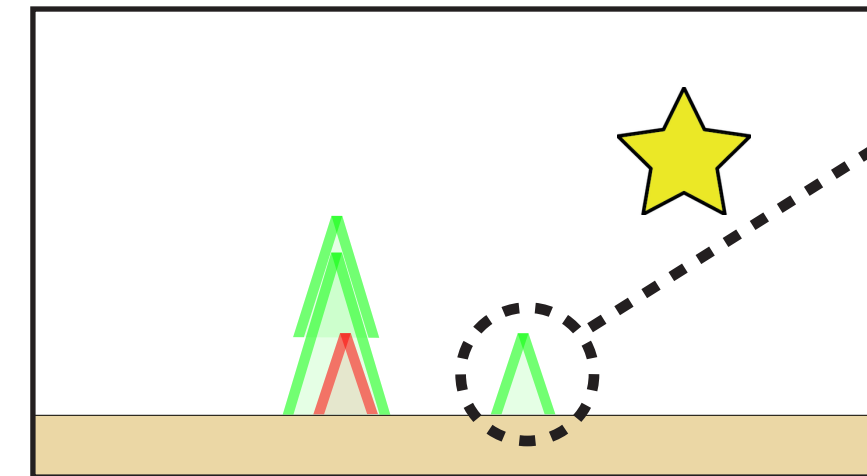
One red cone is above at least two other cones

b) Context based generation

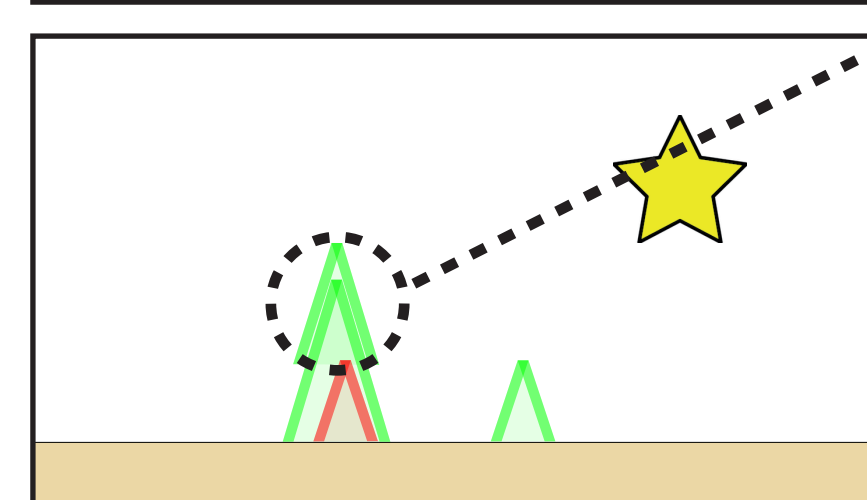red, colour $\rightarrow$
$$= (x_1, \text{red}, \text{colour}) \rightarrow$$
$$\wedge(= (x_1, \text{red}, \text{colour}), = (x_1, \text{small}, \text{size})) \rightarrow$$
$$\exists(\lambda x_1 : \wedge(= (x_1, \text{red}, \text{colour}), = (x_1, \text{small}, \text{size}), \mathcal{X})$$
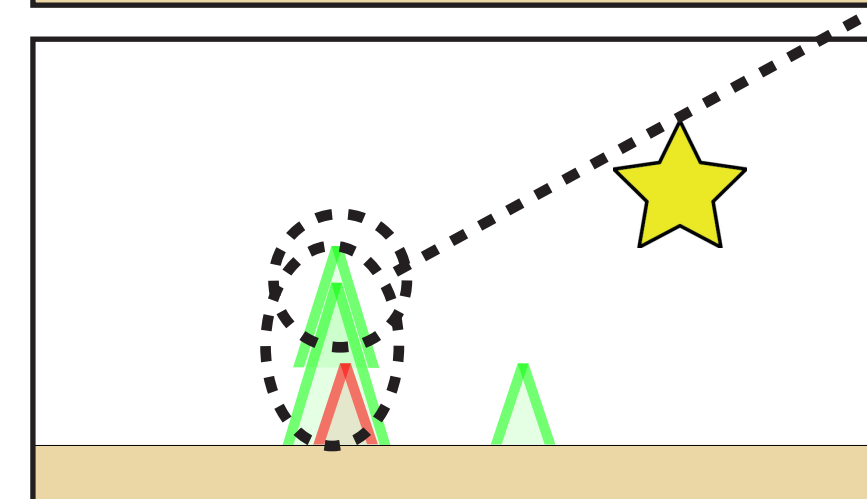
There is a small red cone

green, colour $\rightarrow$
$$= (x_1, \text{green}, \text{colour}) \rightarrow$$
$$N^{\geq}(\lambda x_1 : = (x_1, \text{green}, \text{colour}), 3, \mathcal{X})$$

There are at least three green cones

medium, size $\rightarrow$
$$\geq (x_1, \text{medium}, \text{size}) \rightarrow$$
$$N^=(\lambda x_1 : x_1, \geq (\text{medium}, \text{size}), 2, \mathcal{X})$$

Two cones of at least medium size

contact $\rightarrow$
$$= (x_1, x_2, \text{contact}) \rightarrow$$
$$\wedge(\wedge(= (x_1, \text{green}, \text{colour}), = (x_2, \text{green}, \text{colour})), = (x_1, x_2, \text{contact})) \rightarrow$$
$$\exists(\lambda x_1 : \exists(\lambda x_2 : \wedge(\wedge(= (x_1, \text{green}, \text{colour}), = (x_2, \text{green}, \text{colour})), = (x_1, x_2, \text{contact})), \mathcal{X}), \mathcal{X})$$

Two green cones touch