Focus Software: Process and Results

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Software Goals

- Explainable and understandable
- Replicable and maintainable
- Scalable
- Transferrable
- Distributable
- Upgradable
- Integratable
- Tunable

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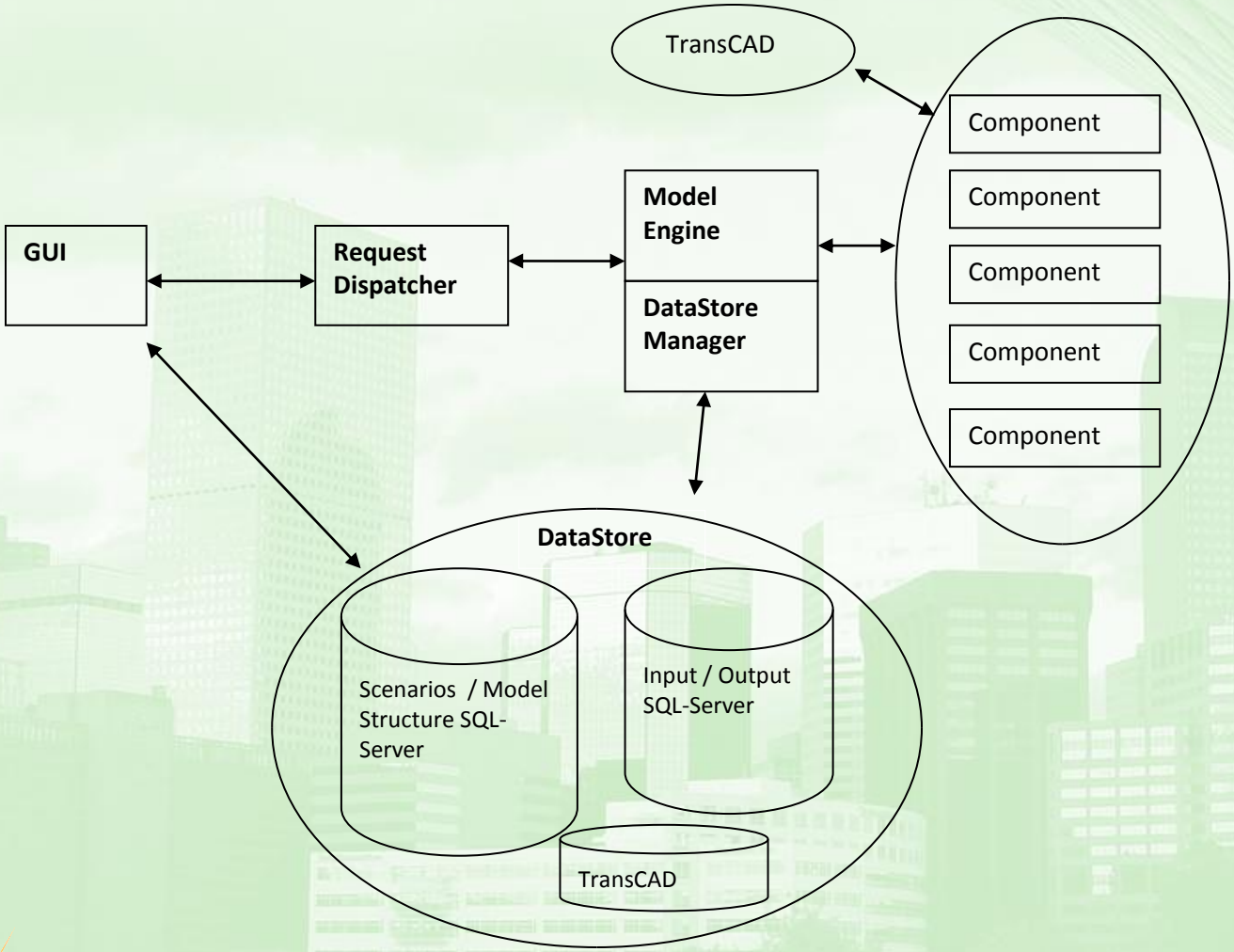
The Big Picture



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A few design comments

- Breadth-first design
  - Runs one model component at a time
- Loosely-coupled services and components
  - Easier distributability
- Highly object-oriented code
  - Enhances several design objectives
- Database driven
  - One of our favorite parts!

