PackUp: Tools for Package Upgradability Solving SYSTEM DESCRIPTION

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## Package Management Systems

install p

remove p

Janota et al. (INESC-ID & UCD)

PackUp: Tools for Package Upgradability Solving

# Package Management Systems

#### install p

remove p

- may install other packages on which it depends
- may uninstall other packages with which it conflicts

• p may depend on n or q

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install p p depends n OR q n conflicts z

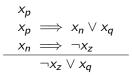
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$$\begin{array}{c} x_p \\ x_p \implies x_n \lor x_q \\ x_n \implies \neg x_z \end{array}$$

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\end{array}$$

 Deciding whether a package can be installed or not is NP-complete.

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- p depends on q OR r
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- 2. install z and keep q

#### Scenario

### Solutions

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- 2. install  $\mathbf{z}$  and keep  $\mathbf{q}$

### Morale

• some configurations are more preferable than others

# **Problem Definition**

- Each package has ...
  - a name and a version.
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### Example

package: p
version: 1
depends: q>=5, r=3
conflicts: x!=1, n

#### -new,-removed

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### • Can be easily translated to OPB and other similar formalisms.

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- Soft clauses represent preference.
- Weights chosen to represent the lexicographic ordering, i.e., for a criterion  $(f_1, \ldots, f_n)$

$$W_i = 1 + \sum_{i < j} W_j \times c_j$$

where  $c_j$  is the number of clauses generated for the function  $f_j$ .

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preferences in an analogous fashion, e.g. p=3 should stay installed

 $(W, x_p^3)$ 

## **Encoding Versions**

# Common Intervals (p,1).depends = $z \ge 3$ as $\neg x_p^1 \lor x_z^3 \lor x_z^4 \lor x_z^5 \cdots \lor x_z^k$ (q,1).depends = $z \ge 5$ as $\neg x_q^1 \lor x_z^5 \lor \cdots \lor x_z^k$

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(p,1).depends = 
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 as  $\neg x_p^1 \lor x_z^3 \lor x_z^4 \lor x_z^5 \cdots \lor x_z^k$   
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(q,1).depends = z>=5 as  $\neg x_q^1 \lor x_z^5 \lor \cdots \lor x_z^k$ 

Interval Joining

$$\neg x_q^1 \lor x_z^3 \lor x_z^4 \lor \mathfrak{i}_z^5 \\ \neg x_q^1 \lor \mathfrak{i}_z^5$$

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## Interval variables

### Introduce Fresh Variables Representing Intervals

- $i_p^v$  a version greater than or equal to v of p is installed
- $i_{\downarrow p}^{\nu}$  a version less than or equal to  $\nu$  of p is installed
- $\mathfrak{u}_p^{\wedge}$  versions greater than or equal to v of p are uninstalled
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### Interval Variables' Semantics Is Defined Inductively

$$\neg \mathfrak{f}_{p}^{v} \lor x_{p}^{v} \lor \mathfrak{f}_{p}^{v+1} (\neg \mathfrak{u}_{p}^{v} \lor \neg x_{p}^{v}) \land (\neg \mathfrak{u}_{p}^{v} \lor \mathfrak{u}_{p}^{v-1}) \cdots$$

# Computing Lexicographic Optimization

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```
minimizing criterion (f_1, \ldots, f_n)
```

```
1 for i \leftarrow 1 \dots n do

2 v_i \leftarrow \text{minimize}(f_i) in \phi

3 \phi \leftarrow \phi \land (f_i = v_i)
```

# Invoking PackUP

• MaxSAT solver—solver invoked just once

--max-sat \ --external-solver 'msuncore -wl -bmo'

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OPB solver—solver invoked multiple times

```
--external-solver 'minisatp' \setminus
```

--multiplication-string '

# Summary

- PackUP enables solving package upgradability problem with an external solver
- Instantiations cudf2msu and cudf2opb participated in the 3<sup>rd</sup> MISC Live, winning 4/5 tracks.
- The solver can be a MaxSAT or OPB.
- The use of OPB enables iterative approach to lexicographic optimization
- Package versions are encoded using interval variables.
- Released under GPL

```
http://sat.inesc-id.pt/~mikolas/sw/packup
```