

SciDB:
Massively Parallel Array Data Storage,
Processing and Analysis

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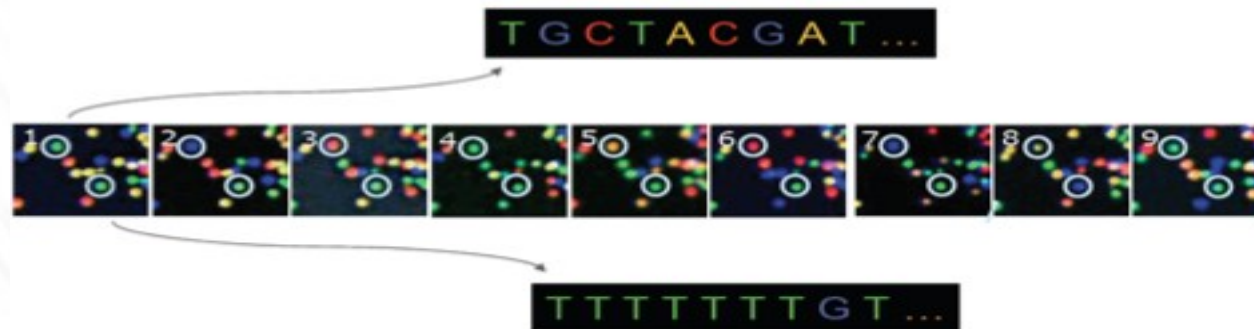
```

@PHUSCA-W21172_91027:1:1:0:1521#0/1
NAGCCCTGCCCCTTCTGAGAGTCCCTTGTTAAGCAA
+PHUSCA-W21172_91027:1:1:0:1521#0/1
DNWWWVWUWWWWVWUWUWUWWWWVUTSTSB
@PHUSCA-W21172_91027:1:1:0:1784#0/1
NACCAGGACTATTTGCACTCTTTGGGGAAGGCTCGA
+PHUSCA-W21172_91027:1:1:0:1784#0/1
DOWYUVVUYUYYYWWWYYYWUTVYRPUWYWWT

```

X 85 Million

X 10 per day



@PHUSCA-W21172_91027 :

1 : 1 : 0 : 1939

#0 / 1

Sequencing Machine Identifier

1. Flow Cell Lane
2. Tile Number
3. X Index on Tile
4. Y Index on Tile

Something complex and biological.

```
@PHUSCA-W21172_91027:1:1:0:1521#0/1
NAGCCCTGCCCCTTCTGAGAGTCCCTTGTTAAGCAA
+PHUSCA-W21172_91027:1:1:0:1521#0/1
DNWWWVUWWWWVUWUWUWWWWVUTSTSB
@PHUSCA-W21172_91027:1:1:0:1784#0/1
NACCAGGACTATTTGCACTCTTTGGGGAAGGCTCGA
+PHUSCA-W21172_91027:1:1:0:1784#0/1
DOWYUVVUYUYYYWWWYYYWUTVYRPWUWYWWT
```

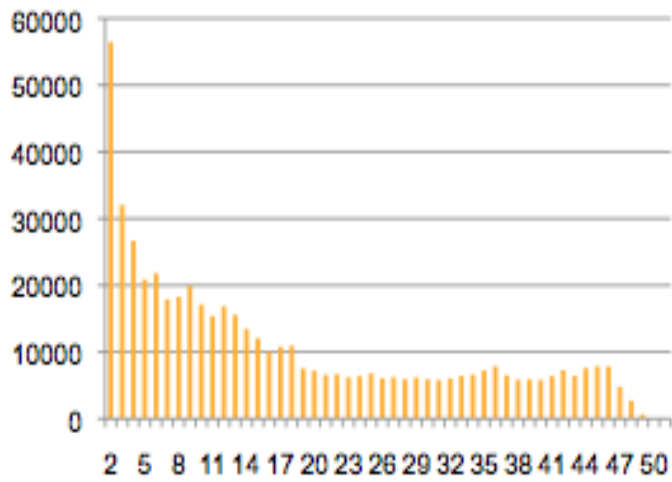
 **'Short Reads' have fixed length, 50 offsets in this case.**

```
...
NAGCCCTGCCCCTTCTGAGAGTCCCTTGTTAAGCAA
NACCAGGACTATTTGCACTCTTTGGGGNAGGCTCGA
NACAATCTGAGTNTGGTGATCCTGGTACCCCAGACC
```