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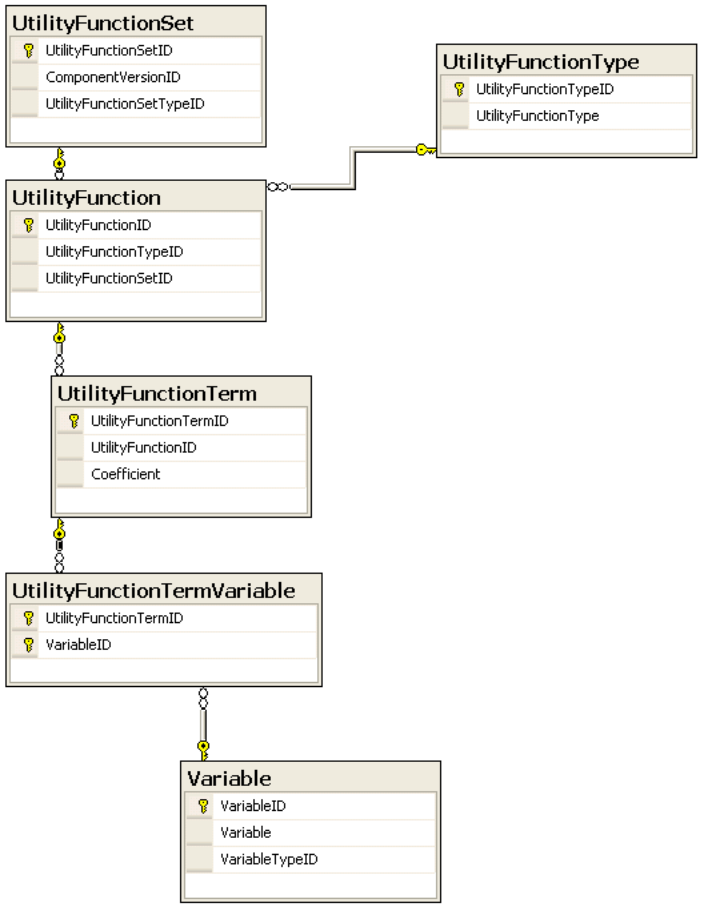
Utility function structure: database



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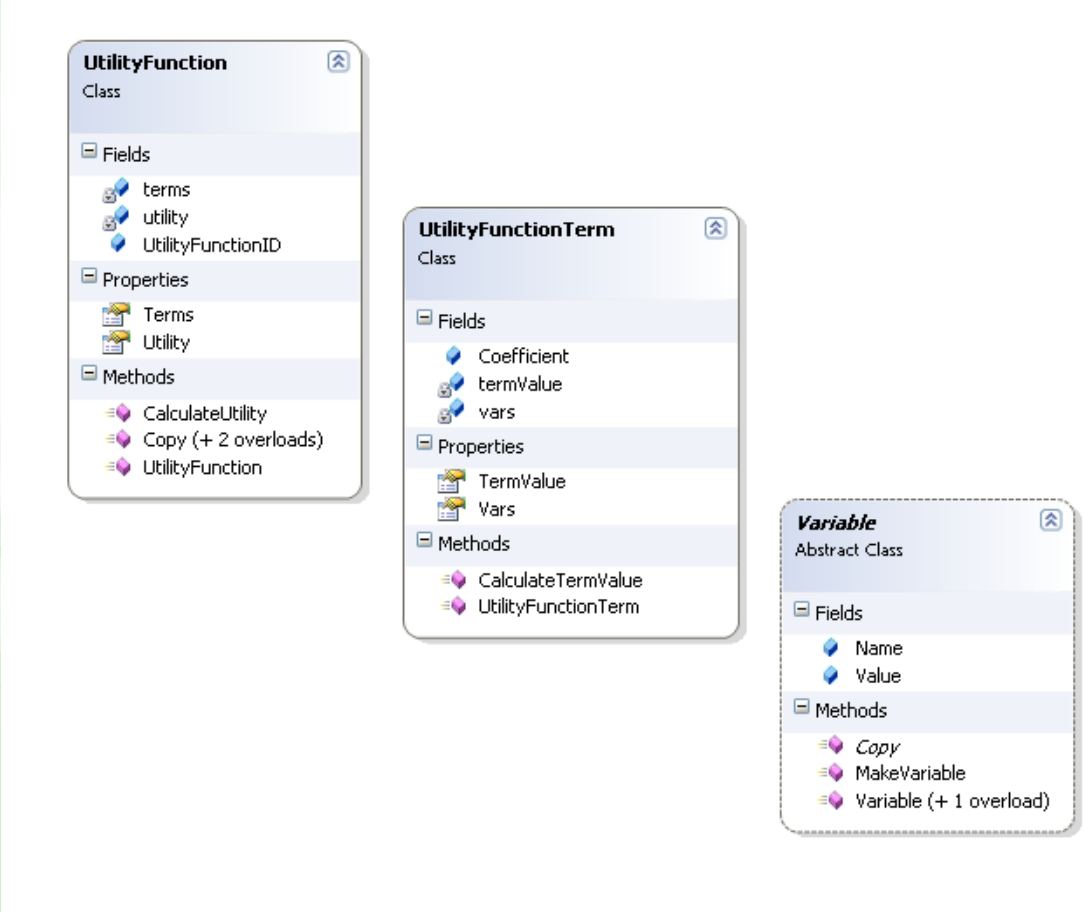
Utility function structure: C# classes



