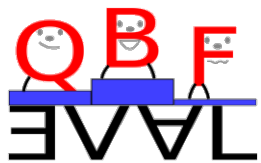
The 10th QBF Solvers Evaluation (QBFEVAL'17)

Luca Pulina[1] **and Martina Seidl**[2]

[1]University of Sassari (Italy)
[1]Johannes Kepler University, Linz (Austria)

Pragmatics of Constraint Reasoning 2017
Melbourne, August 28, 2017



What is a quantified Boolean Formula?

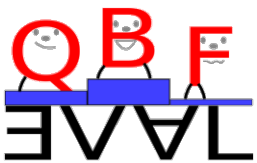
Consider a Boolean formula in **conjunctive normal form** (CNF), e.g.,

$$\underbrace{(x_1 \vee x_2)}_{\textit{clause}} \wedge (\overbrace{\neg x_1}^{\textit{literal}} \vee \overbrace{x_2}^{\textit{literal}})$$

Adding **existential** "$\exists$" and **universal** "$\forall$" quantifiers, e.g.,

$$\underbrace{\forall x_1 \exists x_2}_{\textit{prefix}} \underbrace{(x_1 \vee x_2) \wedge (\neg x_1 \vee x_2)}_{\textit{matrix}}$$

yields a **quantified Boolean formula** (QBF).



What is the meaning of a QBF?

The QBF

$$\forall x_1 \exists x_2 (x_1 \vee x_2) \wedge (\neg x_1 \vee x_2)$$

is true if and only if

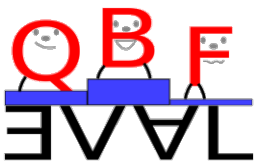
> *for* ***every value of*** x_1 *there* ***exist a value of*** x_2 *such that* $(x_1 \vee x_2) \wedge (\neg x_1 \vee x_2)$ *is propositionally satisfiable.*

Given any QBF ψ:

- if $\psi = \forall x \varphi$ then ψ is true iff $\varphi_{|x=0} \wedge \varphi_{|x=1}$ is true
- if $\psi = \exists x \varphi$ then ψ is true iff $\varphi_{|x=0} \vee \varphi_{|x=1}$ is true

Problem QSAT

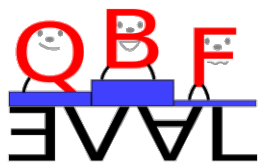
Decide whether a given QBF is true or false.



Why QBFs?

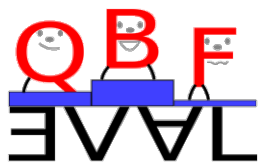
- QSAT is **PSPACE-complete**, i.e., the (supposedly) hardest class of problems for which we could not prove EXPTIME-hardness.

- Several reasoning tasks admit a **compact** QBF encoding, e.g.
  - **Conformant planning**: does there **exist** a sequence of actions such that **for all** initial conditions we can reach the goal?
  - **"Black box" circuit verification**: does there **exist** a set of inputs to a circuit such that **for all** possible realizations of some of its modules, the output is not correct?
  - **Adversarial games**: does there **exist** a sequence of moves such that **for all** possible counter-moves of my adversary I am guaranteed to win?

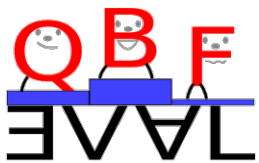


QBFEVAL'17 – Keynotes

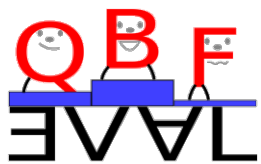
- Judges: Olaf Beyersdorff, Daniel Le Berre, Martin Suda, and Christoph Wintersteiger.
- 7 tracks
  - 1 non-competitive
- 47 systems submitted by 19 teams
- 7928 formulas submitted by 10 teams
  - 3662 formulas in QDIMACS 1.1 format.
  - 1766 formulas in QCIR format.
  - 2500 formulas for DQBF.
- Two stages



Outline

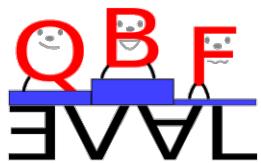


Outline



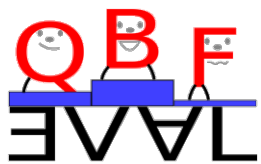
Tracks

1. Prenex CNF (PCNF)
   - 30 solvers
2. Prenex non-CNF (PNCNF)
   - 8 solvers
3. 2QBF
   - 29 solvers
4. Parallel QBF Solvers
   - 1 solver
5. Random QBFs (RQBF)
   - 30 solvers
6. Prenex CNF Preprocessors challenge
   - 2 systems
7. DQBF Solvers
   - 3 solvers



