The 14th QBF Solvers Evaluation (QBFEVAL'22)

Luca Pulina[1], Martina Seidl[2], and Ankit Shukla[2]

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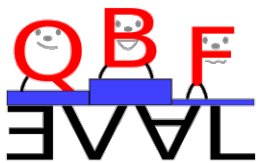
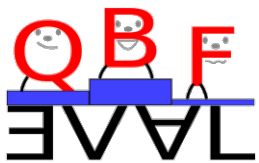
FLoC Olympic Games
August 3, 2022



Quantified Boolean Formulas (QBF)

- Extension of propositional logic
  - explicit quantifiers ($\forall$, $\exists$) over the Boolean variables
- Canonical PSPACE-complete problem
  - more succinct encoding than SAT (NP-complete)
- Many application domains: synthesis, AI, verification, ...



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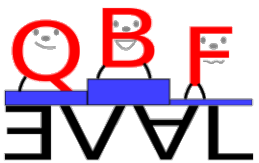
$$\overbrace{\exists x \exists y \forall u \exists z . (u \rightarrow z) \wedge (y \vee u \vee \neg z) \wedge (x \vee \neg u \vee \neg z) \wedge (x \leftrightarrow \neg y)}^{\text{closed QBF in prenex form (PNCNF)}}$$



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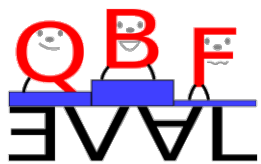

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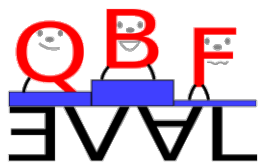

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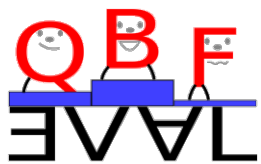
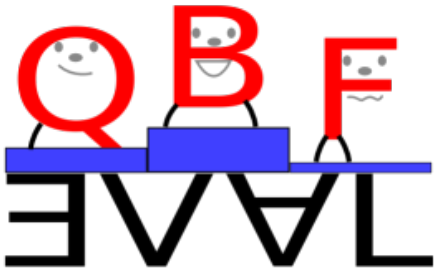
- *Prenex Conjunctive Normal Form (PCNF)*
  supported by most solvers
- *Dependency QBF (DQBF)*
  Henkin quantifiers (NExpTime-Complete !!!)

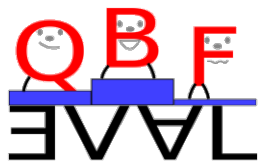


QBFEval At A Glance

- short history

2003	1st QBFEval
2013, 2014	QBFGallery
2022	14th QBFEval





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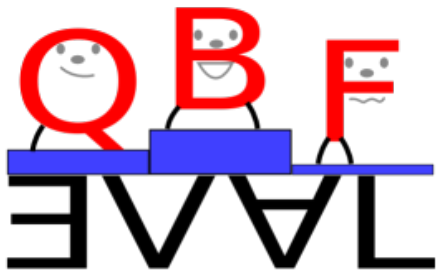
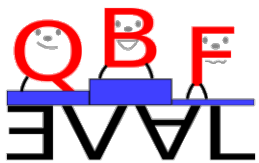


- bi-annual (sometimes annual) event
- affiliated to SAT Conference
- QBFGallery 2014 & QBFEval 2018 were part of FLoC Olympic Games



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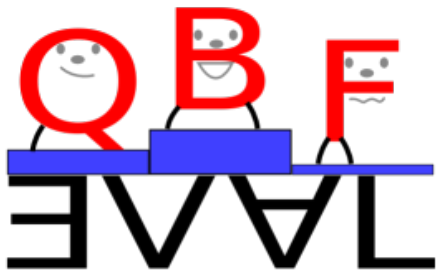

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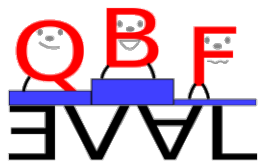
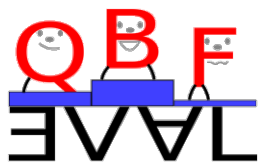
- main purpose:
  - objective comparison of solvers
  - collection of benchmarks