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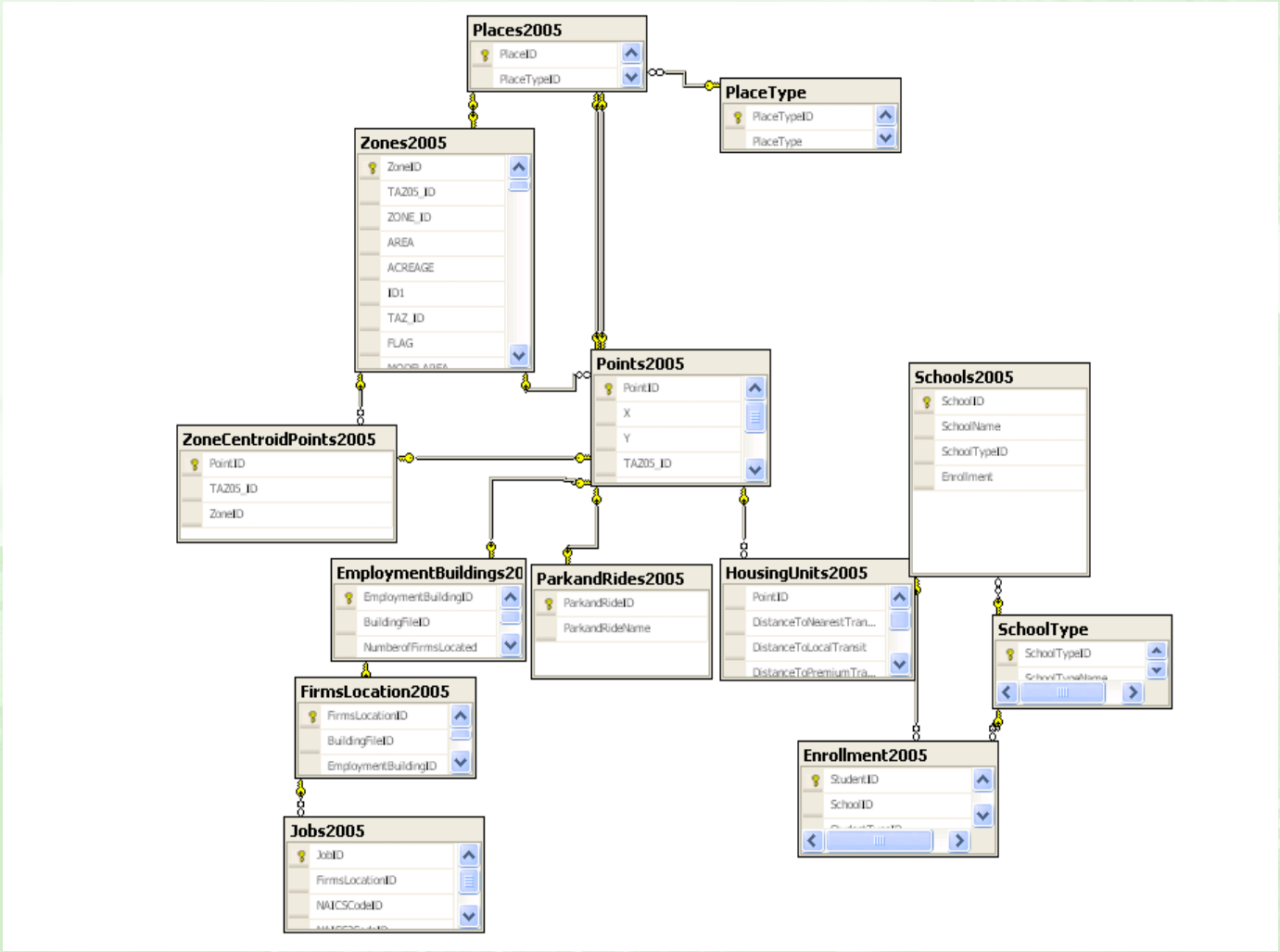
Points and zones: database