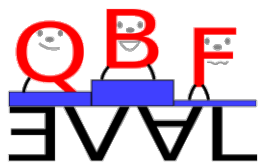
Tracks

1. Prenex CNF (PCNF)
   - 30 solvers
2. Prenex non-CNF (PNCNF)
   - 8 solvers
3. 2QBF
   - 29 solvers
4. Parallel QBF Solvers – CANCELED
   - 1 solver
5. Random QBFs (RQBF)
   - 30 solvers
6. Prenex CNF Preprocessors challenge – CANCELED
   - 2 systems
7. DQBF Solvers – CANCELED
   - 3 solvers



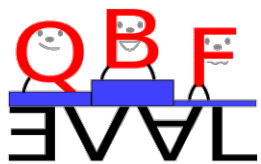
Submitted Solvers (1/2)

Solver	Track	Author(s)
aigsolve	PCNF, RQBF	C. Scholl, F. Pigorsch
aspq2	2QBF	G. Amendola, C. Dodaro, F. Ricca
cqesto, qfun	PNCNF	M. Janota
qesto, rareqs, rev_qfun	PCNF, 2QBF, RQBF	M. Janota
cadet	2QBF	M. N. Rabe
caqe (v1, v2, v3)	PCNF, 2QBF, RQBF	L. Tentrup, M. N. Rabe
cued_1919 (NL, NNL)	PCNF, 2QBF, RQBF	L. Chen, J. R. Jiang
dynqbf-bloqqer-hqspre	PCNF, 2QBF, RQBF	G. Charwat, S. Woltran
dynqbf-bloqqer (-hqspre-it, -variant)	2QBF	G. Charwat, S. Woltran
ghostQ (cegar, plain)	PNCNF	W. Klieber
ghostQ (cegar, PG-cegar, PG-plain)	PCNF, 2QBF, RQBF	W. Klieber
heretiq, ijtihad (v1, v2)	PCNF, 2QBF, RQBF	V. Hadzic



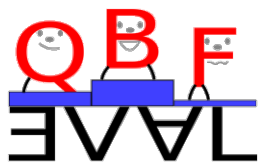
Submitted Solvers (2/2)

Solver	Track	Author(s)
HQSpre_solver	PCNF, RQBF	R. Wimmer, S. Reimer, P. Marin, B. Becker
iProver-QBF, iProver-QBF-bloqqer	PCNF, 2QBF, RQBF	K. Korovin
no-prefix_opt_depqbf	2QBF	F. Lonsing and U. Egly
prefix_opt_depqbf	PCNF, RQBF	F. Lonsing and U. Egly
qbfrelay, qbfrelay_limited_depqbf	PCNF, 2QBF, RQBF	F. Lonsing and U. Egly
qell (default, unit)	PCNF, 2QBF, RQBF	K. Tu, T. Hsu, J. R. Jiang
quabs	PNCNF	L. Tentrup
qute (default, opt500, random)	PCNF, RQBF	T. Peitl, F. Slivovsky, S. Szeider
qute (hybrid, opt617, opt993)	PNCNF	T. Peitl, F. Slivovsky, S. Szeider
xb-qsts (bqsts2.0, xbqsts1.0, xbqsts2.0)	PCNF, 2QBF, RQBF	S. Tasharrofi, T. Janhunen



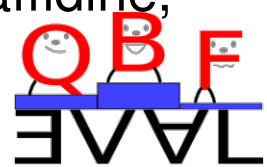
Submitted Formulas (1/2)

- 2QBF Encoding of Boolean Functional Synthesis
  - 42 instances submitted by S. Akshay, S. Chakraborty, A. K. John, S. Shah and M. N. Rabe, UC Berkeley. (PCNF, 2QBF)
- Patch Generation for Engineering Change Order of Integrated Circuits
  - 5 instances submitted by L. Chen and J. R. Jiang, National Taiwan University. (PCNF)
- Mapping user-specified functions to configurable combinational logic in FPGAs
  - 12 instances submitted by T. Preusser, University of Texas. (PCNF)
- Safety Synthesis using QBF
  - 1354 instances submitted by L. Tentrup, Saarland University. (PCNF, PNCF, 2QBF)



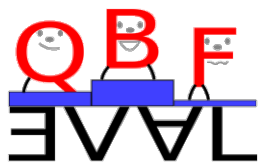
Submitted Formulas (2/2)

