THE UNIVERSITY *of* EDINBURGH
informatics

Modelling System Administration
Problems with CSPs

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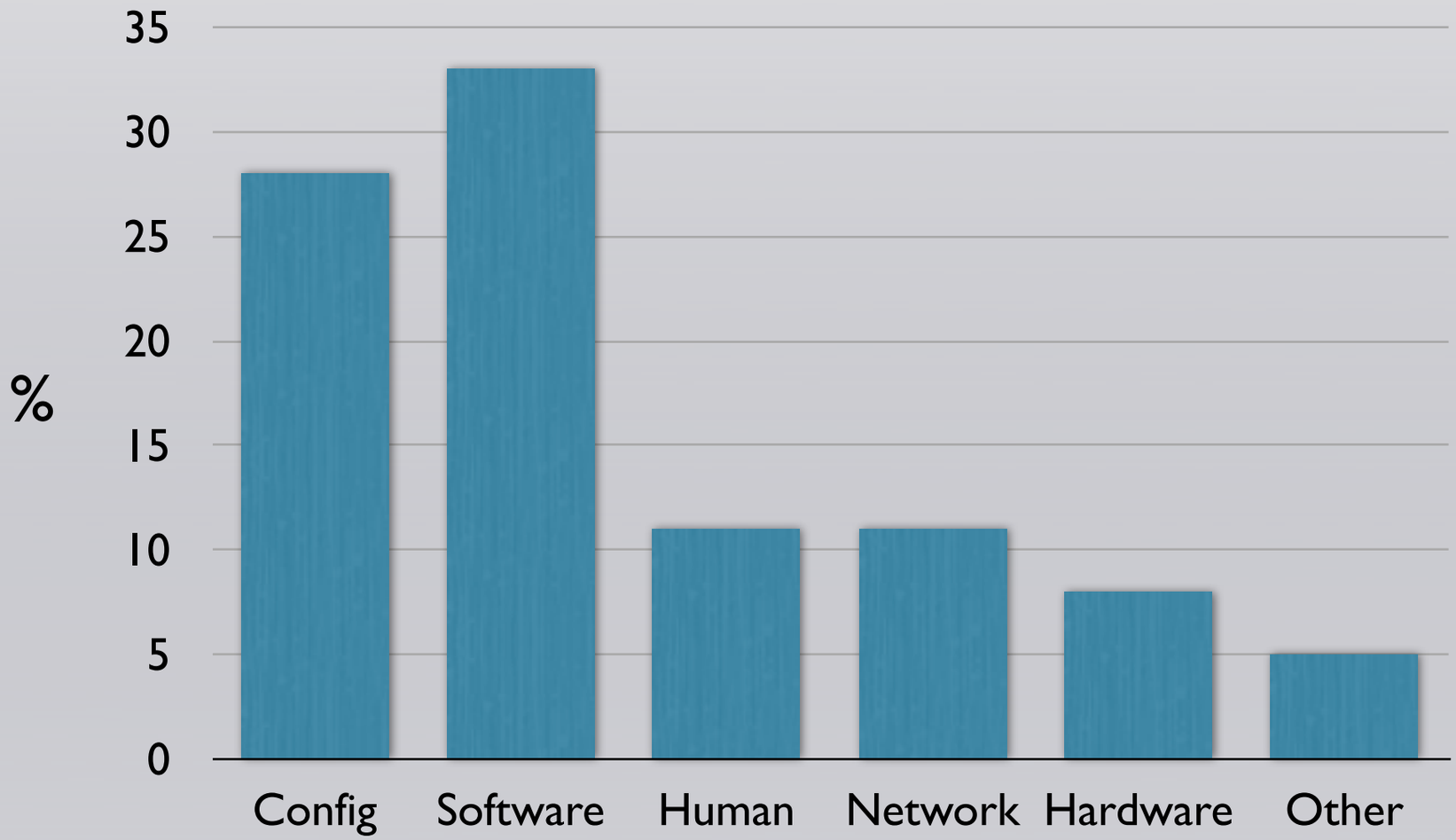
Google

Service disruption events by most likely cause at one of Google's main services, over 6 weeks (2009)



The Datacenter as a Computer: An Introduction to the Design of Warehouse-Scale Machines, Hoelzle & Barroso, 2009.