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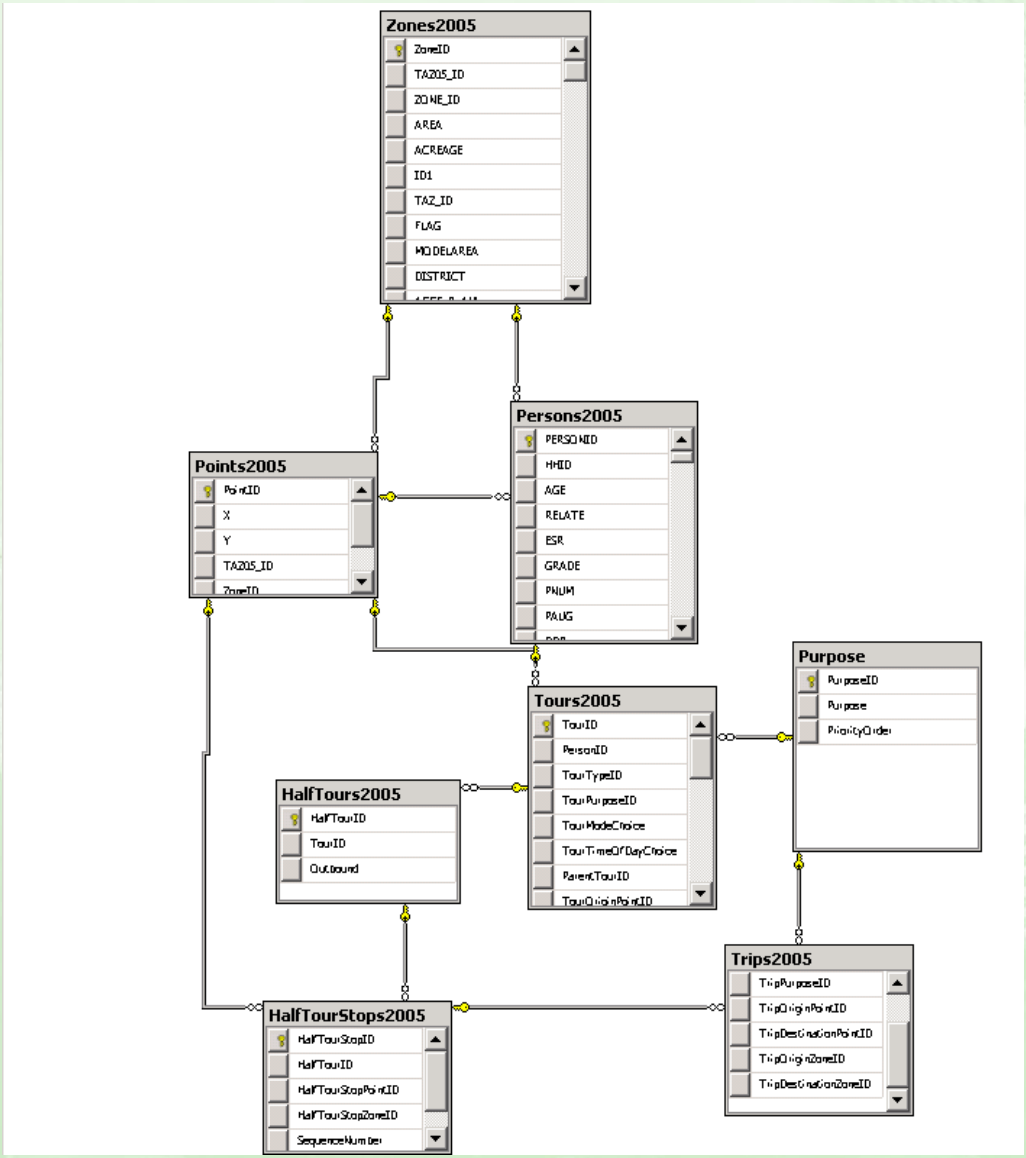
Output data: database