- Sketch Performance Benchmarks
  - 14 instances submitted by M. N. Rabe, UC Berkeley. (PCNF, 2QBF)
- Bounded Synthesis for Petri Games
  - 360 instances submitted by J. Hecking-Harbusch, Saarland University. (PNCNF)
- Combinational equivalence
  - 50 instances submitted by W. Klieber, Carnegie Mellon University. (PNCNF, RQBF)
- Hard 2QBFs
  - 1873 instances submitted by G. Amendola and F. Ricca, University of Calabria, and M. Truszczynski, Kentucky University. (2QBF, RQBF)
- QBF Benchmark for Positional Games
  - 312 instances submitted by V. Mayer-Eichberger and A. Saffidine, University of New South Wales, Sydney. (RQBF)



The Dataset

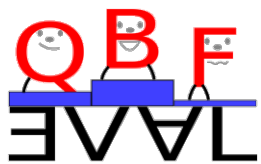
- **Dataset 1**: Prenex CNF Track.
- **Dataset 2**: Prenex non-CNF Track.
- **Dataset 3**: 2QBF Track.
- **Dataset 4**: Random QBFs Track.



Dataset 1 (1/2)

Prenex CNF Fixed Structure Formulas (FSF) in QDIMACS 1.1 format.

- Selection from QBFLIB considering
  - Results of past QBFEVALs (**Empirical hardness coefficient**)
  - Features of the instances (e.g. clauses, variables, ...)
- Submitted formulas
  - No more than 10% of the total test set comes from a submitter also authoring a competing solver



Dataset 1 (1/2)

Prenex CNF Fixed Structure Formulas (FSF) in QDIMACS 1.1 format.

- Selection from QBFLIB considering
  - Results of past QBFEVALs (**Empirical hardness coefficient**)
  - Features of the instances (e.g. clauses, variables, ...)
- Submitted formulas
  - No more than 10% of the total test set comes from a submitter also authoring a competing solver

Empirical hardness coefficient (*HC*)

For each instance i

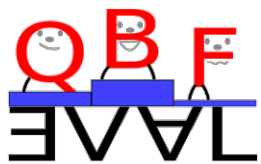
$$HC_i = \frac{S_i}{S_t}$$

- S_i: number of solvers that solved i
- S_t: total number of solvers participating to a given event

Dataset 1 (2/2)

The dataset is composed of:

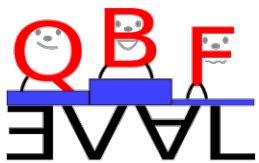
- FSFs of QBFEVAL'16 having HC in the range [0, 0.5) (**227**).



Dataset 1 (2/2)

The dataset is composed of:

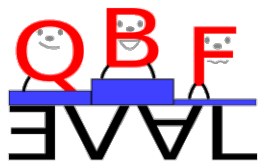
- FSFs of QBFEVAL'16 having HC in the range [0, 0.5) (**227**).
- Hard instances ($HC_i = 0$) from Tracks 1 and 3 of QBFEVAL'10 (**21**).
- A selection of hard instances of QBFEVAL'08 (**52** out of 520).



Dataset 1 (2/2)

The dataset is composed of:

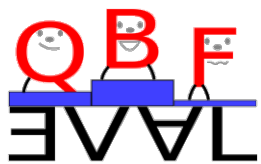
- FSFs of QBFEVAL'16 having HC in the range [0, 0.5) (**227**).
- Hard instances ($HC_i = 0$) from Tracks 1 and 3 of QBFEVAL'10 (**21**).
- A selection of hard instances of QBFEVAL'08 (**52** out of 520).
- A selection of **152** FSFs from QBFLIB (never involved in previous QBFEVALs).



Dataset 1 (2/2)

The dataset is composed of:

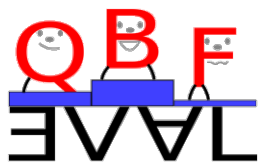
- FSFs of QBFEVAL'16 having HC in the range [0, 0.5) (**227**).
- Hard instances ($HC_i = 0$) from Tracks 1 and 3 of QBFEVAL'10 (**21**).
- A selection of hard instances of QBFEVAL'08 (**52** out of 520).
- A selection of **152** FSFs from QBFLIB (never involved in previous QBFEVALs).
- **1** additional formula from submitters suggestions
  - we received only two "suggestions"; the remaining 9 formulas were already involved in the selection



Dataset 1 (2/2)

The dataset is composed of:

- FSFs of QBFEVAL'16 having HC in the range [0, 0.5) (**227**).
- Hard instances ($HC_i = 0$) from Tracks 1 and 3 of QBFEVAL'10 (**21**).
- A selection of hard instances of QBFEVAL'08 (**52** out of 520).
- A selection of **152** FSFs from QBFLIB (never involved in previous QBFEVALs).
- **1** additional formula from submitters suggestions
  - we received only two "suggestions"; the remaining 9 formulas were already involved in the selection
- A selection of **70** new submitted formulas
  - balanced selection considering the constraints in the call