Declarative Configuration

- LCFG - Anderson, 1993 - University of Edinburgh
- Cfengine - Burgess, 1993 - University College Oslo
- Bcfg2 - Desai, 2004 - Argonne National Laboratory

- Puppet - Reductive Labs, 2005

Declarative Configuration

```
package {'apache':
    ensure => installed
}
```

instead of

```
sudo apt-get –y install apache
```

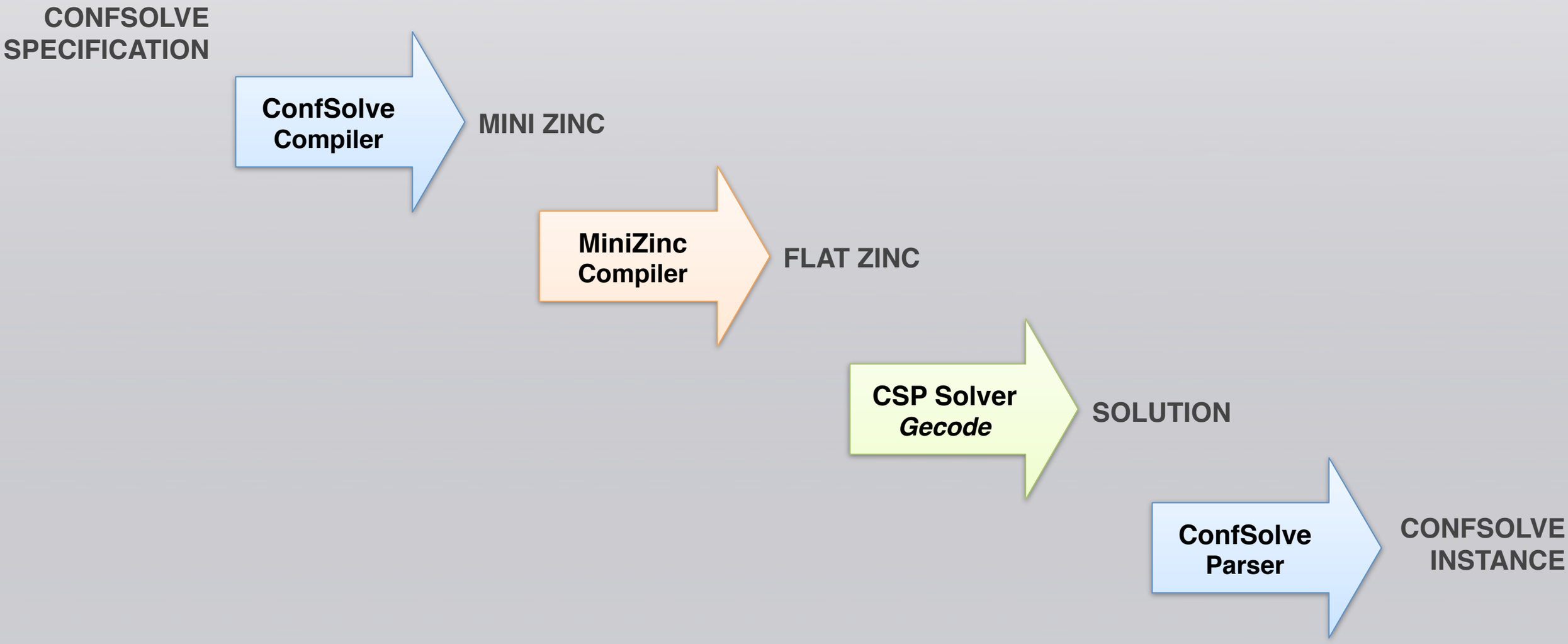
Puppet

```
class tomcat {

  $tomcat_port = 8080
  $tomcat_password = 'pass'

  Package {
    ensure => installed,
  }

  package { 'tomcat6':
  }

  package { 'tomcat6-user':
    require => Package['tomcat6'],
  }

  package { 'tomcat6-admin':
    require => Package['tomcat6'],
  }

  file { "/etc/tomcat6/tomcat-users.xml":
    owner => 'root',
    require => Package['tomcat6'],
    notify => Service['tomcat6'],
  }

  file { '/etc/tomcat6/server.xml':
     owner => 'root',
     require => Package['tomcat6'],
     notify => Service['tomcat6'],
  }
```

What's Missing?