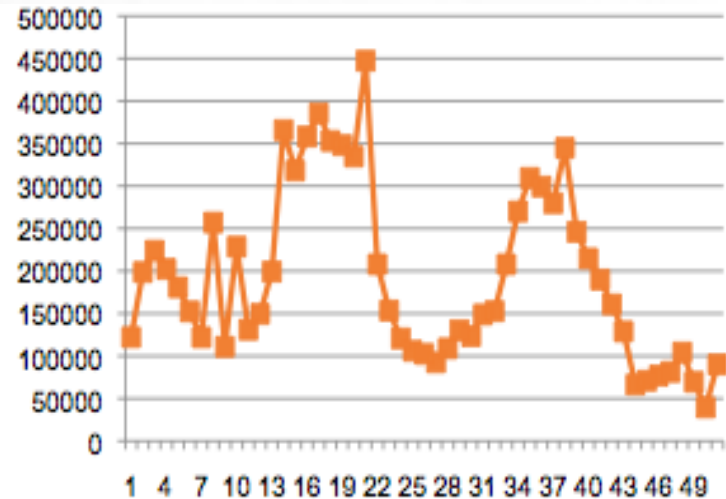
- ... A - Adenine
- G - Guanine
- T - Thymine (Uracil)
- C - Cytosine
- N - "ERROR"

Quality control—how many 'N' values appear, and where—is an important process management question.

Quality Control Metrics



Sequences with a "N"



Position of the "N"

Why another DBMS?

```
CREATE TABLE Short_Reads (  
  Machine_ID          CHAR(25) NOT NULL,  
  Flow_Cell_Lane     INTEGER  NOT NULL,  
  Tile_Number        INTEGER  NOT NULL,  
  X                  INTEGER  NOT NULL,  
  Y                  INTEGER  NOT NULL,  
  Offset             INTEGER  NOT NULL,  
  Base_Pair          CHAR(1)  NOT NULL,  
  Supp               FLOAT  
  PRIMARY KEY ( Machine_ID,  
                Flow_Cell_Lane_Number,  
                Tile_Number, X, Y, Offset )  
);
```

- Explicit storage of key information multiplies data storage requirements.
- Order of key (or index) specification biases performance.
- Many problems where 'previous' and 'next' have semantic heft.

Introducing SciDB

```
CREATE ARRAY Reads
  ( Read::CHAR(1), Supp::FLOAT )
  [ Seq_ID:0,*, Offset:0,50 ];
```

G ^{0.5}	C ^{0.3}	A ^{0.1}	A ^{0.9}	C ^{0.2}	A ^{0.9}	T ^{0.1}	.	.	.	.	T ^{0.2}	T ^{0.1}	A ^{0.6}	A ^{0.5}
C ^{0.2}	T ^{0.9}	T ^{0.7}	A ^{0.8}	C ^{0.5}	N [?]	G ^{0.5}	.	.	.	.	C ^{0.8}	C ^{0.3}	A ^{0.5}	T ^{0.2}
.
T ^{0.3}	A ^{0.6}	C ^{0.4}	N [?]	G ^{0.8}	C ^{0.5}	C ^{0.7}	.	.	.	.	G ^{0.3}	C ^{0.9}	A ^{0.7}	A ^{0.9}

```
( AGGREGATE (
  COUNT(), R.Offset,
  FILTER ( R.Read = 'N', READS AS R )
));
```