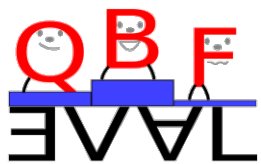


Dataset 1 (2/2)

The dataset is composed of:

- FSFs of QBFEVAL'16 having HC in the range [0, 0.5) (**227**).
- Hard instances ($HC_i = 0$) from Tracks 1 and 3 of QBFEVAL'10 (**21**).
- A selection of hard instances of QBFEVAL'08 (**52** out of 520).
- A selection of **152** FSFs from QBFLIB (never involved in previous QBFEVALs).
- **1** additional formula from submitters suggestions
  - we received only two "suggestions"; the remaining 9 formulas were already involved in the selection
- A selection of **70** new submitted formulas
  - balanced selection considering the constraints in the call

Total: 523 formulas.

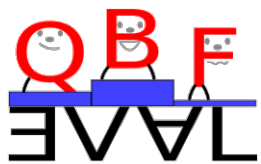


Dataset 1 (2/2)

The dataset is composed of:

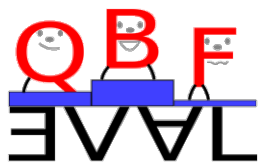
- FSFs of QBFEVAL'16 having HC in the range [0, 0.5) (**227**).
- Hard instances ($HC_i = 0$) from Tracks 1 and 3 of QBFEVAL'10 (**21**).
- A **selection** of hard instances of QBFEVAL'08 (**52** out of 520).
- **A selection of 152 FSFs from QBFLIB (never involved in previous QBFEVALs).**
- **1** additional formula from submitters suggestions
  - we received only two "suggestions"; the remaining 9 formulas were already involved in the selection
- A selection of **70** new submitted formulas
  - balanced selection considering the constraints in the call

Total: 523 formulas.



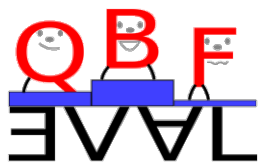
Formulas selection (1/3)

- FSF in QBFLIB (QDIMACS 1.1 format): **15019**



Formulas selection (1/3)

- FSF in QBFLIB (QDIMACS 1.1 format): **15019**
- We discard from the selection:
  - Instances with only 1 quantified set (284 instances)
  - Instances with a total amount of variables less than 50 (211)
  - Easy formulas ($HC_i = 1$) from past QBFEVALs (909).

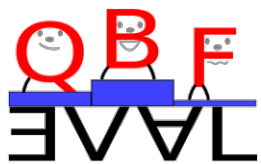


Formulas selection (1/3)

- FSF in QBFLIB (QDIMACS 1.1 format): **15019**
- We discard from the selection:
  - Instances with only 1 quantified set (284 instances)
  - Instances with a total amount of variables less than 50 (211)
  - Easy formulas ($HC_i = 1$) from past QBFEVALs (909).

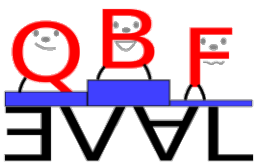
Grouping remaining instances (13615) using syntactic features

- existential variables, universal variables, clauses, and quantified sets



Formulas selection (2/3)

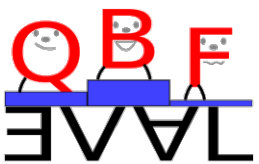
Feature	Min	1st	Med	3rd	Max
Existential Variables	36	1021	4806	18295	2199062
Universal Variables	1	16	66	180	55022
Clauses	65	318	15627	60578	5934890
Quantified Sets	2	3	3	3	1141



Formulas selection (2/3)

Feature	Min	1st	Med	3rd	Max
Existential Variables	36	1021	4806	18295	2199062
Universal Variables	1	16	66	180	55022
Clauses	65	318	15627	60578	5934890
Quantified Sets	2	3	3	3	1141

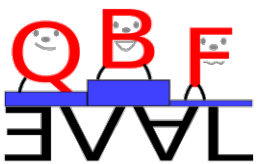
- Group instances with the help of an **unsupervised classification algorithm**
  - Partition Around Medoids (PAM)



Formulas selection (2/3)

Feature	Min	1st	Med	3rd	Max
Existential Variables	36	1021	4806	18295	2199062
Universal Variables	1	16	66	180	55022
Clauses	65	318	15627	60578	5934890
Quantified Sets	2	3	3	3	1141