- The ability to verify that a configuration conforms to a model
- The ability to **infer** valid configurations from a model

ConfSolve - Architecture



ConfSolve

- designed to be high-level and more familiar to system administrators:
- object oriented (like Puppet, CIM)
- inheritance
- primitives: integer, booleans, sets, enums
- objects, object references, sets of object references
- quantification, summation

Example

```
enum Network { Public, Private }

class Machine {
  var cpu as int
  var memory as int
  var disk as int
  var network as Network
  where cpu == 16          // 16 * 1/2 CPU
  where memory == 16384    // 16 GB
  where disk == 2048       // 2 TB
  where network == Network.Public
}

class Role {
  var host as ref Machine
  var disk as int
  var cpu as int
  var memory as int
  var network as Network
}
```

Example (ctd.)

```
class SmallRole extends Role {
  where cpu == 1
  where memory == 768
  where disk <= 20
}

class LargeRole extends Role {
  where cpu == 4
  where memory == 3584
  where disk <= 490
}
```

Example (ctd.)

```
var machines as Machine[2]

var sql_server as LargeRole
where sql_server.disk == 412

var web_server as SmallRole
where web_server.disk == 15
where web_server.network == Network.Public
```

Example (ctd.)


```
var roles as ref Role[2]

where foreach (m in machines) {
  sum (r in roles where r.host == m) {
    r.cpu
  } <= m.cpu
```

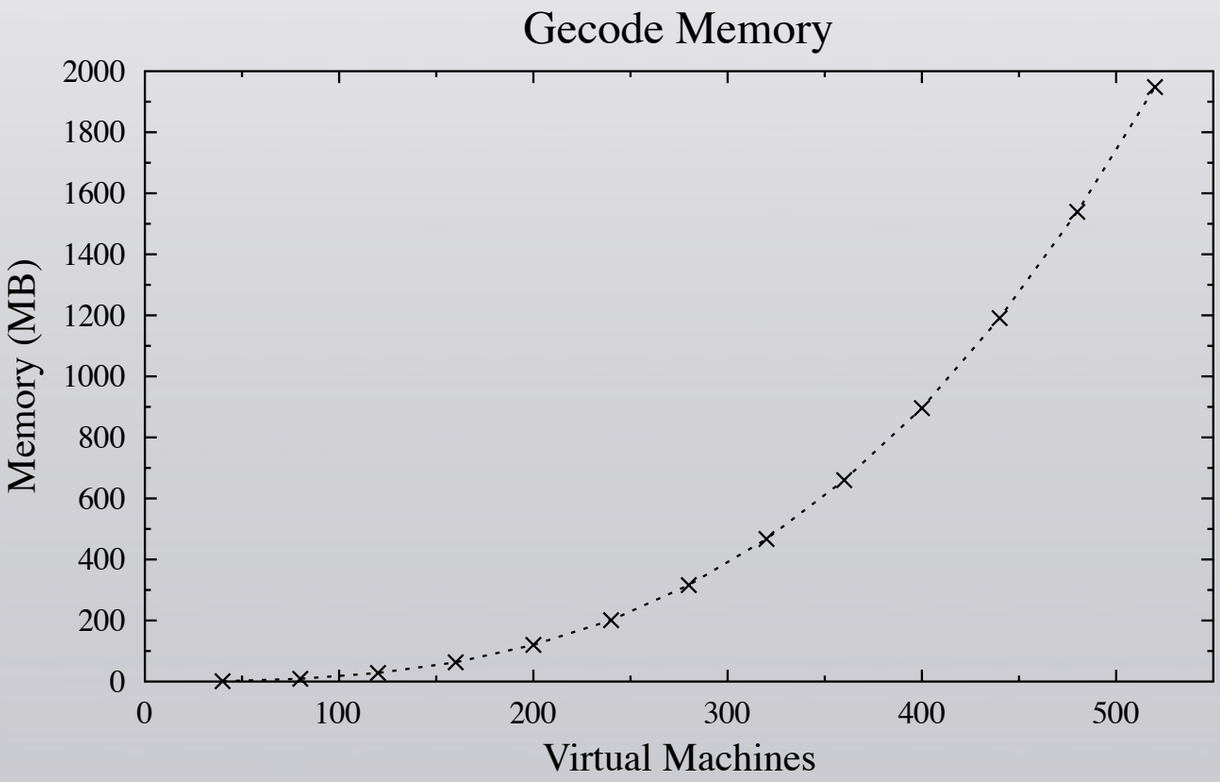

```
class Role {
  var host as ref Machine
```

```
  sum (r in roles where r.host == m) {
    r.memory
  } <= m.memory

  sum (r in roles where r.host == m) {
    r.disk
  } <= m.disk
}
```

Example (solution)