Architecture Overview 1

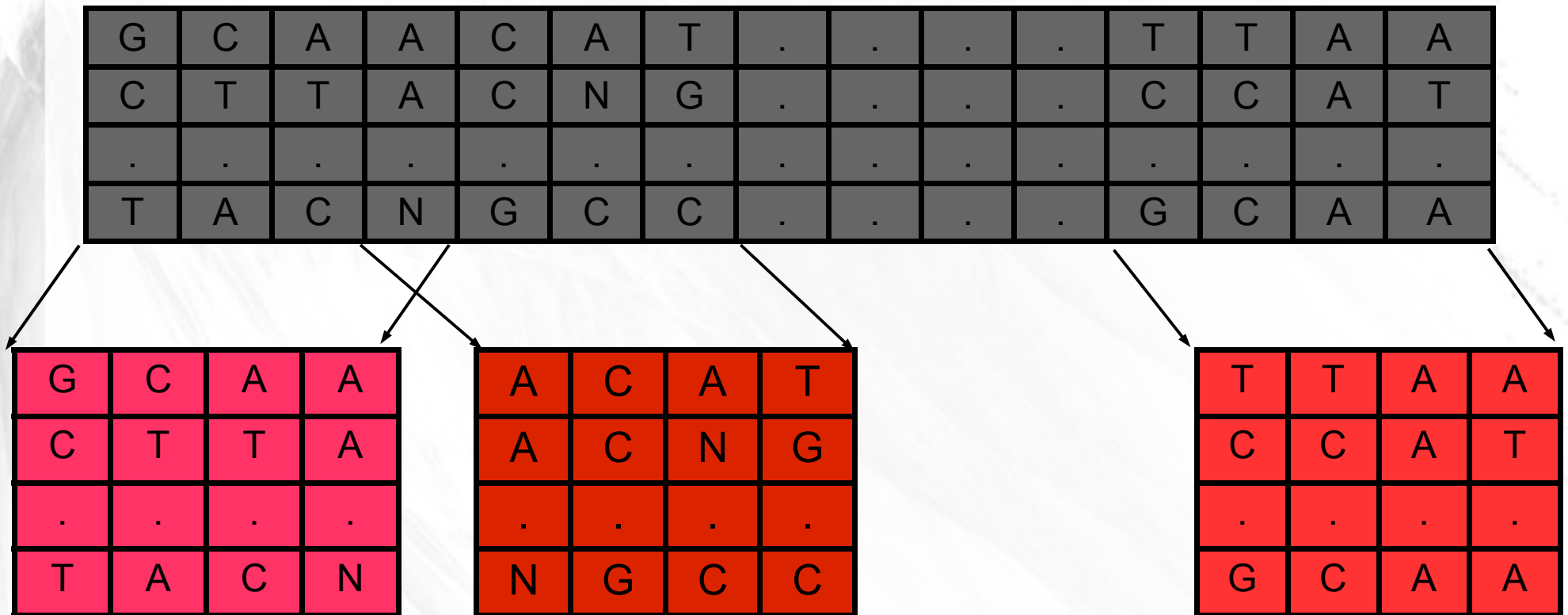
G ^{0.5}	C ^{0.3}	A ^{0.1}	A ^{0.9}	C ^{0.2}	A ^{0.9}	T ^{0.1}	.	.	.	.	T ^{0.2}	T ^{0.1}	A ^{0.6}	A ^{0.5}
C ^{0.2}	T ^{0.9}	T ^{0.7}	A ^{0.8}	C ^{0.5}	N [?]	G ^{0.5}	.	.	.	.	C ^{0.8}	C ^{0.3}	A ^{0.5}	T ^{0.2}
.
T ^{0.3}	A ^{0.6}	C ^{0.4}	N [?]	G ^{0.8}	C ^{0.5}	C ^{0.7}	.	.	.	.	G ^{0.3}	C ^{0.9}	A ^{0.7}	A ^{0.9}