- Group instances with the help of an **unsupervised classification algorithm**
  - Partition Around Medoids (PAM)
- **How to determine the total amount of clusters?**

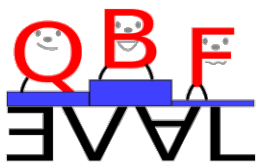


Formulas selection (2/3)

Feature	Min	1st	Med	3rd	Max
Existential Variables	36	1021	4806	18295	2199062
Universal Variables	1	16	66	180	55022
Clauses	65	318	15627	60578	5934890
Quantified Sets	2	3	3	3	1141

- Group instances with the help of an **unsupervised classification algorithm**
  - Partition Around Medoids (PAM)
- **How to determine the total amount of clusters?**
  - Test the number of clusters ranging from 2 to 40.
  - Select the number with the highest *silhouette* value

    we discard results with clusters having more that about 30% of instances.

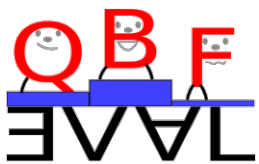


Formulas selection (2/3)

Feature	Min	1st	Med	3rd	Max
Existential Variables	36	1021	4806	18295	2199062
Universal Variables	1	16	66	180	55022
Clauses	65	318	15627	60578	5934890
Quantified Sets	2	3	3	3	1141

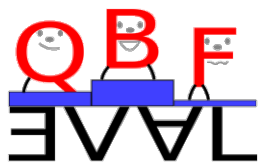
- Group instances with the help of an **unsupervised classification algorithm**
  - Partition Around Medoids (PAM)
- **How to determine the total amount of clusters?**
  - Test the number of clusters ranging from 2 to 40.
  - Select the number with the highest *silhouette* value

    we discard results with clusters having more that about 30% of instances.
  - **Final number of clusters: 32**



Formulas selection (3/3)

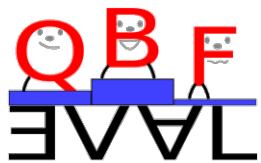
How are the clusters are composed?



Formulas selection (3/3)

How are the clusters are composed?

- Label the feature dataset with the cluster name.
- Use a supervised learning algorithm to classify the instances.
  - RIPPER: a propositional rule learner that generate a symbolic model in the form of rules.
  - 10x stratified cross-validation accuracy: 97.2%.



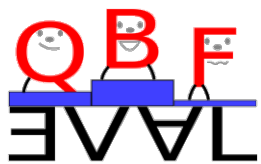
Formulas selection (3/3)

How are the clusters are composed?

- Label the feature dataset with the cluster name.
- Use a supervised learning algorithm to classify the instances.
  - RIPPER: a propositional rule learner that generate a symbolic model in the form of rules.
  - 10x stratified cross-validation accuracy: 97.2%.

Example of the model:

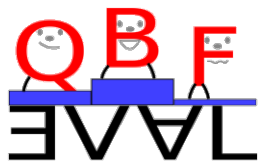
```
(ExistentialVariables >= 1615241) => Cluster=cluster_30 (4.0/0.0)
(UniversalVariables >= 25010) => Cluster=cluster_32 (7.0/0.0)
(Clauses >= 1945422) and (ExistentialVariables <= 471245) => Cluster=cluster_19 (19.0/0.
(Sets >= 775) => Cluster=cluster_29 (19.0/0.0)
(Sets >= 571) => Cluster=cluster_28 (38.0/0.0)
```



Dataset 2

Prenex non-CNF formulas in QCIR (QBFGallery 14) format.

- A selection of **190** QCIR formulas of QBFEVAL'16
  - HC in [0, 0.5)

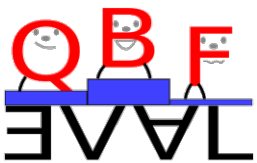


Dataset 2

Prenex non-CNF formulas in QCIR (QBFGallery 14) format.

- A selection of **190** QCIR formulas of QBFEVAL'16
  - HC in [0, 0.5)
- A selection of
  - **20** formulas from the Suite Amendola-Ricca-Truszczynski, submitted in 2016.
  - **42** formulas from Bounded Synthesis for Petri Games.
  - **30** formulas from Combinational Equivalences.
  - **38** formulas from Safety Synthesis.

Total: 320 formulas.



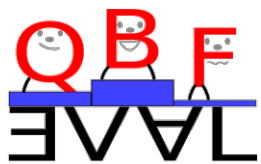
Dataset 3

Prenex CNF ∀∃ formulas in QDIMACS 1.1 format.

