Tiresias: The Database Oracle for How-To Queries

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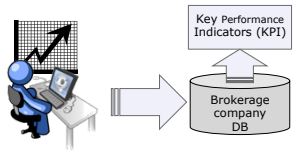
Hypothetical (What-If) Queries



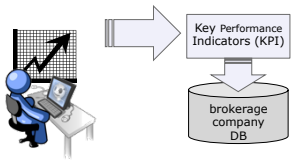
Example from [Balmin et al. VLDB 2000]
"An analyst of a brokerage company wants to know what would be the effect on the return of customers' portfolios if during the last 3 years they had suggested Intel stocks instead of Motorola"

change something in the source (hypothesis) → forward → observe the effect in the target

Forward Data Management

Reverse Data Management

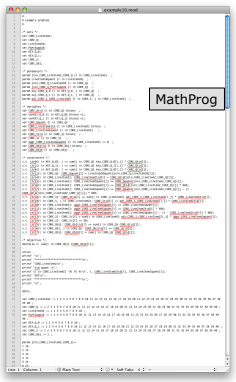
How-To Queries

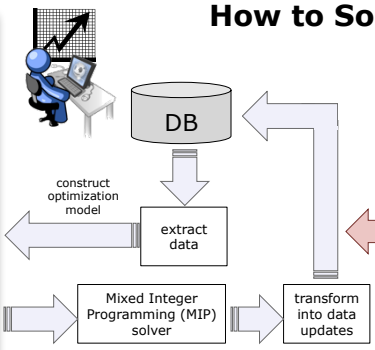


Modified example:
"An analyst wants to figure out how to achieve a 10% return in customer portfolios, with the least number of trades"

change something in the source (hypothesis) ← reverse ← observe the effect in the target

How to Solve a How-To Query



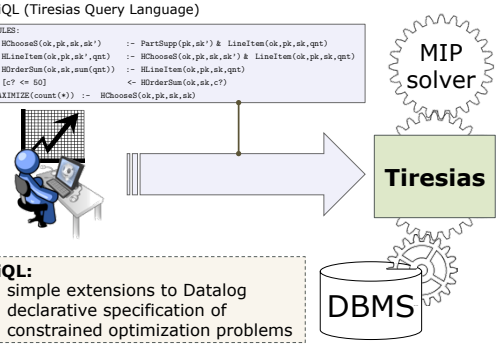


The hard way

The easy way

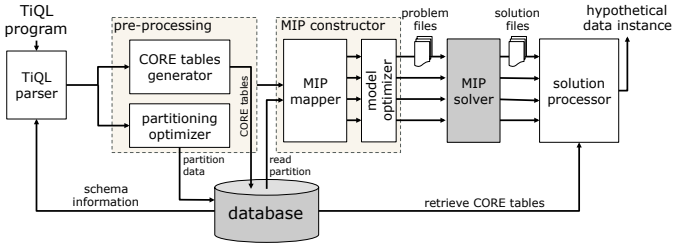
TiQL (Tiresias Query Language)

```
RULES:
  HChooseS(ok,pk,sk,sk')     :- PartSupp(pk,sk') & LineItem(ok,pk,sk,qnt)
  HLineItem(ok,pk,sk',qnt)   :- HChooseS(ok,pk,sk,sk') & LineItem(ok,pk,sk,qnt)
  HOrderSum(ok,sk,sum(qnt))  :- HLineItem(ok,pk,sk,qnt)
  [c? <= 50]                 <- HOrderSum(ok,sk,c?)
MAXIMIZE(count(*)) :-  HChooseS(ok,pk,sk,sk)
```



TiQL:
- simple extensions to Datalog
- declarative specification of constrained optimization problems

Tiresias Architecture



TiQL Semantics

Deduction Rule	HP($\bar{x}$) :- body	Similar to repair semantics
Reduction Rule	HP($\bar{x}$) :< body	Subset of relation
Constraint Rule	[arithm-pred] <- body	Expresses KPIs

Example:

```
HChooseS(ok,pk,sk,sk')      KEY:(ok,pk,sk),(ok,pk,sk')
HChooseS(ok,pk,sk,sk')  :-  PartSupp(pk,sk') & LineItem(ok,pk,sk,qnt)
```

Definition of hypothetical table

Deduction rule

Possible worlds:

LineItem

ok	*pk*	*sk*	*quant*
1	P15	S10	22
2	P32	S43	45

PartSupp

pk	*sk*
P15	S10
P15	S21
P32	S10
P32	S43

HChooseS-1

ok	*pk*	*sk*	*sk'*
1	P15	S10	S10
2	P32	S43	S10

HChooseS-2

ok	*pk*	*sk*	*sk'*
1	P15	S10	S21
2	P32	S43	S43

HChooseS-3

ok	*pk*	*sk*	*sk'*
1	P15	S10	S10
2	P32	S43	S43

HChooseS-4

ok	*pk*	*sk*	*sk'*
1	P15	S10	S21
2	P32	S43	S10

TiQL to MIP Translation

Key Constraints

$$\sum_{i,key(x_i)=k_j} x_i \leq 1$$

Provenance Constraints

$Y = X_1 \vee X_2 \vee \ldots \vee X_n$

$\forall i, y \geq x_i$

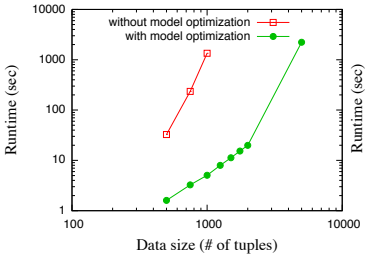
$y \leq \sum_i x_i$

$Y = X_1 \wedge X_2 \wedge \ldots \wedge X_n$

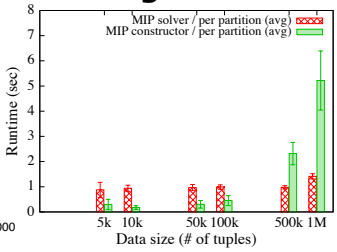
$\forall i, y \leq x_i$

$y \geq \sum_i x_i - (n-1)$

Model Optimizer



Scaling Potential



Partitioning Optimizer Evaluation