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Running it

- Tests on 1, 2, 4 and 8 processors
  - Doubling cores cuts run time in half
- Run time – 48 hrs
  - One db server, one code, 4 cores each
- Design effects on run time:
  - 10 highway time periods, 4 transit.
  - 2,800 zones, no location choice set selection (yet.)
  - “big” OO language (C#)
- Exploring hardware options
  - Outsourcing
  - In-house computing

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Explainable and Understandable

```
log.InfoFormat("Starting person loop @ {0} with {1} rows", DateTime.Now, inputPersons.Rows.Count);
foreach(DataRow person in inputPersons.Rows)
{
    int id = Convert.ToInt32(person[colInputPersons_PERSONID]);
    int homeZone = Convert.ToInt32(person[colInputPersons_HomeZone]);

    //Put new row of person data into person data dictionary
    this.UtilityFunctionParameters.UpdateDecisionMakerVariables(person);

    //if on new zone, get new zonal data and put into zonal alternatives
    if (homeZone != currentHomeZone)
    {
        UpdateVariablesWithMatrices(homeZone, zonalAlternatives);

        currentHomeZone = homeZone;
    }

    //Get new mode choice logsums and put into zonal alternatives
    modeChoiceLogsum = fullCarLogsum.Solve(modeChoiceLogsum);

    for (int index = 0; index < zonalAlternatives.Length; index++)
    {
        zonalAlternatives[index]["DisaggregateModeChoiceLogsum"].Value = modeChoiceLogsum[index];
    }


    string choosenAlternative = MakeChoice(modelStructure);

    AddPersonToOutputForUpdate(dtOutputPersons, choosenAlternative, person, id, homeZone, noCarLogsum);

    rowsProcessed++;
    if ((rowsProcessed % 10000) == 0)
        log.InfoFormat("Thread {0} Processed {1} rows at {2}", System.Threading.Thread.CurrentThread.Ma

 }
log.InfoFormat("Person loop completed = {0}", DateTime.Now);
```

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Replicability

- By June 1, 2009
  - Developed effective template discrete choice component
  - Developed full-detail database structure
- By November 1, 2009
  - Functional versions of all 27 discrete choice components
  - “Non-hilarious” results for all of them
- After tour mode choice, tour time of day (a tricky one!) took three weeks.

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Scalability (a few examples)

- Nowhere in the code do the number of people and households appear
- Automatic detection of available processors:

```
}


// we'll loop over a selection of these by some column
protected DatabaseReference mainInputReference;

protected int minInputID;
protected int maxInputID;


public override Status Run()
{
    Status = Status.OK;
    ReadData();
    if (!nProcessorsToUse.HasValue) nProcessorsToUse = Environment.ProcessorCount;
    int nProcessors = nProcessorsToUse.Value;
    int rows = maxInputID - minInputID + 1;
    int chunkSize = (int)Math.Ceiling(((decimal)rows) / (decimal)(nProcessors * NUMBER_OF_CHUNKS_PER_PRO
    for (int step = 1; step <= NumberOfSteps; step++)
```

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Transferrable

- No non-transportation applications yet, but:
- Software calls a diverse set of components:
  - Two simply run TransCAD
  - One processes *PopSyn* outputs
  - Two random distribution simulators
  - One calculates disaggregate logsums
  - One calculates size sum variables
  - 15 execute logit choice