- The formulas of the 2QBF track of QBFEVAL'16 having HC in the range [0, 0.5) (**118**).
- The **13** hard instances of the 2QBF track of QBFEVAL'10.
- A selection of **12** 2QBF instances on hard formulas of QBFEVAL'08.
- **166** formulas selected from QBFLIB and never involved in previous QBFEVALs.
- A selection of **75** new submitted formulas.

Total: 384 formulas.

Notice that this dataset does not overlap with the one of the Prenex CNF Track.

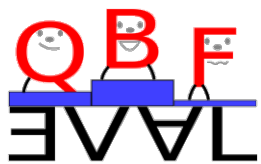


Dataset 4

Prenex CNF formulas with probabilistic components in their generation (QDIMACS 1.1 format).

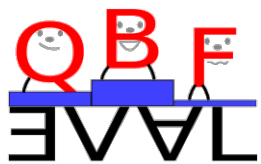
- Formulas of the Random track of QBFEVAL'16 having hardness coefficient in the range [0, 0.5) (**319**).
- A selection of:
  - **30** instances from Combinational Equivalence.
  - **113** instances from QBF Benchmark for Positional Games.
  - **43** instances from Hard 2QBFs.

Total: 505 formulas.



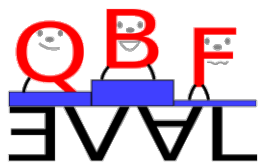
Summing up...

Track	# Systems	# Formulas	
Prenex CNF	30	523	
Prenex non-CNF	8	320	
2QBF	29	384	
Random QBFs	30	505	



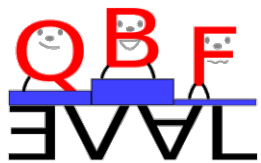
Summing up...

Track	# Systems	# Formulas	# Solv. by bloqqer
Prenex CNF	30	523	78
Prenex non-CNF	8	320	NA
2QBF	29	384	120
Random QBFs	30	505	2

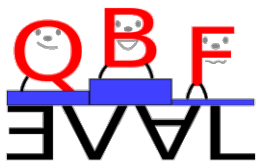


Scores, Resources and Infrastructure

- **Score** Total amount of solved formulas
- **Resources** The CPU time granted to each system for each formula is **900 seconds**, while the memory limit is set to **32GB**.
- **Infrastructure** StarExec cluster



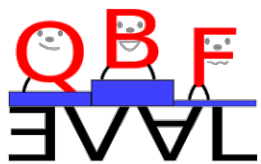
Outline



Winners

SAT Conference – Thursday, 31st August

14:00–15:30	Room 110	SAT7: Competition results (chair: Laurent Simon)
14:00		MaxSAT Evaluation 2017 *Carlos Ansótegui, Fahiem Bacchus, Matti Järvisalo and Ruben Martins*
14:30		Competitive Evaluation of QBF Solvers (QBFEVAL'17) *Luca Pulina and Martina Seidl*
15:00		SAT competition 2017 *Marijn Heule, Matti Jarvisalo and Tomas Balyo*



Prenex CNF Track – Results (1/2)

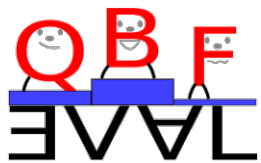
- The winner solved **286** (out of 523) instances
  - 55% of the dataset
- 2 solvers solved at least 50% of the dataset
- 27 (out of 30) solvers solved at least 25% of the dataset

Prenex CNF Track – Results (1/2)

- The winner solved **286** (out of 523) instances
  - 55% of the dataset
- 2 solvers solved at least 50% of the dataset
- 27 (out of 30) solvers solved at least 25% of the dataset

State-of-the-art (SOTA) solver

The ideal solver that always fares the best time among all the participants.



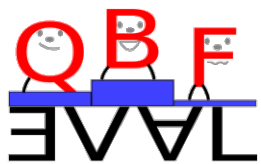
Prenex CNF Track – Results (1/2)

- The winner solved **286** (out of 523) instances
  - 55% of the dataset
- 2 solvers solved at least 50% of the dataset
- 27 (out of 30) solvers solved at least 25% of the dataset

State-of-the-art (SOTA) solver

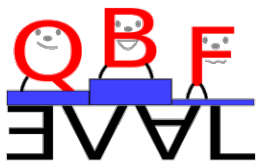
The ideal solver that always fares the best time among all the participants.