1. Vertical Partitioning into multiple single-attribute arrays.

G	C	A	A	C	A	T	.	.	.	.	T	T	A	A
C	T	T	A	C	N	G	.	.	.	.	C	C	A	T
.
T	A	C	N	G	C	C	.	.	.	.	G	C	A	A

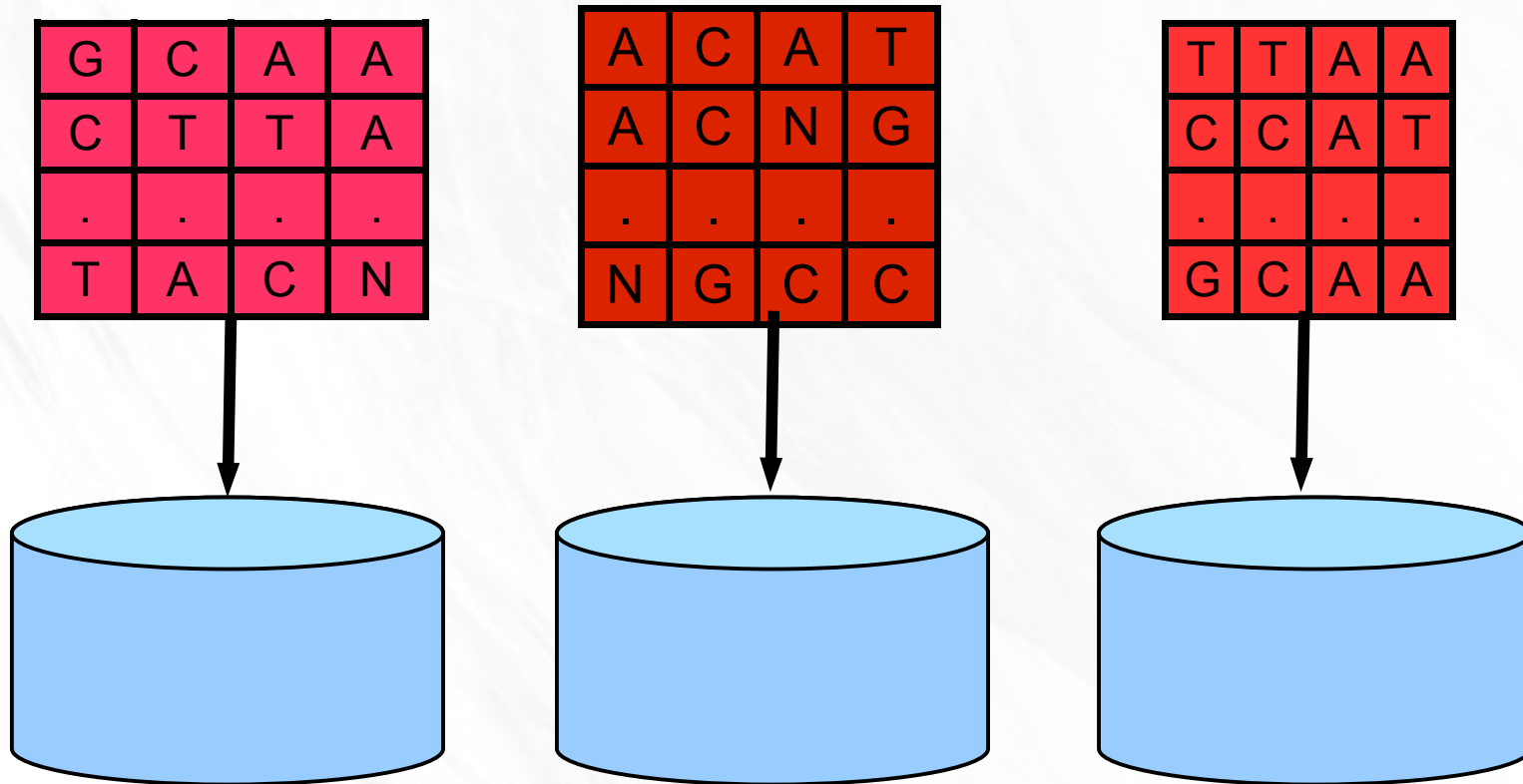
0.5	0.3	0.1	0.9	.	.	.	0.6	0.5
0.2	0.9	0.7	0.8	.	.	.	0.5	0.2
.
0.3	0.6	0.4	?	.	.	.	0.7	0.9

Architecture Overview 2



2. Divide the single-value array into overlapping partitions, or *chunks*.

Architecture Overview 3.



3. Assign *chunks* to physical nodes in a massively parallel architecture.

Architecture 4: Query Processing

- **Query expressions parsed into physical plans.**
 - Minimal heuristics for coarse plan.
 - Run time re-organization of plan based on progress.
- **Parallelizable segments of plans distributed.**
 - Governing query manager coordinates segments.
- **Local segment execution.**
 - 'Chunk at a time' processing.
 - Extensible type system and Array-Value Operators.

Project Status

- **Pick-up team of developers.**
 - Science project developers.
 - Experienced DBMS server types.
 - SciDB is an Open-Source (GPL-3) project.
- **Crash-or-Crash-Through development.**
 - Demonstration system at VLDB-09.
 - Currently developing V1, due Q2 2010.
- **Help!?**
 - Fun research questions to answer.
 - Lots of work to do.
 - <http://www.scidb.org/>