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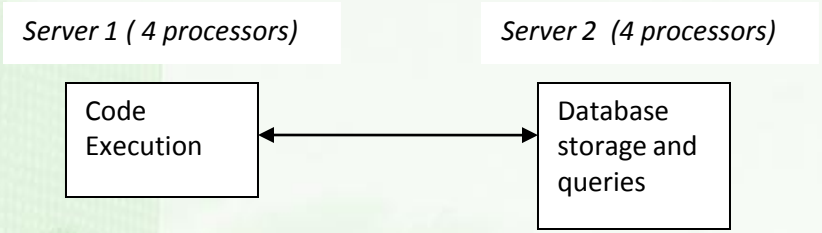
Distributable

- Currently running on two servers:



- Various tests on various hardware

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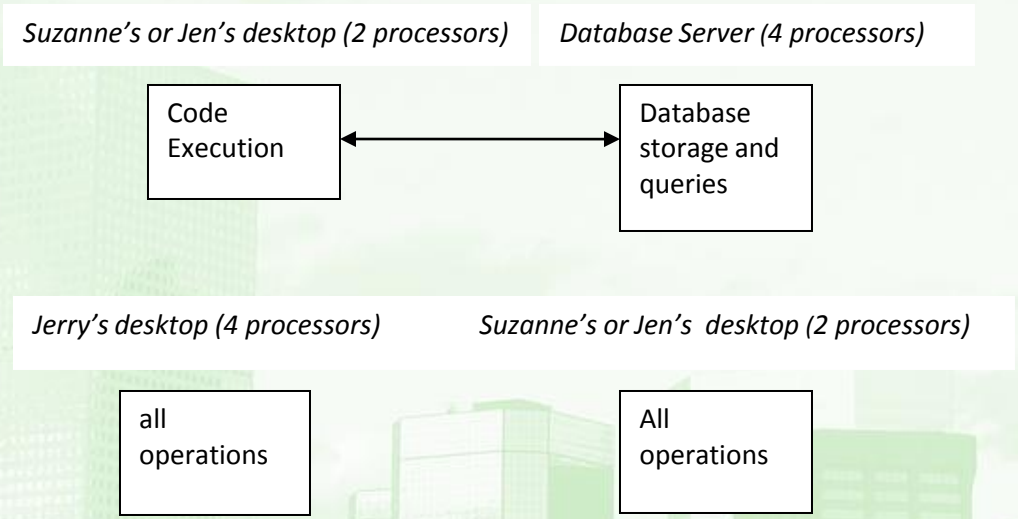
Distributable



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Upgradable

- "Round robin" threading execution upgrade
  - Upgrade Class ModelComponentWithThreads
  - Change how the threads are queued

- Pass-by-reference copy method for decision-agent-specific variables:
  - Upgrade Copy method in Class DecisionMakerSpecificVariable
  - Big run time improvement

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Integratable

- Point: to enable seamless integration with other systems at DRCOG

- No examples yet, but plans include:
  - Search model input and out through DRCOG website
  - Integrate with DRCOG regional data model

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Tunable

- Number of threads
- "Chunks" per thread

```
public override Status Run()
{
    Status = Status.OK;
    ReadData();
    if (!nProcessorsToUse.HasValue) nProcessorsToUse = Environment.ProcessorCount;
    int nProcessors = nProcessorsToUse.Value;
    int rows = maxInputID - minInputID + 1;
    int chunkSize = (int)Math.Ceiling(((decimal)rows) / (decimal)(nProcessors * NUMBER_OF_CHUNKS_PER_PRO
    for (int step = 1; step <= NumberOfSteps; step++)
```

- Virtual server cores
- Cloud computing?

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Lessons and Conclusions

Caveman version:

- Relational database goooood!
- OO language gooood!
- Erik still not clear on final runtimes!
- DRCOG tribe learn model reeeeel good!
- Learning process hurt head sometimes!
- We learn to fight by standing in middle of battle!

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Possible Enhancement

- Automate point-based land use.
- Upgrade of the scenario management system
- Location choice set generation and shadow pricing.
- Integration with DTA
- Enhanced toll modeling
- Upgrades with new survey data
- Model rollout and distribution enhancements.

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