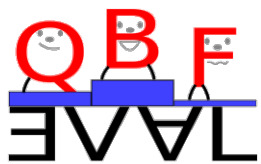
QBFEVAL'22 – Key Facts

- Organizers: Luca Pulina, Ankit Shukla, Martina Seidl.
- Judges: Olaf Beyersdorff and Christoph Wintersteiger.
- 4 tracks
  - PCNF Track (Prenex Conjunctive Normal Form)
  - PNCNF Track (Prenex Non-Cojunctive Normal Form)
  - DQBF Track (Dependency QBF)
  - CIT Track (Crafted Instances)
- Two stages
  1. initial check on easy instances with feedback to solver developers
  2. evaluation run



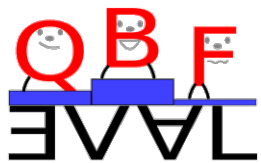
Overview Solvers

Solver	Track	Author(s)
depqbf (QxQBH, opt_qdo)	PCNF, CIT	F. Lonsing
dqbdd	DQBF	Juraj Sic
hqs	DQBF	R. Wimmer, A. Ge-Ernst, C. Scholl
miniQU (conf1, conf2, conf3)	PCNF, CIT	F. Slivovsky
miniQU (LDQ, QDL)	PNCNF (LDQ, QDL)	F. Slivovsky
pedant (hqspre, default, noML)	DQBF	F. Reichl, F. Slivovsky
caqe (bloqqer-qdo)	CIT	M. N. Rabe and L. Tentrup
caqe (pre)	PCNF	M. N. Rabe and L. Tentrup
ghostq (cegar)	PNCNF	W. Klieber
qfun	PNCNF	M. Janota
quabs (quabs-caqe)	PNCNF	L. Tentrup
qute (default)	CIT	F. Slivovsky
rareqs	PCNF	M. Janota



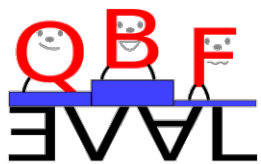
New Formulas

- Exact Circuit Synthesis Based on QBF Solving: 160 instances in QCIR format submitted by Franz-Xaver Reichl and Friedrich Slivovsky.
- Lifted QBF Encodings for the HEX game: 216 instances in QCIR and QDIMACS format submitted by Irfansha Shaik and Jaco van de Pol.
- Organic Synthesis QBF Encodings - Lifted Classical Planning: 218 instances in QCIR and QDIMACS format submitted by Irfansha Shaik and Jaco van de Pol.
- New generator for QDIMACS formulas
  - Linear Domino QBF Benchmark Set
  - Submitted by Randal Bryant



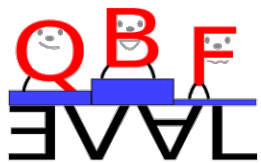
The Dataset

- Prenex CNF Track:
  - **478** new instances
  - **521** instances (dataset QBFEVAL'20)
- Prenex non-CNF Track: **594** new instances
- DQBF Track: **354** instances (dataset QBFEVAL'20)
- Crafted Instances Track: **172** instances (dataset QBFEVAL'20)

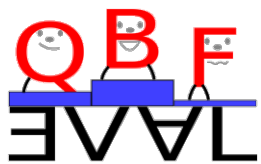


Scores, Resources and Infrastructure

- **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



And the Winners Are ...



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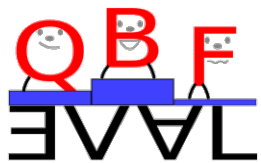
PNCNF quabs



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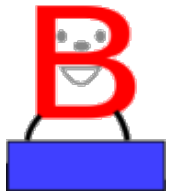

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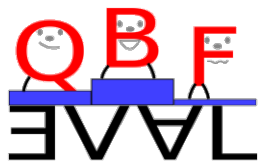

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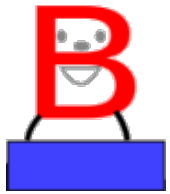

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DQBF Pedant

More details at the Competition Session of the SAT conference!!!!

Conclusions

- Results **soon avaliable** at `www.qbfeval.org`
  - Detailed description of solvers and instances
  - Further insights into setup & data
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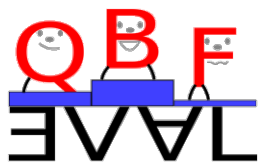
Help us making QBFLIB and QBFEVAL better!

`info@qbflib.org`



Acknowledgments

Participants All solver and benchmark submitters!

Judges O. Beyersdorff, C. Wintersteiger.

StarExec A. Stump