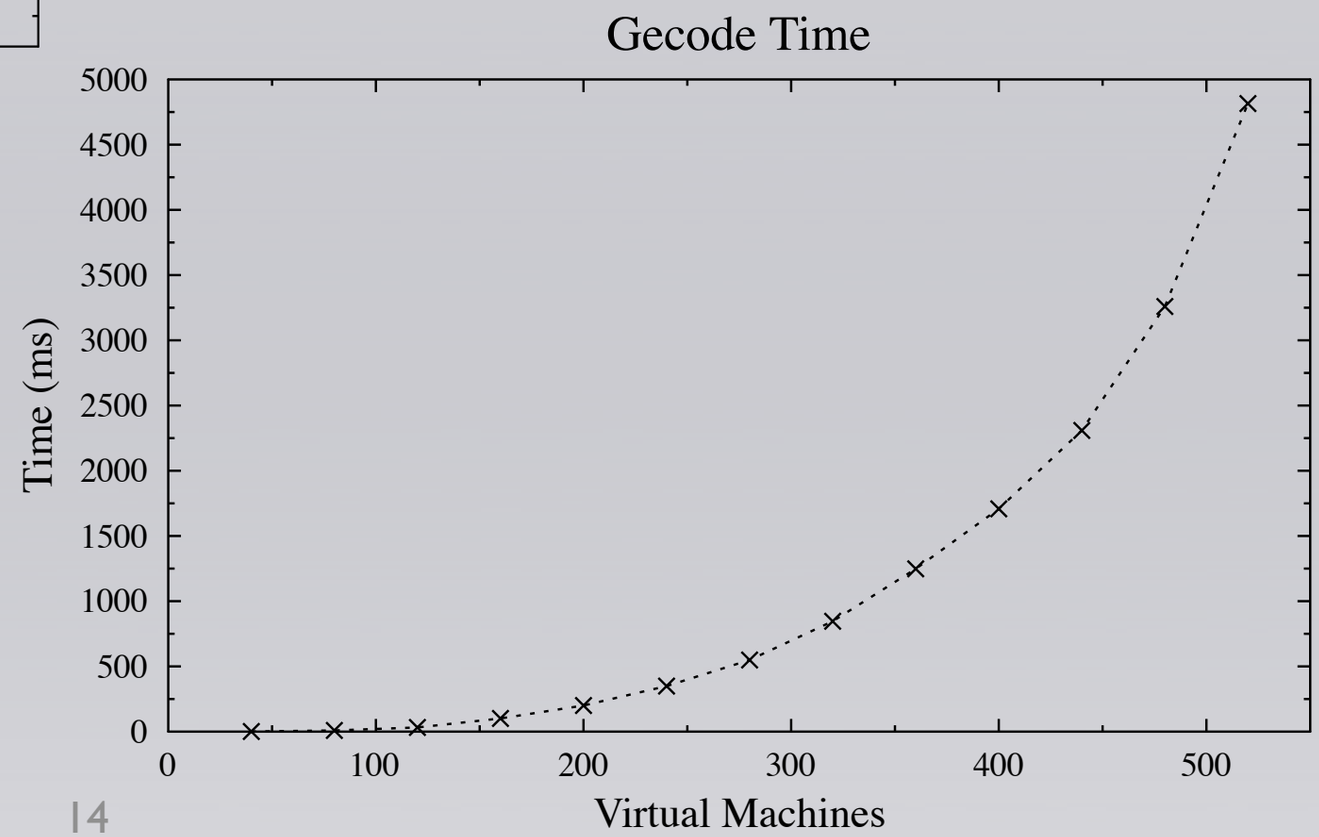
```
roles: Role {sql_server, web_server}

machines[1]: Machine {
    cpu: 16;
    memory: 16384;
    disk: 2048;
    network: Public;
}

machines[2]: Machine {
    cpu: 16;
    memory: 16384;
    disk: 2048;
    network: Public;
}

sql_server: LargeRole {
    disk: 412;
    cpu: 4;
    memory: 3584;
    network: Public;
    host: machines[1];
}

web_server: SmallRole {
    disk: 15;
    cpu: 1;
    memory: 768;
    network: Public;
    host: machines[1];
}
```

Example - Performance



~500 VMs onto ~250 PMs

2GB RAM, 5000ms



Ongoing & Future Work

- Optimisation
  `where maximise x`

- Refinement of Primitives
  `S extends int { where value > 0 }`

- Min-changes between an altered problem
  e.g. don't re-arrange all the servers if just two can be swapped

Future

- extend ConfSolve with preference constraint syntax
  (using optimisation)

- OCL-like constructs?

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More...

- Binaries for .NET / Mono

  `http://homepages.inf.ed.ac.uk/s0968244/modref2011`

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