- The SOTA solver solved **417** instances (80% of the dataset)
- 26 (out of 30) solvers contributed to the SOTA solver
  - Major contributor: 17%
  - Winner: 6.5%
  - 8 solvers contributed for more than 5%



Prenex CNF Track – Results (2/2)

- 2 (out of 523) easy instances (HC = 1)
- 25 medium hard instances
  - solved by 8 different solvers, not ranked in the first 3 positions.
- **106** hard instances
  - `http://localhost/localqbflib/sota_view.php?year=2017&track=1`

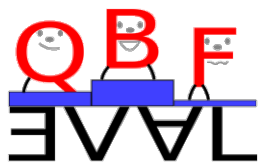


Prenex CNF Track – Results (2/2)

- 2 (out of 523) easy instances (HC = 1)
- 25 medium hard instances
  - solved by 8 different solvers, not ranked in the first 3 positions.
- **106** hard instances
  - `http://localhost/localqbflib/sota_view.php?year=2017&track=1`

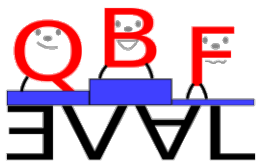
About hard instances...

- 11 (out of 70) new submitted formulas
- 69 (out of 141) hard formulas from past QBFEVALs have been solved
- The instance `ev-pr-6x6-9-5-0-1-2-s` has been solved in QBFEVAL'16 but not in QBFEVAL'17
  - Solved by depqbf-v2 and depqbf-v3



Prenex non-CNF Track – Results (1/2)

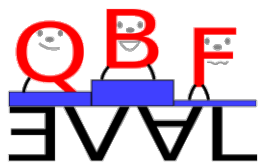
- The winner solved **117** (out of 320) instances
  - 37% of the dataset
- 7 (out of 8) solvers solved at least 25% of the dataset



Prenex non-CNF Track – Results (1/2)

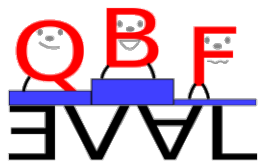
- The winner solved **117** (out of 320) instances
  - 37% of the dataset
- 7 (out of 8) solvers solved at least 25% of the dataset

- The SOTA solver solved 181 instances (57% of the dataset)
- 7 solvers contributed to the SOTA solver
  - 67% of the contribution come from the first three ranked.



Prenex non-CNF Track – Results (2/2)

- 17 (out of 320) easy instances
- 23 medium hard instances
  - solved by 4 different solvers
- **139** hard instances
  - `http://localhost/localqbflib/sota_view.php?year=2017&track=2`

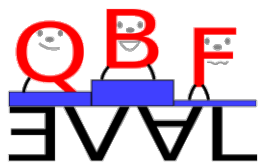


Prenex non-CNF Track – Results (2/2)

- 17 (out of 320) easy instances
- 23 medium hard instances
  - solved by 4 different solvers
- **139** hard instances
  - `http://localhost/localqbflib/sota_view.php?year=2017&track=2`

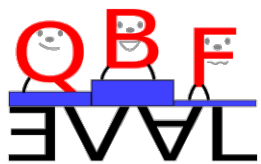
About hard instances...

- 37 (out of 110) new submitted formulas
- 47 hard formulas from QBFEVAL'16 have been solved



2QBF Track – Results (1/2)

- The winner solved **246** (out of 384) instances
  - 64% of the dataset
- 17 solvers solved at least 50% of the dataset
- 24 (out of 29) solvers solved at least 25% of the dataset



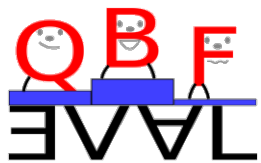
2QBF Track – Results (1/2)

- The winner solved **246** (out of 384) instances
  - 64% of the dataset
- 17 solvers solved at least 50% of the dataset
- 24 (out of 29) solvers solved at least 25% of the dataset

- The SOTA solver solved **343** instances (89% of the dataset)
- 18 solvers contributed to the SOTA solver
  - Major contributor: 38%
  - Winner: 9%
  - 6 solvers contributed for more than 5%

2QBF Track – Results (2/2)

- 9 (out of 384) easy instances
- 18 medium hard instances
  - solved by 6 different solvers
- **41** hard instances
  - `http://localhost/localqbflib/sota_view.php?year=2017&track=3`

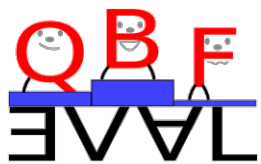


2QBF Track – Results (2/2)

- 9 (out of 384) easy instances
- 18 medium hard instances
  - solved by 6 different solvers
- **41** hard instances
  - `http://localhost/localqbflib/sota_view.php?year=2017&track=3`

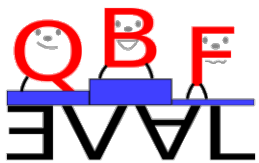
About hard instances...

