Predictive Analysis for Migration Schedulers

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Overview:

Load Balancing
Fault Tolerance
Scheduling

Types of Solutions
Live Migration
Predictive Analysis
Load Balancing Example

Process Distribution ...

Front End

Load Balancer

Host1
VM1 VM4 VM7

Host2
VM2 VM5

Host3
VM3 VM6
Load Balancing

● Priority Based Upon Urgency

● Even Distribution within categories:
  ○ Urgent – Mission Critical – Real Time Processing
  ○ High Priority – High Importance – near Real Time Processing
  ○ Neutral – Medium Importance – Normal Processing
  ○ Low Priority – Low Importance - Not Time Critical Processing
  ○ No Importance – Unimportant – Unimportant Processes
Fault Tolerance

- Failure Types:
  - Network Element Failures
  - Hardware / Resource Failures
  - OS / BIOS / Kernel Failures
  - Process Failures
Fault Tolerance Redundancy Example

High Availability ...

- Front End
- Host 1 (Active)
- Host 2 (Passive)
- Storage 1
- Storage 2

Data Redundancy
Scheduler Dispatching Concepts

Process Queuing ...

Front End  Back End

VM8  VM9  ...

Host1
VM1  VM4  VM7

Host2
VM2  VM5

Host3
VM3  VM6
Scheduling

- Ability to launch processes based upon needed resources
  - Monitor the amount of resources each process utilizes
- Types of Launching Scenarios:
  - Initial Launch
  - Migration for Maintenance
  - Re-balancing - Migration to Another Host
  - Fault Recovery – Migrating after system/process failure.
Policy Units - Attributes of Scheduling

- Filters
- Weights/Scoring
- Balancers:
  - Even Distribution
  - Power Saving
  - Prioritizing
  - Affinity
  - Pinning for optimal performance
Types of Solutions:

- Live Migration
  - Load Balancing
  - Fault Recovery
  - Minimizing Live Migration Pausing
- Redundancy
  - Distribution of processes running simultaneously
  - Fault Recovery
Live Migration:

- Network Connectivity.
- Remote Disk(s) Availability
- Migrating Local Disk(s)
- Copy Memory State in phases
  - All of the current memory contents
  - Current Differences before VM Pausing
  - Minimal Differences during VM Pausing
- Copy CPU State
- The goal is to limit pausing of the VM
- Restarting the VM on the Destination Host
- Cleanup on Source
Live Migration Transitioning

Sequence of Events ...

- **Runs at Source**
  - Setup or Synchronize Disk
  - Start Memory Transfer

- **Paused**
  - Estimate Downtime
  - Continue Memory Transfer and deltas

- **Runs at Destination**
  - Activate Network
  - Complete Memory Transfer and Cleanup.
Live Migration From Host 1 to 2 Transitioning
Predictive Analysis

- Predicting future occurrences via analysis of past performance
- Techniques for Predictive Analysis
- Process for Developing a Prediction Model
- Types of Predictive Models with Examples
- Applying to Scheduling
Predictive Analytics Methodology

Modeling ...

- Historical Data
  - Training Set
  - Testing Set
- Algorithm
- Model
- Results
### Techniques for Predictive Analysis

- Regression techniques
  - Classification and regression trees (CART)
- Linear regression model
  - Multivariate adaptive regression splines
- Discrete choice models
  - Multivariate adaptive regression splines
- Logistic regression
  - Machine learning techniques
- Multinomial logistic regression
  - Neural networks
- Probit regression
  - Multilayer perceptron (MLP)
- Logit versus probit
  - Radial basis functions
- Time series models
  - Support vector machines
- Survival or duration analysis
  - Naïve Bayes
- k-nearest neighbours
  - Geospatial predictive modeling
Process for Developing a Prediction Model

Cyclical ...

1. Project Definition
2. Data Collection
3. Data Analysis
4. Statistics: Validation
5. Modeling
6. Deployment
7. Model Monitoring
Types of Predictive Models with Examples

- **Support Vector Machine – Model**
  - Classification – To predict a category
  - Example: Stock prices increase or decrease – Yes or No, True or False answer.

- **Predict Quantity – Regression**
  - Example: Predicting a person's age based upon height, weight, health and other factors

- **Detect an anomaly – Normal behavior or exception (anomaly)**
  - Example: Money withdrawal anomalies

- **Clustering: Discover structure in unexplored data**
  - Example: Finding groups of customers with similar behavior given large db of customers containing their demographics and past buying records.
Applying Predictive Analytics to Scheduling

● Criteria for Data
  ○ Processing Time / Iterations - Adjusted for Resource Capacity and Priority
  ○ % of Resources used – Adjusted for Capacity and Priority
  ○ Adjust for anomalies when Calculating Averages

● Ideas - Selective Techniques applied for other scheduling applications:
  ○ Combining regression-like modeling and functional approximation, using the sum of exponential functions, to produce probability estimates.
Predictive Analysis Architecture

Concept Overview ...

- **Predictor**
- **Historian**

**Scheduler:**
- **Parameters:**
  - CPU
  - Memory
  - Storage
  - Networking

**Scoring**

**Hosts:**
- **Host1**
  - VM1
  - VM4
  - VM7
- **Host2**
  - VM2
  - VM5
- **Host3**
  - VM3
  - VM6
Tracking Historical Data

- The Time Each Process Starts and Terminates
- The Resources Used By Each Process
- The Time Each Process Uses To Migrate
- The Time / Iterations that Memory / Disk Transfer Occurs Per Size
Considerations Based Upon Analysis

- If Early Migration Can Proceed
- When Early Migration Shall Start
- Error Correction / Anomaly Detection for Accurate Results
Anomaly / Error Calculation Methods to Consider

- Statistical - Calculate % of Error From the Mean and Eliminate Results Outside of the Threshold
- Signal Processing Techniques - Smoothing Filter to Eliminate Glitches
- Machine Learning - Analysis of Patterns and Categorize Between Normal And Out Of Range Results.
Thank You

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