- 20 (out of 75) new submitted formulas
- 29 (out of 37) hard formulas from past QBFEVALs have been solved
- The instance `sortnetsort9.AE.step1.006` has been solved in QBFEVAL'16 but not in QBFEVAL'17
  - Solved by xb-qsts



Random QBFs Track – Results (1/2)

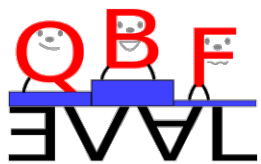
- The winner solved **82** (out of 505) instances
  - 16% of the dataset
- 12 (out of 30) solvers solved at least 10% of the dataset



Random QBFs Track – Results (1/2)

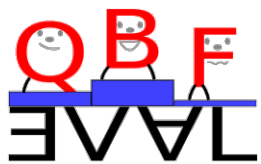
- The winner solved **82** (out of 505) instances
  - 16% of the dataset
- 12 (out of 30) solvers solved at least 10% of the dataset

- The SOTA solver solved **178** instances (35% of the dataset)
- 20 solvers contributed to the SOTA solver
  - Major contributor: 20% (is the winner)
  - 7 solvers contributed for more than 5%



Random QBFs Track – Results (2/2)

- 28 medium hard instances
  - solved by 7 different solvers
- **327** hard instances
  - `http://localhost/localqbflib/sota_view.php?year=2017&track=5`



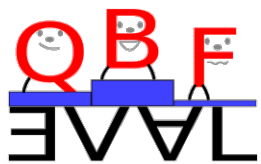
Random QBFs Track – Results (2/2)

- 28 medium hard instances
  - solved by 7 different solvers
- **327** hard instances
  - `http://localhost/localqbflib/sota_view.php?year=2017&track=5`

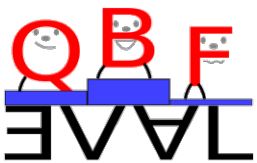
About hard instances...

- 88 (out of 186)
- 29 (out of 37) hard formulas from QBFEVAL'16 have been solved
- 7 instances solved in QBFEVAL'16 but not in QBFEVAL'17

ci.e#1.a#3.E#40.A#60.c#424.w#4.s#2.asp	aqua
ncf_16_128_2_u.10	caqe-picosat
ncf_16_128_8_edau.8	xb-qsts
Q_3-3_v-100-100_r-19.1	aqua
Q_2-3_v-80-100_r-11.1	aqua
x220.19	aqua, depqbf-v2
x220.9	aqua

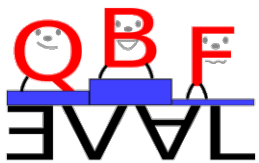


Outline



Conclusions

- Results will be presented at SAT'17 (August 31st, 14.30, Room 110)
- Results **soon avaliable at `www.qbfeval.org`**
  - Detailed description of solvers and instances
  - Further insights into setup & data



Conclusions

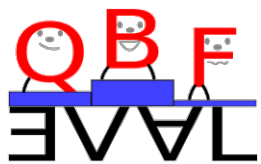
- Results will be presented at SAT'17 (August 31st, 14.30, Room 110)
- Results **soon avaliable at `www.qbfeval.org`**
  - Detailed description of solvers and instances
  - Further insights into setup & data

Future work:

- QBFEVAL'18: rules, tracks, ...
  - A discussion group will be opened
- Instances classification
- Certified answers

Help us making QBFLIB and QBFEVAL better!

`qbfeval@qbflib.org`

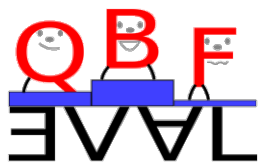


Acknowledgments

Participants G. Amendola, S. Akshay, B. Becker, S. Chakraborty, G. Charwat, L. Chen, C. Dodaro, E. Egly, P. Faymonville, B. Finkbeiner , V. Hadzic J. Hecking-Harbusch, M. Hollinger, T. Hsu, T. Janhunen, M. Janota, J. R. Jiang, A. K. John, W. Klieber, K. Korovin, N. Lee, F. Lonsing, V. Mayer-Eichberger, P. Marin, T. Peitl, F. Pigorsch, T. Preusser, M. N. Rabe, S. Reimer, F. Ricca, A. Saffidine, C. Scholl, S. Shah, F. Slivovsky, S. Szeider, S. Tasharrofi, L. Tentrup, K. Tu, K. Wimmer, R. Wimmer, S. Woltran.

Judges O. Beyersdorff, D. Le Berre, M. Suda, C. Wintersteiger.

StarExec A. Stump



Thank you!